Association of Cardiac Rehabilitation With Survival Among US Veterans

Nirupama Krishnamurthi, MBBS, MPH; David W. Schopfer, MD, MAS; Hui Shen, MS; Mary A. Whooley, MD

Abstract

**IMPORTANCE**  Participation in cardiac rehabilitation (CR) programs at Veterans Affairs (VA) facilities is low. Most veterans receive CR through purchased care at non-VA programs. However, limited literature exists on the comparison of outcomes between VA and non-VA CR programs.

**OBJECTIVE**  To compare 1-year mortality and 1-year readmission rates for myocardial infarction or coronary revascularization between VA vs non-VA CR participants.

**DESIGN, SETTING, AND PARTICIPANTS**  This cohort study included 7320 patients hospitalized for myocardial infarction or coronary revascularization at the VA between 2010 and 2014 who did not die within 30 days of discharge and who participated in 2 or more CR sessions after discharge. The study excluded individuals hospitalized for ischemic heart disease after December 2014 when the VA Choice Act changed referral criteria for non-VA care. Data analysis was performed from November 2019 to January 2020.

**EXPOSURES**  Participation in 2 or more CR sessions within 12 months of discharge at a VA or non-VA facility.

**MAIN OUTCOMES AND MEASURES**  The 1-year all-cause mortality and 1-year readmission rates for myocardial infarction or coronary revascularization from date of discharge were compared between VA vs non-VA CR participants using Cox proportional hazards models with inverse probability treatment weighting.

**RESULTS**  The 7320 veterans with ischemic heart disease who participated in CR programs had a mean (SD) age of 65.13 (8.17) years and were predominantly white (6005 patients [82.0%]), non-Hispanic (6642 patients [91.0%]), and male (7191 patients [98.2%]). Among these 7320 veterans, 2921 (39.9%) attended a VA facility, and 4399 (60.1%) attended a non-VA CR facility. Black and Hispanic veterans were more likely to attend CR programs at VA facilities (509 patients [17.4%] and 378 patients [12.9%], respectively), whereas white veterans were more likely to attend CR programs at non-VA facilities (3759 patients [85.5%]). After inverse probability treatment weighting, rates of 1-year mortality were 1.7% among VA CR participants vs 1.3% among non-VA CR participants (hazard ratio, 1.32; 95% CI, 0.90-1.94; P = .15). Rates of readmission for myocardial infarction or revascularization during the 12 months after discharge were 4.9% among VA CR participants vs 4.4% among non-VA CR participants (hazard ratio, 1.06; 95% CI, 0.83-1.35; P = .62).

**CONCLUSIONS AND RELEVANCE**  These findings suggest that rates of 1-year mortality and 1-year readmission for myocardial infarction or revascularization did not differ for participants in VA vs non-VA cardiac rehabilitation programs. Eligible patients with ischemic heart disease should participate in CR programs regardless of where they are provided.

**Key Points**

**Question**  Among veterans with ischemic heart disease, do the morbidity and mortality benefits associated with participation in a cardiac rehabilitation program differ between Veterans Affairs (VA) (delivered care) vs non-VA (purchased care) settings?

**Findings**  In this cohort study of 7320 US veterans, rates of 1-year mortality and 1-year readmission for myocardial infarction or revascularization did not differ for participants in VA vs non-VA cardiac rehabilitation programs.

**Meaning**  These findings suggest that participation in VA vs non-VA cardiac rehabilitation programs is associated with similar 1-year benefits for morbidity and mortality.

Author affiliations and article information are listed at the end of this article.
Introduction

Cardiac rehabilitation (CR) is a multidisciplinary secondary prevention program aimed at reducing cardiovascular risk in patients with preexisting heart disease. Exercise-based CR has been shown to reduce cardiovascular-associated mortality and hospitalizations and improve quality of life in patients with coronary heart disease.\(^1\,\^2\) Referral to CR is a class I recommendation from the American Heart Association and the American College of Cardiology for patients with recent myocardial infarction (MI), percutaneous coronary intervention (PCI), coronary artery bypass grafting (CABG), chronic stable angina, or heart failure.\(^3\)\(^-\)\(^5\)

Historically, participation in CR programs in the US Department of Veterans Affairs (VA) has been reported to be low among patients with ischemic heart disease, with substantial geographic variation across the country.\(^6\)\(^-\)\(^8\) The VA is adopting innovative means to improve CR participation; however, because not all VA facilities offer CR and a large proportion of veterans live far from a VA facility, referral to a CR program outside the VA (non-VA CR) is a common practice. Evaluation of CR outcomes in the VA (including non-VA referrals) is important to inform policy decisions and clinical care, particularly in the setting of recent changes in VA policy resulting in a potential increase in the use of community care referrals for health care in the VA.

Limited literature currently exists on the comparison of outcomes between VA-delivered and non-VA (purchased community care) CR programs. Therefore, we conducted a cohort study using the national VA electronic health record to compare 1-year all-cause mortality and 1-year readmission rates for non-fatal MI, PCI, and/or CABG among veterans attending VA and non-VA CR programs.

Methods

This study was approved by the San Francisco Veterans Health Administration and University of California, San Francisco institutional review boards. The requirement for informed consent was waived because the research involved no more than minimal risk to the participants, the waiver did not adversely affect the rights or welfare of the participants, and the research could not practically be performed without the waiver. This study follows the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline for cohort studies.

We extracted electronic health record data from the national VA Corporate Data Warehouse for this study. Patients hospitalized for MI, PCI, or CABG at a VA hospital between 2010 and 2014 were identified using the following International Classification of Diseases, Ninth Revision (ICD-9), Current Procedural Terminology (CPT), and Healthcare Common Procedure Coding System (HCPCS) codes: MI (ICD-9 code 410.x), PCI (ICD-9 codes 00.66, 17.55, and 36.Ox; CPT codes 92973, 92974, 92980-92982, 92984, 92995, and 92996; HCPCS codes G0290 and G0291), and CABG (ICD-9 codes 36.O0-36.16, 36.19, and 36.2O; CPT codes 33510-33514, 33516-33519, 33521-33523, 33530, 33533-33536, 33572, 35600, and 93564; HCPCS codes S2205-S2209). To ensure that all patients in the study had similar access to CR, we did not include individuals hospitalized for ischemic heart disease after December 2014, when the VA Choice Act was implemented and substantially changed the approval criteria for veterans to seek purchased care at non-VA hospitals.

Patients who died within 30 days of discharge were excluded from the analysis. Among the remaining patients, we identified those who participated in 2 or more CR sessions within 12 months of discharge using CPT codes 93797, 93798, S9472, S9473, GO422, and GO423 and classified them as CR participants. Because visits and intake sessions without any exercise are often recorded using the same codes as those with exercise training, we required 2 or more encounters associated with the CR codes to qualify as participation to ensure at least 1 session of exercise training and/or behavioral education. Patients hospitalized for MI, PCI, or CABG between 2010 and 2014 who had only 1 or no CR sessions within 12 months of discharge were excluded from the analysis. Any CR encounters obtained from the VA outpatient tables were classified as VA CR, whereas those obtained from Fee Basis files (containing information about health care visits outside the VA that were paid...
for by the VA) were categorized as non-VA CR. The number of CR sessions was calculated from the first session up to a period of 6 months after the first session. For patients who had multiple events (ie, ≥2 hospitalizations for MI, PCI, or CABG) between 2010 and 2014, we selected the first episode of CR participation.

Information on patient demographic characteristics, geographical location, and comorbid conditions (defined as conditions coded in 2 outpatient and/or 1 inpatient encounter in the 12 months before hospitalization) was obtained from the Corporate Data Warehouse files. Mortality and readmissions for major adverse cardiovascular events, including hospitalization for acute MI or coronary revascularization in VA or non-VA settings, were assessed during the 12 months after discharge. Patients who died before starting CR were excluded. Readmissions were counted only if they occurred after at least 2 CR sessions.

**Statistical Analysis**

Baseline characteristics of participants were compared using χ² tests for categorical variables and 2-sided t tests for continuous variables, with P < .05 considered statistically significant. Stabilized propensity weights were generated for VA CR vs non-VA CR participants using data on patient demographic characteristics, regional distribution, indication for CR, and comorbid conditions. We used Cox proportional hazards models with inverse probability treatment weighting to compare mortality and readmissions for VA CR participants with those for non-VA CR participants. Sensitivity analysis was performed by stratifying participants into 2 groups according to time to first CR session from discharge (0-6 months vs >6 months) and then comparing mortality and readmission outcomes between VA and non-VA CR participants within the 2 strata. All statistical analyses were performed using SAS Enterprise Guide statistical software version 7.15 HF3 (SAS Institute) and Stata statistical software version 15.1 (StataCorp). Data analyses were performed from November 2019 to January 2020.

**Results**

Between 2010 and 2014, 84,489 patients were hospitalized at a VA facility in the US for MI, PCI, or CABG. Among these eligible patients, 7,320 (8.7%) participated in 2 or more CR sessions. Patients who participated in CR had a mean (SD) age of 65.13 (8.17) years and were predominantly white (6,005 patients [82.0%]), non-Hispanic (6,642 patients [91.0%]), and male (7,191 patients [98.2%]) (Table 1). Of the 7,320 CR participants, 2,921 (39.9%) attended CR programs at a VA facility, and the remainder 4,399 (60.1%) attended a non-VA CR facility. Black and Hispanic veterans were more likely to attend CR programs at VA facilities (509 patients [17.4%] and 378 patients [12.9%], respectively), whereas white veterans were more likely to attend non-VA facilities (3,759 patients [85.5%]). Between 2010 and 2014, the number of non-VA CR participants steadily increased (from 766 veterans in 2010 to 1,032 veterans in 2014), whereas the number of VA CR participants remained stable (596 veterans in 2010 and 614 veterans in 2014). The 2 groups were similar in terms of the distribution of comorbid conditions; however, non-VA CR participants had higher rates of comorbid hypertension (3,212 patients [73.0%] vs 1,958 patients [67.0%]) and dyslipidemia (3,122 patients [71.0%] vs 1,975 patients [67.6%]), whereas VA CR participants had more chronic kidney disease (371 patients [12.7%] vs 459 patients [10.4%]).

Time from index event to CR enrollment was similar in VA vs non-VA programs (63 vs 60 days). The unadjusted 1-year mortality rate was similar between VA and non-VA CR participants (1.9% vs 1.5%). Similarly, the unadjusted 1-year overall readmission rates for MI, PCI, or CABG did not differ between VA and non-VA CR participants (5.1% vs 4.5%). However, the unadjusted readmission rate for CABG was lower (0.1% vs 0.4%), and the readmission rate for PCI was higher (3.6% vs 2.5%), among VA vs non-VA participants (Table 1). On applying inverse probability treatment weighting, both groups were similar in their weighted distribution of demographic characteristics and comorbid conditions (Table 2). Rates of 1-year
Table 1. Characteristics of Veterans Attending CR Programs at VA vs Non-VA Facilities

| Characteristic                              | CR program participants, No. (%) |
|---------------------------------------------|----------------------------------|
|                                             | Total (N = 7320) | VA (n = 2921) | Non-VA (n = 4399) | P value |
| Age, mean (SD), y                           | 65.13 (8.17) | 65.26 (8.39) | 65.04 (8.02) | .26 |
| Male                                        | 7191 (98.2) | 2866 (98.1) | 4325 (98.3) | .52 |
| Racea                                       |                   |                   |                   |      |
| White                                       | 6005 (82.0) | 2246 (76.9) | 3759 (85.5) | <.001 |
| Black                                        | 868 (11.9) | 509 (17.4) | 359 (8.2) |      |
| Other                                        | 319 (4.4) | 129 (4.4) | 190 (4.3) |      |
| Ethnicity, Hispanic or Latino<sup>b</sup>   | 508 (6.9) | 378 (12.9) | 130 (3.0) | <.001 |
| Marital status, married<sup>c</sup>        | 4092 (55.9) | 1459 (49.9) | 2633 (59.9) | <.001 |
| Year of discharge                           |                   |                   |                   |      |
| 2010                                        | 1362 (18.6) | 596 (20.4) | 766 (17.4) |      |
| 2011                                        | 1422 (19.4) | 587 (20.1) | 835 (19.0) |      |
| 2012                                        | 1387 (18.9) | 560 (19.2) | 827 (18.8) |      |
| 2013                                        | 1503 (20.5) | 564 (19.3) | 939 (21.3) |      |
| 2014                                        | 1646 (22.5) | 614 (21.0) | 1032 (23.5) |      |
| VA region                                   |                   |                   |                   |      |
| Midwest                                     | 2703 (36.9) | 805 (27.6) | 1898 (43.1) | <.001 |
| Southeast                                   | 1730 (23.6) | 786 (26.9) | 944 (21.5) |      |
| North Atlantic                               | 1252 (17.1) | 420 (14.4) | 832 (18.9) |      |
| Continental                                  | 975 (13.3) | 637 (21.8) | 338 (7.7) |      |
| Pacific                                      | 660 (9.0) | 273 (9.3) | 387 (8.8) |      |
| Indication for CR                           |                   |                   |                   |      |
| Acute myocardial infarction                  | 2435 (33.3) | 981 (33.6) | 1454 (33.1) | .04 |
| Coronary artery bypass grafting             | 2613 (35.7) | 1080 (37.0) | 1533 (34.8) |      |
| Percutaneous coronary intervention           | 2272 (31.0) | 860 (29.4) | 1412 (32.1) |      |
| Comorbid conditions                          |                   |                   |                   |      |
| Hypertension                                 | 5170 (70.6) | 1958 (67.0) | 3212 (73.0) | <.001 |
| Dyslipidemia                                 | 5097 (69.6) | 1975 (67.6) | 3122 (71.0) | .002 |
| Diabetes                                     | 3060 (41.8) | 1186 (40.6) | 1874 (42.6) | .09 |
| Heart failure                                | 995 (13.6) | 435 (14.9) | 560 (12.7) | .01 |
| Stroke                                       | 298 (4.1) | 140 (4.8) | 158 (3.6) | .01 |
| Peripheral vascular disease                  | 808 (11.0) | 297 (10.2) | 511 (11.6) | .05 |
| Chronic obstructive pulmonary disease        | 1003 (13.7) | 382 (13.1) | 621 (14.1) | .21 |
| Chronic kidney disease                       | 830 (11.3) | 371 (12.7) | 459 (10.4) | .002 |
| Valvular heart disease                       | 908 (12.4) | 351 (12.0) | 557 (12.7) | .41 |
| Arrhythmias                                  | 1259 (17.2) | 474 (16.2) | 785 (17.8) | .07 |
| Cancer                                       | 810 (11.1) | 358 (12.3) | 452 (10.3) | .01 |
| Dementia                                     | 32 (0.4) | 15 (0.5) | 17 (0.4) | .42 |
| Anemia                                       | 837 (11.4) | 360 (12.3) | 477 (10.8) | .05 |
| Depression                                   | 1466 (20.0) | 607 (20.8) | 859 (19.5) | .19 |
| Posttraumatic stress disorder                | 925 (12.6) | 348 (11.9) | 577 (13.1) | .13 |
| Alcohol abuse or dependence                  | 419 (5.7) | 186 (6.4) | 233 (5.3) | .05 |
| Smoking                                      | 1968 (26.9) | 750 (25.7) | 1218 (27.7) | .06 |
| Time from discharge to first CR session, median (interquartile range), d | 61 (37-105) | 63 (40-106) | 60 (35-105) | .27 |
| 1-y Mortality                                | 122 (1.7) | 56 (1.9) | 66 (1.5) | .17 |
| 1-y Readmissions total                       | 346 (4.7) | 148 (5.1) | 198 (4.5) | .26 |
| Myocardial infarction                        | 112 (1.5) | 41 (1.4) | 71 (1.6) | .47 |
| Coronary bypass grafting                     | 19 (0.3) | 3 (0.1) | 16 (0.4) | .03 |
| Percutaneous coronary intervention           | 215 (2.9) | 104 (3.6) | 111 (2.5) | .01 |

Abbreviations: CR, cardiac rehabilitation; VA, Veterans Affairs.

<sup>a</sup> Data on race were missing for 128 participants (37 VA participants and 91 non-VA participants).

<sup>b</sup> Data on ethnicity were missing for 170 participants (66 VA participants and 104 non-VA participants).

<sup>c</sup> Data on marital status were missing for 1 VA participant.
mortality were 1.7% among VA vs 1.3% among non-VA CR participants (hazard ratio [HR], 1.32; 95% CI, 0.90-1.94; \( P = .15 \) (Figure 1A and Table 3). Rates of readmission for MI or revascularization during the 12 months after discharge were 4.9% among VA participants vs 4.4% among non-VA CR participants (HR, 1.06; 95% CI, 0.83-1.35; \( P = .35 \)) (Figure 1B and Table 3). Separate Cox proportional hazard models estimating the hazard of readmission for MI and CABG did not show any statistically significant differences.

## Table 2. Weighted Distribution of Participant Characteristics by CR Delivery Site

| Characteristic                        | CR program participants, % | P value |
|---------------------------------------|-----------------------------|---------|
|                                       | VA                          | Non-VA  |         |
| Age, mean (SD), y                     | 64.94 (8.14)                | 64.96 (8.22) | .90     |
| Male                                  | 98.1                        | 98.2    | .74     |
| Race                                  |                             |         |         |
| White                                 | 83.8                        | 84.0    |         |
| Black                                 | 12.1                        | 12.0    | .97     |
| Other                                 | 4.1                         | 4.0     |         |
| Ethnicity, Hispanic or Latino         | 6.9                         | 8.5     | .07     |
| Marital status, married               | 55.6                        | 55.3    | .80     |
| Year of discharge                     |                             |         |         |
| 2010                                  | 18.0                        | 17.8    |         |
| 2011                                  | 18.8                        | 18.2    |         |
| 2012                                  | 18.7                        | 18.9    | .97     |
| 2013                                  | 20.9                        | 21.0    |         |
| 2014                                  | 23.6                        | 24.1    |         |
| VA region                             |                             |         |         |
| Midwest                               | 37.2                        | 36.4    |         |
| Southeast                             | 23.5                        | 22.0    |         |
| North Atlantic                        | 16.5                        | 16.8    | .26     |
| Continental                           | 13.4                        | 15.4    |         |
| Pacific                               | 9.4                         | 9.4     |         |
| Indication for CR                     |                             |         |         |
| Acute myocardial infarction           | 33.7                        | 34.0    |         |
| Coronary artery bypass grafting       | 35.3                        | 34.8    | .93     |
| Percutaneous coronary intervention    | 30.9                        | 31.1    |         |
| Comorbid conditions                   |                             |         |         |
| Hypertension                          | 70.4                        | 70.1    | .83     |
| Dyslipidemia                          | 68.9                        | 68.9    | .96     |
| Diabetes                              | 41.5                        | 41.5    | .98     |
| Heart failure                         | 13.4                        | 13.3    | .92     |
| Stroke                                | 4.1                         | 4.3     | .70     |
| Peripheral vascular disease           | 11.0                        | 10.9    | .89     |
| Chronic obstructive pulmonary disease | 13.7                        | 13.9    | .88     |
| Chronic kidney disease                | 11.4                        | 11.1    | .75     |
| Valvular heart disease                | 12.4                        | 12.7    | .73     |
| Arrhythmias                           | 17.4                        | 17.2    | .85     |
| Cancer                                | 11.1                        | 10.8    | .79     |
| Dementia                              | 0.4                         | 0.4     | .90     |
| Anemia                                | 11.6                        | 11.6    | .96     |
| Depression                            | 20.2                        | 20.1    | .92     |
| Posttraumatic stress disorder         | 12.5                        | 13.0    | .54     |
| Alcohol abuse or dependence           | 6.1                         | 6.4     | .65     |
| Smoking                               | 26.9                        | 27.1    | .85     |
| 1-y Mortality                         | 1.7                         | 1.3     | .15     |
| 1-y Readmission                       | 4.9                         | 4.4     | .35     |

Abbreviations: CR, cardiac rehabilitation; VA, Veterans Affairs.
significant difference between the 2 groups; however, the hazard of 1-year readmission for PCI was higher among VA CR participants than non-VA CR participants (HR, 1.45; 95% CI, 1.08-1.94; \( P = .01 \)).

On stratifying patients by time from discharge to first CR session, we found that 6561 patients (89.6%) started CR within 6 months of discharge and the remaining 759 patients (10.3%) started CR after 6 months. We found no differences in 1-year mortality (HR, 1.33; 95% CI, 0.90-1.97; \( P = .15 \)) or 1-year overall readmission (HR, 1.06; 95% CI, 0.82-1.35; \( P = .66 \)) rates for MI or revascularization between VA and non-VA CR participants in either strata (Table 3). Figure 2 shows the probability of mortality at 1 year according to the number of CR sessions.

**Discussion**

Among patients who were hospitalized at a VA facility between 2010 and 2014 for MI, PCI, or CABG, only 8.7% participated in CR, with 39.9% of participants attending VA-delivered CR programs and 60.1% attending non-VA (purchased care) CR programs. Black and Hispanic veterans were more likely to attend VA CR, whereas white veterans were more likely to attend non-VA CR, suggesting that VA-delivered care may address some of the racial and ethnic disparities seen in prior studies. There were no statistically significant differences in rates of 1-year mortality or 1-year overall readmissions for major adverse cardiovascular events between those who attended CR in VA vs non-VA settings. These findings highlight the need to redouble efforts to improve participation in CR, regardless of where it is provided, among eligible patients with ischemic heart disease.

**Table 3. Mortality and Readmissions at 1 Year Among All Patients Who Underwent CR at VA vs Non-VA Facilities and Among Patients Who Started CR Within 6 Months of Discharge**

| Characteristic               | All patients | Patients who started CR within 6 mo |
|------------------------------|--------------|-------------------------------------|
|                              | HR (95% CI)  | \( P \) value                       | HR (95% CI)  | \( P \) value                       |
| 1-y Mortality                | 1.32 (0.90-1.94) | .15                                 | 1.33 (0.90-1.97) | .15                                 |
| 1-y Readmission total        | 1.06 (0.83-1.35) | .62                                 | 1.06 (0.82-1.35) | .66                                 |
| Myocardial infarction        | 0.71 (0.45-1.12) | .14                                 | 0.71 (0.44-1.14) | .16                                 |
| Coronary bypass grafting     | 0.28 (0.07-1.10) | .07                                 | 0.29 (0.07-1.14) | .07                                 |
| Percutaneous coronary        | 1.45 (1.08-1.94) | .01                                 | 1.46 (1.08-1.96) | .01                                 |

Abbreviations: CR, cardiac rehabilitation; HR, hazard ratio; VA, Veterans Affairs.
Prior studies\textsuperscript{1,2,9-15} have established the association of CR with reduced cardiovascular mortality. Several studies\textsuperscript{16-23} have compared the quality of care between VA and non-VA settings; however, to our knowledge, this study is the first to compare outcomes of CR between VA and non-VA facilities. A systematic review comparing the quality of VA and non-VA care found that mortality outcomes were comparable between the 2 settings or favored VA care, depending on the condition studied.\textsuperscript{21} A study\textsuperscript{22} from 2007 found higher mortality rates in VA facilities among patients who underwent revascularization procedures. However, 2 newer studies\textsuperscript{20,24} looking at 30-day mortality outcomes found that compared with non-VA care, VA care was associated with better survival among patients hospitalized for MI or PCI. One study\textsuperscript{20} found higher readmission rates for MI in the VA compared with non-VA hospitals.

Given the heterogeneity in outcomes between VA and non-VA care, it is reassuring to find that participation in CR programs in either setting is associated with similar all-cause mortality and overall readmission rates for MI or revascularization. This is particularly relevant in light of the fact that most VA medical centers do not have on-site CR programs, necessitating referral to non-VA programs.\textsuperscript{7,8} In addition, a qualitative study\textsuperscript{25} looking at barriers to CR participation in the VA found that the most common reason for refusal was patient transportation issues. Because there is discussion around expanding community care in the VA alongside the impetus to increase CR participation, our research can help inform both practitioner and patient decisions around referral to CR.

Our results included a higher probability of 1-year readmission for PCI among VA CR participants than non-VA CR participants. However, our analysis only captured readmissions at VA hospitals or non-VA hospitals that were reimbursed by the VA. Veterans who attended non-VA CR may have been more likely than those who attended VA CR programs to have rehospitalizations covered through private insurance or Medicare, in which case we could have undercounted readmissions in the non-VA care group. Given that the mortality rates and 1-year MI readmission rates were similar between the 2 groups, the finding that VA CR participants were readmitted more often for PCI (at VA facilities or those reimbursed by the VA) should not be viewed as an indicator of a worse health outcome.

Limitations

There are several limitations to our study. Because we used electronic health records to obtain nationwide data for this study, we were unable to account for intangible factors, such as patient motivation and psychological factors that play an important role in CR participation and completion. We were also unable to account for data such as numbers of vessels revascularized, ejection fraction, or medication adherence, which are important measures of disease severity. However, we adjusted for CR indication and traditional risk factors for cardiovascular disease, which would, in part, reflect

Figure 2. Probability of Mortality at 1 Year by Number of Cardiac Rehabilitation (CR) Sessions
Furthermore, CR is available at fewer than one-half of VA facilities, and we did not have information on which facilities offered formal CR programs. Thus, we were unable to include program availability or distance to VA CR programs in our propensity model.

Conclusions

This study found that VA and non-VA CR programs were associated with similar 1-year mortality and 1-year overall readmission rates for MI, PCI, or CABG. We hope that these findings encourage greater referral of all eligible patients to CR, either at the VA or outside the VA, and promote adherence to CR programs. In addition, we hope that this information helps patients make an informed decision about participation in and completion of CR programs.
4. Thomas RJ, King M, Lui K, Oldridge N, Piña IL, Spertus J; Writing Committee Members. AACVPR/ACCF/AHA 2010 update: performance measures on cardiac rehabilitation for referral to cardiac rehabilitation/secondary prevention services—a report of the American Association of Cardiovascular and Pulmonary Rehabilitation and the American College of Cardiology Foundation/American Heart Association Task Force on Performance Measures (Writing Committee to Develop Clinical Performance Measures for Cardiac Rehabilitation). Circulation. 2010;122(13):1342-1350. doi:10.1161/CIR.0b013e3181f51859

5. McMahon SR, Ades PA, Thompson PD. The role of cardiac rehabilitation in patients with heart disease. Trends Cardiovasc Med. 2017;27(6):420-425. doi: 10.1016/j.tcm.2017.02.005

6. Beatty AL, Truong M, Schopfer DW, Shen H, Bachmann JM, Whooley MA. Geographic variation in cardiac rehabilitation participation in Medicare and Veterans Affairs populations: opportunity for improvement. Circulation. 2018;137(18):1899-1908. doi:10.1161/CIRCULATIONAHA.117.029471

7. Schopfer DW, Krishnamurthi N, Shen H, Duvernoy CS, Forman DE, Whooley MA. Association of Veterans Health Administration home-based programs with access to and participation in cardiac rehabilitation. JAMA Intern Med. 2018;178(5):715-717. doi:10.1001/jamainternmed.2017.8039

8. Schopfer DW, Takemoto S, Allsup K, et al. Cardiac rehabilitation use among veterans with ischemic heart disease. JAMA Intern Med. 2014;174(10):1687-1689 [retracted and replaced in: JAMA Intern Med. 2016;176(11):1726-1727]. doi:10.1001/jamainternmed.2014.3441

9. Beatty AL, Doll JA, Schopfer DW, et al. Cardiac rehabilitation participation and mortality after percutaneous coronary intervention: insights from the Veterans Affairs Clinical Assessment, Reporting, and Tracking Program. J Am Heart Assoc. 2018;7(19):e010010. doi:10.1161/JAHA.118.010010

10. Chernomordik F, Sabbag A, Tzur B, et al. Cardiac rehabilitation following an acute coronary syndrome: trends in referral, predictors and mortality outcome in a multicenter national registry between years 2006-2013—report from the Working Group on Cardiac Rehabilitation, the Israeli Heart Society. Eur J Prev Cardiol. 2017;24(2):123-132. doi:10.1177/2047487316680692

11. Coll-Fernández R, Coll R, Pascual T, et al. Cardiac rehabilitation and outcome in stable outpatients with recent myocardial infarction. Arch Phys Med Rehabil. 2014;95(2):322-329. doi:10.1016/j.apmr.2013.09.020

12. Dunlay SM, Pack QR, Thomas RJ, Killian JM, Roger VL. Participation in cardiac rehabilitation, readmissions, and death after acute myocardial infarction. Am J Med. 2014;127(6):538-546. doi:10.1016/j.amjmed.2014.02.008

13. Rauch B, Davos CH, Doherty P, et al; Cardiac Rehabilitation Section, European Association of Preventive Cardiology (EAPC); Institute of Medical Biometry and Informatics (IMBi), Department of Medical Biometry, University of Heidelberg; Cochrane Metabolic and Endocrine Disorders Group, Institute of General Practice, Heinrich-Heine University. The prognostic effect of cardiac rehabilitation in the era of acute revascularisation and statin therapy: a systematic review and meta-analysis of randomized and non-randomized studies—the Cardiac Rehabilitation Outcome Study (CROS). Eur J Prev Cardiol. 2016;23(18):1914-1939. doi:10.1177/2047487316671181

14. Sunner J, Harrison A, Doherty P. The effectiveness of modern cardiac rehabilitation: a systematic review of recent observational studies in non-attenders versus attenders. PLoS One. 2017;12(5):e0177658. doi:10.1371/journal.pone.0177658

15. Witt BJ, Jacobsen SJ, Weston SA, et al. Cardiac rehabilitation after myocardial infarction in the community. J Am Coll Cardiol. 2004;44(5):988-996. doi:10.1016/j.jacc.2004.05.062

16. Bilimoria KY, Bentrem DJ, Tomlinson JS, et al. Quality of pancreatic cancer care at Veterans Administration compared with non-Veterans Administration hospitals. Am J Surg. 2007;194(5):588-593. doi:10.1016/j.amjsurg.2007.07.012

17. Choi JC, Bakaeen FG, Huh J, et al. Outcomes of coronary surgery at a Veterans Affairs hospital versus other hospitals. J Surg Res. 2009;156(1):150-154. doi:10.1016/j.jss.2009.03.041

18. Fink AS, Hutter MM, Campbell DC Jr, Henderson WG, Mosca C, Khuri SF. Comparison of risk-adjusted 30-day postoperative mortality and morbidity in Department of Veterans Affairs hospitals and selected university medical centers: general surgical operations in women. J Am Coll Surg. 2007;204(6):1127-1136. doi:10.1016/j.jamcollsurg.2007.02.060

19. Henderson WG, Khuri SF, Mosca C, Fink AS, Hutter MM, Neumayer LA. Comparison of risk-adjusted 30-day postoperative mortality and morbidity in Department of Veterans Affairs hospitals and selected university medical centers: general surgical operations in men. J Am Coll Surg. 2007;204(6):1103-1114. doi:10.1016/j.jamcollsurg.2007.02.068

20. Nuti SV, Qin L, Rumsfeld JS, et al. Association of admission to Veterans Affairs hospitals vs non-Veterans Affairs hospitals with mortality and readmission rates among older men hospitalized with acute myocardial infarction, heart failure, or pneumonia. JAMA. 2016;315(6):582-592. doi:10.1001/jama.2016.0278
21. O'Hanlon C, Huang C, Sloss E, et al. Comparing VA and non-VA quality of care: a systematic review. *J Gen Intern Med*. 2017;32(1):105-121. doi:10.1007/s11606-016-3775-2

22. Vaughan-Sarrazin MS, Wakefield B, Rosenthal GE. Mortality of Department of Veterans Affairs patients undergoing coronary revascularization in private sector hospitals. *Health Serv Res*. 2007;42(5):1802-1821. doi:10.1111/j.1475-6773.2007.00720.x

23. Wang V, Coffman CJ, Stechuchak KM, et al. Comparative assessment of utilization and hospital outcomes of Veterans receiving VA and non-VA outpatient dialysis. *Health Serv Res*. 2018;53(3)(suppl):5309-5330. doi:10.1111/1475-6773.13022

24. Barnett PG, Hong JS, Carey E, Grunwald GK, Joynt Maddox K, Maddox TM. Comparison of accessibility, cost, and quality of elective coronary revascularization between Veterans Affairs and community care hospitals. *JAMA Cardiol*. 2018;3(2):133-141. doi:10.1001/jamacardio.2017.4843

25. Schopfer DW, Priano S, Allsup K, et al. Factors associated with utilization of cardiac rehabilitation among patients with ischemic heart disease in the Veterans Health Administration: a qualitative study. *J Cardiopulm Rehabil Prev*. 2016;36(3):167-173. doi:10.1097/HCR.0000000000000166