Sex and Race/Ethnicity–Related Disparities in Care and Outcomes After Hospitalization for Coronary Artery Disease Among Older Adults

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Background—It is unclear to what extent cardiovascular health disparities exist and can be modified among sexes, racial/ethnic groups, and geographic regions in US hospitals.

Methods and Results—We conducted a cohort study of 49,358 patients aged 65 years and older, admitted to 366 US hospitals from 2003 to 2009 as part of the Get With The Guidelines—Coronary Artery Disease registry linked with Medicare inpatient data. We examined mortality disparities of sex, race/ethnicity, and geographic region with 3-year mortality. The mediator was defined as receiving optimal quality of care. Logistic regression with generalized estimating equations and mediation analysis were used. Compared with men, women were less likely to receive optimal care (odds ratio=0.92; 95% confidence interval: 0.88–0.95; \( P<0.0001 \)) and more likely to have higher mortality if they received suboptimal care (odds ratio=1.25; 95% confidence interval: 1.00–1.55; \( P=0.05 \), \( P \) for interaction=0.04). Approximately 69% of the sex disparity may potentially be reduced by providing optimal quality of care to women. Quality of care did not differ across racial/ethnic groups or geographic regions. Blacks were more likely to die than whites (odds ratio=1.33; 95% confidence interval: 1.21–1.46; \( P<0.0001 \)), and this disparity persisted regardless of the quality of care received.

Conclusions—Women were less likely than men to receive optimal care at discharge. The observed sex disparity in mortality could potentially be reduced by providing equitable and optimal care. In contrast, the higher mortality observed in black patients could not be accounted for by differences in the quality of care measured in this study.

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Key Words: cardiovascular disease ■ epidemiology ■ ethnic groups ■ mortality ■ sex

According to the Global Burden of Disease report from the World Health Organization, cardiovascular disease is the leading cause of death globally, with 17.5 million deaths from cardiovascular disease in the year of 2012 alone, accounting for 31% of all global deaths.1 Among these deaths, an estimated 7.4 million were because of coronary heart disease and 6.7 million were because of stroke. Decreasing cardiovascular mortality has been identified as a key public health priority by the American Heart Association, which has proposed to decrease cardiovascular mortality by 20% by 2020.2 Similarly, the Centers for Disease Control and Prevention have set reducing cardiovascular mortality as the top priority to prevent a million heart attacks and strokes by 2017.3 To reduce cardiovascular deaths and related public health burdens, it is important to first identify modifiable factors that health-care professionals could use to improve clinical care for cardiac patients, particularly for high-risk populations.

Women generally receive less evidence-based medical care than men and have higher rates of death after acute myocardial infarction (AMI).4-6 Furthermore, racial and ethnic differences in short-term and long-term mortality still remain. Statins and \( \beta \)-blockers are significantly underused among black patients, a disparity that may not be improving over time.10-12 In a recent analysis of 200,900 patients from 926 US centers participating in the Get With The Guidelines (GWTG)—Stroke program between 2003 and 2008, there were important racial/ethnic differences in baseline characteristics and clinical profiles, as well as both short-term and long-term outcomes.13 Despite these disparities, it is unknown whether and to what extent providing optimal quality of care could reduce cardiovascular

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WHAT IS KNOWN

- Women generally receive less evidence-based medical care than men and have higher rates of death after presenting with coronary artery disease. Racial and ethnic differences in short-term and long-term mortality still remain.
- The Get With The Guidelines program aims to improve quality of care for these patients and assess whether providing optimal quality of care could reduce cardiovascular health disparities across different sex, race/ethnic groups, and geographic regions.

WHAT THE STUDY ADDS

- Women received lower quality of care compared with men at hospital discharge after an admission for coronary artery disease.
- The excess mortality in women was modified by the quality of care received and 69% of the sex-mortality disparity could potentially be reduced by providing universally high-quality care.

health disparities across different sex, race/ethnic groups, and geographic regions.

To address these questions, we examined data from the GWTG-Coronary Artery Disease (CAD) Program, a nationwide registry of patients hospitalized for cardiac conditions.14 We determined whether a summary score of the quality of care performance measures differs across sex, race/ethnic groups, and geographic regions and the degree to which quality of care accounts for the association between sex, race/ethnicity, or geographic region with subsequent mortality.

Methods

Study Population
We linked 125,135 patients in the GWTG-CAD registry with Medicare inpatient data from 551 hospitals across the United States. The GWTG-CAD registry is a national program organized by the American Heart Association to improve quality of care for cardiac patients.14,15 Participation in the GWTG-CAD registry was voluntary and nationwide. Patients entered into the GWTG-CAD database must have met International Classification of Diseases, Ninth revision, diagnoses 410 to 414 (diagnosis of AMI, unstable angina, chronic stable angina, and ischemic heart disease) inclusion criteria or have symptomatic peripheral vascular disease. Case finding was based on clinical identification of patients with qualifying clinical diagnoses or International Classification of Diseases, Ninth revision, identification with clinical verification from data abstraction. Participating hospitals submit clinical data regarding patients’ in-hospital care and outcomes. The Medicare linkage includes Part A (inpatient) claims and the associated denominator file. After exclusions, our final analytic sample included 49,358 patients, aged 65 years or older, from 366 US hospitals from January 1, 2003, to December 31, 2009 (Figure in the Data Supplement).

Demographic Groups of Interest
Our primary stratifying characteristics included sex (men or women), race/ethnicity (white, black, Asian, Hispanic, other), and geographic region (northeast, midwest, south, west). Information was extracted from medical records that were collected during patient hospitalization through patient self-reporting and recorded separately by trained hospital personnel.

Mortality
Our outcome was 3-year all-cause mortality. Death events were ascertained on the basis of the death date recorded in the denominator/vital status file.

Measures of Quality of Care
Quality of care performance measures included (1) aspirin within 24 hours; (2) aspirin on hospital discharge; (3) β-blocker on hospital discharge; (4) angiotensin-converting enzyme inhibitor/angiotensin receptor blocker for patients with low-ejection fraction on hospital discharge; (5) smoking cessation counseling; and (6) lipid-lowering medications.16–19 As a potential mediator of the association of demographic characteristics with mortality, we constructed a binary variable of optimal quality of care, defined as receiving all performance measures the patient was eligible for. We also constructed a continuous variable for quality of care, defined as total number of performance measures the patient received divided by total number of which the patient was eligible for.14,15 Patients with contraindications to any of the medications in the quality of care measures were not eligible for that specific medication and were therefore excluded from the denominator.

Covariates
For these analyses, covariates were selected a priori based on clinical knowledge. We adjusted for the following patient characteristics: age (continuous), calendar year (categorical), cardiac diagnosis (ST-segment elevation myocardial infarction [MI], non-ST-segment elevation MI, AMI unspecified, unstable angina versus CAD), medical history (atrial fibrillation/flutter, chronic obstructive pulmonary disease, diabetes mellitus, hypertension, peripheral vascular disease, dyslipidemia, stroke, prior MI, CAD, prior percutaneous coronary intervention/coronary artery bypass surgery, heart failure, carotid stenosis, renal insufficiency, dialysis, pacemaker-biventricular/resynchronization/cardiac resynchronization therapy, implantable cardioverter defibrillator, anemia, depression, valvular heart disease, and smoking), body mass index (continuous), systolic blood pressure at discharge (continuous), and ejection fraction (continuous). A total of 47,236 (95.7%) patients had complete medical records in our study. For covariates in medical history, only 4.3% were missing for medical history variables, 10.0% were missing for body mass index, 13.8% were missing for ejection fraction <40% or moderate or severe dysfunction, and 10.1% were missing for systolic blood pressure. For missing data on covariates, we performed simple imputation with the median for continuous variables, imputed sex-specific median for body mass index, and dominant level for categorical variables. Data entered in the GWTG database have previously been compared with the information abstracted from deidentified medical records by professionally trained auditors.20 The accuracy rate was 96.1% for overall composite with intermediate to excellent agreement (Kappa statistics or intraclass correlation coefficient from 0.40 to ≥0.75).20

Statistical Analyses
Baseline characteristics of the study population by sex, race/ethnicity, and geographic region were examined using proportions for categorical variables and medians and interquartile range for continuous variables. We tested differences between groups using χ² tests for categorical variables and Kruskal–Wallis tests for continuous variables. We evaluated the following associations using logistic regression and generalized estimating equations accounting for clustering within hospitals: 1) the associations between sex, race/ethnic groups, and geographic regions with 3-year all-cause mortality; 2) the associations between sex, race/ethnic groups, and geographic regions with performance measures. We further examined whether there was an interaction between sex, race/ethnic groups, geographic region, and performance measures. We also tested whether there was...
an interaction between sex and age for their association with 3-year mortality. A score test was used.

We conducted mediation analysis to evaluate the association between sex, race/ethnicity, and geographic region with mortality and accounting for interaction between exposures and mediators. We calculated the proportion of mortality disparity that could be reduced through providing optimal quality of care. As a sensitivity analysis, we further repeated the analysis with 1-year mortality data, and estimated the influence of unmeasured confounders on our findings. We repeated the interaction analysis between quality of care and geographic region with adjustment for age, sex, and race only. We also estimated overall in-hospital mortality and in-hospital mortality trend by sex, race, and geographic region by performing additional analyses with in-hospital deaths included (other inclusion/exclusion criteria remained the same).

Institutions participating in the GWTG-CAD were required to comply with local regulatory and privacy guidelines and obtain institutional review board approval when necessary. Because the data were used primarily for quality improvement, participating sites were granted a waiver of informed consent under the Common Rule. The analyses were based on aggregated data deidentified for research purposes. All analyses were completed using SAS 9.3 (SAS Institute), with 2-sided test and a significance level of 0.05. Quantiles served as the registry coordinating center. The Duke Clinical Research Institute served as the data analysis center.

Results
During 3 years of follow-up, we documented a total of 16 130 (32.7%) deaths, 8323 (35.6%) among women and 7807 (30.8%) among men. Black and Asian displayed the highest unadjusted mortality rates in our study sample (38.5% and 38.3%, respectively), followed by white 32.3% and Hispanic 29.8%.

Disparities According to Sex
At baseline, women tended to present with hypertension and heart failure at hospital admission more often than men (P<0.0001) and were less likely to receive lipid-lowering medications and in-hospital procedures (P<0.0001, Table 1). Compared with men, women were less likely to receive optimal care at hospital discharge (odds ratio (OR)=0.92; 95% confidence interval (CI): 0.88–0.95; P<0.0001, Table 2). Women had a 1.2-fold higher 3-year mortality than men in univariable analyses, but the disparity was attenuated after adjustment for demographic and medical characteristics (OR=0.99; 95% CI: 0.95–1.03; P=0.73; Table 3).

However, we identified a significant interaction between sex and quality of care measures (P for interaction=0.04; Table 4) on mortality. Compared with men, women had higher odds of mortality (OR=1.25; 95% CI: 1.00–1.55; P=0.05; Table 4) if they received suboptimal care, though the sex disparity disappeared with optimal care (OR=0.97; 95% CI: 0.93–1.01; P=0.18; Table 4). Approximately 69% of the association between sex and all-cause mortality could potentially be reduced by providing optimal quality of care to women patients hospitalized for cardiac conditions (proportion mediated=69%; P=0.001).

We identified a significant interaction between sex and age with P=0.004. Among patients aged 80 years or younger, women had 1.12 times higher odds of 3-year mortality compared with men (OR=1.12; 95% CI: 1.06–1.19; P=0.0002), whereas for patients aged 80 years or older, there was no significant elevated mortality comparing women versus men (OR=0.98; 95% CI: 0.93–1.05; P=0.60).

Disparities According to Race/Ethnicity
Compared with white patients, black patients showed a higher prevalence of diabetes mellitus, hypertension, and dialysis (P<0.0001) but were similar regarding quality of care measures received (Table I in the Data Supplement). Differences in quality of care measures according to race/ethnicity were nonsignificant (Table 2). Black patients were at higher odds for mortality than white patients (OR=1.33; 95% CI: 1.21–1.46; P<0.0001 for 3-year mortality; Table 3), and the disparity persisted regardless of the quality of care received (Table 4). Interaction terms between racial/ethnic and quality of care measures were not significant (P for interaction=0.30). The mortality disparity comparing black versus white patients was not further reduced or eliminated by providing optimal quality of care (P value for mediated effect=0.87).

Disparities According to Region
In comparison with the other geographical regions, the south exhibited the lowest measures in patients discharged on angiotensin-converting enzyme inhibitors or angiotensin receptor blockers (77%) and the administration of lipid lowering medications for patients with low-density lipoprotein≥100 (80%). The west region had the lowest prevalence of patients discharged on β-blockers (90%) and patients who received smoking cessation advice for current smokers (83%, Table II in the Data Supplement). Across all regions, the prevalence of adherence to performance measures was generally high from 80% to 97%. There was no statistically significant difference in terms of quality of care across geographic regions (Table 2). Moreover, we did not identify a significant mortality difference based on geographic region. Compared with the northeast region, the midwest, south, and west regions had lower 3-year mortality although the associations were nonsignificant (Table 3). We did not detect a significant interaction between geographical regions and quality of care measures (P for interaction=0.32). Compared with the northeast region, the mortality rates between the midwest and northeast regions were not statistically different (OR=0.91; 95% CI: 0.78–1.06; P=0.21; Table 3). Mediation analysis suggested that the mortality difference between midwest and northeast regions, although not statistically significant, might potentially be further reduced through quality of care measures (P=0.0002 for mediated effect).

Sensitivity Analyses
As sensitivity analyses, we repeated analyses using 1-year mortality and also repeated mediation analyses using quality of care as a continuous variable. When we modeled quality of care as a continuous variable, ≈42% of the sex–mortality association was mediated through quality of care, with P value for mediated effect=0.002. Our main conclusions remained the same. As hospital characteristics and revascularization strategies were highly associated with quality of care measures in this database, we did not adjust for these variables in our mediation analyses. For our main analyses, the mortality disparities persisted after further adjusting for hospital characteristics. When we considered...
Table 1. Baseline Characteristics of 49358 Patients from 366 Hospitals in the United States (January 1, 2003–December 31, 2009) by Sex

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total N (49358)</th>
<th>Overall</th>
<th>Women (23369)</th>
<th>Men (25989)</th>
<th>With Events (8323)</th>
<th>Without Events (15046)</th>
<th>With Events (7807)</th>
<th>Without Events (18182)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demographics</strong></td>
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<tr>
<td>Age,* median (25th, 75th percentiles, yr)</td>
<td>49358</td>
<td>77 (71, 83)</td>
<td>82 (76, 88)</td>
<td>76 (71, 82)</td>
<td>80 (73, 85)</td>
<td>73 (69, 79)</td>
<td>&lt;0.0001</td>
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<td>Race/ethnicity</td>
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<tr>
<td>Asian, %</td>
<td>1184</td>
<td>2.40</td>
<td>2.52</td>
<td>2.19</td>
<td>3.11</td>
<td>2.21</td>
<td>&lt;0.0001</td>
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<tr>
<td>Hispanic, %</td>
<td>2529</td>
<td>5.12</td>
<td>4.61</td>
<td>5.22</td>
<td>4.74</td>
<td>5.44</td>
<td>&lt;0.0001</td>
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<tr>
<td>Black, %</td>
<td>2814</td>
<td>5.70</td>
<td>7.81</td>
<td>6.46</td>
<td>5.55</td>
<td>4.17</td>
<td>&lt;0.0001</td>
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<tr>
<td>White, %</td>
<td>40834</td>
<td>82.73</td>
<td>80.88</td>
<td>82.39</td>
<td>82.49</td>
<td>83.96</td>
<td>&lt;0.0001</td>
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<tr>
<td>BMI,* median (25th, 75th percentiles, kg/m²)</td>
<td>44411</td>
<td>26.62</td>
<td>24.86</td>
<td>27.04</td>
<td>25.62</td>
<td>27.34</td>
<td>&lt;0.0001</td>
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<tr>
<td><strong>Medical history</strong></td>
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<tr>
<td>Diabetes mellitus, %</td>
<td>15867</td>
<td>33.59</td>
<td>38.45</td>
<td>31.95</td>
<td>39.80</td>
<td>30.03</td>
<td>&lt;0.0001</td>
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<tr>
<td>Hyperlipidemia, %</td>
<td>23162</td>
<td>49.03</td>
<td>39.69</td>
<td>51.43</td>
<td>43.97</td>
<td>53.54</td>
<td>&lt;0.0001</td>
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<tr>
<td>Hypertension, %</td>
<td>35105</td>
<td>74.32</td>
<td>77.28</td>
<td>78.43</td>
<td>71.17</td>
<td>70.88</td>
<td>&lt;0.0001</td>
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<tr>
<td>Prior MI, %</td>
<td>9908</td>
<td>20.98</td>
<td>21.94</td>
<td>16.19</td>
<td>27.12</td>
<td>21.87</td>
<td>&lt;0.0001</td>
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<tr>
<td>ICD, %</td>
<td>263</td>
<td>0.56</td>
<td>0.51</td>
<td>0.31</td>
<td>1.06</td>
<td>0.57</td>
<td>&lt;0.0001</td>
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<tr>
<td>Heart failure, %</td>
<td>8522</td>
<td>18.04</td>
<td>33.37</td>
<td>13.34</td>
<td>29.73</td>
<td>9.83</td>
<td>&lt;0.0001</td>
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<tr>
<td>Depression, %</td>
<td>1276</td>
<td>2.70</td>
<td>4.85</td>
<td>3.05</td>
<td>2.80</td>
<td>1.37</td>
<td>&lt;0.0001</td>
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<tr>
<td>Current smoker, %</td>
<td>7120</td>
<td>14.43</td>
<td>11.63</td>
<td>13.78</td>
<td>15.45</td>
<td>15.80</td>
<td>&lt;0.0001</td>
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<tr>
<td>Ejection fraction&lt;40% or moderate or severe dysfunction, %</td>
<td>11127</td>
<td>22.54</td>
<td>26.73</td>
<td>16.38</td>
<td>36.34</td>
<td>19.81</td>
<td>&lt;0.0001</td>
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<td>Region</td>
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<tr>
<td>West, %</td>
<td>8588</td>
<td>17.40</td>
<td>15.64</td>
<td>16.62</td>
<td>17.69</td>
<td>18.72</td>
<td>&lt;0.0001</td>
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<tr>
<td>South, %</td>
<td>17538</td>
<td>35.53</td>
<td>34.27</td>
<td>34.91</td>
<td>35.26</td>
<td>36.74</td>
<td>&lt;0.0001</td>
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<tr>
<td>Midwest, %</td>
<td>13825</td>
<td>28.01</td>
<td>27.92</td>
<td>29.62</td>
<td>26.53</td>
<td>27.36</td>
<td>&lt;0.0001</td>
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<tr>
<td>Northeast, %</td>
<td>9407</td>
<td>19.06</td>
<td>22.17</td>
<td>18.85</td>
<td>20.52</td>
<td>17.18</td>
<td>&lt;0.0001</td>
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<tr>
<td>Urban, %</td>
<td>42522</td>
<td>86.15</td>
<td>84.30</td>
<td>86.29</td>
<td>85.08</td>
<td>87.34</td>
<td>&lt;0.0001</td>
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<td>In-hospital procedures</td>
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<tr>
<td>No procedure, %</td>
<td>6642</td>
<td>15.5</td>
<td>40.27</td>
<td>10.52</td>
<td>28.40</td>
<td>5.79</td>
<td>&lt;0.0001</td>
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<tr>
<td>Cardiac catheterization/coronary angiography, %</td>
<td>28099</td>
<td>65.7</td>
<td>47.42</td>
<td>69.62</td>
<td>57.44</td>
<td>72.22</td>
<td>&lt;0.0001</td>
<td></td>
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<tr>
<td>Cardioversion, %</td>
<td>155</td>
<td>0.4</td>
<td>0.39</td>
<td>0.25</td>
<td>0.37</td>
<td>0.44</td>
<td>0.04</td>
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<tr>
<td>CABG or cardiac valve surgery, %</td>
<td>5477</td>
<td>12.8</td>
<td>5.37</td>
<td>11.71</td>
<td>9.16</td>
<td>17.71</td>
<td>&lt;0.0001</td>
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<tr>
<td>PCI or PCI with stent, %</td>
<td>22072</td>
<td>51.6</td>
<td>31.26</td>
<td>55.43</td>
<td>38.04</td>
<td>60.90</td>
<td>&lt;0.0001</td>
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<tr>
<td>Performance measures (eligible patients only)</td>
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<tr>
<td>Patients receiving optimal care, %</td>
<td>40141</td>
<td>81.33</td>
<td>76.26</td>
<td>83.27</td>
<td>77.42</td>
<td>83.71</td>
<td>&lt;0.0001</td>
<td></td>
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<tr>
<td>Patients with documented LVSD discharged on ACE inhibitors or ARB, %</td>
<td>7972</td>
<td>80.20</td>
<td>75.78</td>
<td>84.14</td>
<td>75.57</td>
<td>83.46</td>
<td>&lt;0.0001</td>
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<tr>
<td>Patients discharged on aspirin, %</td>
<td>43463</td>
<td>95.80</td>
<td>92.84</td>
<td>96.44</td>
<td>94.79</td>
<td>96.92</td>
<td>&lt;0.0001</td>
<td></td>
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<tr>
<td>Patients discharged on beta-blockers, %</td>
<td>41776</td>
<td>93.38</td>
<td>92.11</td>
<td>93.79</td>
<td>93.55</td>
<td>93.52</td>
<td>&lt;0.0001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current smokers who receive smoking cessation advice, %</td>
<td>6229</td>
<td>87.49</td>
<td>85.43</td>
<td>89.15</td>
<td>83.25</td>
<td>88.75</td>
<td>&lt;0.0001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patients with LDL &gt;100 who receive lipid lowering drugs, %</td>
<td>8076</td>
<td>83.58</td>
<td>72.65</td>
<td>85.23</td>
<td>75.66</td>
<td>88.24</td>
<td>&lt;0.0001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>AMI and angina patients without contraindications who receive aspirin &lt;24 h, %</td>
<td>28889</td>
<td>93.04</td>
<td>91.21</td>
<td>93.65</td>
<td>91.70</td>
<td>94.20</td>
<td>&lt;0.0001</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*P values are based on Pearson χ² tests for categorical variables. ACE indicates angiotensin-converting enzyme; ARB, angiotensin receptor blocker; AMI, acute myocardial infarction; BMI, body mass index; CABG, Coronary artery bypass surgery; ICD, implantable cardioverter defibrillator; LDL, Low-density lipoprotein; LVSD, Left ventricular systolic dysfunction; MI, myocardial infarction; and PCI, percutaneous coronary intervention.

*P values are based Kruskal–Wallis tests.
Exposure                              | Unadjusted OR (95% CI)   | P-value | Adjusted* OR (95% CI)   | P-value |
---|----------------------------------|---------|------------------------|---------|
Women vs men†                        | 0.92 (0.89, 0.95)       | <0.0001 | 0.92 (0.88, 0.95)       | <0.0001 |
Black vs white‡                       | 0.97 (0.92, 1.03)       | 0.29    | 0.95 (0.89, 1.03)       | 0.20    |
Hispanic vs white‡                    | 1.00 (0.91, 1.10)       | 0.98    | 0.97 (0.86, 1.08)       | 0.53    |
Asian vs white‡                      | 0.94 (0.79, 1.11)       | 0.46    | 0.90 (0.74, 1.10)       | 0.29    |
Other vs white‡                       | 0.87 (0.78, 0.96)       | 0.007   | 0.89 (0.80, 0.99)       | 0.03    |
Midwest vs northeast§                 | 1.18 (0.67, 2.08)       | 0.56    | 0.92 (0.68, 1.25)       | 0.59    |
West vs northeast§                    | 1.29 (0.74, 2.26)       | 0.37    | 1.08 (0.83, 1.41)       | 0.56    |
South vs northeast§                   | 1.05 (0.61, 1.82)       | 0.85    | 0.92 (0.70, 1.20)       | 0.52    |

The adjustment variables include age (continuous), calendar year (categorical), cardiac diagnosis (ST-segment elevation myocardial infarction, non-ST-segment elevation myocardial infarction, acute myocardial infarction unspecified, unstable angina vs coronary artery disease, categorical), medical histories (atrial fibrillation/flutter, chronic obstructive pulmonary disease, diabetes mellitus, hypertension, peripheral vascular disease, dyslipidemia, stroke, prior myocardial infarction, coronary artery disease, prior percutaneous coronary intervention/coronary artery bypass surgery, heart failure, carotid stenosis, renal insufficiency, dialysis, pacemaker-biventricular/resynchronization/cardiak resynchronization therapy, implantable cardioverter defibrillator, anemia, depression, valvular heart disease, and smoking, categorical), body mass index (continuous), systolic blood pressure at discharge (continuous), and ejection fraction (continuous). CI indicates confidence interval; and OR, odds ratio.

†Unadjusted model including only sex (women vs men) as an independent variable.
‡Unadjusted model including only race/ethnicity (black, Hispanic, Asian, other race/ethnic groups vs white) as a sole independent variable.
§Unadjusted model including only race/ethnicity (black, Hispanic, Asian, other race/ethnic groups vs white) as a sole independent variable.

Discussion

In this national registry of contemporary cardiac patients, consisting of 49,358 cardiac patients across 366 hospitals in the United States, women were less likely to receive optimal care at hospital discharge after an admission for CAD. Approximately 69% of the observed sex disparity in mortality could potentially be reduced or greatly eliminated by providing optimal quality of care. In contrast, the higher mortality observed in black patients could not be accounted for by differences in the quality of care measured in this study. We did not observe statistically significant differences in care or outcomes by geographic region.

Disparities According to Sex

Sex differences in mortality after MI have been described extensively in the literature, with a majority of the studies focused on short-term mortality, particularly the first year after MI.4–8,15,24,25 Compared with men, women tend to be older at the time of AMI, have more comorbidities, are less likely to receive revascularization, have longer average length of stay, and higher in-hospital mortality.5,24,25 Results on sex differences in long-term mortality after MI have been sparse and inconsistent.7 Previous sex differences were largely explained by the differences in age, comorbidities, and treatment use.7

Whether and how differences in quality of care could explain or alleviate this sex–mortality gap are largely unknown. Our results suggest that providing optimal care to cardiac patients could yield large gains in reducing sex-related disparities. Previous studies in the GWTG database have identified sex (women) as a significant predictor for worse adherence to performance measures.9 In our study, women aged >65 years received significantly lower quality of care compared with men. Moreover, we provide the first evidence that this sex–mortality disparity is modified by level of quality of care, and that ≈70% of the sex disparity could potentially be reduced through providing optimal healthcare. This highlights the importance of targeting and tailoring quality of care programs to specific high-risk populations.

In our study, women were aged >65 years. Some studies suggest that a sex–age interaction exists, such that young women tended to have lower quality of care and higher mortality, compared with their older counterparts.5,6,16,26 Future studies need to focus on providing optimal care for younger age groups, especially younger women and further explore the sex–age interaction.4,16 More extensive mediation analysis is also needed to further clarify how age, cardiovascular risk factors, clinical presentation, treatments, and quality of care,
individually and jointly, contribute to short-term and long-term sex-specific mortality disparity.

Disparities According to Race/Ethnicity

From 2001 through 2007, the overall hospitalization rate for AMI decreased for white men and women, although the decrease was much smaller for blacks compared with their white counterparts. Black patients tend to have higher prevalence of obesity and hypertension and have higher post-MI mortality. Some studies reported that hospital quality contributes significantly to racial disparities for outcomes after coronary artery bypass surgery surgery, and the mortality disparity between black and white patients was greatly attenuated by adjusting for patient characteristics. The high mortality rate among blacks may be explained by demographic and comorbidities, not by differential evidence-based medication prescription. In our study, black patients had higher prevalence of diabetes mellitus, hypertension, and dialysis but have paradoxically lower reperfusion and revascularization rates but have paradoxically higher in-hospital mortality compared with white patients. Previous study provided data on long-term mortality and suggested that there was no significant difference in terms of quality of care received across different geographic regions. Compared with the northeast, mortality in the midwest was numerically but not statistically significantly higher although mediation analysis suggested that providing optimal care could further reduce the difference in mortality between midwest and northeast regions. There was also no difference in terms of regional mortality for blacks and Hispanics compared with whites.

Table 3. Multivariate Adjusted Association Between Race/Ethnic Groups, Sex, or Geographic Region with 3-Year All-Cause Mortality

<table>
<thead>
<tr>
<th>Exposure</th>
<th>Events/Person</th>
<th>OR (95% CI)</th>
<th>P</th>
<th>OR (95% CI)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Unadjusted</td>
<td></td>
<td>Adjusted</td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>7807/25989</td>
<td>Reference</td>
<td></td>
<td>Reference</td>
<td></td>
</tr>
<tr>
<td>Women vs men*</td>
<td>8323/23369</td>
<td>1.20 (1.15, 1.24) &lt;0.0001</td>
<td>0.99 (0.95, 1.03) 0.72</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>13172/40834</td>
<td>Reference</td>
<td></td>
<td>Reference</td>
<td></td>
</tr>
<tr>
<td>Black vs white†</td>
<td>1083/2814</td>
<td>1.32 (1.20, 1.45) &lt;0.0001</td>
<td>1.33 (1.21, 1.46) &lt;0.0001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hispanic vs white†</td>
<td>754/2529</td>
<td>0.91 (0.84, 0.98) 0.01</td>
<td>0.95 (0.87, 1.02) 0.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asian vs white†</td>
<td>453/1184</td>
<td>0.96 (0.84, 1.10) 0.58</td>
<td>0.93 (0.80, 1.08) 0.33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other vs white†</td>
<td>668/1997</td>
<td>0.95 (0.81, 1.13) 0.57</td>
<td>1.00 (0.87, 1.16) 0.97</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northeast</td>
<td>3447/9407</td>
<td>Reference</td>
<td></td>
<td>Reference</td>
<td></td>
</tr>
<tr>
<td>Midwest vs northeast‡</td>
<td>4395/13825</td>
<td>0.70 (0.55, 0.88) 0.002</td>
<td>0.91 (0.78, 1.06) 0.21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>South vs northeast‡</td>
<td>5605/17538</td>
<td>0.71 (0.58, 0.87) 0.001</td>
<td>0.90 (0.78, 1.03) 0.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>West vs northeast‡</td>
<td>2683/8588</td>
<td>0.65 (0.51, 0.83) 0.0006</td>
<td>0.87 (0.74, 1.02) 0.09</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Each adjusted model including sex (categorical), race/ethnicity (categorical), and other patient characteristics. The adjustment variables include age (continuous), calendar year (categorical), cardiac diagnosis (ST-segment elevation myocardial infarction, non-ST-segment elevation myocardial infarction, acute myocardial infarction unspecified, unstable angina vs. coronary artery disease, categorical), medical histories (atrial fibrillation/flutter, chronic obstructive pulmonary disease, diabetes mellitus, hypertension, peripheral vascular disease, dyslipidemia, stroke, prior myocardial infarction, coronary artery disease, prior percutaneous coronary intervention/coronary artery bypass surgery, heart failure, carotid stenosis, renal insufficiency, dialysis, pacemaker-biventricular/resynchronization/cardiac resynchronization therapy, implantable cardioverter defibrillator, anemia, depression, valvular heart disease, and smoking, categorical), body mass index (continuous), systolic blood pressure at discharge (continuous), and ejection fraction (continuous). CI indicates confidence interval; and OR, odds ratio.

*Unadjusted model including only sex (women vs men) as an independent variable.
†Unadjusted model including only race/ethnicity (black, Hispanic, Asian, other race/ethnic groups vs white) as a sole independent variable.
‡Unadjusted model including only region (midwest, west, south vs northeast) as a sole independent variable.

Future studies should focus on long-term continuity of care for secondary prevention as minorities might have difficulties affording long-term medications and treatments, limited access to healthy food and safe environment, and worse health awareness and literacy. Previously, in the GWTG-CAD program, we reported a higher in-hospital mortality comparing Asian-American with white patients. In this study, we were able to examine this mortality gap over a longer time frame, and the differences in mortality were now attenuated and no longer significant.

Disparities According to Region

Geographic differences in MI incidence and mortality are well known. In recent years, there was a significant decline in the AMI hospitalization rate and 30-day mortality among older US patients although the geographic disparities in MI incidence have increased and in MI-related mortality have narrowed. For ST-segment–elevation myocardial infarction, patients from the midwest, south, and west have higher reperfusion and revascularization rates but have paradoxically higher in-hospital mortality compared with the northeast. Our study provided data on long-term mortality and suggested that there was no significant difference in terms of quality of care received across different geographic regions. Compared with the northeast, mortality in the midwest was numerically but not statistically significantly higher although mediation analysis suggested that providing optimal care could further reduce the difference in mortality between midwest and northeast regions.
Conclusions

In this nationwide, large sample of Americans hospitalized with ischemic cardiac conditions, women were less likely to receive optimal care at discharge compared with men. The
substantial sex disparity in mortality could potentially be reduced by providing equitable and optimal care. Compared with white patients, black patients have an elevated risk of mortality although the mortality disparity observed could not be accounted for by differences in the quality of care measured. This study did not find significant differences in care or outcomes by geographic region.

Acknowledgments

Qintiles is the data collection coordination center for the American Heart Association/American Stroke Association Get With The Guidelines programs. Qintiles (Cambridge, Massachusetts) served as the registry coordinating center. The Duke Clinical Research Institute (Durham, NC) served as the data analysis center, and institutional review board approval was granted to analyze aggregate deidentified data for research purposes.

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