JOURNAL OF WOMEN'S HEALTH
Volume 26, Number 10, 2017

DOI: 10.1089/jwh.2016.6057

Sex Differences in 1-Year Outcomes After Percutaneous Coronary Intervention in the Veterans Health Administration

Melissa M. Farmer, PhD,[1] Maggie A. Stanislawski, PhD,[2] Mary E. Plomondon, PhD, MSPH,[2] Bevanne Bean-Mayberry, MD,[1,3] Nataria T. Joseph, PhD,[4] Lauren E. Thompson, MD, MSCS,[5,6] Jessica L. Zuchowski, PhD, MPH,[1] Stacie L. Daugherty, MD, MSPH,[5,6] Elizabeth M. Yano, PhD, MSPH,[1,7] and P. Michael Ho, MD, PhD[2,5,6]

Abstract

Background: Advancements in percutaneous coronary intervention (PCI) for treating obstructive coronary artery disease have reduced major adverse events, including mortality. Yet, evidence as to whether women and men experience similar outcomes is mixed. The objective was to examine sex differences in 1-year major adverse cardiac outcomes for the national population of patients undergoing PCI at Veterans Health Administration (VA) cardiac catheterization laboratories.

Methods: All Veterans undergoing PCI at VA hospitals between October 1, 2007 and September 30, 2013 ($N = 64{,}757$; Women = 1,040) were included. Cox proportional hazards models compared 1-year postprocedural outcomes [rehospitalization for myocardial infarction (MI), all-cause mortality, and major adverse cardiovascular events (MACE)] by sex.

Results: Women Veterans undergoing PCI were more likely to be younger, black, obese, and have chronic depression and less likely to have common cardiovascular risk factors and to have had prior cardiac events than Veteran men. One-year rates for women versus men were 2.1% and 2.5% for rehospitalization (p-value = 0.57); 3.5% and 4.9% for mortality (p-value = 0.14), and 5.4% and 6.9% for MACE (p-value = 0.18). There were no significant sex differences in any of the outcomes in Cox proportional hazards models.

Conclusions: Despite differences in clinical risk factors at the time of PCI, women and men Veterans treated at VA cardiac catheterization laboratories experienced comparable 1-year rehospitalization for MI, mortality, and MACE post-PCI. These results demonstrated similar 1-year post-PCI outcomes for men and women in a national population of patients who have more comorbidities and mental health issues than the general population.

Keywords: veterans, gender differences, women, cardiovascular disease, percutaneous coronary intervention

Introduction

Cardiovascular disease is the leading cause of death in the United States accounting for over 610,000 deaths each year.[1] Despite the belief that heart disease is a ''man's disease,'' a similar number of women and men die annually from heart disease in the United States.[1] However, women and men experience cardiovascular disease very differently, with sex differences in certain risk factors, clinical symptoms, presentation for evaluation, and referral for appropriate cardiovascular treatment.[2–6] Moreover, compared to men, women have lower utilization of evidence-based treatments for cardiovascular disease and lower quality of care, especially younger women.[7–11]

Percutaneous coronary intervention (PCI), or coronary angioplasty, is a nonsurgical procedure for treating obstructive

[1]VA HSR&D Center for the Study of Healthcare Innovation, Implementation & Policy, VA Greater Los Angeles Healthcare System, Sepulveda, California.
[2]VA Eastern Colorado Health Care System, Denver, Colorado.
[3]Department of Medicine, UCLA David Geffen School of Medicine, Los Angeles, California.
[4]Social Sciences Division, Pepperdine University, Malibu, California.
[5]Division of Cardiology, School of Medicine, University of Colorado, Aurora, Colorado.
[6]Colorado Cardiovascular Outcomes Research (CCOR) Consortium, Colorado.
[7]Department of Health Policy and Management, UCLA Fielding School of Public Health, Los Angeles, California.

coronary artery disease (CAD, including unstable angina, acute MI, and multivessel CAD). Over the last few decades, advancements in PCI have reduced inhospital and long-term major adverse cardiovascular events (MACE) and mortality in patients undergoing coronary interventions.[12,13] However, evidence on sex differences in outcomes after PCI has been mixed[14–19] and chiefly relies on studies based on local or regional samples or multisite registries rather than national samples or population-based data.

The Veterans Health Administration (VA) healthcare system is the largest national healthcare delivery system in the United States, with electronic medical record data and a cardiac catheterization laboratory clinical quality program called the VA Clinical Assessment Reporting and Tracking (CART) Program,[20] which is capable of elucidating sex differences in PCI outcomes on a national scale. As the leading cause of hospitalization for Veterans,[21] cardiovascular disease is a serious issue for the VA. Veterans are at higher risk of heart disease than the general population with their risk compounded by their increased prevalence of comorbidities linked with cardiovascular disease, including diabetes, spinal cord injury, and posttraumatic stress disorder (PTSD).[21,22]

With the twofold increase in the population of women Veterans utilizing VA services in the last decade alone,[23] the VA has made a concentrated effort to identify gender disparities in quality of care. In the VA, both women and men patients use any outpatient VA and primary care services comparably, but women Veterans tend to use more services than men: in FY12, women Veterans were more likely to be frequent users (six of more) and heavy users (12 or more) of outpatient VA care across all age groups, were more likely to be heavy users of primary care (six or more primary care visits), were more likely to use mental health or substance use disorder services, and were twice as likely to have utilized at least one day of non-VA (fee) medical care than men Veterans.[23,24] Prior research has shown that women Veterans have more risk factors for cardiovascular disease, including higher low-density lipoprotein (LDL) cholesterol levels than Veteran men after adjustments for age.[25] They also have higher rates for military sexual trauma, which is associated with a higher risk for PTSD, depression, and anxiety.[26] In terms of treatment, a prior study demonstrated that women Veterans undergoing diagnostic cardiac catheterization at the VA had lower rates of obstructive CAD than men Veterans and had lower 1-year mortality and all-cause rehospitalization rates.[27] However, whether women with obstructive CAD after PCI have similar outcomes to men with obstructive CAD is unknown.

The aim of this study was to examine sex differences in 1-year major adverse cardiac outcomes in a national population of patients undergoing PCI at VA facilities by assessing sex differences in 1-year postprocedural outcomes, including rehospitalization for myocardial infarction (MI), all-cause mortality, and MACE. This research advances the current literature by (1) capturing a population of all PCI patients in a national medical care system; (2) including patients with significant comorbidities; and (3) including a younger female population presenting with cardiovascular risks, a population that has been historically understudied due to limited inclusion in research.[3] Because women Veterans are at increased risk and utilize VA services differently than their male counterparts,[23,24] we hypothesized that men and women Veterans had different outcomes after PCI.

Materials and Methods

Study design and setting

This is a retrospective examination of all Veterans nationally undergoing PCI at the VA cardiac catheterization laboratories between October 1, 2007 and September 30, 2013. The study utilizes the VA CART Program, a national clinical quality program for all VA cardiac catheterization laboratories launched in 2005 to support clinical care, promote the quality of care, and advance knowledge through research.[20] A key feature of the CART Program is a clinical software application designed to collect standardized data on all coronary angiograms and PCI completed in all VA cardiac catheterization laboratories nationwide. The software is embedded in the VA electronic medical record and allows providers to enter patient and procedural information (preprocedure assessment, coronary angiography, and PCI) as part of routine clinical workflow. We evaluated all Veterans undergoing PCI at the VA: the first PCI for all patients aged 18 and older undergoing treatment at any of the 77 VA catheterization laboratories with follow-up information was included.

Data and measures

The CART software was designed using standardized definitions which conform to the definitions and standards of the American College of Cardiology's National Cardiovascular Data Registry (ACC-NCDR) and incorporates features such as pull-down menus and automated clinical report generation to ensure uniformity of data entry by different providers and in different cardiac catheterization laboratories.[28] CART clinical data are combined with administrative VA data sources (National Care Patient Data, Pharmacy Benefits Management Database, the Vital Status File, VA Medicare Database, the Decision Support Network, the Corporate Data Warehouse, and the Planning Systems Support Group) to create a longitudinal data repository, which supports the quality assessment and quality improvement mission of the CART Program. CART captures mortality from the VA Vital Status database that pulls from VA administrative data, VA Beneficiary Identification Records Locator Subsystem (BIRLS), Medicare, and Social Security Administration death files. Biological sex was identified from the CART database and VA administrative files.[27]

Outcomes: We assessed three outcomes at 1 year post-PCI: (1) rehospitalization for MI, (2) all-cause mortality, and (3) MACE (rehospitalization for MI, stroke, or death). We excluded MI codes occurring within the 14-day period after the PCI based on prior work demonstrating that these reflect the index presentation and coronary procedure, rather than representing a *de novo* MI.[29] Outcomes were assessed through from October 1, 2007 to September 30, 2013. We identified ICD-9 codes for rehospitalization for MI and stroke from the VA administrative data file (available upon request). All-cause mortality was determined by the VA Vital Status file.

Patient characteristics: Patient demographics (including age, race, and ethnicity), clinical risk factors, and comorbidities are presented in Table 1 and were determined from the VA electronic medical record using standard

Table 1. Characteristics of Veteran Population Who Underwent Percutaneous Coronary Intervention and Bivariate Comparisons by Sex

Variable	*All Veterans,* N *and median/%* (N = *64,757*)	*Women Veterans,* N *and median/%* (N = *1,040*)	*Men Veterans,* N *and median/%* (N = *63,717*)	p-*value*
Demographics				
Age [Median (IQR)]	64.2 (60.0–70.5)	60.4 (54.7–65.8)	64.2 (60.1–70.6)	<0.0001
Race				<0.0001
White	51,915 (80.2%)	702 (67.5%)	51,213 (80.4%)	
Black	7,776 (12.0%)	240 (23.1%)	7,536 (11.8%)	
Other	5,066 (7.8%)	98 (9.4%)	4,968 (7.8%)	
Ethnicity: Hispanic	4,435 (6.8%)	63 (6.1%)	4,372 (6.9%)	0.31
Risk factors and Comorbidities				
Tobacco use	41,345 (63.8%)	644 (61.9%)	40,701 (63.9%)	0.19
Obese (vs. nonobese)	31,079 (48.0%)	542 (52.1%)	30,537 (47.9%)	0.0073
Chronic Depression	23,267 (35.9%)	553 (53.2%)	22,714 (35.6%)	<0.0001
Hypertension	58,720 (90.7%)	913 (87.8%)	57,807 (90.7%)	0.0012
BPS [Median (IQR)]	134.3 (125.4–143.5)	134.6 (125.0–144.4)	134.3 (125.4–143.5)	0.72
BPD [Median (IQR)]	75.7 (69.7–82.1)	74.4 (68.4–80.9)	75.8 (69.7–82.1)	<0.0001
Hyperlipidemia	58,473 (90.3%)	898 (86.3%)	57,575 (90.4%)	<0.0001
Cholesterol [Median (IQR)]	162.7 (139.0–192.0)	186.0 (157.3–221.0)	162.3 (139.0–191.7)	<0.0001
LDL [Median (IQR)]	91.0 (71.3–115.7)	105.5 (82.3–134.0)	90.6 (71.0–115.3)	<0.0001
HDL (Median (IQR))	37.0 (31.3–44.0)	43.3 (36.7–52.6)	37.0 (31.3–44.0)	<0.0001
Diabetes	31,741 (49.0%)	495 (47.6%)	31,246 (49.0%)	0.36
Congestive heart failure	16,172 (25.0%)	220 (21.2%)	15,952 (25.0%)	0.0041
Chronic obstructive pulmonary disease	15,542 (24.0%)	228 (21.9%)	15,314 (24.0%)	0.11
Cerebrovascular disease	12,481 (19.3%)	207 (19.9%)	12,274 (19.3%)	0.6
Peripheral arterial disease	15,477 (23.9%)	204 (19.6%)	15,273 (24.0%)	0.0011
Framingham risk				<0.0001
High	18,410 (28.4%)	82 (7.9%)	18,328 (28.8%)	
Medium	36,057 (55.7%)	549 (52.8%)	35,508 (55.7%)	
Low	10,290 (15.9%)	409 (39.3%)	9,881 (15.5%)	
Prior MI	24,641 (38.1%)	344 (33.1%)	24,297 (38.1%)	0.0009
Prior CABG	18,415 (28.4%)	187 (18.0%)	18,228 (28.6%)	<0.0001
Indication for PCI				0.0004
ACS[a]	32,624 (50.4%)	583 (56.1%)	32,041 (50.3%)	
Stable angina	24,759 (38.2%)	365 (35.1%)	24,394 (38.3%)	
Other/unknown	7,374 (11.4%)	92 (8.8%)	7,282 (11.4%)	

Comparisons were conducted using chi-square tests for categorical variables and Mann–Whitney Wilcoxon nonparametric tests for continuous variables.

BPS, blood pressure systolic; BPD, blood pressure diastolic; LDL, low-density lipoprotein; HDL, high-density lipoprotein; MI, myocardial infarction; CABG, coronary artery bypass grafting; PCI, percutaneous coronary intervention; ACS, acute coronary syndrome.

[a]ACS Includes STEMI (ST segment elevation myocardial infarction), NSTEMI (Non ST segment elevation myocardial infarction), and unstable angina.

definitions.[28] We defined obesity as a body–mass index (BMI) ≥30. Framingham 10-year cardiovascular risk scores were calculated using age, sex, renal failure, diabetes, history of smoking, and average blood pressure and cholesterol data over the year before PCI (hypertension and hyperlipidemia were used if blood pressure or cholesterol was missing),[30] and were categorized as low: <10%, intermediate: 10%–20%, or high: >20%.[31,32] Because we cross-referenced CART clinical data with other VA administrative data, most variables were not missing. Race and cholesterol were the exceptions (both missing approximately 5%), and we imputed those missing values using regression methods in the SAS procedure PROC MI.[33]

Statistical analyses

In descriptive analyses, we compared demographic and clinical characteristics among PCI patients by sex. We conducted comparisons using chi-square tests for categorical variables and Mann–Whitney Wilcoxon nonparametric tests for continuous variables. We compared the unadjusted rates of each outcome of interest using estimated 1-year cumulative incidence, cumulative incidence plots, and Gray's test,[34] accounting for the censoring of outcomes for some patients, as well as for death as a competing risk for MI.

To compare postprocedural outcomes by sex, we constructed a series of Cox proportional hazards models with sex as the primary independent predictor (male as reference group) and a robust estimator of the covariance matrix to account for clustering by hospital.[35] The null model was used to assess the unadjusted association between sex and the outcomes. To determine the impact of risk factors on this relationship, covariates were added sequentially to the previous model in the following order: (model 1) age, (model 2) Framingham risk category (low, medium, or high), (model 3) race (white, black, or other), and (model 4) other cardiac risk

factors, including congestive heart failure (CHF), cerebrovascular disease, peripheral arterial disease (PAD), chronic obstructive pulmonary disease (COPD), obese (vs. not obese), and indication for PCI at presentation [(1) acute coronary syndrome (ST segment elevation myocardial infarction (STEMI), Non ST segment elevation myocardial infarction (NSTEMI), and unstable angina, (2) stable angina, or (3) other/unknown]. Due to low event rates among Hispanic women, ethnicity was not included in the models.

All tests for statistical significance were two tailed, and *p*-values <0.05 were considered statistically significant. The statistical analyses were performed by the CART Coordinating Center at the Denver VA Medical Center using SAS version 9.4 (SAS Institute, Inc., Cary, NC) and R 3.2.2 ''cmprsk'' package.[34,36] This study was approved by the Colorado Multiple Institutional Review Board and the VA Greater Los Angeles Institutional Review Board.

Results

The study population consisted of 64,757 Veterans who underwent PCI during the study period, including 1,040 women (1.6%). Patient characteristics at time of procedure are shown in Table 1 by sex. Female Veterans were younger than male Veterans (median age 60 vs. 64 years, respectively; $p<0.0001$), more likely to be black (23% vs. 12%; $p<0.0001$), obese (52% vs. 48%; $p<0.007$), and have chronic depression (53% vs. 36%; $p<0.0001$). Female Veterans were less likely to have common cardiovascular risk factors such as hypertension (88% vs. 91%; $p=0.0012$) and hyperlipidemia (86% vs. 91%; $p<0.0001$). For cholesterol, females had higher median overall cholesterol (186.0 vs. 162.3; $p<0.0001$) and higher median LDL (105.5 vs. 90.6; $p<0.0001$), but they also had higher median high-density lipoprotein (HDL 43.3 vs. 37.0; $p<0.0001$) than the males. They also had significantly lower Framingham risk scores: only 8% were high risk compared to 29% of men ($p<0.0001$). Furthermore, female Veterans were less likely to have cardiovascular disease such as CHF (21% vs. 25%; $p=0.0041$), PAD (20% vs. 24%; $p=0.0011$), prior MI (33% vs. 38%; $p=0.0009$), and prior coronary artery bypass grafting (CABG; 18% vs. 29%; $p<0.0001$) compared to male Veterans. For PCI indication, female Veterans were more likely to present with ACS, whereas male Veterans were more likely to present with stable angina and unknown/other reasons. There were no significant sex differences in tobacco use and diabetes.

One-year post-PCI outcomes in the overall population are shown in Table 2. Rates for rehospitalization for MI were 2.1% for females and 2.5% for males (*p*-value = 0.57).

Table 2. Estimated 1-Year Cumulative Incidence Rates for Rehospitalization, Mortality, and Major Adverse Cardiovascular Events by Sex

Event within 1 year	*Women Veterans (%)*	*Men Veterans (%)*
Rehospitalization	2.09 (1.17, 2.97)	2.45 (2.29, 2.54)
Mortality	3.49 (2.33, 4.64)	4.91 (4.73, 5.08)
MACE	5.38 (4.00, 6.75)	6.86 (6.67, 7.06)

MACE, major adverse cardiovascular events.

Table 3. Sex Differences Using Cox Proportional Hazards Models for 1-Year Rehospitalization, Mortality, and Major Adverse Cardiovascular Events Controlling for Baseline Covariates

1-year outcome	*Hazard ratio and CI Women versus men Veterans*	p-*value*
Rehospitalization	0.97 (0.55, 1.70)	0.9074
Mortality	0.89 (0.62, 1.29)	0.5385
MACE	0.94 (0.70, 1.26)	0.6624

All models adjust for age, Framingham risk category, race, and other cardiac risk factors (including congestive heart failure, cerebrovascular disease, peripheral artery disease, and chronic obstructive pulmonary disease), obesity, and acuity of presentation (acute coronary syndrome, stable angina, or other/unknown).

Mortality was 3.5% for females and 4.9% for males (*p*-value = 0.14), and MACE was 5.4% for females and 6.9% for males (*p*-value = 0.18). There were no significant sex differences in the base Cox proportional hazards models (model 1, sex and age only; results not shown) for any of the outcomes, and sex remained nonsignificant in all adjusted Cox proportional hazards models (model 4 shown on Table 3).

Discussion

The objective of this study was to examine sex differences in 1-year major adverse cardiovascular outcomes, including mortality for the national population of patients undergoing PCI at VA cardiac catheterization laboratories. We found no significant sex differences in 1-year post-PCI outcomes for this national population: women and men treated at VA cardiac catheterization laboratories experienced comparable rates of rehospitalization for MI, mortality, and MACE one year post-PCI. There were no sex differences even before adjusting for Framingham risk, race, obesity, other cardiovascular diagnoses (CHF, CAD, PAD, and COPD), and indication for PCI indicating that although the men tended to be sicker and at higher risk on most cardiovascular indicators at presentation for PCI than women, both groups still experienced similar outcomes. Our results are consistent with the prior studies showing that men and women experience similar 1-year post-PCI mortality,[16,37–39] MI,[37] and MACE;[37] however, unlike the prior literature, we found no significant differences in outcomes by sex even before adjusting for sex differences in risk.

This research is one of the first studies of sex differences and PCI on a national population of patients in a healthcare system, including 1-year mortality, MI, and MACE. Unlike prior studies, where women were older and estrogen protection over the years may have been a factor in delaying the onset of cardiovascular disease,[16,37–42] the women in our study were younger on average than the men. Yet, we still found no significant sex differences. Consistent with prior research,[16,37–40,42] women were more likely to have some comorbidities (*i.e.*, depression and obesity) than the men, yet lower rates of prior cardiac events or traditional cardiac risk factors. Veterans have on average two more comorbidities than the general population[43,44] and have higher rates of depression and other mental health conditions.[45] Therefore, the Veteran population undergoing PCI was considerably

sicker than cohorts in prior studies, yet comparable outcomes by sex remained.

Much of the inconsistency in the literature on sex differences in outcomes after PCI has focused on short-term outcomes showing women at increased risk for some complications[14–19,37,46] and similar outcomes for others.[14,16,38,40,47] Perhaps contemporary improvements in PCI[12,13] have alleviated previously seen gender differences in short-term MACE and mortality outcomes post-PCI. At the VA specifically, there may be more equitable use of bleeding avoidance strategies and other therapies, which were previously shown to be used less often with female patients in other cohorts,[15] thus leading to more equitable outcomes. Another possibility is that women who survive the early complications of PCI have a survival advantage in the long term. Given that two studies with even longer term outcomes (30–36 months) found similar risk for MI[48] and actual lower risk of mortality for women,[40,48] future research should focus on the full spectrum of the cardiovascular healing process post-PCI that spans from inhospital complications through multiyear follow-up.

Our findings support comparable treatment outcomes for women and men Veterans post-PCI; however, our data were limited to those patients seen in the cardiac laboratory for PCI and cannot address any sex/gender-related referral bias. Because past research has demonstrated sex differences in diagnosis and referral for noninvasive testing in the general population,[3] additional research is needed to evaluate referral patterns and timing to the cardiac procedures. Examinations of these patterns over time can also examine whether delays in presentation to emergency departments have changed for women and men with increased public education and awareness campaigns such as the American Heart Association's Go Red for Women.[49] As many cardiac emergencies are treated at the closest emergency room, which may or may not be VA, the focus on VA cardiac catheterization laboratories could have led to underreporting of events that were treated outside the VA and not recorded in the VA electronic medical record. Even though the CART data capture all procedures done outside of the VA that are paid for by the VA (fee basis files), future work should focus on understanding dual treatment both inside and outside the VA healthcare system. Finally, even though our analyses combined multiple years of national VA data and included over 1,000 women Veterans, the number of women Veterans undergoing PCI and experiencing postprocedural outcomes compared to men was small. This sample size restricted the number of covariates and interaction terms we could include in the final multivariable risk models, and we may have been underpowered to detect differences in the outcomes examined, particularly rehospitalization for MI. However, our estimates suggest that there are no clinically meaningful differences in these outcomes by sex. As the population of women Veterans continues to increase, there is an opportunity to continue to monitor sex differences in PCI outcomes.

Conclusions

The results are consistent with work from United States and international registries while expanding the broader literature to demonstrate similar 1-year post-PCI mortality, MI, and MACE rates for men and women in a national population of patients who are sicker and have more mental health issues than the general population. Despite the presence of these factors that usually reduce access to definitive care, we found no sex differences in outcomes: women and men Veterans experience similar post-PCI 1-year major adverse cardiac outcomes. Although the number of women Veterans at the VA has more than doubled in the last decade,[23] women are still a numerical minority at the VA. Given that the populations of men and women Veteran are different, especially in terms of age, race, cardiovascular risk factors, and indication for PCI, future research should examine interactive effects on sex and these factors in this growing population.

Acknowledgments

This research was supported by the Enhancing Mental and Physical health of Women through Engagement and Retention (EMPOWER) VA QUERI program (QUE 15-272; PI: Hamilton) and the VA Women's Health Research Network (SDR 10-012; PIs: Yano, Frayne and Hamilton). Dr. Joseph was funded by a VA Advanced Women's Health Fellowship, VA Greater Los Angeles Healthcare System (TWH 65-016). Dr. Daugherty was supported by Award Number K08HL 103776 and RO1HL133343 from the National Heart, Lung and Blood Institute. Dr. Yano's effort was funded through a VA HSR&D Senior Research Career Scientist Award (RCS 05-195)

The views expressed in the manuscript are solely those of the authors, and do not necessarily represent the views of the U.S. Department of Veterans Affairs, the United States government or the National Heart, Lung and Blood Institute.

Author Disclosure Statement

All authors report that no competing financial interests exist.

References

1. Xu J, Murphy SL, Kochanek KD, et al. Deaths: Final Data for 2013. Natl Vital Stat Rep 2016;64:1–119.
2. Vaccarino V, Badimon L, Corti R, et al. Ischaemic heart disease in women: Are there sex differences in pathophysiology and risk factors? Position paper from the working group on coronary pathophysiology and microcirculation of the European Society of Cardiology. Cardiovasc Res 2011;90:9–17.
3. Mehta LS, Beckie TM, DeVon HA, et al. Acute Myocardial Infarction in Women: A Scientific Statement From the American Heart Association. Circulation 2016;133:916–947.
4. Nguyen HL, Saczynski JS, Gore JM, et al. Age and sex differences in duration of prehospital delay in patients with acute myocardial infarction: A systematic review. Circ Cardiovasc Qual Outcomes 2010;3:82–92.
5. Lichtman JH, Leifheit-Limson EC, Watanabe E, et al. Symptom recognition and healthcare experiences of young women with acute myocardial infarction. Circ Cardiovasc Qual Outcomes 2015;8(2 Suppl 1):S31–S38.
6. Crea F, Battipaglia I, Andreotti F. Sex differences in mechanisms, presentation and management of ischaemic heart disease. Atherosclerosis 2015;241:157–168.
7. Bugiardini R, Yan AT, Yan RT, et al. Factors influencing underutilization of evidence-based therapies in women. Eur Heart J 2011;32:1337–1344.

8. Daly C, Clemens F, Lopez Sendon JL, et al. Gender differences in the management and clinical outcome of stable angina. Circulation 2006;113:490–498.
9. Virani SS, Woodard LD, Ramsey DJ, et al. Gender disparities in evidence-based statin therapy in patients with cardiovascular disease. Am J Cardiol 2015;115:21–26.
10. Bangalore S, Fonarow GC, Peterson ED, et al. Age and gender differences in quality of care and outcomes for patients with ST-segment elevation myocardial infarction. Am J Med 2012;125:1000–1009.
11. Nguyen HL, Goldberg RJ, Gore JM, et al. Age and sex differences, and changing trends, in the use of evidence-based therapies in acute coronary syndromes: Perspectives from a multinational registry. Coron Artery Dis 2010;21:336–344.
12. Roe MT, Messenger JC, Weintraub WS, et al. Treatments, trends, and outcomes of acute myocardial infarction and percutaneous coronary intervention. J Am Coll Cardiol 2010;56:254–263.
13. Singh M, Rihal CS, Gersh BJ, et al. Twenty-five-year trends in in-hospital and long-term outcome after percutaneous coronary intervention: A single-institution experience. Circulation 2007;115:2835–2841.
14. Peterson ED, Lansky AJ, Kramer J, et al. Effect of gender on the outcomes of contemporary percutaneous coronary intervention. Am J Cardiol 2001;88:359–364.
15. Daugherty SL, Thompson LE, Kim S, et al. Patterns of use and comparative effectiveness of bleeding avoidance strategies in men and women following percutaneous coronary interventions: An observational study from the National Cardiovascular Data Registry. J Am Coll Cardiol 2013;61:2070–2078.
16. Chiu JH, Bhatt DL, Ziada KM, et al. Impact of female sex on outcome after percutaneous coronary intervention. Am Heart J 2004;148:998–1002.
17. Ahmed B, Piper WD, Malenka D, et al. Significantly improved vascular complications among women undergoing percutaneous coronary intervention: A report from the Northern New England Percutaneous Coronary Intervention Registry. Circ Cardiovasc Interv 2009;2:423–429.
18. Numasawa Y, Kohsaka S, Miyata H, et al. Gender differences in in-hospital clinical outcomes after percutaneous coronary interventions: An insight from a Japanese multicenter registry. PLoS One 2015;10:e0116496.
19. Dreyer RP, Wang Y, Strait KM, et al. Gender differences in the trajectory of recovery in health status among young patients with acute myocardial infarction: Results from the variation in recovery: Role of gender on outcomes of young AMI patients (VIRGO) study. Circulation 2015;131:1971–1980.
20. Maddox TM, Plomondon ME, Petrich M, et al. A national clinical quality program for Veterans Affairs catheterization laboratories (from the Veterans Affairs clinical assessment, reporting, and tracking program). Am J Cardiol 2014;114:1750–1757.
21. Office of Research and Development. VA Research on Cardiovascular Disease Available at: www.research.va.gov/topics/cardio.cfm. Accessed June 28, 2016.
22. Katon WJ. Clinical and health services relationships between major depression, depressive symptoms, and general medical illness. Biol Psychiatry 2003;54:216–226.
23. Frayne SM, Phibbs CS, Friedman SA, et al. Sourcebook: Women Veterans in the Veterans Health Administration. Volume 1. Sociodemographic Characteristics and Use of VHA Care. Washington, DC: Women's Health Evaluation Initiative, Women Veterans Health Strategic Heatlh Care Group, Veterans Health Administration, Department of Veterans Affairs, 2010.
24. Frayne SM, Phibbs CS, Saechao F, et al. Sourcebook: Women Veterans in the Veterans Health Administration. Volume 3. Sociodemographics, Utilization, Cost of Care, and Health Profile. Washington, DC: Women's Health Evaluation Initiative, Women's Health Services, Veterans Health Administration, Department of Veterans Affairs, 2014.
25. Goldstein KM, Melnyk SD, Zullig LL, et al. Heart matters: Gender and racial differences cardiovascular disease risk factor control among veterans. Women's Health Issues 2014;24:477–483.
26. Klingensmith K, Tsai J, Mota N, et al. Military sexual trauma in US veterans: Results from the National Health and Resilience in Veterans Study. J Clin Psychiatry 2014;75:e1133–e1139.
27. Davis MB, Maddox TM, Langner P, et al. Characteristics and outcomes of women veterans undergoing cardiac catheterization in the Veterans Affairs Healthcare System: Insights from the VA CART Program. Circ Cardiovasc Qual Outcomes 2015;8(2 Suppl 1):S39–S47.
28. Brindis RG, Fitzgerald S, Anderson HV, et al. The American College of Cardiology-National Cardiovascular Data Registry (ACC-NCDR): Building a national clinical data repository. J Am Coll Cardiol 2001;37:2240–2245.
29. Maddox TM, Stanislawski MA, O'Donnell C, et al. Patient access and 1-year outcomes of percutaneous coronary intervention facilities with and without on-site cardiothoracic surgery: Insights from the Veterans Affairs (VA) Clinical Assessment, Reporting, and Tracking (CART) program. Circulation 2014;130:1383–1391.
30. Framingham Heart Study. Coronary Heart Disease (10-year risk) Available at: www.framinghamheartstudy.org/risk-functions/coronary-heart-disease/10-year-risk.php. Accessed December 17, 2015.
31. Expert Panel on Detection E. Treatment of High Blood Cholesterol in Adults. Executive Summary of The Third Report of The National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, And Treatment of High Blood Cholesterol In Adults (Adult Treatment Panel III). JAMA 2001;285:2486–2497.
32. Diagnostic Catheterization Writing G, Patel MR, Bailey SR, et al. ACCF/SCAI/AATS/AHA/ASE/ASNC/HFSA/HRS/SCCM/SCCT/SCMR/STS 2012 appropriate use criteria for diagnostic catheterization: A report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, Society for Cardiovascular Angiography and Interventions, American Association for Thoracic Surgery, American Heart Association, American Society of Echocardiography, American Society of Nuclear Cardiology, Heart Failure Society of America, Heart Rhythm Society, Society of Critical Care Medicine, Society of Cardiovascular Computed Tomography, Society for Cardiovascular Magnetic Resonance, Society of Thoracic Surgeons. J Thorac Cardiovasc Surg 2012;144:39–71.
33. VA Information Resource Center. VIReC Technical Report: VA Race Data Quality. Hines, IL: U.S. Dept. of Veterans Affairs, Health Services Research and Development Service, VA Information Resource Center 2011.
34. Gray B. cmprsk: Subdistribution Analysis of Competing Risks. R package version 2.2-7 Available at: http://CRAN.R-project.org/package=cmprsk. Accessed June 29, 2016.

35. Lin DY, Wei LJ. The Robust Inference for the Cox Proportional Hazards Model. J Am Stat Assoc 1989;84:1074–1078.
36. Team RC. R: A language and environment for statistical computing. Available at: www.R-project.org/. Accessed July 5, 2016.
37. Al-Fiadh AH, Andrianopoulos N, Farouque O, et al. Contemporary outcomes in women undergoing percutaneous coronary intervention for acute coronary syndromes. Int J Cardiol 2011;151:195–199.
38. Bakhai A, Ferrieres J, James S, et al. Treatment, outcomes, costs, and quality of life of women and men with acute coronary syndromes who have undergone percutaneous coronary intervention: Results from the antiplatelet therapy observational registry. Postgrad Med 2013;125:100–107.
39. Jacobs AK, Johnston JM, Haviland A, et al. Improved outcomes for women undergoing contemporary percutaneous coronary intervention: A report from the National Heart, Lung, and Blood Institute Dynamic registry. J Am Coll Cardiol 2002;39:1608–1614.
40. Berger JS, Sanborn TA, Sherman W, et al. Influence of sex on in-hospital outcomes and long-term survival after contemporary percutaneous coronary intervention. Am Heart J 2006;151:1026–1031.
41. Duvernoy CS, Smith DE, Manohar P, et al. Gender differences in adverse outcomes after contemporary percutaneous coronary intervention: An analysis from the Blue Cross Blue Shield of Michigan Cardiovascular Consortium (BMC2) percutaneous coronary intervention registry. Am Heart J 2010;159:677–683 e671.
42. Hess CN, McCoy LA, Duggirala HJ, et al. Sex-based differences in outcomes after percutaneous coronary intervention for acute myocardial infarction: A report from TRANSLATE-ACS. J Am Heart Assoc 2014;3:e000523.
43. Rogers WH, Kazis LE, Miller DR, et al. Comparing the health status of VA and non-VA ambulatory patients: The veterans' health and medical outcomes studies. J Ambul Care Manage 2004;27:249–262.
44. Selim AJ, Kazis LE, Rogers W, et al. Risk-adjusted mortality as an indicator of outcomes: Comparison of the Medicare Advantage Program with the Veterans' Health Administration. Med Care 2006;44:359–365.
45. Sambamoorthi U, Bean-Mayberry B, Findley PA, et al. Organization of care and diagnosed depression among women veterans. Am J Manag Care 2010;16:657–665.
46. Kwok CS, Kontopantelis E, Kunadian V, et al. Effect of access site, gender, and indication on clinical outcomes after percutaneous coronary intervention: Insights from the British Cardiovascular Intervention Society (BCIS). Am Heart J 2015;170:164–172, 172 e161–e165.
47. Singh M, Rihal CS, Gersh BJ, et al. Mortality differences between men and women after percutaneous coronary interventions. A 25-year, single-center experience. J Am Coll Cardiol 2008;51:2313–2320.
48. Anderson ML, Peterson ED, Brennan JM, et al. Short- and long-term outcomes of coronary stenting in women versus men: Results from the National Cardiovascular Data Registry Centers for Medicare & Medicaid services cohort. Circulation 2012;126:2190–2199.
49. American Heart Association. American Heart Association Go Red for Women Available at: www.goredforwomen.org/. Accessed June 6, 2016.

Address correspondence to:
Melissa Farmer, PhD
VA HSR&D Center for the Study of Healthcare Innovation Implementation & Policy
VA Greater Los Angeles Healthcare System
16111 Plummer Street (152)
Sepulveda, CA 91343

E-mail: melissa.farmer@va.gov