Circulation
JOURNAL OF THE AMERICAN HEART ASSOCIATION

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Circulation. 2007;116:1653-1662; originally published online September 24, 2007;
doi: 10.1161/CIRCULATIONAHA.107.701466
Circulation is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231

Print ISSN: 0009-7322. Online ISSN: 1524-4539

Use of Cardiac Rehabilitation by Medicare Beneficiaries After Myocardial Infarction or Coronary Bypass Surgery

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Background—Cardiac rehabilitation (CR) is effective in prolonging survival and reducing disability in patients with coronary heart disease. However, national use patterns and predictors of CR use have not been evaluated thoroughly.

Methods and Results—Using Medicare claims, we analyzed outpatient (phase II) CR use after hospitalizations for acute myocardial infarctions or coronary artery bypass graft surgery in 267 427 fee-for-service beneficiaries aged ≥65 years who survived for at least 30 days after hospital discharge. We used multivariable analyses to identify predictors of CR use and to quantify geographic variations in its use. We obtained unadjusted, adjusted-smoothed, and standardized rates of CR use by state. Overall, CR was used in 13.9% of patients hospitalized for acute myocardial infarction and 31.0% of patients who underwent coronary artery bypass graft surgery. Older individuals, women, nonwhites, and patients with comorbidities (including congestive heart failure, previous stroke, diabetes mellitus, or cancer) were significantly less likely to receive CR. Coronary artery bypass graft surgery during the index hospitalization, higher median household income, higher level of education, and shorter distance to the nearest CR facility were important predictors of higher CR use. Adjusted CR use varied 9-fold among states, ranging from 6.6% in Idaho to 53.5% in Nebraska. The highest CR use rates were clustered in the north central states of the United States.

Conclusions—CR use is relatively low among Medicare beneficiaries despite convincing evidence of its benefits and recommendations for its use by professional organizations. Use is higher after coronary artery bypass graft surgery than with acute myocardial infarctions not treated with revascularization procedures and varies dramatically by state and region of the United States. **(*Circulation*. 2007;116:1653-1662.)**

Key Words: bypass ■ coronary disease ■ exercise ■ myocardial infarction ■ prevention

Patients with coronary heart disease (CHD) who have experienced an acute myocardial infarction (AMI) or have undergone coronary artery bypass graft (CABG) surgery are prime candidates for cardiac rehabilitation (CR) services. Meta-analyses of randomized controlled trials have consistently shown that participation in CR programs improves mortality and morbidity outcomes and may favorably influence cardiac risk factors.[1–5] In these studies, reductions in all-cause mortality ranged from 15% to 28% and reductions in cardiac mortality from 26% to 31%. Although some of these trials preceded concomitant intensive approaches to reduce coronary risk reduction, such as the widespread use of antilipemic medications, survival benefits were of a magnitude similar to those observed in more recent studies.[5] Exercise training in CR programs has been shown to be safe, with very low rates of nonfatal myocardial infarctions or cardiac mortality among patients of all ages.[6,7]

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A clinical practice guideline for CR was published in 1995 and subsequently endorsed by a number of professional associations[6,8,9] and the Centers for Medicare and Medicaid Services (CMS).[10] Core components of CR include an exercise plan; nutritional counseling; management of blood lipid levels, diabetes mellitus, high blood pressure, and weight; smoking cessation; and psychosocial interventions.[11]

Hospitalizations for coronary diagnoses frequently provide patients with inpatient or phase I CR, including supervised early mobilization and education on controlling risk factors and physical activities after discharge. However, as the duration of hospitalization for AMI has shortened,[12] outpatient CR has become increasingly important. Outpatient (phase II) CR can be initiated as soon as 3 weeks after hospital discharge, generally in a supervised hospital- or community-based ambulatory setting, and includes super-

Received March 11, 2007; accepted July 12, 2007.

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Circulation is available at http://circ.ahajournals.org DOI: 10.1161/CIRCULATIONAHA.107.701466

vised exercise, nutrition counseling, and other lifestyle modification interventions aimed at reducing cardiac risk factors. After supervised CR, patients are encouraged to maintain healthy lifestyles and unsupervised exercise with periodic monitoring of symptoms, risk factors, and medications by medical providers (phase III CR).

The high prevalence of CHD and its important contribution to disability[13] underscore the importance of efforts to improve clinical outcomes and prevent recurrent CHD events. In 2003, >13 million people in the United States had CHD, >860 000 people suffered AMIs, and 480 000 people died of CHD.[14] Disease burdens are especially high in people aged ≥65 years, who account for >55% of AMIs and 86% of CHD deaths.[15] The economic burden of CHD (both medical and social costs) falls disproportionately on the elderly.

Since 1982, Medicare, the primary health insurer for people in the United States aged ≥65 years, has provided coverage for up to 3 weekly outpatient CR sessions for 3 months after AMI, CABG surgery, or stable angina pectoris, if these sessions are prescribed and supervised by a physician.[10] In March 2006, CMS expanded coverage to include percutaneous revascularization procedures, heart valve surgery, and heart or heart-lung transplant.[16]

Using Medicare claims data, we identified patient and hospital predictors of outpatient CR use. This is the largest (267 427 patients) and most comprehensive analysis to date of the use of outpatient CR.

Methods

Cohort

The cohort consisted of Medicare beneficiaries who had an index hospitalization in 1997 in a US nonfederal, acute care hospital with "a qualifying coronary diagnosis or procedure." Inclusion was based on a principal discharge diagnosis code (with the use of the *International Classification of Diseases, Ninth Revision* code for AMI [410.xx] or a procedure code for CABG [36.1x]). For patients with >1 qualifying admission during 1997, the earliest admission was considered the "index" admission.

Additional inclusion criteria were age ≥65 years at the time of admission, an index hospitalization stay of ≤31 days and alive at 30 days after discharge (used to identify reasonable CR candidates), and uninterrupted enrollment in fee-for-service payment (not in capitated health plan) and entitlement under Medicare Part A and Part B during the 12 months after the index hospitalization discharge date. Patients with index hospitalizations in Puerto Rico or US territories were excluded because of small numbers of patients.

Data Sources

The primary data source was Medicare's National Claims History File. For qualifying patients, we linked inpatient claims with Medicare's master enrollment database to obtain information on date of birth, sex, race, date of death (where applicable), residence zip code, enrollment status over time, entitlements (Part A and Part B), and group health plan membership. Census 2000 data were linked to the patient's residence zip code statistics as proxies for socioeconomic, educational, and disability statuses. We used American Hospital Association and Medicare data to determine hospital characteristics for index admissions.

CR Services Use

The use of CR services was defined as any Medicare payment in hospital outpatient claims for at least 1 CR session (Current Procedure Terminology codes 93797 and 93798) within 1 year after discharge from the index hospitalization. We also evaluated how soon after discharge from the index hospitalization CR was initiated. We characterized CR intensity by the number of sessions received within 1 year and the number of days they spanned.

Predictors of CR Use

Predictors of CR use were identified with the use of Andersen and Aday's classic behavioral model of health services utilization that focuses on predisposing, enabling, and illness characteristics of patients.[17,18] CR candidates were classified into 2 main groups: AMI or CABG surgery without AMI. Patients with AMI were further classified into 3 subgroups: medical treatment only, percutaneous coronary intervention (PCI) without CABG, or CABG. Patients who received both CABG and PCI were classified as CABG.

Patient demographic and comorbidity characteristics were examined with the use of information from the claims data. We identified 25 comorbidity groups considered related to CR use that resembled Charlson's groupings using diagnostic and procedure codes from the index hospitalization (or any hospitalization within 1 year before) and DxCG software (DxCG, Inc, Boston, Mass, 2001[19]). For patients aged 65 years, the qualifying age for Medicare benefits for the elderly, on average the claims file contained only half a year of prehospitalization data to identify comorbid conditions. These participants represented only ≈6% of the entire study cohort.

We also examined distance from the patient's residence to the nearest CR facility. Distance to CR was defined as the shortest distance (in miles) from the patient's zip code centroid to the nearest available CR facility within the state (located by its exact latitude and longitude). We assumed that patients did not cross state borders to receive CR.

Patient socioeconomic characteristics were inferred by Medicaid dual eligibility and census data. Enrollment in Medicaid was the only patient-level indicator of low income available in the claims file. We also assigned variables to each patient reflecting the proportions of people within the patient's zip code: residing in urban areas; living under the poverty line according to race and age groups (65 to 74 and ≥75 years); having some college education according to sex and race; having any disability (according to race, sex, and age group); and household median income by age group of the head of household. We created overall quintiles for each of these indicators. We used 5 hospital characteristics: availability of cardiac catheterization, angioplasty, and open heart surgery; number of beds; and medical school affiliation.

Statistical Analyses

We first performed univariate and bivariate analyses. We used univariate analyses to determine the proportion of patients receiving CR. We employed bivariate analyses to describe differences in CR use by patient demographics, comorbidities, characteristics of the index hospitalization and hospital in which it occurred, patient zip code, census region, and state (50 states and the District of Columbia). We computed t tests for continuous variables and χ^2 tests for categorical variables.

We next estimated a multiple logistic regression model to identify patient and hospital predictors of CR use. Covariates in the model were as follows: patient demographics and comorbid conditions, characteristics of the index hospitalization and inpatient facility, socioeconomic and disability characteristics of the patient's zip code, distance to nearest CR facility, and state indicators. We adjusted for clustering of patients within their index hospital through generalized estimating equations using the GENMOD procedure in SAS software, version 9.1 (SAS Institute Inc, Cary, NC). A single correlation (exchangeable option) affecting any pair of patients within each cluster (hospital) was used, and adjusted odds ratios (ORs) of CR use were obtained for each variable included in the model.

Geographic Variation

To quantify geographic variation in CR use, we estimated a random intercept hierarchical logistic regression model. The random intercepts represented the underlying log-odds of CR use for each state and were assumed to vary across states. We adjusted for patient demographic and socioeconomic characteristics using the same predictors as in the generalized estimating equations model. The model was fitted with the use of the SAS GLIMMIX procedure. We then calculated both state-adjusted estimates of CR use and standardized state-specific rates of CR use using the methodology developed by one of the authors (S.T.N.).[20] The adjusted state-specific CR use rate was estimated as the average of the predicted individual probabilities of all the CR candidates living in each state. The expected state rate was calculated as the average of the predicted individual probabilities as if those individuals were living in an average state (through the exclusion of the effect of the state-specific random effect). The standardized state-specific rate of CR use was then estimated as the adjusted, state-specific CR rate divided by the expected CR rate for that state, multiplied by the national unadjusted CR rate.

Each state's 95% confidence interval (CI) on its adjusted rate was examined to determine whether it excluded the national CR rate. If it did, then we concluded that the state had higher or lower rates than expected.

The authors had full access to and take full responsibility for the integrity of the data. All authors have read and agree to the manuscript as written.

Results

Use of CR

Our study cohort consisted of 267 427 patients, of whom 18.7% (49 877) received at least 1 session of outpatient CR after hospital discharge (Table 1). Recipients of CR received an average of 24 sessions (SD 12). Men were more likely to receive CR than women (22.1% versus 14.3%); use was inversely related to age; and whites were more than twice as likely as nonwhites to receive CR. Only 5.2% of people dually eligible for Medicaid and Medicare received CR compared with 20.3% of those who were not.

Overall, CR was used in 13.9% of patients hospitalized for AMI and in 31.0% of those who underwent CABG surgery. Only 11.1% of patients with an AMI and no subsequent revascularization procedure during the index hospitalization received CR. Patients were more likely to receive CR if they had been admitted from home (19.3%) than if they had been transferred from another acute care hospital (13.2%) or nursing home (5.6%). Index admissions to hospitals with cardiac catheterization, angioplasty, and open heart surgery capabilities increased CR use to 22.4% from 13.8% in hospitals with none of these capabilities. Slightly higher CR rates were observed in hospitals affiliated with medical schools (20.5%) versus those not affiliated (17.1%).

Women, older people, nonwhites, and patients receiving Medicaid received somewhat fewer sessions on average. Patients initiated CR an average of 55 days after discharge from the index hospitalization, with 25% initiating therapy within 21 days and >25% initiating >2 months after discharge. Women, nonwhites, and Medicaid recipients began ≈1 week later than their complementary groups ($P<0.0001$), but there was no association of age with the timing of CR initiation.

Comorbidities

Commonly reported comorbidities among patients with a coronary diagnosis or procedure (Table 2) were hypertension (57%), congestive heart failure (37%), diabetes mellitus (26%), arrhythmias (33%), chronic pulmonary disease (21%), and musculoskeletal conditions (mainly arthritis) (18%). Overall, CR users had fewer comorbidities than nonusers (2.1 versus 2.7; $P<0.0001$) among the 25 comorbidity groups considered. In a bivariate analysis, patients with congestive heart failure, diabetes mellitus with complications, cerebrovascular disease, chronic pulmonary disease, or renal disease had moderate reductions in any CR use (0.69 to 0.77), whereas patients with dementia or metastatic malignancies were very unlikely to receive CR.

Other Patient-Related Predictors of CR Use

Older individuals, women, and nonwhites were less likely to receive CR than their comparison groups (Table 3). For example, men and women aged 75 to 84 years were only 87% and 69%, respectively, as likely to receive CR as men aged 65 to 74 years. Sex differences increased with age. Whites were 33% more likely to receive CR than nonwhites after adjustment for age and sex (OR=1.33 versus 1.00).

CABG surgery during the index hospitalization was a strong predictor of CR use whether or not it was performed after an AMI (OR=3.5). Patients who received PCI after an AMI were nearly 2 times more likely to receive CR than those with no revascularization procedure (OR=1.8).

Distance to the nearest CR facility was an important predictor of CR use in a multivariable analysis, with use declining monotonically as distance increased (Table 3). For example, patients living in the farthest quintile were 71% less likely to participate in CR than those living in the quintile closest to a CR facility (adjusted OR=0.29).

CR use was also associated with the zip code characteristics of the patient's residence including degree of urbanization, income, proportion of the population at or below the poverty level, and proportion with college education (not shown). Patients living in zip codes with the highest levels of urbanization and poverty were 36% and 17% less likely to use CR than those living in the most rural or least impoverished areas, respectively ($P<0.001$). Conversely, patients living in zip codes with the highest levels of median household income and education were 23% and 33% more likely to use CR than those living in zip codes with the lowest income and education ($P<0.001$).

Hospital Predictors

Patients transferred from a skilled nursing facility or long-term care facility for their index hospitalizations were less likely to receive CR (OR=0.72) than those admitted from home. Patients from smaller hospitals were more likely to participate in CR (OR=1.27), as were those hospitalized in facilities not affiliated to medical schools (OR=1.33) compared with patients in hospitals with the opposite characteristics.

Geographic Variations

More than a 9-fold geographic variation in CR use was found among states in all unadjusted, adjusted-smoothed (shrinkage), and standardized rates, with rates ranging from 6.6% in Idaho to 53.5% in Nebraska after multivariable adjustment (Table 4). Large regional variations are evident in the Figure, with the highest-use states clustered in the north central

Table 1. Cohort Characteristics and Crude Rates of CR Use

Characteristic	No. of Patients	Percentage of Cohort	Crude Rate of Any CR Use, %
Entire cohort	267 427	100	18.7
Sociodemographic characteristics of patients			
Gender and age group			
Men (overall)	149 383	55.9	22.1
65–74 y	84 089	31.4	26.6
75–84 y	54 012	20.2	18.6
≥85 y	11 282	4.2	4.6
Women (overall)	118 044	44.1	14.3
65–74 y	47 908	17.9	21.7
75–84 y	49 122	18.4	12.4
≥85 y	21 014	7.9	2.1
Race			
Whites	245 504	91.8	19.6
Nonwhites	21 923	8.2	7.8
Medicaid at discharge			
No	238 315	89.1	20.3
Yes	29 112	10.9	5.2
Index hospitalization			
AMI in principal diagnosis	192 926	72.1	13.9
No coronary revascularization	151 187	56.5	11.1
AMI+PCI	27 431	10.3	20.9
AMI+CABG	13 372	5.0	29.8
AMI+PCI+CABG	936	0.4	35.7
CABG, no AMI in principal diagnosis	74 501	27.9	31.0
CABG alone	73 239	27.4	31.0
CABG+PCI	1262	0.5	30.4
Origin of hospitalization			
Home	252 953	94.6	19.3
Transferred from acute care hospital	4609	1.7	13.2
Transferred from SNF or LCF	9865	3.7	5.6
Patient destination after discharge			
Home	194 451	72.7	19.5
Transferred to acute care hospital	45 146	16.9	20.2
Transferred to SNF or LCF	27 830	10.4	10.2
Hospitalizations within prior 12 mo			
None	190 554	71.3	21.0
For AMI	6130	2.3	11.6
For other condition	70 743	26.5	12.8
Availability of coronary procedures at index hospital			
Open heart surgery, angioplasty, and catheterization	135 268	50.6	22.4
Angioplasty and cardiac catheterization only	9244	3.5	13.2
Cardiac catheterization only	30 965	11.6	12.8
None of the above	44 636	16.7	13.8
Unknown	47 314	17.7	17.6
Medical school affiliation			
No	138 444	51.8	17.1
Yes	118 607	44.4	20.5
Unknown	10 376	3.9	17.6

SNF indicates skilled nursing facility; LCF, long-term care facility. Beginning of CR=number of days from index hospital discharge to first CR session. The average number of comorbid conditions was 2.06 (SD 1.70) for CR users and 2.71 (SD 2.22) for non-CR users.

Table 2. Crude Rates and Adjusted ORs of CR Use by Patient Comorbid Conditions

Comorbid Condition	No. of Patients	Percentage of Cohort*	Crude Rate of Any CR Use	Adjusted ORs† Estimate	Adjusted ORs† Lower 95% Confidence Limit	Adjusted ORs† Upper 95% Confidence Limit
Cardiovascular disease						
Hypertensive heart disease	152 433	57.0	11.0%	0.88	0.86	0.89
Congestive heart failure	97 605	36.5	11.0%	0.77	0.75	0.80
Arrhythmias	88 216	33.0	17.8%	0.96	0.93	0.98
Peripheral vascular disease	51 011	19.1	15.3%	0.92	0.90	0.95
Valvular heart disease	47 993	17.9	14.2%	0.95	0.92	0.98
Heart conduction disorders	44 304	16.6	16.3%	1.04	1.00	1.07
Cerebrovascular disease	27 459	10.3	13.3%	0.77	0.74	0.80
Cardiac arrest	23 708	8.9	14.8%	0.99	0.95	1.03
Diabetes mellitus without complications	70 775	26.5	15.9%	0.90	0.87	0.92
Chronic liver disease	779	0.3	8.5%	0.63	0.48	0.83
Metastatic malignancies	1989	0.7	6.3%	0.43	0.36	0.52
Malnutrition	3954	1.5	6.4%	0.63	0.54	0.73
Other liver disease	3654	1.4	13.1%	0.98	0.88	1.09
Bone fractures	4814	1.8	4.2%	0.51	0.44	0.59
Central neurological condition	5618	2.1	10.0%	0.71	0.65	0.78
Dementia	12 126	4.5	2.4%	0.34	0.30	0.38
Malignancies	11 205	4.2	12.9%	0.86	0.81	0.91
Chronic pulmonary disease	57 256	21.4	13.5%	0.77	0.75	0.79
Musculoskeletal condition	47 588	17.8	15.9%	1.03	1.00	1.06
Hematologic (nonmalignant) disease	64 045	23.9	19.6%	1.02	0.99	1.04
Urinary tract disease	47 107	17.6	11.7%	0.89	0.86	0.92
Infectious diseases	20 241	7.6	9.5%	0.89	0.85	0.94
Gastric ulcer	18 172	6.8	11.1%	0.85	0.81	0.89
Renal disease	18 712	7.0	8.5%	0.69	0.65	0.73
Diabetes mellitus with complications	13 490	5.0	10.2%	0.77	0.72	0.82

*Cohort: n=267 427.

†Based on multivariable model, as described in Methods section on statistical analysis.

region. The rate of CR use by state was strongly positively correlated with the number of CR facilities per 10 000 people aged ≥65 years (r=0.82, P<0.001).

Discussion

Importance

This is the largest and most comprehensive study of which we are aware to examine the use of CR in older patients with CHD. We found that only 13.9% of Medicare beneficiaries with AMIs and 31.0% of those who had undergone CABG surgery received CR services after index hospitalizations in 1997. For AMI, this rate is higher than the 7% found in elderly patients in 1990[21] but lower than the 29% rate found in a 2001 survey of patients aged 65 to 79 years in 19 states and the District of Columbia.[22] Our study found lower use rates in women, nonwhites, older patients, and "dual eligibles" who were also receiving Medicaid. Our study also documents the deterrent effects on CR use of lower mean income, less education, and higher prevalence of disability. Patients with more concomitant illnesses were less likely to receive CR.

Geographic variations in CR use are especially striking. Use rates were >4-fold higher in north central states (Nebraska, Iowa, North and South Dakota, Minnesota, and Wisconsin) than in southern states. In seeking explanations, we found no correlations between these state variations in CR use with indicators of health consciousness (eg, smoking rates) or quality of care (eg, use of pneumococcal vaccine or use of β-blockers after an AMI) among elders in 1997.[23] Instead, interviews with CR staff suggest the role of factors such as the training and attitudes of physicians and CR staff, abundance of training programs for CR staff, the application of standing orders for CR, and procedures and data systems for initiating and tracking referral and entry into CR.[24]

Higher rates of CR use in patients undergoing CABG surgery than in those with AMIs probably reflect the high salience of the surgical procedure to the patient and systematic referral by cardiac surgeons. Our finding of a strong deterrent effect on CR use of a greater distance from the patient's residence to a CR facility, even after correction for patient and hospital characteristics in multivariable analyses, is consistent with other studies.[25,26]

Table 3. Adjusted ORs for CR Use by Patient and Hospitalization Characteristics and Availability of CR

Characteristics	Adjusted OR*	Lower 95% Confidence Limit	Upper 95% Confidence Limit
Patient characteristics			
Gender by age group			
Male, aged 65–74 y	1.00	Reference group	...
Male, aged 75–84 y	0.87	0.84	0.91
Male, aged ≥85 y	0.29	0.27	0.32
Female, aged 65–74 y	0.98	0.95	1.01
Female, aged 75–84 y	0.69	0.66	0.72
Female, aged ≥85 y	0.17	0.15	0.19
Race			
Nonwhite	1.00	Reference group	...
White	1.33	1.26	1.41
Medicaid at discharge			
No	1.00	Reference group	...
Yes	0.44	0.42	0.47
Index hospitalization characteristics			
Type of coronary diagnosis and revascularization			
AMI in principal diagnosis			
No coronary revascularization	1.00	Reference group	...
AMI+PCI	1.84	1.75	1.94
AMI+CABG†	3.54	3.30	3.78
CABG, no AMI in principal diagnosis‡	3.55	3.35	3.76
Origin of hospitalization			
Home	1.00	Reference group	...
Transferred from acute care hospital	0.89	0.81	0.98
Transferred from SNF or LCF	0.72	0.65	0.79
Patient destination after discharge			
Home	1.00	Reference group	...
Transferred to acute care hospital	1.71	1.64	1.79
Transferred to SNF or LCF	0.64	0.61	0.68
Hospitalizations within 1 year before index hospitalization			
For any cause			
No	1.00	Reference group	...
Yes	0.95	0.92	0.98
For AMI			
No	1.00	Reference group	...
Yes	0.92	0.84	1.01
Facility characteristics for index hospitalization			
Availability of cardiac catheterization			
Unknown	0.80	0.28	2.32
No	0.89	0.82	0.97
Yes	1.00	Reference group	...
Hospital size			
Unknown	1.60	0.55	4.61
1–160 beds (quintiles 1–4)	1.27	1.11	1.46
≥161 beds (quintile 5)	1.00	Reference group	...
Medical school affiliation			
Unknown	1.05	0.86	1.28
No	1.33	1.21	1.46
Yes	1.00	Reference group	...
Distance from patient zip code to nearest CR facility, mean (range)§			
Quintile 1: 1.0 (0.3–1.5) miles	1.00	Reference group	...
Quintile 2: 2.4 (1.6–3.2) miles	0.93	0.89	0.97
Quintile 3: 4.6 (3.3–6.4) miles	0.78	0.74	0.81
Quintile 4: 10.2 (6.5–14.9) miles	0.58	0.55	0.61
Quintile 5: 31.8 (15.0–231.0) miles	0.29	0.27	0.31

SNF indicates skilled nursing facility; LCF, long-term care facility.

*Based on multivariable model, as described in Methods section on statistical analysis. The within-hospital correlation in the generalized estimating equations model was 0.094.

†Includes 334 patients with both CABG and PCI.

‡Includes 384 patients with both CABG and PCI.

§Upper bound of quintile 5 was Winsorized at 231 miles for 1100 observations. For ≈2% of the cohort, distance was not calculated because of lack of zip code information.

Table 4. Crude, Adjusted, and Standardized Rates of CR Use by State

State	CR Candidates, n	CR Users, n	Crude CR Rate, %	Adjusted CR Rate,* %	Standardized CR Rate,† %
Alabama	5565	593	10.7	10.7‡	10.5
Alaska	196	46	23.5	22.8‡	30.2
Arizona	3084	483	15.7	15.7‡	12.7
Arkansas	3570	363	10.2	10.2‡	11.4
California	14 389	2642	18.4	18.4	16.9
Colorado	2183	644	29.5	29.5‡	25.1
Connecticut	3543	699	19.7	19.7	21.4
Delaware	806	200	24.8	24.7‡	25.1
District of Columbia	733	89	12.1	12.3‡	11.4
Florida	19 756	2789	14.1	14.1‡	13.2
Georgia	6854	574	8.4	8.4‡	9.7
Hawaii	576	40	6.9	7.0	16.7
Idaho	862	54	6.3	6.6‡	5.7
Illinois	12 342	3585	29.1	29.0‡	25.3
Indiana	7485	2007	26.8	26.8‡	23.8
Iowa	4197	1952	46.5	46.4‡	42.0
Kansas	2974	683	23.0	22.9‡	22.7
Kentucky	5419	657	12.1	12.1‡	13.2
Louisiana	4280	722	16.9	16.9	16.9
Maine	1816	299	16.5	16.4	21.6
Maryland	4359	325	7.4	7.5‡	8.3
Massachusetts	6252	1115	17.8	17.8‡	23.5
Michigan	11 787	2272	19.3	19.3	18.4
Minnesota	4401	1877	42.7	42.6‡	36.7
Mississippi	2945	240	8.2	8.2‡	10.9
Missouri	7891	1921	24.3	24.3‡	21.2
Montana	976	301	30.8	30.8‡	22.4
Nebraska	2227	1194	53.6	53.5‡	39.2
Nevada	1190	181	15.2	15.3‡	13.5
New Hampshire	1214	315	26.0	25.9‡	21.8
New Jersey	7408	1158	15.6	15.6	17.3
New Mexico	999	85	8.5	8.7‡	10.6
New York	15 811	1922	12.2	12.2‡	13.3
North Carolina	9409	984	10.5	10.5‡	10.8
North Dakota	1186	487	41.1	40.8‡	38.6
Ohio	13 652	2469	18.1	18.1	17.4
Oklahoma	3917	279	7.1	7.2‡	8.6
Oregon	2022	352	17.4	17.4	15.5
Pennsylvania	15 740	2732	17.4	17.4	17.8
Rhode Island	1062	151	14.2	14.2	19.8
South Carolina	4073	945	23.2	23.2‡	22.4
South Dakota	1273	623	48.9	48.7‡	40.0
Tennessee	8316	1097	13.2	13.2‡	13.5
Texas	15 939	2451	15.4	15.4‡	15.9
Utah	1334	348	26.1	26.1	19.8
Vermont	717	112	15.6	15.6	18.4
Virginia	6731	1154	17.1	17.2	16.6
Washington	4165	649	15.6	15.6	14.5
West Virginia	3197	483	15.1	15.1	17.5
Wisconsin	6305	2439	38.7	38.7‡	31.6
Wyoming	299	95	31.8	31.4‡	26.9
Total	267 427	49 877	18.7	18.7	18.0

*Smoothed, shrinkage, risk-adjusted estimate.

†Assumes nationally representative demographics, health status, index hospitalization, socioeconomics, hospital characteristics, and CR availability in each state.

‡Adjusted log-odds of the CR rates were statistically different (at the $P=0.05$ level) from the overall national adjusted log-odds CR rate.

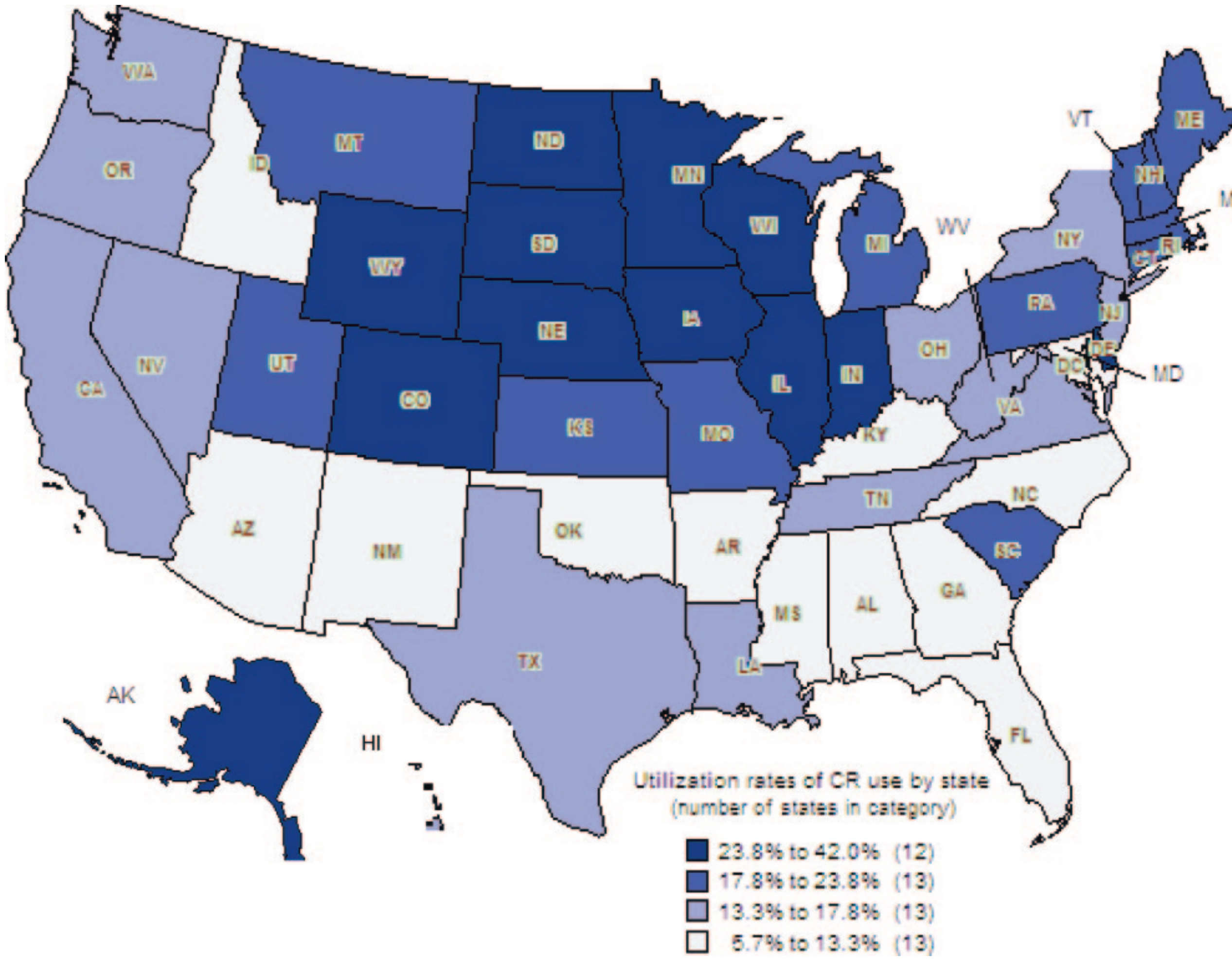

Figure. Standardized rates of CR by state.

Because distance to the nearest CR facility was an important predictor of CR use, payers may wish to explore the feasibility of reimbursing community- or home-based CR programs as supplements or alternatives to facility-based programs, particularly in rural and sparsely populated areas. Available evidence indicates that such programs are safe and equally effective, at least for patients who are at low or moderate risk of complications after AMIs or revascularization procedures.[6,27]

Study Limitations

Our study's main limitations relate to its heavy reliance on Medicare claims data and its focus on 1997 hospitalizations. Medicare claims have strengths and limitations. They provide excellent information on the principal diagnoses for hospital admissions, major diagnostic and treatment procedures received, and some information on comorbid conditions. However, claims lack important clinical data such as left ventricular ejection fraction, body weight, smoking habits, and lipid levels, and they do not accurately distinguish treatment complications, such as cardiac arrhythmias or cardiac arrests, from preexisting conditions.

Medication use is not generally available to researchers from Medicare claims. The fact that our study focused on index hospitalizations for AMI or CABG surgery during 1997 means that it does not reflect subsequent changes in the standards for care for AMIs, newer medications for CHD, advances in cardiac surgery, or the increased use and sophistication of PCI. Although changes in medical practice may have affected the use of CR, Medicare's eligibility criteria for AMI and CABG remained unchanged until 2006. On balance, we believe that our findings closely mirror recent CR use patterns in Medicare beneficiaries. Other, less important, study limitations are its restriction to Medicare beneficiaries with both Part A and Part B coverage who were continuously enrolled in fee-for-service Medicare. Hence, we cannot generalize our findings to individuals who did not have Part B or who were enrolled in health maintenance organizations, but they constitute small shares of Medicare beneficiaries. In 1997, 97% of 32.2 million beneficiaries enrolled in Part A also had Part B,[28] and ≈85% of Medicare beneficiaries were under fee-for-service regulations.[29]

Effects of the Underuse of CR

The low CR utilization rates we have documented are discouraging in light of the considerable evidence that supports the effectiveness of CR. Meta-analyses of controlled studies have found 15% to 28% reductions in all-cause mortality and 26% to 31% reductions in cardiac mortality. In addition, studies have documented substantial reductions in morbidity and decreases in cardiac risk factors.[1–5] If it is assumed that the CR use rate in Nebraska (53.5%) was achieved in all other states, 93 000 additional Medicare beneficiaries would have received CR, and cardiac mortality would have decreased 26% to 31% in these individuals. Cost-effectiveness analyses suggest that achieving these gains would be highly cost-effective.[30,31]

Opportunities to Increase the Use of CR

Increased use of CR might be achieved by improving methods of referring patients to CR facilities after their hospitalizations, implementing quality indicators, and increasing reimbursement rates for these services. Opportunities to increase referrals include using automatic referrals after qualifying hospital admissions,[32] creating Web-based referral opportunities, and learning lessons from states that currently demonstrate high utilization rates. For example, striking increases in referrals, from 27% to 62%, were achieved by 1 Web-based referral opportunity.[33] A high overall referral rate, however, may not eliminate disparities reflecting lower use, for example, among women,[34,35] nonwhites,[36] or the very old.

Referral to, enrollment in, and completion of CR programs have been proposed as quality indicators in cardiovascular care.[37] Such measures might be considered by organizations such as the American College of Cardiology, American Heart Association, Agency for Health Care Research and Quality, National Committee for Quality Assurance, and Joint Commission on Accreditation of Health Care Organizations as means to increase appropriate CR use. They might also be adopted by Medicare in its pay-for-reporting program and the pay-for-performance initiative for hospitals that it is currently developing. Rewards could be given both to the hospital from which the patient was discharged and to the responsible physician.[38,39] Quality indicators might reflect both referral rates to CR and the completion of a specified number (eg, 24) of CR sessions within 90 days after a hospital discharge. Lessons from recent pay-for-performance demonstrations suggest the importance of aligning incentives between physicians and hospitals, incorporating case-mix adjustment, and rewarding improvement as well as excellent performance.[40]

Finally, increased reimbursement rates for CR could serve as positive incentives. Medicare expanded eligibility for CR services in 2006 to include PCI and other indications but did not change levels of reimbursement for the service.[16] The midpoint reimbursement rate by Medicare for a phase II CR session was $15.50 in 2001[41] and was $34 in 2006 (CMS, unpublished data, 2006). Some CR providers argue that the current rate does not fully cover costs and is a deterrent to CR use. CMS could reassess reimbursement levels against their resource costs and compare the merits of reimbursement per session versus packaged reimbursement per program completed. Separate payments for key components, such as nutritional counseling and stress management, might also be considered.

In conclusion, this study has found low national utilization rates of CR after AMI and CABG surgery and remarkable cross-state variations in use. Lower use rates were found in women, nonwhites, dual eligibles, and the very old and in persons with more comorbidities, with lower socioeconomic status, or who live farther from a CR facility.

Acknowledgments

The authors would like to thank Armen Thoumaian, PhD, (CMS) for his support as Project Officer; Grant Ritter, PhD, (Brandeis University) for his statistical assistance; Celia Hsu Dahlman, MA, (CHD Research Associates) for preparing the Medicare data files; Sarita Bhalotra, MD, PhD, and Gail K. Strickler, PhD, (Brandeis University) for reviewing the report underlying this article; Clare L. Hurley, MM, and Chrisann Newransky, MA, (Brandeis University) for their contributions to the style and organization of the article; and Honglian Yu (Brandeis University) for help with references.

Source of Funding

This research was supported by the CMS (contract No. 500-95-0060, Task Order 02).

Disclosures

None.

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CLINICAL PERSPECTIVE

Cardiac rehabilitation (CR) prolongs survival and reduces disability in patients after a coronary event and therefore is considered the standard of care after myocardial infarction or coronary bypass surgery. However, estimates of its use have varied widely because it has not been studied in a comprehensive national database. Using national Medicare claims data, we found that CR use was only 13.9% after myocardial infarction and 31% after coronary artery bypass surgery. Least likely to participate were older patients, women, nonwhites, less educated patients, patients of lower socioeconomic status, patients with multiple comorbidities, and those at the greatest distance from a CR center. We also found a 9-fold variation of CR use by state, with highest use clustered in the north central states of the United States and lowest use in the southern states. Given the considerable evidence that supports the effectiveness of CR and the high geographic disparity in participation, we suggest that CR use should be considered as a quality indicator after myocardial infarction or coronary artery bypass surgery and that efforts should be made to increase its use. Automatic referral of appropriate patients at the time of hospital discharge should be implemented, and efforts should be made to increase geographic availability of CR programs. The present study can be used as a benchmark for future efforts to increase CR use in the Medicare population, many of whom are struggling to maintain functional independence.