

STATE-OF-THE-ART PAPER

## Current Status of Cardiac Rehabilitation

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Cardiac rehabilitation is increasingly recognized as an integral component of the continuum of care for patients with cardiovascular disease. Its application is a class I recommendation in most contemporary cardiovascular clinical practice guidelines. Despite the documentation of substantial morbidity and mortality benefits, cardiac rehabilitation services are vastly underutilized. The core components of cardiac rehabilitation have been detailedly delineated. Implementation of newly available performance measures offers the potential to enhance referral to, enrollment in, and completion of cardiac rehabilitation. (J Am Coll Cardiol 2008;51:1619–31)  
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Over a decade ago, the 1995 clinical practice guideline *Cardiac Rehabilitation* from the U.S. Department of Health and Human Services, Agency for Healthcare Policy and Research (AHCPR), and the National Heart, Lung, and Blood Institute (1) characterized cardiac rehabilitation as the provision of comprehensive long-term services involving medical evaluation; prescriptive exercise; cardiac risk factor modification; and education, counseling, and behavioral interventions. This delineation remains highly relevant and applicable today. The AHCPR guideline highlights the effectiveness of multifaceted and multidisciplinary cardiac rehabilitation services integrated in a comprehensive approach. The goal of this multifactorial process is to limit the adverse physiological and psychological effects of cardiac illness, to reduce the risk of sudden death or reinfarction, to control cardiac symptoms, to stabilize or reverse progression of the atherosclerotic process, and to enhance the patient's psychosocial and vocational status. Provision of cardiac rehabilitation services, per the guideline (1), was to be directed by a physician, but implementation could be accomplished by a variety of health care professionals.

Although traditionally most candidates for cardiac rehabilitation services were patients following myocardial infarction (MI) (2) or coronary artery bypass graft (CABG) surgery, contemporary use also includes patients following percutaneous coronary interventions (PCIs); heart or heart/lung transplantation recipients; patients with stable angina or stable chronic heart failure; those with peripheral arterial disease with claudication; and patients following cardiac surgical procedures for heart valve repair or replacement (3). Indeed, referral for cardiac rehabilitation is a class I indication (useful and effective) in most contemporary clinical practice guidelines, including those for ST-segment eleva-

tion MI (4), unstable angina/non-ST-segment elevation MI (5), chronic stable angina (6), PCI (7), CABG surgery (8), heart failure (9), valvular heart disease (10), peripheral arterial disease (11), and cardiovascular prevention in women (12). In recent years, participants in cardiac rehabilitation programs have increasingly included patients who are older, those who have multiple comorbidities, and those with heart failure and/or peripheral arterial disease, as well as patients following PCI or cardiac transplantation.

The 1995 cardiac rehabilitation clinical practice guideline (1) documented that a minority of patients appropriate for cardiac rehabilitation services were referred or enrolled. Over a decade later, the use of cardiac rehabilitation services by Medicare beneficiaries after MI or CABG surgery remains relatively low, although it is higher after CABG surgery than after MI without such revascularization; furthermore, enrollment in cardiac rehabilitation varies dramatically by U.S. state and region (13). Women and elderly patients remain less likely to participate (14).

Despite the role of cardiac rehabilitation having been extensively documented, endorsed, and promoted by a number of health care organizations and their position statements for the comprehensive secondary prevention of cardiovascular events, performance measures for referral to and delivery of the vastly underutilized cardiac rehabilitation/secondary prevention services were not available until 2007. These performance measures were created for hospital settings, office practices, and cardiac rehabilitation programs (15), designed as a mechanism to more rapidly translate the strongest clinical evidence into practice and providing incentive for rehabilitation referral and better standardizing of care.

### Core Components of Cardiac Rehabilitation/Secondary Prevention

The core components of cardiac rehabilitation/secondary prevention are detailedly outlined in a Scientific Statement from

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**Abbreviations  
and Acronyms**

**CABG** = coronary artery bypass graft  
**CHD** = coronary heart disease  
**HDL-C** = high-density lipoprotein cholesterol  
**LDL-C** = low-density lipoprotein cholesterol  
**MI** = myocardial infarction  
**PCI** = percutaneous coronary intervention

the American Heart Association and the American Association of Cardiovascular and Pulmonary Rehabilitation (16) and highlight the integral role of cardiac rehabilitation in the secondary prevention of cardiovascular disease. These interventions are designed to optimize cardiovascular risk reduction, foster healthy behaviors and compliance with those behaviors, reduce cardiovascular disability, and promote an active lifestyle for patients with cardiovascular disease. The physiological parameters

targeted by the pillars of cardiac rehabilitation include actionable themes of improvement in exercise habits and exercise tolerance and optimization of coronary risk factors, including improvement in lipid and lipoprotein profiles, body weight, blood glucose levels, blood pressure levels, and cessation of smoking. Attention is devoted to the emotional responses to living with heart disease, specifically amelioration of stress and anxiety and lessening of depression (i.e., managing the psychosocial problems commonly affecting cardiac patients). An essential goal, particularly for elderly patients, is functional independence. The return to appropriate and satisfactory occupation is considered to be beneficial to both individual patients and society. Young coronary patients, often characterized by adverse psychological and coronary risk profiles, with poorer long-term prognosis, can benefit substantially from rehabilitation interventions (17). Incorporation of strategies to optimize patient adherence to lifestyle and pharmacologic interventions via knowledge, motivation, and skills is integral to the attainment of sustained benefit.

Referral for enrollment in cardiac rehabilitation optimally occurs within the first 1 to 3 weeks following discharge from the hospital after a coronary event; in physician office practice, referral may be initiated within the first year following a cardiovascular event. Outpatients with a qualifying diagnosis within the prior year who have not previously participated in an outpatient cardiac rehabilitation program should be referred for such care by their health care provider. Referral is also appropriate in an office-based setting for patients with chronic stable angina and for those with stable congestive cardiac failure.

**Patient assessment.** Initial assessment of the patient encompasses the current and prior cardiovascular medical and surgical diagnoses, compilation of comorbidities, and delineation of cardiovascular symptoms and the cardiovascular risk profile. The standard cardiovascular physical examination is documented and a 12-lead resting electrocardiogram obtained. Of value is assessment of the patient's perceived health status and/or health-related quality of life. Emphasis should focus on the patient taking appropriate doses of cardiovascular medications for the specific diagnosis per all American College of Cardiology/American Heart Association

guidelines and ensuring that the patient receives an annual influenza vaccination.

**Nutritional counseling.** Nutritional counseling mandates acquisition of baseline data regarding daily caloric intake and dietary content of saturated fat, trans-fat, cholesterol, sodium, and nutrients (18). The patient's eating habits, including alcohol consumption, should be related to the target nutritional components, based on the specific cardiac problem and relevant comorbidities. Education and counseling should include dietary goals and individualized dietary modifications, with sensitivity to personal and cultural variables.

**Weight management.** Obesity is an independent risk factor for cardiovascular disease and adversely impacts cardiovascular risk factors. Measurement of weight, height, and waist circumference and calculation of body mass index provide the basis for establishing both short- and long-term weight goals related to the patient's specific cardiovascular problem and associated risk factors. The body mass index goal is 18.5 to 24.9 kg/m<sup>2</sup>, with a waist circumference of <40 inches for men and <35 inches for women. Weight management involves a combination of diet, physical activity/exercise, and a behavioral program (18). Whereas a 30-min daily exercise regimen is suitable as a global recommendation, exercise designed for weight reduction or maintenance of such weight reduction should involve 60 to 90 min of daily exercise (12).

**Blood pressure management.** Measurement of blood pressure, per the Seventh Report of the Joint National Committee (JNC7) (19), should include assessment for orthostatic hypotension, evaluation to assess current treatment and compliance, and ascertainment of use of nonprescription drugs that may adversely impact blood pressure. There is a consistent, continuous, and independent association of blood pressure levels with cardiovascular and renal disease risk, with optimal blood pressure control lowering cardiovascular risk. The components of lifestyle modification, including regular physical activity/exercise, weight management, moderate sodium restriction, increased consumption of fresh fruits, vegetables, and low-fat dairy products, alcohol moderation, smoking cessation, and indications for pharmacotherapy, derive from the JNC7 guidelines. Goal blood pressure is <140/90 mm Hg. More stringent blood pressure control (goal blood pressure <130/80 mm Hg) is currently recommended for high-risk patients with coronary atherosclerotic vascular disease, with a goal blood pressure of <120/80 mm Hg in the presence of ventricular systolic dysfunction (20).

**Lipid management.** The benefit of lipid-lowering agents and lifestyle modification for patients with documented cardiovascular disease has been established by multiple clinical trials (21). Lipid management involves ascertainment of fasting measures of total cholesterol, high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), and triglycerides, as a basis for assessment of current treatment and compliance. Serial measurement of lipid levels and of creatine kinase and liver function test levels are based on recommendations of the National Cholesterol Education Program Adult Treatment Panel

(NCEP-ATP) III (22). Goal lipid levels are an LDL-C <100 mg/dl, and if triglycerides are >200 mg/dl, non-HDL-C should be <130 mg/dl. A more aggressive reduction of LDL-C to a goal of <70 mg/dl is reasonable for high-risk patients. These goals for lipid values are based on the recommendations of the NCEP-ATP III and its update (23). Counseling involves dietary recommendations that include addition of plant stanol/sterols and viscous fiber and the encouragement to consume more omega-3 fatty acids. The provision and monitoring of pharmacotherapy require coordination with the patient's primary care provider or cardiologist.

**Diabetes management.** Both diabetes mellitus and impaired fasting glucose are associated with adverse long-term cardiovascular outcomes; improved glycemic control favorably affects cardiovascular morbidity and mortality. Physical activity reduces insulin resistance and glucose intolerance (24). The presence or absence of diabetes should be confirmed for all patients and among diabetic patients the details of diabetic status obtained, including medications, diet, monitoring of blood glucose levels, and extent of compliance. Goal is an HgA<sub>1c</sub> <7%. Patient education should encompass specific details regarding exercise, particularly among patients taking insulin, and teaching patients self-monitoring skills for unsupervised exercise. Coordination of care with the patient's primary care physician or endocrinologist is requisite.

**Tobacco cessation.** Encompassed in this evaluation are current and past smoking status, with particular emphasis on smoking cessation within the prior 12 months. Exposure to second-hand smoke also should be ascertained. The readiness for smoking cessation should be determined, with intervention by education and counseling, social support as needed, and pharmacologic support as warranted. Relapse prevention skills should be taught and practiced. Smoking cessation can reduce cardiovascular risk by about one-third in patients with cardiovascular disease.

**Psychosocial management.** Depression is highly prevalent after acute cardiac events, with 20% to 45% of patients having significant depression after acute MI. Depression is an independent risk factor for mortality with acute MI or unstable angina, and several studies suggest improvement with cardiac rehabilitation interventions (25). Psychosocial evaluation encompasses identification of depression, anxiety (26), anger or hostility (17), social isolation, family distress, sexual dysfunction, and substance abuse using standard interview and/or measurement techniques. Psychotropic medications should be identified. Psychosocial complications occur in up to 20% of patients after MI. Depression, in particular, has been associated with less energy, more fatigue, lower exercise capacity, and a reduced quality of life and sense of well-being. Women, particularly younger women, appear to be at increased risk for depression after a coronary event (27). Individual and/or group education and counseling are warranted, with referral to appropriate specialists as indicated. Patients with depressive symptoms have a 5-fold increased risk of noncompletion of cardiac rehabilitation and therefore require enhanced

attention and support (28). Recall that women have a 2-fold increased risk of noncompletion: thus the particular attention warranted for women, who are more likely to be depressed than men after a coronary event.

**Physical activity counseling.** Activity levels and exercise capacity, both occupational and recreational, should be ascertained, including activities of daily living. Assessments involve the readiness to change physical activity behavior and barriers to increasing physical activity. Advice and support, as well as referral to an exercise program, should be implemented. Exercise or simulated work testing may be appropriate for the small subset of patients whose jobs require heavy labor. Recommendations are for a minimum of 30 min and up to 60 min of moderate physical activity on most if not all days of the week, with strategies to incorporate increased physical activity into usual daily activities. Activities should initially be low impact, with gradual increases in activity duration and intensity. A 20% to 30% reduction in all-cause mortality has been documented in patients with cardiovascular disease who adhere to a regular physical activity regimen (29).

**Exercise training.** The risk of cardiovascular complications of exercise should be assessed before initiation of exercise training, using a standardized assessment to identify patients who may have unstable symptoms or other factors that characterize them as at increased risk for adverse cardiovascular events. Symptom-limited exercise testing may be warranted before enrollment in an exercise-based cardiac rehabilitation program, with exercise test performance guiding the level of supervision required for exercise training. Energy expenditure is related to the intensity and duration of exercise. An individualized exercise prescription should incorporate aerobic and resistance training and should address specific patient comorbidities. The standard guidelines for exercise training involve warm-up, cool-down, and flexibility exercise incorporation into each exercise session, with progressive updating of the exercise prescription as clinical status changes.

**Use of preventive medications.** Adherence to the preventive medications prescribed by the health care provider should be assessed, with education and counseling implemented about the importance of such adherence. This requires ongoing communication with the primary health care provider and/or cardiologist as medications are changed and/or patient concerns arise. Education regarding adherence to preventive medications potentially translates into improved patient outcomes.

**Data collection for cardiac rehabilitation.** Table 1 delineates sample data collection tools that encompass the intervention, the target goal, the initial assessment, the intervention plan and communication, reassessment before completion of the program, and changes in the intervention plan and their communication.

### Clinical Trial Data

Most randomized trials of exercise training involved patients with coronary heart disease, and the meta-analyses

**Table 1 Sample Data Collection Tools for the Cardiac Rehabilitation/Secondary Prevention Performance Measurement Set B**

American Association of Cardiovascular and Pulmonary Rehabilitation, American College of Cardiology, and American Heart Association Cardiac Rehabilitation/Secondary Prevention Program Performance Measurement Set Data Collection Flow Sheet (ideally collected prospectively)

Patient Name or Code:		Birth Date:			
Gender: <input type="checkbox"/> M <input type="checkbox"/> F		Date of event(s):			
Diagnosis: <input type="checkbox"/> MI <input type="checkbox"/> CABG <input type="checkbox"/> Angina <input type="checkbox"/> Valve repair or replacement <input type="checkbox"/> PCI <input type="checkbox"/> Transplantation <input type="checkbox"/> CHF					
Race/Ethnicity: <input type="checkbox"/> African American <input type="checkbox"/> Asian American <input type="checkbox"/> Native American <input type="checkbox"/> Non-White Hispanic <input type="checkbox"/> White <input type="checkbox"/> Other					
Risk Category <input type="checkbox"/> Low <input type="checkbox"/> Moderate <input type="checkbox"/> High					
Target Goal		Initial Assessment	Intervention Plan and Communication	Reassessment Prior to Completion of Program	Changes in Intervention Plan and Communication
Date					
Tobacco Use	Complete cessation of tobacco use	<input type="checkbox"/> Never <input type="checkbox"/> Recent (quit less 6 months ago) <input type="checkbox"/> Current	<i>Complete only if current or recent tobacco use</i> <input type="checkbox"/> Individual education and counseling <i>or</i> <input type="checkbox"/> Referral to a tobacco cessation program <i>and</i> <input type="checkbox"/> Health care provider notified	<input type="checkbox"/> Abstaining <input type="checkbox"/> Smoking	<i>Complete only if still smoking</i> <input type="checkbox"/> Individual education and counseling <i>or</i> <input type="checkbox"/> Referral to a tobacco cessation program <i>and</i> <input type="checkbox"/> Health care provider notified
Blood Pressure Control	<140/90 mm Hg or <130/80 mm Hg if patient has diabetes or chronic kidney disease	<input type="checkbox"/> Patient with diagnosis of treated or untreated hypertension <input type="checkbox"/> Not hypertensive	<i>Complete only if patient has a diagnosis of hypertension:</i> Education completed: <input type="checkbox"/> Target BP goal <input type="checkbox"/> Medication compliance <input type="checkbox"/> Lifestyle modification	<input type="checkbox"/> Intermittent monitoring of BP during CR	<input type="checkbox"/> Policy in place concerning communication with health care providers, including thresholds for communication
Lipid Control	For CVD and CVD equivalents: LDL-C <100 mg/dL if triglycerides are >200 mg/dL, non-HDL-C should be <130 mg/dL	<input type="checkbox"/> Optimal control <input type="checkbox"/> Suboptimal control	<i>Applies to all patients with CVD:</i> Education completed: <input type="checkbox"/> Target lipid goals <input type="checkbox"/> Medication compliance <input type="checkbox"/> Lifestyle modification	<i>Complete only if suboptimal control on initial assessment:</i> <input type="checkbox"/> Patient encouraged to contact health care provider about reassessment of lipid control	<input type="checkbox"/> Policy is in place to communicate with health care providers as needed
Physical Activity Habits	30+ min, minimum 5 d per week	<input type="checkbox"/> Optimal habits <input type="checkbox"/> Suboptimal habits	<input type="checkbox"/> Education completed concerning optimal physical activity habits <i>Complete only if habits are suboptimal</i> <input type="checkbox"/> Intervention plan developed with the patient	<input type="checkbox"/> Optimal habits <input type="checkbox"/> Suboptimal habits	<i>Complete only if habits remain suboptimal</i> <input type="checkbox"/> An intervention plan is developed with the patient <input type="checkbox"/> Health care provider notified
Weight Management	Body mass index: 18.5 to 24.9 kg/m <sup>2</sup> <i>and</i> Waist circumference: men <40 inches women <35 inches	<input type="checkbox"/> At target <input type="checkbox"/> Above target	<i>Applies to all patients</i> <input type="checkbox"/> Education completed concerning target goals, diet, behavior change, regular physical activity <i>or</i> <input type="checkbox"/> Referral to a weight management program <i>and</i> <input type="checkbox"/> Health care provider notified if above target	<input type="checkbox"/> At target <input type="checkbox"/> Above target	<i>Complete only if remains above target</i> <input type="checkbox"/> Additional education completed for target goals, diet, behavior change, exercise <i>or</i> <input type="checkbox"/> Referral to a weight management program <i>and</i> <input type="checkbox"/> Health care provider notified

Continued on next page

**Table 1** Continued

	Target Goal	Initial Assessment	Intervention Plan and Communication	Reassessment Prior to Completion of Program	Changes in Intervention Plan and Communication
Presence or Absence of DM or IFG (fasting blood glucose 110–125 mg/dL)	HbA <sub>1c</sub> <7%	<input type="checkbox"/> Diagnosis of DM or IFG present <input type="checkbox"/> Diagnosis of DM or IFG absent	Complete only if diabetes mellitus is present: <input type="checkbox"/> Documentation that patient has attended skill training and medical nutrition therapy session or <input type="checkbox"/> Referral to skill training and medical nutrition therapy session or <input type="checkbox"/> Intervention plan recommended which includes: target goals for HbA <sub>1c</sub> , medical nutrition counseling, and skill training Complete only if IFG is present: <input type="checkbox"/> Education is completed concerning the importance of weight management and physical activity	Complete only if diabetes mellitus or IFG is present: <input type="checkbox"/> Attendance at appropriate education or skill training session	<input type="checkbox"/> A policy is in place concerning communication with appropriate health care professionals including thresholds for notification
Presence or Absence of Depression	Assessment of presence or absence of depression using a valid and reliable screening tool	<input type="checkbox"/> Patient screened for depression <input type="checkbox"/> Patient not screened for depression	Complete only if screening tool indicates possible depression: <input type="checkbox"/> Results discussed with patient and <input type="checkbox"/> Health care provider notified	<input type="checkbox"/> Patient re-screened for depression <input type="checkbox"/> Patient not re-screened for depression	Complete only if screening tool indicates possible depression: <input type="checkbox"/> Results discussed with patient and <input type="checkbox"/> Health care provider notified
Exercise Capacity	Assessment of symptom-limited exercise tolerance and development of an individualized exercise prescription	<input type="checkbox"/> Assessment and exercise prescription completed <input type="checkbox"/> Assessment and exercise prescription not completed	<input type="checkbox"/> Exercise prescription communicated to the patient and health care provider	<input type="checkbox"/> Re-assessment and exercise prescription completed <input type="checkbox"/> Re-assessment and exercise prescription not completed	<input type="checkbox"/> Revised exercise prescription communicated to the patient and health care provider
Use of Preventive Medications	Adherence to prescribed preventive medications	<input type="checkbox"/> Patient has been prescribed preventive medications by his/her health care provider(s)	<input type="checkbox"/> Individual education and counseling about the importance of adherence to appropriate preventive medications or <input type="checkbox"/> Group education and counseling about the importance of adherence to appropriate preventive medications	<input type="checkbox"/> Individual or group education completed	<input type="checkbox"/> Patient is encouraged to discuss questions or concerns about prescribed preventive medications with his/her healthcare providers

Target goals are from the 2006 AHA/ACC Secondary Prevention Guidelines (39). Assessment terms and definitions are from the outcomes registry proposal. Reprinted, with permission, from Thomas et al. (15).

BP = blood pressure; CABG = coronary artery bypass grafting; CHF = congestive heart failure; CR = cardiac rehabilitation/secondary prevention; CVD = cardiovascular disease; DM = diabetes mellitus; HDL-C = high-density lipoprotein cholesterol; IFG = impaired fasting glucose; LDL-C = low-density lipoprotein cholesterol; MI = myocardial infarction; PCI = percutaneous coronary intervention.

encompassed trials of exercise alone or as a component of multidisciplinary cardiac rehabilitation. An early meta-analysis (2) of randomized trials of exercise and coronary risk interventions showed a reduction in cardiovascular mortality without an effect on recurrent nonfatal MI; however, medical therapies reflected the accepted practices of the 1970s and 1980s. A concurrent overview of 22 randomized trials of exercise training after MI showed reduced risks for cardiovascular mortality and fatal reinfarction (30). Because most of these trials of exercise training antedated contemporary beneficial medical and revascularization therapies, a relevant question was whether the

magnitude of benefit from cardiac rehabilitation per se was similar in the contemporary environment. Further data subsequently invalidated this challenge.

The Cochrane Database on Exercise-Based Rehabilitation for Coronary Heart Disease concluded that exercise-based cardiac rehabilitation effectively reduced cardiac death, without clear evidence as to whether an exercise-only or a comprehensive cardiac rehabilitation program was more beneficial (31). Total mortality was reduced by 27% in patients participating in exercise only-based rehabilitation, in contrast to a 13% reduction in total mortality with comprehensive cardiac rehabilitation. There was no effect

on recurrent nonfatal MI. Medications were not well documented in most trials. Some shortcomings of this analysis were that the population reviewed was predominantly male, middle-aged, and low risk, with the ethnic origin of the participants seldom reported. Only comprehensive cardiac rehabilitation reduced total cholesterol and LDL-C levels, but effects of cholesterol-lowering drugs could not be excluded. The question was again raised as to whether improved drug interventions compromised the treatment effect of cardiac rehabilitation over time. Issues with these meta-analysis conclusions are that they depend substantially on the trials included.

A recent systematic review and meta-analysis of randomized trials of exercise both alone and as a component of multidisciplinary cardiac rehabilitation (29) involved women as one-fifth of the cohort and included a substantial representation of both patients >65 years of age and those following myocardial revascularization procedures. Trials with 6 or more months of follow-up were included if they assessed the effects of exercise training as an isolated intervention or in combination with psychological or educational interventions. Exercise-based rehabilitation was associated with lower all-cause (odds ratio [OR] 0.80) and cardiac mortality (OR 0.74) rates compared with usual medical care, with favorable but nonsignificant trends documented for both nonfatal MI and the requirement for myocardial revascularization procedures. Exercise rehabilitation with and without risk factor education and counseling effected greater reductions compared with control populations in total cholesterol, triglycerides, systolic blood pressure, and self-reported smoking, without significant differences in LDL-C or HDL-C levels (29). Health-related quality of life improved similarly with cardiac rehabilitation and with usual care. The investigators concluded that this review confirmed the benefits of exercise-based cardiac rehabilitation in the context of contemporary cardiovascular service provision; benefits appeared independent of the coronary heart disease diagnosis, the type of cardiac rehabilitation, the dose of exercise intervention, the length of follow-up, the quality of the trial, and the publication date of the trial.

Another metaanalysis of secondary prevention programs for coronary heart disease (CHD) patients encompassed 63 randomized trials that included 21,295 patients (32). Benefits did not differ for programs that incorporated risk-reduction strategies and supervised exercise, those that consisted solely of an exercise program, and those that provided risk-factor education or counseling but no supervised exercise component. These secondary prevention programs reduced recurrent MI by 17% at a median of 12 months; mortality benefit became apparent with longer follow-up: 15% overall and 47% at 2 years. Importantly, information garnered from this analysis showed that survival benefit was similar in recently published trials to those of over 2 decades earlier (before the widespread use of contemporary medical therapies) and in populations that included the contemporary case mix of patients after myocardial revascular-

ization therapies (8,29). The authors concluded that secondary prevention programs translated into improved processes of care, coronary risk factor profiles, functional status, and quality of life.

A review of 46 randomized trials of secondary prevention in 18,821 patients with coronary heart disease was recently conducted by the Agency for Healthcare Research and Quality (33); secondary prevention programs were demonstrated to reduce hospitalizations, recurrent MI, and long-term mortality.

Exercise also appears beneficial for patients with stable CHD. A small trial of men with angina and angiographic evidence of CHD showed significantly higher 1-year survival free of cardiac events with exercise training than with PCI with stenting: 88% versus 70%. Additionally, exercise capacity was greater and costs were lower in the exercise group (34).

In a study of over 500 consecutive coronary patients enrolled in cardiac rehabilitation compared with control patients not completing rehabilitation, depressive symptoms were assessed by questionnaire and mortality was evaluated at a mean follow-up of 40 months. Depressed patients had a >4-fold higher mortality than nondepressed patients, 22% versus 5%, and depressed patients who completed rehabilitation had a 73% lower mortality, 8% versus 30%. Importantly, reduction in depressive symptoms and the associated decrease in mortality were related to improvement in fitness; only a mild improvement in levels of fitness was needed to produce the benefit on depressive symptoms and the associated decrease in mortality (35).

Exercise training after MI has also been suggested to improve ventricular function and attenuate ventricular remodeling. Patients with an initial Q-wave MI and a left ventricular ejection fraction <10% in the ELVD (Exercise and Left Ventricular Dysfunction) trial received 6 months of exercise training (36). There was a resultant increase in both exercise capacity and left ventricular ejection fraction (34% to 38%).

In addition to the exercise benefits documented for patients with CHD, another current meta-analysis (37) addressed exercise training for patients with stable heart failure. Exercise training effected an improvement in functional capacity, a reduction in cardiorespiratory symptoms, and a trend toward increased survival. Many patients with heart failure have underlying CHD, potentially another explanation of their favorable response to cardiac rehabilitation exercise training. Although heart failure guidelines (9) recommend exercise training for such patients, there is currently no Medicare reimbursement, pending the outcome of a National Institutes of Health-sponsored large randomized clinical trial of exercise training in heart failure.

## Benefits and Safety of Cardiac Rehabilitation

The most substantial evidence-based benefits of cardiac rehabilitation include an improvement in exercise tolerance,

improvement in symptoms, improvement in blood lipid levels, reduction in cigarette smoking, improvement in psychosocial well-being, reduction of stress, and reduction in mortality (1), recurrent MI, and requirement for myocardial revascularization procedures (29,32).

An appropriately prescribed and implemented exercise training program is an integral component of cardiac rehabilitation, and confers particular benefit for patients with decreased exercise tolerance. Exercise training has beneficial hemodynamic effects for patients after MI, that is, a decrease in heart rate and blood pressure response for any given level of physical activity, with an improvement in aerobic capacity that averages 20%. Specific activity recommendations are available for women, for older adults, for patients with chronic heart failure and after cardiac transplantation, for stroke survivors, and for patients with claudication due to peripheral arterial disease. Strength (resistance) training, superimposed on aerobic training, improves skeletal muscle strength and endurance.

In addition to reductions in recurrent MI and mortality, benefits of exercise rehabilitation include enhancement of functional capacity, which encompasses an increase in the activity threshold before the onset of ischemia and reduction of symptoms; this enables return to work and to leisure and recreational activities. Moderate increases in functional capacity can help maintain independent living for elderly patients (38).

The mechanisms of benefit are multifaceted; a number of factors can contribute to the benefits of exercise rehabilitation, including improvements in the lipid profile, reduction in blood pressure, and prevention and treatment of type II diabetes. Other factors also potentially contributory include a reduction in inflammation, as indicated by a decrease in serum C-reactive protein (39); possible ischemic preconditioning; improved endothelial function; and a more favorable fibrinolytic balance.

A number of studies have documented the safety of exercise cardiac rehabilitation in supervised exercise programs, although, again, many of them antedated the contemporary beneficial medical and revascularization therapies (40–42). Investigators estimated that major cardiac events, including MI and resuscitated cardiac arrest, occurred in 1 in 50,000 to 100,000 patient-hours of supervised exercise, with only 2 fatalities reported for 1.5 million patient-hours of supervised exercise (40,41). The 2007 Scientific Statement from the American Heart Association on Exercise and Acute Cardiovascular Events (43) estimated the risk of any major cardiovascular complication, including cardiac arrest, death, or MI, as 1 event in 60,000 to 80,000 hours of supervised exercise. In a contemporary French registry, 1 cardiac event occurred per 50,000 patient-hours of exercise training and 1.3 cardiac arrests per million hours (44). This must be considered in the context of the classification or risk stratification for exercise. Class A individuals encompass those who are apparently healthy, without an increased cardiovascular risk with exercise; class B identifies patients

with clinically stable established CHD who are at low risk of cardiovascular complications with vigorous exercise; class C individuals, owing to their history of multiple MIs or cardiac arrest, New York Heart Association functional class III or IV or an exercise capacity of <6 metabolic equivalents, and significant ischemia at exercise testing, are considered to be at moderate or high risk of cardiac complications during exercise; for the sake of completeness, class D patients are those with unstable disease who require activity restriction and for whom exercise, as long as this classification remains operative, is contraindicated. The typical patients referred for outpatient exercise cardiac rehabilitation are in class B or C and challenge us to apply differing extents of exercise monitoring or supervision. Patients at moderate or high risk for cardiac complications with exercise (class C) are recommended to participate in a medically supervised program, for at least 8 to 12 weeks after an acute event, until the safety of the prescribed exercise regimen has been established. Although low-risk patients may initially benefit from medically supervised exercise, self-monitored home-based exercise programs have also been documented to be effective and safe and potentially associated with better rates of adherence compared with group-based programs.

Specific educational, counseling, and pharmacologic strategies can achieve smoking cessation. Lipid management requires intensive nutrition education, counseling, and behavioral interventions to improve dietary fat and cholesterol intake. Optimal lipid control characteristically entails pharmacologic management, in addition to diet and exercise training. Diet, exercise, and behavioral interventions are recommended for weight management. A multifactorial education, counseling, behavioral, and pharmacologic approach is the recommended strategy for management of hypertension. Increased attention is currently directed to the management of diabetes and to the more rigorous control of coexisting coronary risk factors in diabetic patients (45). Specific U.S. national guidelines address the goals and recommended strategies for lipid management, blood pressure control, management of diabetes, of obesity and smoking cessation (19,22,46–48).

Common psychosocial problems in patients referred for cardiac rehabilitation include depression, anger, anxiety, and social isolation. Education, counseling, and/or psychosocial interventions, either alone or as a component of multifactorial cardiac rehabilitation, can improve psychosocial well-being and quality of life and are recommended to complement the psychosocial benefits of exercise training. To date, psychosocial interventions have not been documented to alter the prognosis of coronary patients.

### Special Populations

**Women.** Women, particularly elderly women, are less likely to be referred for cardiac rehabilitation and, when referred, are less likely to attend. This disparity occurs

despite the documentation that both genders receive equal benefit from participation in cardiac rehabilitation exercise training (3,49); specifically, women whose functional capacity at entry into rehabilitation is often less favorable are likely to attain greater benefit.

Minority women have a more adverse prognosis after hospitalization for an acute coronary event, and cardiac rehabilitation has been shown to improve survival. Yet nonwhite women are less likely than white women to be referred to cardiac rehabilitation and are more likely to report financial barriers; more than one-half of the women in the survey providing these data represented ethnic minorities (50).

The Evidence-Based Guidelines for Cardiovascular Disease Prevention in Women specifically recommend cardiac rehabilitation after a coronary event (12).

**Elderly.** Elderly patients are at high risk of disability after a coronary event or hospitalization for heart failure. Complications of MI and myocardial revascularization procedures are more frequent at an elderly age, with the prolonged hospitalization for these events predisposing to physical deconditioning. Therefore, more than one-half of patients eligible for cardiac rehabilitation services are older than age 65 years. Application of this modality to elderly patients has gained increasing acceptance and advocacy (51) as its benefits and safety have been documented (1,3,52).

Elderly patients also have less referral to and participation in exercise rehabilitation, despite the demonstration of exercise trainability similar to younger patients (53); elderly women and men show similar functional improvement. Elderly patients are typically less fit than their younger peers after a coronary event, in part owing to their lesser fitness before the event. In the studies reviewed, adherence to exercise training in elderly patients was high, and no complications or adverse outcomes of exercise training in elderly subjects were described in any study (1). Implementation of exercise training for elderly patients requires only modest modifications in the exercise prescription, training techniques, and standard program components, with consideration given to the cardiovascular changes associated with aging and attention to comorbidities that may impair mobility.

Elderly patients who participate in multifactorial cardiac rehabilitation have significant reductions in coronary risk factors. Findings similar to these U.S. data were reported in the French nationwide PREVENIR survey (54), which also emphasized the under-representation of elderly patients, especially elderly women, in cardiac rehabilitation populations after an acute coronary syndrome. Given that physician recommendation is the strongest determinant of entry into cardiac rehabilitation and maintenance of participation (55), physicians should strongly encourage elderly patients of both genders to participate in an exercise-based cardiac rehabilitation program.

A pilot study examining older adults' expectations and experiences with cardiac rehabilitation suggested that such

patients value more socialization opportunities, more variation in the types of exercise offered, enhanced teaching about stress management, and adaptation of teaching strategies to the needs of older individuals. Older men feared pain with exercise, whereas older women expressed the need for emotional support. This study buttressed the strength of physician referral as the major reason for patient participation or nonparticipation in cardiac rehabilitation (56).

**Patients with heart failure.** Exercise training is recommended for patients with stable class II to class III heart failure who do not have advanced arrhythmias or other contraindications to exercise (9). Beneficial effects of exercise may occur as early as 3 weeks after the initiation of exercise training. Recommendations for the intensity and duration of exercise in patients with heart failure incorporate a longer warm-up period to increase skeletal muscle vasodilation before reaching a training intensity, with exercise training beginning at an intensity of 40% to 60% of the maximal oxygen uptake ( $VO_2$  max) and characterized by exercise intervals of 2 to 6 min separated by 1 or 2 min of rest. The exercise interval is gradually increased until the patient can tolerate 30 min of continuous exercise. The rating of perceived exertion, per the Borg scale (57), should be at a level of 10 to 13 and may be more beneficial than the heart rate response to measure exercise intensity, because heart rate response is often impaired in the patient with heart failure. In one small randomized trial, however, higher-intensity interval aerobic activity, even in elderly patients, provided greater benefit in reversing ventricular remodeling, improving aerobic capacity, and improving quality of life (58).

Heart failure patients should exercise for a 15- to 30-min session 3 to 5 times a week, with avoidance of repetitive lifting of significant weight owing to the potential deleterious effect of isometric exercise on ventricular function. Recommended exercise modalities include walking on a treadmill or track, or use of a stationary bicycle or arm ergometer, with the exercise intensity increased every 1 to 2 weeks to achieve the same rating of perceived exertion. For patients unable to access a structured cardiac rehabilitation program, walking at a moderate pace is recommended.

**Cardiac transplantation patients.** Because the cardiovascular response to exercise is muted by the loss of autonomic heart rate control after cardiac transplantation, the rating of perceived exertion is used to regulate exercise intensity, and is initially set at 60% to 70% of the  $VO_2$  max. As with heart failure patients, longer warm-up and cool-down periods are important, because of the longer requisite duration of the physiologic response to exercise and recovery with impaired cardiac innervation.

## Barriers to Participation in Cardiac Rehabilitation

Although many patients with CHD and heart failure are appropriate candidates for cardiac rehabilitation services, fewer than 30% of eligible U.S. patients currently participate

**Table 2 Cardiac Rehabilitation/Secondary Prevention Performance Measurement Set B-1**

Performance Measure B-1	
B-1. Structure-Based Measurement Set	
The cardiac rehabilitation/secondary prevention (CR) program has policies in place to demonstrate that:	
1. A physician-director is responsible for the oversight of CR program policies and procedures and ensures that policies and procedures are consistent with evidence-based guidelines, safety standards, and regulatory standards (43). This includes appropriate policies and procedures for the provision of alternative CR program services, such as home-based CR.	
2. An emergency response team is immediately available to respond to medical emergencies (44). <ul style="list-style-type: none"> <li>A. In a hospital setting, physician supervision is presumed to be met when services are performed on hospital premises (45).</li> <li>B. In the setting of a free-standing outpatient CR program (owned/operated by a hospital, but not located on the main campus), a physician-directed emergency response team must be present and immediately available to respond to emergencies.</li> <li>C. In the setting of a physician-directed clinic or practice, a physician-directed emergency response team must be present and immediately available to respond to emergencies.</li> </ul>	
3. All professional staff have successfully completed the National Cognitive and Skills examination in accordance with the AHA curriculum for basic life support (BLS) with at least one staff member present who has completed the National Cognitive and Skills examination in accordance with the AHA curriculum for advanced cardiac life support (ACLS) and has met state and hospital or facility medico-legal requirements for defibrillation and other related practices (43,46,47).	
4. Functional emergency resuscitation equipment and supplies for handling cardiovascular emergencies are immediately available in the exercise area (44).	
<b>Numerator</b>	The number of CR programs in the health care system that meet these structure-based performance measure criteria
<b>Denominator</b>	All CR programs within a health care system
<b>Period of Assessment</b>	Per reporting year
<b>Method of Reporting</b>	Inclusive data collection tracking sheet
<b>Sources of Data</b>	Written program policies
Rationale	
The delivery of CR services is physician-directed and provided by a multidisciplinary staff of health care professionals. A system for communication between a physician-director with expertise in CVD management and a referring or primary physician enhances the program's success in helping that patient achieve individualized target goals. It is the responsibility of the physician-director to assure that the information and instruction given to patients in CR is consistent with the most current clinical practice guidelines.	
There is a growing trend among patients referred to and completing early outpatient CR to be older, at higher risk, and have more chronic comorbidities (48). Medical supervision is the most important day-to-day safety factor in CR (43). Personnel and equipment for ACLS are essential to the adequate delivery of emergency care for patients who experience cardiac arrest or other life-threatening events during CR sessions.	
Although rare, cardiovascular emergencies can occur during exercise training in CR programs. Studies suggest that the incidence of cardiac arrest requiring defibrillation is approximately 1 arrest every 100,000 patient-hours (49). Practice guidelines for management of cardiac arrest include the use of BLS and ACLS strategies, such as early defibrillation (17,43). Such strategies have been shown to help improve outcomes in persons who experience cardiac arrest (50).	
Some CR programs seek certification of their program by health care organizations, such as AACVPR, in order to show that they meet certain standards for the delivery of CR services. Such a certification process, while outside the scope of this document, may result in documentation of a program's ability to meet this (B-1) and other CR performance measures mentioned in this document. Currently, for instance, CR program certification through AACVPR requires that all of the above policies (Items 1 to 4 above) are in place and operational.	
Corresponding Guidelines and Clinical Recommendations	
Medical Director Responsibilities for Outpatient Cardiac Rehabilitation/Secondary Prevention Programs (43) (No class of recommendation or level of evidence given) There is a physician-director responsible for program oversight and to ensure that policies and procedures are consistent with evidence-based guidelines, safety standards, and regulatory standards.	
AACVPR Guidelines for Cardiac Rehabilitation and Secondary Prevention Programs (51) (No class of recommendation or level of evidence given) All professional staff have completed BLS training; at least 1 staff member is present who has successfully completed training in ACLS.	
Medical supervision for moderate- to high-risk patients will be provided by a physician, registered nurse, or other appropriately trained staff member who has successfully completed AHA curriculum for ACLS and has met state and hospital or facility medico-legal requirements for defibrillation and other related practices.	
Exercise Standards for Testing and Training: A Statement for Health Professionals From the American Heart Association. AHA Scientific Statement (52) (No class of recommendation or level of evidence given) An emergency response team is immediately available to respond to medical emergencies.	
CMS National Coverage Determination for Cardiac Rehabilitation Programs (45) (No class of recommendation or level of evidence given) Functional emergency resuscitation equipment and supplies for handling cardiovascular emergencies are immediately available in the exercise area.	
Challenges to Implementation	
Adherence to this measure requires the engagement of a physician-director who is accountable for policy development and implementation.	

Reprinted, with permission, from Thomas et al. (15). All references within this table are from Thomas et al. (15).

in supervised structured cardiac rehabilitation programs after a cardiovascular event (59–61). More vulnerable populations—women, nonwhites, patients >65 (particularly >75) years of age, and those with less medical insurance coverage—are particularly underrepresented (54,59). More prevalent comorbidities, lower socioeco-

omic status, and greater distance from a cardiac rehabilitation facility are associated with lower use rates (13). Confirmation of racial disparities in the referral for cardiac rehabilitation challenges us to examine patient and provider factors that contribute to these inequities as a basis for remediation (62).

Major barriers include the low patient referral rate, poor patient motivation, inadequate insurance reimbursement, and geographic limitations as to the accessibility of structured rehabilitation program sites. Insurance reimbursement (including government reimbursement) in the U.S. typically covers 36 exercise sessions (3 times weekly for 12 weeks) and the associated education and counseling.

Implementation of performance measures for cardiac rehabilitation offers the potential to enhance referral to, enrollment in, and completion of cardiac rehabilitation (15).

### Alternative Modes of Delivery of Cardiac Rehabilitation Services

Given the low percentage of eligible patients who participate in structured supervised cardiac rehabilitation, alternative approaches other than the traditional supervised group interventions were recommended in the AHCPR clinical practice guideline (1) as safe and effective for stable coronary patients. The guideline advocated transtelephonic and other means of monitoring and surveillance to extend cardiac rehabilitation services beyond the setting of supervised,

structured, and group-based rehabilitation. The 2005 scientific statement of the American Heart Association (40) offered several models that included home-based programs, for which a nurse serves as a case manager to supervise and monitor patient care and progress, and community-based group programs with guidance by nurses or nonphysician health care providers. Electronic media (internet-based) programs can provide alternative methods for home-based comprehensive risk modification, education, and instruction as well as for guidance of a structured exercise regimen.

A small Canadian survey of patient preferences showed that time-constrained working cardiac patients were more likely to prefer home-based rehabilitation, but that patient preferences did not differ based on age or gender (63).

The attractiveness of these alternative paradigms is their potential to provide cardiac rehabilitation to low- and moderate-risk patients, who comprise the majority of contemporary U.S. patients with stable CHD, most of whom currently do not participate in structured, supervised cardiac rehabilitation. In one study, the participation rate with medically directed home exercise was 72% at 6 months and

**Table 3 Cardiac Rehabilitation/Secondary Prevention Performance Measurement Set B-3c**

Performance Measure B-3c—Individualized Assessment of Optimal Lipid Control	
For each eligible patient enrolled in the cardiac rehabilitation/secondary prevention (CR) program, there is documentation that the following criteria have been met:	
1. An assessment of blood lipid control and use of lipid-lowering medications, with target goals defined by the AHA/ACC secondary prevention guidelines.	
2. For patients with a diagnosis of hyperlipidemia, an intervention plan has been recommended to the patient. This should include education about target lipid goals, importance of medication compliance, lifestyle modification for optimal dietary and regular physical activity habits, and weight control.	
3. Prior to completion of the CR program, lipid control and the lipid management plan, including lifestyle modification, are reassessed and communicated to the patient as well as to the primary care provider and/or cardiologist.	
<b>Numerator</b>	Number of patients in the health care system's CR program(s) who meet the performance measure for lipid control
<b>Denominator</b>	Number of patients in the health care system's CR program(s)
<b>Period of Assessment</b>	Per reporting year
<b>Method of Reporting</b>	Inclusive data collection tracking sheet
<b>Sources of Data</b>	Electronic- or paper-based prospective flow sheet (preferred) or retrospective medical record review
Rationale	
Multiple clinical trials have shown the benefit of lipid-lowering agents and lifestyle modification for patients with documented cardiovascular disease (39). A more aggressive low-density lipoprotein (LDL) target goal of <70 mg/dL should be considered for persons with multiple cardiovascular risk factors, particularly when they are under suboptimal control (e.g., a patient with coronary artery disease who continues to smoke).	
Corresponding Guidelines and Clinical Recommendations	
AHA/ACC Guidelines for Secondary Prevention for Patients With Coronary and Other Atherosclerotic Vascular Disease: 2006 Update (39)	
<i>Class I</i>	
Goal: Low-density lipoprotein-cholesterol (LDL-C) <100 mg/dL; If triglycerides are >200 mg/dL, non-high-density lipoprotein cholesterol (HDL-C) should be <130 mg/dL. (Level of Evidence: B, for lifestyle modification; A, for pharmacological treatment)	
AHA/AACVPR Scientific Statement: Core Components of Cardiac Rehabilitation/Secondary Prevention Programs: 2007 Update (57)	
(No class of recommendation or level of evidence given)	
Goals:	
<b>Short-term:</b> Continued assessment and modification of intervention until LDL <100 mg/dL (further reduction to a goal <70 mg/dL is considered reasonable).	
<b>Long-term:</b> LDL <100 mg/dL (further reduction to a goal <70 mg/dL is considered reasonable). Secondary goal: non-HDL-C <130 mg/dL (further reduction to a goal of <100 mg/dL is considered reasonable).	
AHA Scientific Statement: Diet and Lifestyle Recommendations Revision 2006 (58)	
(No class of recommendation or level of evidence given)	
Goal: Aim for recommended levels of LDL-C, HDL-C, and triglycerides.	
Related Performance Measurement Sets	
Clinical Performance Measures. Chronic Stable Coronary Artery Disease. Tools Developed by Physicians for Physicians. Physician Consortium for Performance Improvement (59)	
Percentage of patients receiving at least one lipid profile during the reporting year. Percentage of patients who are receiving a statin (based on current ACC/AHA guidelines).	

41% at 4 years, similar to that of supervised exercise regimens (64). An unmet need remains the long-term assessment of the adherence to and effectiveness of these novel approaches and ascertainment of the optimal mode(s) of delivery of such services.

### Performance Measures: Promise for Progress

The performance measures for cardiac rehabilitation (15) are divided into those that are structure-based, related to the provision of appropriate personnel and equipment for cardiac rehabilitation programs, and those that are process-based, quantifying specific aspects of cardiac rehabilitation care. An example of a structure-based measurement set relates to the physician director responsibility for the oversight of a cardiac rehabilitation program and to the characteristics of an emergency response team (Table 2). Medical director (65) and other cardiac rehabilitation staff responsibilities and duties (66) have been presented in detail by the American Heart Association and the American Association for Cardiovascular and Pulmonary Rehabilitation. Process-based measures are available for all components of cardiovascular risk reduction. Table 3 shows an example related to lipid management.

As noted elsewhere in the present review, performance measurement sets have been designed for the hospital setting, the physician office, and the cardiac rehabilitation program setting, such that performance measures relate both to the appropriate referral of patients to cardiac rehabilitation and to the appropriate performance of cardiac rehabilitation.

### Summary

Cardiac rehabilitation is an integral component of the continuum of care for patients with cardiovascular disease. As of March 2006, the U.S. Center for Medicare and Medicaid Services (67,68) concluded that cardiac rehabilitation is reasonable and necessary after acute MI (within the prior 12 months), CABG surgery, stable angina pectoris, PCI with or without stenting, heart valve repair or replacement, and heart or heart-lung transplantation (1,31). The report of the Agency for Healthcare and Research and Quality concluded that secondary prevention programs improved processes of care, enhanced quality of life and functional status, and reduced hospitalization, recurrent MI, and long-term mortality.

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