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REVIEW

Population-level differences in revascularization treatment and outcomes among various United States subpopulations

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Abstract

Despite recent general improvements in health care, significant disparities persist in the cardiovascular care of women and racial/ethnic minorities. This is true even when income, education level, and site of care are taken into consideration. Possible explanations for these disparities include socioeconomic considerations, elements of discrimination and racism that affect socioeconomic status, and access to adequate medical care. Coronary revascularization has become the accepted and recommended treatment for myocardial infarction (MI) today and is one of the most common major medical interventions in the United States, with more than 1 million procedures each year. This review discusses recent data on disparities in co-morbidities and presentation symptoms, care and access to medical resources, and outcomes in revascularization as treatment for acute coronary syndrome, looking especially at women and minority populations in the United States. The data show that revascularization is used less in both female and minority patients. We summarize recent data on disparities in co-morbidities and presentation symptoms related to MI; access to care, medical resources, and treatments; and outcomes in women, blacks, and Hispanics. The picture is complicated among the last group by the many Hispanic/Latino subgroups in the United States. Some differences in outcomes are partially explained by presentation symptoms and co-morbidities and external conditions such as local hospital capacity. Of particular note is the striking differential in both presentation co-morbidities and mortality rates seen in women, compared to men, especially in women $\leqslant$ 55 years of age. Surveillance data on other groups in the United States such as American Indians/Alaska Natives and the many Asian subpopulations show disparities in risk factors and co-morbidities, but revascularization as treatment for MI in these populations has not been adequately studied. Significant research is required to understand the extent of disparities in treatment in these subpopulations.

Key words: Revascularization; Myocardial infarction; Cardiovascular; Disparities; Minorities

Core tip: Disparities persist in the care of myocardial infarction (MI) in women and racial/ethnic minorities in the United States. They arrive at the hospital later, present with more risk factors and co-morbidities, and are less likely to receive guideline treatments. Women and blacks are less likely to receive revascularization. Younger women have more in-hospital mortality, and both blacks and women have greater long-term risk for death, recurrent MI, and re-hospitalization. Disparities in risk factors and co-morbidities among Hispanics/Latinos are complicated by the many subgroups. American Indians/Alaska Natives and Asian subpopulations have been much less studied, but surveillance data indicate more risk factors and co-morbidities among these subgroups.

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INTRODUCTION

Despite recent general improvements in health care, significant disparities persist in the cardiovascular care of women and racial/ethnic minorities, even when income, education level, and site of care are taken into consideration[1]. A lack of significant improvements in cardiometabolic risk factors, including hypertension, dyslipidemia, obesity, and cardiorenal metabolic syndrome, combined with increased prevalence of diabetes among blacks, accounts for much of the observed racial differences. Eliminating racial/ethnic disparities alone could prevent an estimated 1.1 million hospitalizations a year[2].

Explanations suggested for the observed continued disparities include socioeconomic considerations and elements of discrimination and racism that affect socioeconomic status and access to adequate medical care.

Socioeconomic status

Patients with acute myocardial infarction (AMI) living in poorer regions were of advanced age and more likely to be non-white and presented with more co-morbidities and were more likely to be smokers. Lower education was associated with more mature age, nonwhite race, more co-morbidity, and lower ejection fraction[3]. In the PREMIER study, lower levels of socio economic status were associated with higher risk of mortality and re-hospitalization in patients hospitalized for AMI. Patients with lower income levels had worse initial overall symptoms and clinical presentation at admission and worse quality of care. Baseline clinical status largely explained the excess mortality but not re-hospitalization[4].

Achieving less than a high school level of education was linked with a 67% increase in one to five-year mortality in women and a 37% increase in men among nearly 16000 Medicare patients admitted for myocardial infarction (MI) from 1991 to 2001, adjusting for a number of clinical factors. Education level was associated with 1- to 5-year MI recurrence in men only[5]. Patients with high financial stress had worse physical and psychological health, worse disease-specific overall quality of life, and more angina 1 year after hospitalization than patients without such stress in a study of 2344 AMI patients discharged in 2003 and 2004. Four-year mortality rates did not differ[6].

Current cardiovascular health disparities

Cardiovascular disease (CVD) health disparities continue to exist among women and minorities. Krieger[7] proposed an "ecosocial" approach to the study of discrimination and health. She posited that inequitable race relations simultaneously benefit the group claiming racial superiority at the expense of those deemed inferior[7]. Minority patients with acute coronary syndrome (ACS) are at greater risk for the full spectrum of cardiac disease including MI, re-hospitalization, and mortality than non-minority patients[8,9]. American Indians/Alaska Natives (AI/AN) have significantly higher rates of obesity, diabetes, CVD, CHD, stroke, and stroke-related death than the general United States population. AI/AN women are particularly at risk[10].

Interventional studies designed to reduce disparities in CVD risk factors and outcomes have included hypertension, hyperlipidemia, tobacco cessation, physical inactivity, and heart failure management. These studies were few, limited by not enough patients, had short follow-up times, and showed only modest clinical gains[11]. Investigators have found "compelling evidence" of disparities in cardiac interventions between whites and blacks. These are not explained by confounding factors such as insurance coverage and disease severity[12].

Table 1 provides a current summary of racial and gender cardiovascular disparities.

REVASCULARIZATION

Revascularization is an accepted treatment for MI, with recommendations available on the use of CABG *vs* PCI, including anatomical considerations[14]. Although ST-segment elevation myocardial infarction (STEMI) incidence decreased between 2001 and 2010, PCI for STEMI increased by 33.5% among patients aged 65 to 79 years and by 22% for those ⩾ 80 years[15].

PCI has continued to be inferior to CABG for anatomical conditions such as left main disease. Despite advances in both procedures, risk for repeat revascu-

Table 1 Summary of current minority disparities related to cardiovascular disease[13]

Total CVD prevalence and total CVD mortality are higher in females than in males
Black males have higher prevalence than white males (44.4% *vs* 36.6%) and higher mortality (369.2/100000 *vs* 278.4/100000)
Black females have higher prevalence than white females (48.9% *vs* 32.4%) and higher mortality (260.5/100000 *vs* 192.2/100000)
Mexican American males have lower prevalence than white males (33.4% *vs* 36.6%)
Mexican American females have lower prevalence than white females (30.7% *vs* 32.4%)
The prevalence of having ≥ 2 risk factors is highest among blacks (48.7%), followed by AI/AN (46.7%), and lowest among Asians (25.9%). The prevalence is similar among men (37.8%) and women (36.4%)
The prevalence of having ≥ 2 risk factors is lower among college graduates (25.9%) than among those with less than a high school diploma (52.5%); a similar disparity in prevalence of risk factors is seen among those making ≥ $50000/yr (28.8%) *vs* those making < $10000/yr (52.5%)
Among older Americans (≥ 65 yr), hypertension is more prevalent in women than in men (57% *vs* 54%) and women have a significantly lower rate of hypertension control
Hypertension increased from 1988 through 2002 in both blacks and whites: From 35.8% to 41.4% in blacks (44.0% among black females) and from 24.3% to 28.1% in whites
Blacks develop hypertension earlier in life and have higher average blood pressures. As a result, blacks have a non-fatal stroke rate 1.3 times that of whites and a fatal stroke rate 1.8 times that of whites. Blacks also have a rate of death attributable to hypertension 1.5 times greater than that of whites and a 4.2-times-higher rate of end-stage kidney disease
Black and Mexican American males have higher mean LDL levels than white males (blacks, 115.9 mg/dL; Mexican Americans, 119.7 mg/dL; whites, 115.1 mg/dL); both black and Mexican American females have lower mean LDL levels than white females (blacks, 114.2 mg/dL; Mexican Americans, 115.0 mg/dL; whites 115.7 mg/dL)
Among men, non-Hispanic blacks (38%) and Mexican Americans (36%) are more likely than non-Hispanic whites (34%) to be obese. Among women, non-Hispanic blacks (54%) and Mexican Americans (45%) are more likely to be obese than non-Hispanic whites (33%)
The prevalence of physician-diagnosed diabetes mellitus in adults > 20 yr is highest in non-Hispanic blacks (12.6%) followed by Hispanics (11.8%), Asian Americans (8.4%), and non-Hispanic whites (7.1%). The prevalence of diagnosed diabetes in adult Asian Indians is more than twice as high (14%) as that in Chinese (6%) or Japanese (5%) Americans. Death rates per 100000 attributable to diabetes mellitus are 23.1 for white males, 43.6 for black males, 15.6 for white females, and 35.1 for black females
The age-adjusted prevalence of diabetes in AI/AN adults aged < 35 yr rose from 8.5% to 17.1% between 1994 and 2004; the rate was higher in females in all age groups

LDL: Low-density lipoprotein; CVD: Cardiovascular disease; AI/AN: American Indians/Alaska Natives.

larization still appears to be higher with PCI[16]. Mohr *et al*[17] found no significant differences between CABG and PCI in all-cause death or stroke, but patients with intermediate or high SYNTAX scores treated with PCI had more serious adverse cardiac and cerebrovascular events at 5-year follow-up. CABG, compared to PCI, offered significant protection from long-term mortality[18], but PCI offers advantages in accessibility. A recent expert consensus found no difference in either in-hospital or 30-d mortality with primary PCI between sites with and without on-site surgical backup[19].

Coronary revascularization has become one of the most common major medical interventions in the United States, with over 1 million procedures yearly[20]. Even so, revascularization is used less in both female and minority patients[21,22]. Local hospital capacity helps to explain the revascularization disparities between black and white AMI patients[23].

This review presents recent data on disparities in co-morbidities and presentation symptoms, care and access to medical resources, and outcomes in revascularization as treatment for ACS.

WOMEN

Co-morbidities and presentation symptoms

Among 6746 STEMI patients undergoing primary PCI, stratified by age (< 65 years, ≥ 65 years), hypertension was higher in both groups of women than in men, and younger women had a higher likelihood of being current smokers. Older women also had more diabetes than men[24]. In a cohort that included 15120 women, women were less likely than men to be taking cardioprotective medications in the first year after their diabetes diagnosis[25]. The impact of this lack of adherence to medications on cardiovascular disparities is difficult to estimate, but crude mortality in MI patients has been found to be highest in those with diabetes[26].

In the Variation in Recovery: Role of Gender on Outcomes of Young AMI Patients (VIRGO) study, younger female AMI patients (18 to 55 years) had worse pre-event health than men, including more diabetes, dyslipidemia, and obesity. They also had significantly more angina, stroke, and congestive heart failure, worse physical function, and poorer quality of life than male AMI patients in the same age group[27,28]. Similar results were found in a cohort of younger AMI patients (≤ 55 years) from the Translational Research Investigating Underlying disparities in Acute Myocardial infarction Patients' Health Status (TRIUMPH) study[29,30]. Lower resting metabolic rates in black women may contribute to the higher levels of obesity seen in black women compared to white women[31].

Between 1997 and 2009, awareness of CVD as the leading cause of death in women increased significantly, but black and Hispanic women still had significantly less awareness than white women. Only 53% of the women interviewed would call 9-1-1 if they thought they had symptoms of a heart attack[32]. Hispanic women were also less likely to know the symptoms of a heart attack and more likely to underestimate their weight[33].

Chest pain is critical in the decision to initiate dia-

gnostic testing for ACS upon presentation, yet up to 35% of AMI patients do not report chest pain, which can lead to misdiagnosis and a higher risk of death. Female ACS patients aged 55 years or younger had a higher probability of presenting without chest pain and with NSTEMI. This was not associated with markers of coronary disease severity[34,35]. However, women aged 65 and older were actually less likely to present without chest pain than similarly aged men[36]. African American women were more likely to present with stomach associated symptoms and less chest related signs than white women and had significantly greater all-cause and cardiovascular mortality[37].

Women with STEMI have increased left ventricular filling pressures during acute STEMI *vs* men, independent of age, high blood pressure, and size of the infract. This suggests that pulmonary capillary wedge pressure may mediate the effect of sex on outcomes post-STEMI[38].

Seeking better risk estimates for women, Cook *et al*[39] compared the Adult Treatment Panel Ⅲ (ATP-Ⅲ) score, the Framingham risk score and the Reynolds Risk Score CVD model. The ATP-Ⅲ overestimated the risk for coronary heart disease and the Framingham CVD model overestimated the risk for major CVD. After recalibration, the Reynolds Risk Score was better calibrated for both black and white women than either of the Framingham-based models[39]. A high-sensitivity troponin assay that incorporated diagnostic thresholds that were specific for women and men increased the ability to diagnose MI in women compared to a single-threshold contemporary assay, but this was not as effective in men. Women with MI identified by the high-sensitivity assay or by both assays had the highest risk for death or recurrent MI at 12 mo[40]. Independent predictors of obstructive CAD in women with chest pain and an abnormal stress test included body mass index (BMI) < 30 kg/m^2, a history of smoking, low high-density lipoprotein (HDL), a significant family history of early heart disease, age ⩾ 55 years, lateral abnormality on stress imaging, and exercise capacity < 5 metabolic equivalents. the risk score had a negative predictive value of 80%[41].

Care/medical resources

Disparities in care for AMI among women fall largely into three categories: The likelihood of hospitalization, the time to hospital or to guideline treatment from onset of symptoms, and the administered treatments themselves.

Between 1992 and 2010, rates of hospitalization for AMI per 10000 Medicare enrollees were significantly lower in both black and white women, persisting as hospitalization rates for AMI in general declined. Rates of PCI within 30 d of AMI continued to be significantly lower in both black and white women. Mortality differences by race declined, but remained higher in women[42].

Between 1960 and 2008, women had consistently longer prehospital delay from symptom onset (median 1.8 to 7.2 h *vs* 1.4 to 3.5 h in men). The characteristics associated with delay in females included being older, not being married, having a previous history of MI, being alone during symptom onset, and not wanting to bother anyone[43]. The time from the first appearance of symptoms-to-balloon time was also significantly longer in women than in men, largely driven by later presentation to the hospital. Women were more often treated with just medical management and were more likely to receive medications such as a diuretic or warfarin on discharge, whereas men more often received b-blockers and statins. Compared with men, women had significantly higher levels of major adverse cardiovascular events; major bleeding; death; and target vessel revascularization for ischemia in-hospital and at 30 d. In women, higher rates at these end points persisted at 3 years[44]. At hospital arrival, female STEMI patients had delays in both door-to-code and code-to-balloon times. Independent determinants of delays in door-to-balloon times included female sex, hypertension, maximum ST-elevation, office hours, and triage category[45].

Among ACS patients aged 18 to 55 years, women had significantly less income; more diabetes mellitus, hypertension, family history of CVD, and previous CVD events; and more depression and anxiety before symptom onset. Females were less likely to have a diagnosis of STEMI and more likely to have a diagnosis of unstable angina. Women were less likely to receive ECG or fibrinolytic therapy within established time benchmarks but did not differ from men in timely PCI. Females with STEMI were less likely to have reperfusion therapy than males, and females with NSTEMI were less likely to have PCI, although the proportions of male and female patients with NSTEMI who had cardiac catheterization were similar. The determinants of poorer access to care included anxiety, more risk factors, and lack of chest pain at presentation[46].

STEMI patients aged ⩽ 45 years generally had more non-traditional cardiovascular profiles and had lower in-hospital mortality, but younger women had significantly poorer quality of care, with longer delay in door-to-thrombolytic time, and higher in-hospital mortality rates than younger men[47]. In patients receiving care for CVD in Veterans Health Administration facilities in 2010 and 2011, women had higher mean LDL cholesterol levels than men but were significantly less likely to receive statin treatment according to recent cholesterol guidelines[48]. Between 2008 and 2011, patients hospitalized for non-ACS indications who had in-patient STEMI were more likely to be older and female and less likely to undergo cardiac catheterization or PCI. These patients had more than 3-fold greater in-hospital mortality[49].

At 30 d after discharge, no difference was found by race/ethnicity since inception of the Medicare Part D

prescription drug benefit in usage of statins, β-blockers or ACE inhibitors but women were less likely than men to be using β-blockers and angiotensin-converting enzyme inhibitors. At 12 mo, black and Hispanic women were the least likely to be adherent, followed by white, Asian, and other women and by black and Hispanic men[50].

Golden *et al*[51] looked at cardiovascular testing after evaluation for chest pain. This analysis focused on the physician-patient discussions and how these affect patient decisions around cardiovascular testing. The primary outcomes were sex differences in recommendations for testing. Physicians were less likely to tell women their symptoms could result from heart disease or to recommend cardiovascular testing or cardiac catheterization. No patients in this study did not follow the recommendations of their doctors[51].

Hormone replacement and combined hormone contraception

A recent analysis of data from the large Women's Health Initiative, including 13 years of follow-up, found the risk for both CHD and stroke to be higher with combined estrogen plus progesterone in all age groups, but risk for MI was slightly reduced in the 50 to 59 year age group. Among women with previous hysterectomy taking estrogen alone, women aged 50 to 59 years had slightly less risk for CHD and MI, but not older women taking estrogen alone and the risk for stroke and venous thrombosis was higher. These findings do not support the use of hormone therapy, although it might be a reasonable option to manage menopause symptoms during early menopause[52]. A more recent Cochrane review of 19 trials largely confirmed these results[53].

The potential added risk of MI associated with combined hormonal contraceptives has also been controversial. Most women who take oral contraceptives take a combined estrogen-progestin preparation and today's contraceptives have much smaller doses of estrogen than earlier versions. In a very large Danish cohort, women taking doses of 30 to 40 μg ethinyl estradiol had a roughly 2-fold risk of both thrombotic stroke and MI, but risk varied with the type of progestin. Those taking 20 μg ethinyl estradiol had approximately a 1.5-fold risk of both thrombotic stroke and MI with all types of progestin except drospirenone, which offered no excess risk[54]. In a more recent but much smaller study in Turkey that also examined MI/PCI sequelae, women taking a contraceptive containing 30 μg ethinyl estradiol combined with drospirenone had increased risk for STEMI. Following PCI, patients had increased thrombus burden, were less likely to have complete ST resolution, and were more likely to develop congestive heart failure than women not taking the contraceptive. Confounding factors in this study included the small number of oral contraceptive users and the fact that women taking contraceptives were more likely to be smokers, suggesting that oral contraceptives should not be prescribed to smokers, especially if aged more than 35 years[55]. It has been noted that taking combined hormonal contraceptives is safer than pregnancy and delivery[56].

Outcomes

Age-adjusted CVD mortality rates in the United States from 1980 through 2002 declined more in men than women (52% among men and by 49% among women). However, between 2000 and 2002, the mortality rate in women aged 35 to 54 years increased by 1.5% despite declining in this group during the earlier study years. By contrast, in both men and women aged ⩾ 55 years, declines in mortality rate accelerated between 2000 and 2002[57].

In a decade long prospective study of STEMI patients undergoing primary PCI, hypertension was more prevalent in both younger (< 65 years) and older (⩾ 65 years) women than in men of the same age. Younger women were more likely to smoke, have less obstructive CAD, and to have a family history of CVD than younger men, whereas older women had more diabetes than older men but were less likely to smoke. Overall mortality was greater in women, but younger women had more risk of mortality at 30 d and at 1 year than men of the same age, whereas older women had significantly increased risk of mortality only at 30 d, not at 1 year[24].

In-hospital mortality was higher in women for both STEMI and NSTEMI but more so for STEMI patients. However, younger women actually were the main drivers in this difference in mortality. Among NSTEMI patients, in-hospital mortality rate differences reversed among women ⩾ 70 years, who had better in-hospital survival than men of the same age[58]. Similarly, women were older than men for both STEMI and NSTEMI diagnoses and were less likely to be treated with PCI or CABG for either. Female STEMI patients had more in-hospital mortality than men of similar ages in all age categories except 80 to 89 years. Female NSTEMI patients had higher rates of in-hospital mortality than men of the same age through age 69 years, but women ⩾ 70 years had better survival than men of the same age[59].

AMI hospitalization rates did not decline in either sex in United States patients aged 30 to 54 years between 2001 and 2010, but women had more co-morbidities, longer hospital stays, and more in-hospital mortality than men across all ages. In-hospital mortality declined significantly for women but not for men[60]. In adults ⩾ 20 years of age hospitalized for AMI, younger women had a higher rate of renal disease, diabetes, systolic heart failure, and malignancies than similarly aged men. Women ⩽ 55 years experienced a significant increase in AMI rates, which did not occur in men in this age group. Women also had higher 30-d mortality rates than men, although this declined in both sexes

over the 10 years of the study. Women 20-55 had 45% higher odds of 30-d mortality than men of the same age, which persisted over the study. Only women ⩾ 75 years of age had borderline better mortality rates than men[61]. In a systematic review of between-sex AMI mortality, unadjusted mortality was higher in women at both 5 and 10 years. Sex differences in long-term mortality after AMI were largely explained by differences in age, co-morbidities, and differential treatment usage by women compared with men[62].

An analysis of outcomes by sex and long-term outcomes by sex and type of stent found that women had more in-hospital complications, including mortality, MI, bleeding, and vascular complications. At 30 mo, women had a slightly lower adjusted risk for death, but there weren't any significant sex-related differences in adjusted rates of MI, bleeding, or revascularization. Males and females benefited similarly from the use of drug-eluting stents[63]. The most significant predictors of re-hospitalization for ACSs within 1 year were CABG prior to hospitalization for the AMI, female sex, and in-hospital PCI. No difference was found in risk of ACS re-hospitalization by type of stent, but the strongest predictors of revascularization were multi-vessel disease and in hospital PCI with a bare metal stent[64].

Significant pre-PCI predictors of 30-d re-admission comprised gender, age, Medicare or other government insurance, a history of heart failure and kidney disease. Predictors after PCI included not receiving a prescription for b-blocker upon discharge, vascular complications, and prolonged length of stay[65].

At age 45, the risk of death increased more significantly in white men than black men. White men had six times the increased risk of death compared to white women, whereas black males had only twice the increased risk of fatal CHD compared to black women. The risk of mortality between sexes equalized by age 95 in both blacks and whites. Adjustments for CHD risk factors did not explain this disparity between races in gender difference in CHD mortality[66].

Sex differences in perceived stress could be a central explanation for gender based differences in post-AMI recovery. Women had significantly higher baseline stress, mostly explained by co-morbidities, state of physical and mental health, intra-family conflicts, caregiving demands, and financial hardship. Higher stress was associated with worse female recovery at 1 mo post-AMI in angina, overall quality of life, and mental health[67]. A study to distinguish the effects of gender role *vs* biological sex on quality of life after ACS found that at baseline and at 1, 6, and 12 mo, women had clinically significant lower Health Related Quality of Life scores than men. Social support and gender-related variables such as housework responsibility were statistically significant predictors of physical limitation, angina frequency, and disease perception, but biological sex predicted only physical limitation[68].

The status of CVD in women internationally

Women in other countries with health care systems vastly different from that of the United States have been found to experience similar disparities. Recent studies in Spain, China, Germany, Vietnam, and Italy found equivalent differences in presentation symptoms and co-morbidities, access to treatments, and outcomes compared to men[69-73].

Table 2 summarizes disparities in women in presentation, treatment, and outcomes of acute coronary syndrome.

BLACKS

Co-morbidities and presentation symptoms

Differences between blacks and whites at presentation for ACS often fall into three categories: Demographic factors such as income and education, risk factors and co-morbidities, and symptoms.

A constellation of cardiometabolic risk factors, including high blood pressure, high cholesterol, obesity, diabetes mellitus, and chronic kidney disease, coupled with physical inactivity, smoking, and poor eating habits, is more prevalent in blacks and contributes to CVD disparities[2].

Black patients with NSTE ACS in the CRUSADE quality improvement initiative, from 2002 to 2003, were younger; had a higher prevalence of hypertension, diabetes mellitus, congestive heart failure, kidney failure and history of stroke than whites. African American patients had a lower rate of private insurance or primary cardiology care and more likely to be uninsured. Blacks were less likely to be prescribed clopidogrel and GP IIb/IIIa inhibitors or to have diagnostic cardiac catheterization or PCI than white patients. High-risk African Americans had a lower incidence of CABG than high-risk white patients[74].

African Americans in the PREMIER study[75] were more likely than white patients to have Medicaid, no education beyond high school, household income less than $10000, and a prior incidence of heart failure. Comparing rates of hypertension, hypercholesterolemia, diabetes, obesity, and current smoking, more blacks than whites had hypertension and diabetes within each age-sex group. Black men ⩾ 55 years were more likely to smoke, but no differences were observed in the group < 55 years of age. The prevalence of multiple cardiac risk factors was significantly higher for blacks, particularly black women, with 60% of older (⩾ 55 years) and 54% of younger (< 55 years) black women having three or more risk factors[76].

Black patients with confirmed ACS upon presentation were significantly younger and had less education and lower incomes, significantly longer prehospital delays, more hypertension, higher rates of diabetes, higher BMI, and reported more current tobacco use than whites. They were more likely to experience palpitations, chest pressure, and chest pain, and to

Table 2 Summary of disparities in acute myocardial infarction co-morbidities and presentation symptoms, care and access to medical resources, and outcomes in women

Co-morbidities and presentation symptoms
More hypertension and diabetes than men[24]
More diabetes, dyslipidemia, obesity, angina, stroke, and congestive heart failure; worse physical function; and poorer quality of life than men[28]
More hypertension, diabetes, lung disease, depression, and angina; worse general health scores; poorer physical function; and worse quality of life than men[30]
Women ≤ 55 yr of age more likely than men to present without chest pain or with NSTEMI[35]
Women < 45 yr of age more likely than men to present without chest pain, but this reversed with age[36]
Risk less likely to be accurately assessed by standard models or assays[39,40]
More likely than men to be older and have hypertension, hyperlipidemia, and congestive heart failure and less likely to have previous history of MI or revascularization[44]
Women ≤ 55 yr of age more likely to have low income, more diabetes, more hypertension, more family history of CVD, more previous CVD events, and more depression and anxiety; less likely to have diagnosis of STEMI and more likely to have NSTEMI or unstable angina[46]
Higher baseline stress than men[67]
Care/medical resources
Lower rates of hospitalization for AMI and lower rates of PCI as treatment for AMI compared to men[42]
Longer pre-hospital delay from onset of symptoms compared to men[43]
Longer symptom-onset-to-balloon time than men and more likely to be treated with medical management only; less likely to receive b-blockers and statins on discharge[44]
Greater delays than men in both door-to-code and door-to-balloon times[45]
Less likely than men to receive ECG or fibrinolytic therapy within guideline times, to have reperfusion therapy with STEMI, or to have PCI with NSTEMI[46]
Longer door-to-thrombolytic time than men[47]
Less likely than men to have statin treatment for high cholesterol[48]
Women with in-hospital STEMI less likely to have cardiac catheterization or PCI than men[49]
Less likely than men to be using ACE inhibitors, angiotensin receptor blockers, and β-blockers 30 d after discharge[50]
Less likely than men to be told their symptoms could be related to heart disease or to have cardiovascular testing or cardiac catheterization recommended[51]
Less likely than men to be treated with either primary PCI or CABG[73]
Outcomes
Greater mortality than men at 30 d and at 1 yr in women < 65 yr, but only at 30 d in women ≥ 65 yr[24]
Greater in-hospital mortality than men for both STEMI and NSTEMI in women ≤ 69 yr[58]
Greater in-hospital mortality than men for STEMI in women < 80 yr, and greater in-hospital mortality than men for NSTEMI in women ≤ 69 yr[59]
More in-hospital mortality for AMI than men[60]
Higher 30-d mortality rates for AMI than men up to age 75 yr[61]
Higher post-AMI mortality rates than men at both 5 and 10 yr[62]
More in-hospital complications than men, including mortality, MI, bleeding, and vascular complications[63]
More likely than men to be re-hospitalized for ACS within 1 yr[64]
Worse recovery than men at 1 mo post-AMI in angina, overall quality of life, and mental health[67]
Clinically significant lower health-related quality of life scores than men at 1, 6, and 12 mo following ACS event[68]
Higher re-hospitalization rates and lower quality of life than men at 6 mo after AMI[69]
Greater risk of 1-yr re-hospitalization for AMI and higher 1-yr mortality than men[93]

AMI: Acute myocardial infarction; CVD: Cardiovascular disease; STEMI: ST-segment elevation myocardial infarction; CABG: Coronary arterybypass grafting; PCI: Percutaneous coronary intervention; ECG: Electrocardiogram; ACE: Angiotensin converting enzymes; ACS: Acute coronary syndromes.

report more severe symptoms than whites. A higher percentage of black patients received lidocaine, but there was no other significant treatment difference. At 1 mo follow-up, blacks reported significantly more symptoms and more clinic visits than whites. Blacks continued to have more symptoms at 6 mo, but health service usage no longer differed[77].

Care/medical resources

Disparities in clinical care for blacks with AMI fall largely into two categories: The time to hospital or to guideline treatment from onset of symptoms, and the administered treatments themselves.

Black patients undergoing PCI were more apt to be younger and female and to have more hypertension and other chronic illnesses including prior MI, history of gastrointestinal bleeding, and worse baseline hemoglobin. They were also more likely to be on Medicaid or to be uninsured. No differences were found in treatment for STEMI between whites and blacks, but more black patients than white patients had PCI for NSTEMI and more white patients had emergent CABG. No difference was seen in in-hospital mortality rates between whites and blacks. In a propensity-matched subcohort of African American and white patients, blacks were not as likely to receive prasugrel or drug-eluting stents[78].

Time from first arrival to first drug was longest for blacks, but was actually significantly longer for all minority patients than for whites. Door-to-balloon times were significantly longer for blacks, Hispanics, and Asian/Pacific Islanders than for whites. The differences remained significant when controlling for specific hospitals[79]. Cavender *et al*[80] found insignificant differences in door-to-balloon times when comparing white, black, and Hispanics and similar in-hospital mortality rates between groups. However, after controlling for the usual confounding factors, black race was

associated with less likelihood of door-to-balloon time under 90 min (a quality-of-care indicator for treatment of STEMI) compared to white race[80]. Among Medicare beneficiaries with AMI admitted to hospitals without revascularization facilities in 2006, black patients were transferred to a PCI ready hospital more slowly than whites (median 1 d for whites, 2 d for blacks), but the risk-standardized mortality rate in the revascularization hospitals did not differ between races[81].

In a study of hospitalizations for ischemic heart disease in Massachusetts in the pre- and post-health care reform periods (November 2004 to July 2006, and December 2006 to September 2008), blacks had 30% less likelihood of receiving revascularization than whites in pre-health reform Massachusetts. This disparity has persisted post-reform, as have somewhat smaller disparities in Hispanics. Asians were slightly more likely to receive revascularization than whites. Patients living in more educated communities, men, and patients with private insurance were more likely to have revascularization treatment both before and after reform. The adjusted odds of in-hospital mortality were higher in the post-reform period than in the pre-reform period, but no differences were observed in 1-year mortality by race/ethnicity, education level, or sex[82].

Blacks were the least likely to be treated with revascularization in an analysis of data from 12555 patients admitted with AMI in New York city in 1996. Whites were older and more likely to have congestive heart failure. Hispanics were more likely to survive than whites, but blacks and whites did not differ significantly in survival. Non-revascularized blacks and Hispanics were more likely to be discharged alive than non-revascularized whites[83].

In an analysis of data from AMI patients with Medicare, private insurance, as well as those were uninsured or on Medicaid, in nine states (from 2000 to 2005). Blacks and Hispanics were significantly less likely than whites to be revascularized, regardless of insurance status. After adjusting for demographics, co-morbidities, and hospital clustering, blacks were approximately 25% less likely than whites with similar insurance to be treated with revascularization and Hispanics about 5% less likely[84].

The impact of hospital and physician effects on disparities in revascularization treatment was examined in 119386 initial episode AMI patients, aged ⩾ 65 years, and all fee-for-service Medicare recipients in Florida (from 1997 to 2005). Black and Hispanic patients were younger, more likely to be female, and more likely to have diabetes mellitus than white patients. The unadjusted rates of intervention were significantly higher in whites than in either blacks or Hispanics. Black-white disparities for these procedures persisted despite adjustment for age, gender, co-morbidities, socioeconomic status, and hospital characteristics. Hispanic-white disparities held for catheterization and PTCA, but were no longer significant for CABG. Hospital fixed effects were found to not be the full reason behind disparities in cardiac treatment. Physician fixed effects accounted for some disparities in treatment and entirely explained Hispanic treatment differences[85]. Li *et al*[23] assessed data for AMI patients in Pennsylvania from 1995 to 2006 and found African Americans were significantly less likely to be treated with either CABG or PCI within 3 mo of AMI. The PCI rate disparity was more in counties with the lowest AMI hospital capacity[23].

Improvements in process-of-care quality measures were assessed using more than 2 million AMI hospitalizations in 2005 or 2010. Despite significant narrowing of the racial/ethnic gap in performance rates among United States hospitals on these quality measures, the gap in PCI rates between blacks and whites in 2010 remained three times the size of the gap in PCI rates between Hispanics and whites[86].

Outcomes

Black Medicare beneficiaries, aged ⩾ 68 years, admitted with AMI from 2000 to 2005 to non-revascularization hospitals, were significantly less likely to be transferred to a hospital with PCI facilities or to receive revascularization, and had significantly higher 1-year mortality than white patients. After adjustment, disparities between transfer and revascularization rates remained significant. Black patients had lower mortality at 30 d, but significantly higher mortality thereafter, regardless of hospital type[87].

Black patients undergoing PCI had significantly more cardiovascular co-morbidity and had a higher likelihood of presenting with an AMI. At 6 mo, patients of both races had equivalent survival. However, at 5 years, blacks had significantly higher incidence of AMI, congestive heart failure, and mortality than white patients[88]. Nonwhite patients in the TACTICS-TIMI 18 randomized trial had a higher probability of death, MI, or re-hospitalization after adjustment for medical characteristics. Rates of protocol-guided angiography and revascularization were similar in white and non-white ACS patients, but nonwhite patients were significantly less likely to take their cardiac medications, to undergo non-protocol mandated angiography, and to receive a stent if undergoing PCI. They also had less procedural success with PCI. Nonwhite patients had significantly worse prognosis than white patients after adjustment for baseline characteristics[89]. In the BARI 2D trial Black, white, and Hispanic patients with diabetes treated similarly showed similar risk for death or risk for death, MI, or stroke at 5 years and in all, better risk factor control was associated with higher 5-year survival[90].

After adjusting risk in Medicare recipients aged ⩾ 65 years who had CABG performed in 2007 and 2008, using patient characteristics, socioeconomic status, and relative hospital quality, nonwhite patients had a 34% higher risk of death following CABG. Hospitals treating the largest proportion of nonwhite patients

had the highest risk-adjusted mortality for both white and nonwhite patients and hospitals treating the smallest proportion of nonwhite patients had the lowest mortality for both white and nonwhite patients[91]. In a retrospective study of revascularization outcomes in patients with left main CAD, black race and age were the only two independent predictors of adverse cardiac outcomes at 1 year following revascularization[92].

In a national sample of more than 2 million Medicare patients hospitalized for AMI from 1999 to 2010, the incidence of an index AMI declined from 1283 per 100000 person-years in 1999 to 830 in 2010, but the percentage of nonwhite patients increased from 11.0% to 12.7%. The risk of 1-year re-hospitalization for AMI declined in both white and black patients, but the decline was larger in whites (27.7%) than in blacks (13.6%), so that at the end of the study period, the discrepancy between whites and blacks actually increased. All-cause 1-year mortality declined in both sexes and both races between 1999 and 2010, but females had consistently higher 1-year mortality rates than males[93].

In the Family Cardiac Caregiver Investigation To Evaluate Outcomes (FIT-O) study[94], blacks and Hispanics were less likely to report statin use before admission, but statin use after discharge was not significantly different. Patients with a statin prescription at discharge were significantly less likely to be dead or readmitted at 30 d, independent of demographic characteristics or co-morbidity. At 1 year, blacks and Hispanics were 23% more likely than white/Asian patients to be dead or readmitted. This was not associated with statin prescription before or after hospitalization. After adjusting for co-morbidities, the investigators found that race/ethnicity did not predict death or re-hospitalization at 1 year, but age > 65 years, having a caregiver, and lacking health insurance remained significant predictors[95].

O'Neal *et al*[96] found that median survival for black CABG patients with pre-operative β-blockers was 14 years, compared with 11 years for black patients who did not have pre-operative β-blockers. White patients who had pre-operative β-blockers had median survival of 15 years *vs* 13 years for those without pre-operative β-blockers. Despite the absolute difference in median survival, the magnitude of the drugs' effect on survival was statistically similar for black and white patients[96].

Table 3 summarizes disparities in blacks in presentation, treatment, and outcomes of acute coronary syndrome.

HISPANICS

Co-morbidities and presentation symptoms

One challenge in preventing CVD in United States Hispanics is understanding the diversity within that community as it is not at all a homozygous population.

The population's genetics, exposures and related cultural experiences have tremendous variation[97]. Some recent studies that include results for Hispanics have already been presented in the sections on women and blacks.

The Hispanic Community Health Study/Study of Latinos includes individuals from a number of Hispanic backgrounds. The overall rate of high cholesterol was 52% among men (range: 48% in Dominicans and Puerto Ricans to 55% in Central Americans) and 37% in women (range: 31% in South Americans to 41% in Puerto Ricans). About 37% of men were obese (range: 27% in South Americans to 41% in Puerto Ricans) and 43% of women were obese (highest among Puerto Ricans). Approximately 26% of men actually smoking currently (highest in Puerto Ricans) and 15% of women were current smokers (21% in Cuban women, 32% in Puerto Rican women). Puerto Ricans had the highest rates of obesity and current smoking. Central American men and Puerto Rican women had the highest hypercholesterolemia. The presence of having ⩾ 3 risk factors was highest among Puerto Ricans and those who either were United States born or had lived in the United States for 10 or more years[98].

A higher level of education was linked with a higher probability of high blood pressure and large waist measurement in both male and female Mexican Americans born in the United States and those born abroad. The odds of diabetes increased with education among United States-born Mexican American women. Foreign-born Mexican American women who had lived in the United States for 5 to 19 years had the highest risk of diabetes. The odds of having hypertension were 26% lower among Mexican-born men residing in the United States under 5 years, 39% lower for Mexican-born men in the United States 5 to 19 years compared with Mexican-born men in the United States for ⩾ 20 years. Foreign-born males who had lived in the United States for fewer than 5 years had the least probability of diabetes and a large waist circumference[99].

Data from both the National Health and Nutrition Examination Study and the earlier Hispanic Health and Nutrition Examination Study looking at first- and second-generation Mexican Americans showed that first- and second-generation men did not differ in diabetes incidence, cholesterol levels and framingham risk score (FRS). Smoking levels were lower in second-generation men; they also had lower HDL cholesterol levels, and the degree of hypertension was higher than first-generation men. Neither FRS nor diabetes rates differed between first- and second-generation women. The levels of HDL cholesterol were higher in second-generation women and the rates of smoking and total cholesterol was also lower though rates of hypertension were higher than first-generation women[100].

Hispanic patients were more likely to be younger and have diabetes, and less likely to have previous MI or prior revascularization in a comparison to white STEMI patients enrolled in the Get with the Guidelines Registry. Hispanics had a higher probability of being uninsured. Hispanic patients experienced noteworthy time delays in

Table 3 Summary of disparities in acute myocardial infarction co-morbidities and presentation symptoms, care and access to medical resources, and outcomes in blacks

Co-morbidities and presentation symptoms
More likely than whites to have dyslipidemia, hypertension, obesity, insulin resistance, hyperglycemia, diabetes, and chronic kidney disease and to be physically inactive, smoke, and have poor eating habits[2]
More likely than whites to be younger and female and to have hypertension, diabetes, congestive heart failure, renal insufficiency, and history of smoking and stroke; less likely to have private insurance or cardiology care and to be uninsured[74]
More likely than whites to have Medicaid as insurer; to have no education beyond high school; to have low income; and to have a history of congestive heart failure, hypertension, and diabetes[76]
Likely to be younger and to have less education than whites; to have more hypertension, diabetes, higher BMI, and more current tobacco use; also more likely to experience palpitations, chest pressure, and chest pain[77]
More likely than whites to be younger and female and to have more hypertension, diabetes, renal insufficiency, history of smoking, congestive heart failure, previous MI, history of gastrointestinal bleeding, and lower baseline hemoglobin; also more likely to be on Medicaid or uninsured[78]
Care/medical resources
Less likely to be treated with either PCI or CABG within 3 mo of AMI than whites[23]
Longer door-to-drug and door-to-balloon times than for whites[79]
Less likely than whites to have door-to-balloon times < 90 min[80]
Likely to be transferred to a revascularization hospital more slowly than whites[81]
Less likely than whites to receive revascularization treatment[82]
Less likely than whites or Hispanics to receive revascularization treatment[83]
Less likely to be treated with revascularization than whites regardless of insurance status[84]
Less likely than whites to receive cardiac catheterization, PTCA, or CABG[85]
Persistently lower PCI rates in blacks compared to whites[86]
Less likely than whites to be transferred to a hospital with revascularization services or to be revascularized[87]
Less likely than whites to take their cardiac medications, to undergo non–protocol mandated angiography, or to receive a stent if undergoing PCI; less procedural success with PCI[89]
Outcomes
More likely to be discharged alive when not treated with revascularization than whites not receiving revascularization[83]
Lower mortality than in whites at 30 d post-AMI but higher thereafter[87]
Higher rates of recurrent AMI, congestive heart failure, and mortality than whites at 5 yr post-PCI[88]
Higher risk of death, recurrent MI, or re-hospitalization than whites[89]
Higher risk of death than whites following CABG[91]
More likely than whites to have adverse cardiac outcomes at 1 yr post-revascularization[92]
Consistently more likely than whites to have AMI re-hospitalization at 1 yr[93]
Both with and without pre-operative β-blockers, shorter median survival times with CABG than white patients[96]

PTCA: Percutaneous transluminal coronary angioplasty; AMI: Acute myocardial infarction; BMI: Body mass index; CABG: Coronary arterybypass grafting; PCI: Percutaneous coronary intervention.

triage and subsequent related reperfusion, but the use of acute medications and primary PCI was the same in the two groups. Mean in-hospital stay was longer for Hispanics, but in-hospital mortality did not differ significantly. Hispanic patients had less evidence-based discharge care. Despite these disparities, Hispanics had clinical outcomes that did not differ significantly from those of non-Hispanic whites[101].

In STEMI patients who received PCI between 2004 and 2007, patients receiving a bare metal stent (BMS) were more likely to be Hispanic and uninsured; had higher rates of surgical or PCI revascularization, peripheral vascular disease, and diabetes; and had significantly longer hospital stays and a trend toward higher all-cause mortality. Hispanic ethnicity was not an independent predictor of BMS use[102].

Among Mexicans, Hispanics, and non-Hispanic whites presenting with NSTE ACS, Mexicans were younger; had less hypertension, hyperlipidemia, renal failure, and prior revascularization; and were more likely to smoke than Hispanic and non-Hispanic white patients. Mexicans and Hispanics had a significantly higher incidence of diabetes. Acute medication use was similar in all three groups, but Mexican patients were less likely to have revascularization. Mortality was similar in all three groups[103].

Care/medical resources

The literature on disparities in AMI treatment for Hispanics is sparse. Some pertinent data were presented in the previous section, and we here briefly reiterate specific results for Hispanics from studies already cited in earlier sections. These disparities are primarily in the time to treatment and the specific treatments Hispanics received.

Door-to-drug and door-to-balloon times were significantly longer for Hispanic patients than for white patients when receiving primary PCI for STEMI; some of this disparity was explained by the hospitals in which Hispanics were treated[79]. Cavender *et al*[80] found that median door-to-balloon time was marginally longer for Hispanics than for whites. Hispanic ethnicity was not associated with lower odds of door-to-balloon times ⩽ 90 min. There was no association between race/ethnicity and in-hospital mortality.

Hispanics were not as likely as non-Hispanic whites to get in-hospital revascularization regardless of insurance (Medicare, private insurance, uninsured/

Table 4 Summary of disparities in acute myocardial infarction co-morbidities and presentation symptoms, care and access to medical resources, and outcomes in Hispanics

Co-morbidities and presentation symptoms
More likely than non-Hispanic whites to have hypertension, diabetes, and renal failure and to lack health insurance[95]
More likely than non-Hispanic whites to be younger and to have diabetes, but less likely to have previous MI or prior revascularization[101]
More likely than non-Hispanic whites to have diabetes[103]
Care/medical resources
Longer door-to-drug and door-to-balloon times than for whites[79]
Longer door-to-drug and door-to-balloon times than for whites[79]
Less likely than whites to receive catheterization or PTCA[104]
Outcomes
Hispanic patients with diabetes somewhat less likely at 5 yr to be dead, have MI, or have stroke than white patients with diabetes[90]
More likely to be dead or re-hospitalized at 1 yr than non-Hispanic whites[95]
In-hospital mortality increases with age and is higher among Hispanic females[105]

MI: Myocardial infarction; PTCA: Percutaneous coronary angioplasty.

Medicaid) but were more likely than black patients to receive revascularization[84]. Hispanics were less likely than whites to receive catheterization or PTCA, whereas black patients were less likely than white patients to receive catheterization or CABG and were somewhat less likely to have a stress test or echocardiogram[104]. Disparities in the treatment of Hispanic patients *vs* white patients dropped significantly between 2005 and 2010, indicating more equitable care in the same hospital[86].

Outcomes

Data are very limited on clinical outcomes in Hispanic patients treated for AMI. We here briefly reiterate data from studies already cited, but with specific reference to Hispanics, and note one additional recent study of Puerto Rican patients.

Patients with first MI hospitalized in 2007 in San Juan, Puerto Rico, had an average age of 64 years. Women made up 45% of the study population, but the incidence rate per 100000 was significantly higher for men (198) than for women (134). Women were less likely to receive medications such as aspirin, recommended statins, ACE inhibitors, β-blockers, or to have interventional procedures[105].

Hispanic patients with diabetes treated intensively for cardiac risk factors had a smaller risk of death/MI/stroke at 5 years than white diabetics with similar treatment, but the differences were not significant[90]. Hispanic patients with pre-existing coronary heart disease, admitted to a cardiovascular service, were less likely to report statin use before admission and more likely to be dead or re-hospitalized at 1 year than white patients. They also had higher rates of high blood pressure and diabetes and less likely to have health insurance[97].

Table 4 summarizes disparities in Hispanics in presentation, treatment, and outcomes of acute coronary syndrome.

OTHER GROUPS

Recent data are largely lacking on CVD risk factors in general, on CVD health status, and especially on revascularization as treatment for AMI among minority groups other than blacks and Hispanics. A few studies have already been discussed that either originally included some groups but tossed those study participants from the analyses because they were too few to lead to any conclusions or simply added them to other populations (*e.g.*, whites/Asians). Here we include a brief look at some recent attempts to elucidate risk factors, treatment status, or outcomes among other minority groups.

A study of the prevalence of dyslipidemia among minority populations in the United States included Asian Americans, Mexican Americans, and blacks, compared to non-Hispanic whites. Outcome measures were elevated levels of triglyceride, low HDL and high LDL cholesterol levels. Hispanic/Latino patients from subgroups other than Mexican Americans were excluded because of small numbers. Filipino and Mexican American women had the highest prevalence of high triglyceride levels and high LDL cholesterol levels. Asian Indian and Mexican American women had the highest prevalence of low HDL cholesterol levels. Mexican American women and all Asian subgroups except Korean women had higher prevalence of high triglyceride levels than white patients, but black patients had the lowest prevalence of high triglyceride levels (18.1%). In general, the prevalence rates of all three dyslipidemia types were higher in men[106].

Among Chinese, South Korean, Asian Indians, Japanese, Filipinos, and Vietnamese-the six largest Asian subgroups in the United States-Asian Indian men and women and Filipino men had the largest proportionate mortality burden from ischemic heart disease relative to non-Hispanic whites. The mortality impact of hypertension and cerebrovascular disease, namely hemorrhagic CVAs, was more elevated in every Asian-American subgroup than in whites[107].

AI/ANs have higher rates of obesity than any other group, and they are rising at a faster rates compared with non-Hispanic whites. Metabolic syndrome was found in higher rates in AI/AN men and women,

compared with the general population. The prevalence of diabetes among AI/ANs is almost three times the prevalence of diabetes among non-Hispanic whites. The rates of self-reported heart disease, stroke, and cardiovascular mortality were higher in AI/ANs than in whites. Differences in the prevalence of hypertension and hyperlipidemia were more equivocal. English surveys may underestimate the prevalence of these risk factors[10].

Bradley *et al*[79] used time between hospital arrival and reperfusion therapy as their main outcome measure in an analysis of individuals being treated for STEMI. Black patients had the longest door-to-drug time, followed by Asians/Pacific Islanders and Hispanics; all had significantly longer door-to-drug times than white patients. Minorities on a whole had significantly longer door-to-balloon times than whites.

Despite a vastly different health care system, a study in the Netherlands found disparities among minority populations there similar to those observed in the United States Investigators looked at differences between first-generation ethnic minority groups (Antillean, Chinese, Indonesian, Moroccan, South Asian, Surinamese, and Turkish) and the ethnic Dutch population after first hospitalization for AMI or congestive heart failure. Mortality rates at 28 d and 5 years were significantly higher among the migrant groups than in the ethnic Dutch. The rate of AMI re-admission for the migrant groups was nearly a third larger than for ethnic Dutch. Mortality rates for migrants after congestive heart failure differed, with a lower 28-d mortality rate among Moroccans and Turks and a higher 5-year mortality rate among Surinamese, Chinese, and South Asians. Re-admission rates for congestive heart failure were generally higher among migrant groups than in the ethnic Dutch population[108].

CONCLUSION

As this review documents, disparities persist in risk factors, health status, and co-morbidities at presentation; in the allocation of treatments; and in outcomes in revascularization as treatment for MI and, more generally, outcomes associated with CVD between female and minority patients and the general white patient population.

Women, for example, typically have more risk factors and are likely to present with more co-morbidities such as diabetes, dyslipidemia, and obesity than men. This is exacerbated among minority female groups compared with white women. Models intended to assess and estimate risk do not estimate women's risk accurately. Women have longer pre-hospital delay, and once admitted, have more limited access to guideline treatments such as PCI than men. Younger women especially have substantially higher rates of in-hospital and early and long-term mortality than men and are more likely to be re-admitted. These differences decline with age.

Blacks similarly have more risk factors such as dyslipidemia, hypertension, and obesity, and are more likely to present with co-morbidities, especially diabetes. Black patients have poorer access to guideline treatments such as PCI or CABG and experience more long-term mortality, congestive heart failure, and re-admission for AMI.

Disparities among Hispanics are more challenging to characterize, not least because so many Hispanic/Latino groups are represented in the United States population. The range of risk factors and co-morbidities seen across these various groups makes generalizing very difficult. Furthermore, in several studies, Hispanics seemed to have access to comparable care and to have outcomes that are comparable or slightly better than those in white patients, even if their initial presentation does not seem as promising.

The data show many disparities in all three of these groups but offer little explanation for these disparities. One thing women, blacks, and Hispanics often have in common in the United States is lower incomes, which can translate into less access to health insurance and thus less continuity of care. These groups often live in poorer neighborhoods and, for a variety of reasons, may have poorer health habits than their wealthier neighbors. Residential location can mean care in less-than-optimal hospital settings. Several studies reviewed here showed that hospital quality can have a major impact on the quality of treatments and on outcomes. The logical expectation that better access to coverage would translate into better care and better outcomes does not seem to be borne out in the early results from Massachusetts, where health care reform implementation is nearly 10 years old.

Huge knowledge gaps still exist, especially in studies of treatments for AMI and outcomes in minority groups beyond blacks and Hispanics. Little is known about revascularization as treatment for AMI/ACS in AI/ANs or the several Asian subpopulations in the United States or, for that matter, in Hispanic subpopulations. With advances in revascularization techniques and particularly the promising results obtained with drug-eluting stents, new randomized trials and comparative treatment studies that oversample these groups are needed. Admittedly, these can be difficult groups to study because of small numbers, but much too little is known about how to better treat these populations and how to resolve disparities in outcomes.

We'd like to end on a positive note by pointing out that racial/ethnic gaps in treatment quality measures are narrowing and that where rigorous adherence to treatment guidelines is enforced for study purposes, benefits to patients are uniform regardless of race or ethnicity. The news does not seem to be so good for women, however, and much research is still needed to understand observed disparities in outcomes among

younger female patients.

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