CARDIAC REHABILITATION

Cardiac rehabilitation (CR) is the process by which persons with cardiovascular disease (including but not limited to patients with coronary heart disease) are restored to and maintained at their optimal physiological, psychological, social, vocational, and emotional status. (American Association of Cardiovascular and Pulmonary Rehabilitation–AACPR).

The goals of CR are to restore and improve cardiac function, reduce disability, identify and improve cardiac risk factors, and increase cardiac conditioning.

These goals are achieved through the use of a prescribed exercise and education program. The primary outcome for patients with cardiac disease is the ability to resume activities of normal life without significant cardiac symptomatology.

For those able to return to work:

1. Return to productive employment as soon as possible
2. Improve and maintain as good cardiovascular fitness

For those not able to return to work:

1. Maintain as active a life as possible
2. Establish new areas of interest to improve quality of life

Cardiac rehabilitation programs are generally divided into primary prevention, which includes risk factor modification and education before a cardiac event, and secondary prevention, which is cardiac rehabilitation with exercise and risk factor modification after the establishment of cardiac disease, including MI and other conditions.

Primary prevention. As a rehabilitation specialist, it is essential to address lifestyle modification and education as parts of a complete cardiac rehabilitation program. Lifestyle modification is needed to address reversible cardiac risk factors, and education includes teaching patients about all cardiac risk factors. The goal is to achieve a program of cardiac risk factor modification. Programs can be started in schools and parental involvement is also appropriate. Primary prevention can also include the use of medications for prevention of cardiovascular disease complications, and includes treatment of hypertension, lowering lipids, and antiplatelet agents.

Risk factors for cardiovascular disease:

Irreversible risk factors are those that cannot be altered and include male gender, past history of vascular disease, age, and family history of premature CAD (before age 55 in a parent or sibling).

Reversible risk factors for cardiac disease have been known for several decades and include obesity, sedentary lifestyle, hyperlipidemia (Low HDL cholesterol (<0.9 mmol/L [35 mg/dL]), hypercholesterolemia (>5.20 mmol/L [200 mg/dL]), high lipoprotein A, hypertriglyceridemia (>2.8 mmol/L [250 mg/dL]), cigarette smoking, sedentary lifestyle, conditions such as diabetes mellitus, hyperinsulinemia, metabolic syndrome and hypertension.

Modification of all these risk factors is an essential part of a cardiac rehabilitation program.

American Heart Association physical activity recommendations:

1. Get at least 150 minutes per week of moderate-intensity aerobic activity or 75 minutes per week of vigorous aerobic activity, or a combination of both, preferably spread throughout the week.
2. Add moderate- to high-intensity muscle-strengthening activity (such as resistance or weights) on at least 2 days per week.
3. Spend less time sitting. Even light-intensity activity can offset some of the risks of being sedentary.
4. Gain even more benefits by being active at least 300 minutes (5 hours) per week. Increase amount and intensity gradually over time.

Examples of moderate-intensity aerobic activities: brisk walking (at least 2.5 miles per hour), water aerobics, dancing (ballroom or social), gardening, tennis (doubles), biking slower than 10 miles per hour.

Examples of vigorous-intensity aerobic activities: hiking uphill or with a heavy backpack, running, swimming laps, aerobic dancing, heavy yardwork like continuous digging or hoeing, tennis (singles), cycling 10 miles per hour or faster, jumping rope

Patient Education and Reduction of Coronary Risk Factors

1. The modification of risk factors in those with CAD:
– Lower cholesterol
– Lower blood pressure
– Better hypertension management
– Reduced cigarette smoking
2. Improved treatment methods
3. Improved prevention

Secondary risk factor modification programs, which are the more common programs for individuals practicing cardiac rehabilitation, occur after an initial cardiac event. Secondary risk factor modification programs include all the features of the primary prevention programs with the addition of disease-specific education and formal exercise programs.

Phases of cardiac rehabilitation

Phase I (Inpatient Period). This stage of rehabilitation can last from as short as one day to as long as 14 days for cardiovascular patients undergoing invasive procedures or suffering from acute events. This phase is divided into the acute and subacute phases.

Acute

During the acute period, when the patient is still in the coronary care unit (CCU), the goal is to prevent deterioration. Activities of 1–2 METS are performed Passive ROM (1.5 mets): Upper extremity ROM (1.7 mets), Lower extremity ROM (2.0 mets)

Avoid: isometrics (increases heart rate), valsalva (promotes arrhythmia), raising the legs above the heart (can increase preload)

Subacute

During this phase of rehabilitation the patient is transferred to the telemetry or medical ward. Early ambulation is encouraged, and the patient should be performing activities at about the 3–4 MET level. ROM exercise: intensity can be gradually increased by increasing the speed and/or duration.

Phase II (Immediate Outpatient Period)

This period is the convalescent stage following a hospital discharge. The length is partly determined by risk satisfaction and monitoring need. By definition this period is the most closely monitored phase of rehabilitation. This is the supervised ambulatory outpatient phase; it lasts about 3–6 months. ECG stress is typically performed during this phase to guide further rehabilitation.

Phase III and Phase IV (Intermediate and Maintenance Periods)

The third stage of recovery is an extended outpatient period that may be divided into two components, intermediate and maintenance. The intermediate stage follows immediate outpatient cardiac rehabilitation, that is, when the patient is not intensely monitored and/or supervised but is still involved in regular endurance exercise training and lifestyle change.

Phase IV. The goal is to improve physical fitness and decrease risk factors for cardiovascular disease.

Outcomes of cardiac rehabilitation:

1. Improved exercise tolerance
2. Improvement of symptoms
3. Decreased angina
4. Decreased heart failure in patients with left ventricular systolic dysfunction
5. Improved measures of myocardial ischemia (MI)
6. Improved psychosocial well-being
7. Improved blood lipid levels
8. Stress reduction
9. Decreased cigarette smoking
10. Decreased cardiovascular mortality

Indications for inpatient Cardiac Rehabilitation:

1. Patients who have had myocardial infarction
2. Coronary artery bypass surgery (CABG) or angioplasty patients

3. Coronary patients with or without residual ischemia
4. Heart failure and arrhythmias
5. Patients with dilated cardiomyopathy
6. A variety of patients with nonischemic heart disease
7. Patients with concomitant pulmonary disease
8. Patients who have received a pacemaker or an automatic implanted cardioverter-defibrillator
9. Patients who have had heart-valve repair or replacement
10. Aneurysm, aneurysm resection, organ transplantation

Absolute Contraindications for Entry into Inpatient and Outpatient Exercise Training:

1. Unstable angina
2. Resting systolic blood pressure > 200 mm Hg or resting diastolic blood pressure > 110 mm Hg
3. Moderate to severe aortic stenosis
4. Acute systemic illness or fever
5. Uncontrolled atrial or ventricular arrhythmias
6. Uncontrolled tachycardia (> 100 bpm)
7. Symptomatic congestive heart failure
8. Third-degree heart block without pacemaker
9. Active pericarditis or myocarditis
10. Recent embolism
11. Thrombophlebitis
12. Resting ST displacement (> 3 mm) (as seen on ECG)
13. Uncontrolled diabetes
14. Orthopaedic problems that would prohibit exercise

Type of Exercise

Exercise for cardiovascular conditioning should be isotonic, rhythmic, and aerobic; should use large muscle masses and should not involve a large isometric component

• Sessions of exercise should incorporate aerobic activity such as walking/jogging, stationary cycling or water aerobics. Sessions should also incorporate warm-up and cooldown periods. In addition to aerobic activity, resistance exercise (using light weights) may be added on an individual basis

• Resistance exercises have been shown to be a safe and effective method for improving strength and cardiovascular endurance in low-risk patients. Surgical and myocardial infarction patients should wait three to six weeks before beginning resistance training. Patients diagnosed with the following conditions should be excluded from resistance training:

NYHA CARDIAC FUNCTIONAL CLASSIFICATION

Class I NY Heart Association

Patient's cardiac disease does not limit physical activity. Ordinary physical activity does not cause undue fatigue, palpitation, dyspnea, or anginal pain.

Patients can perform to completion any activity requiring > or = 7 mets: (Can carry 24 lbs. up 8 steps, can carry objects that weigh 80 lbs, do outdoor work (shovel snow, spade soil), do recreational activities (skiing, basketball, squash, handball, jog at 5 mph)

Class II NY Heart Association

Patient's cardiac disease results in slight limitation on physical activity. They are comfortable at rest. Ordinary physical activity results in fatigue, palpitation, dyspnea, or anginal pain.

Patient can perform to completion any activity requiring > or = 5 mets, but cannot and does not perform to completion of activities requiring > or = to 7 mets: sexual intercourse to completion without interruption, garden, rake, weed, roller-skate, walk at 4 mph on level ground

Class III NY Heart Association

Patient's cardiac disease results in marked limitation of physical activity. They are comfortable at rest. Less than ordinary physical activity causes fatigue, palpitation, dyspnea, or anginal pain.

Patient can perform to completion any activity that requires > or = 2 mets and < 5 mets: shower without interruption, strip and make bed, Clean windows, Walk 2.5 mph, Bowl, golf, Dress without stopping

Class IV NY Heart Association

Patient's cardiac disease results in inability to carry on any physical activity without discomfort. Symptoms of cardiac insufficiency or of the angina syndrome may be present even at rest. If any physical activity is undertaken, discomfort is increased.

Patient cannot or does not perform to completion activities requiring > or = 2 mets. Cannot carry out activities in Class I – III.

CARDIAC REHABILITATION OF THE POST-MI PATIENT

Acute Phase (Phase I).

Phase I is the acute phase, immediately following the MI up to discharge. Phase I rehabilitation is characterized by early mobilization. The major goal of the phase I program is to condition the patient to perform activities up to four METs, which is within the range of most daily activities at home after discharge. Generally patients are encouraged to be sitting out of bed and in a chair as soon as medically stable, usually by day 1 to 2 (steps 1 to 5). By day 2 to 3, short distance ambulation can be initiated, and bathroom privileges are full (steps 6 to 9). Around day 3, the patient is introduced to the home exercise program, and stairs and increased durationof ambulation are

encouraged (steps 10 to 13). After successful completion of a low level ETT for risk stratification on day 4 to 5, the patient completes learning the home program and is discharged (step 14).

Wenger Protocol

Step Activity

1 Passive range of motion (ROM), ankle pumps, introduction to the program, self-feeding

2 As above, also dangle at side of bed

3 Active assisted ROM, sitting upright in a chair, light recreation, and use of bedside commode

4 Increased sitting time, light activities with minimal resistance, patient education

5 Light activities with moderate resistance, unlimited sitting, seated ADL activities

6 Increased resistance, walking to bathroom, standing ADL, up to 1 h long group meetings

7 Walking up to 100 ft, standing, warm-up exercises

8 Increased walking, walk down stairs (not up), continued education

9 Increased exercise program, review energy conservation, and pacing techniques

10 Increase exercises with light weights and ambulation, begin education on home exercise program

11 Increased duration of activities

12 Walk down two flights of stairs, continue to increase resistance in exercises

13 Continue activities, education and home exercise program teaching

14 Walk up and down two flights of stairs, complete instruction in home exercise program and in energy conservation and pacing techniques

The educational program relating to risk factor modification should be introduced at this time, especially as many patients are ready to listen to advice in their acute hospitalization. A further modification of the classical program is that now most patients are rapidly evaluated for revascularization procedures, and often will start their rehabilitation after a catheterization or a bypass surgery. With or without revascularization, the acute mobilization should be done with cardiac monitoring and under the supervision.

The post-MI HR rise with activity should be kept to within 20 bpm of baseline and the systolic BP rise within 20 mm Hg of baseline. Any decrease of systolic BP of 10 mm Hg or moreshould be considered worrisome and the exercise halted.

Subacute Inpatient Rehabilitation Phase (Phase IB). The guidelines for exercise are often the same as they are for the strict phase I patients, but the period of recovery is longer.

Patients at High Risk During Cardiac Rehabilitation

Ischemic risk

1. Postoperative angina

2. LV ejection fraction <35%
3. NYHA grade III or IV CHF
4. Ventricular tachycardia of fibrillation in the postoperative period
5. SBP drop of ten points or more with exercise
6. Excessive ventricular ectopy with exercise
7. Incapable of self-monitoring
8. Myocardial ischemia with exercise

Arrhythmic risk

1. Acute infarction within 6 wk
2. Active ischemia by angina or exercise testing
3. Significant left ventricular dysfunction (LVEF <30%)
4. History of sustained ventricular tachycardia
5. History of sustained life-threatening supraventricular arrhythmia
6. History of sudden death, not yet stabilized on medical therapy
7. Initial therapy of patients with automatic implantable cardioverter defibrillator (AICD)
8. Initial therapy of a patient with a rate adaptive cardiac pacemaker

Exercise intensity is generally limited to a target heart rate which is known to be safe. The level of exercise is usually done at a level of approximately 70% maximum heart rate or a MET level of 5. For a person more than 40 years old this generally represents a maximum heart rate of 130 bpm or five METs, and for an individual less than 40 years old, 140 bpm or seven METs.

Phase II (Immediate Outpatient Period)Training Phase

Phase II is the convalescent phase, which is done at home and continues the program started in phase I until the myocardial scar has matured.

The training phase of the cardiac rehabilitation program is started after a symptom limited full level ETT or completion of a revascularization procedure and return to full activities.

For patients who are in the low risk group, a program designed to achieve 85% of the maximum heart rate is generally regarded as safe. For individuals who are at greater risk, exercise programs at lower target HRs.

In order to assist in increasing access to cardiac rehabilitation, creative programs have been developed, including at home programs for low-risk post-MI patients, both community-based and home-based programs. A key to success in home-based programs is assuring that patients are able to perform self-monitoring during their exercise program. Just as in the supervised programs, all exercise session should begin with a stretching session, followed by a warm up session, the training exercise, and end with a cool down period. It is important to remember that conditioning benefit is related to the specificity of training, and that the conditioning applies to the specific muscles exercised.

Phase III is the training phase; this usually starts after 4–6 weeks, and is the classic exercise program of conditioning and education.

Despite usually receiving the least attention, the maintenance phase of a cardiac conditioning program is the most important part of the program. If the patient stops exercising, the benefits gained from phase II can be lost in a few weeks. In order to facilitate compliance with maintenance exercise, the program needs to integrate the actual exercises into the patient's lifestyle. There also needs to be an emphasis on secondary prevention measures and how to integrate these changes into the patient's lifestyle.

For moderate level exercises, patients should be told to perform their ongoing exercises at the target heart rate for at least 30 minutes three times a week.

For low-level exercise, patients need to perform exercise five times a week. ECG monitoring is not necessary during the maintenance phase.

Phase IV is the maintenance phase, and is devoted to keeping the aerobic conditioning gains made in phase III. Risk-factor modifications are taught and reemphasized throughout all phases. If the patient stops exercising, the benefits gained from phase III can be lost in a few weeks. The actual exercises need to be integrated into the patient's lifestyle and interests to assure compliance. The secondary prevention measures also need to be integrated into the patient's lifestyle. The ongoing exercises should be performed at the target HR for at least 30 minutes, three times a week, if at a moderate level. If at a low level, exercises need to be performed five times a week. During the maintenance phase, electrocardiogram monitoring is not necessary.

Patient Guidelines for exersing:

1. Wear proper clothing: good shoes, loose-fitting garments, garments appropriate to the ambient temperature.
2. Follow exercise guidelines: 5–10 min low intensity warm-up, 20–30 min exercise at full intensity 5–10 min low intensity cool down
3. Stop exercising for adverse symptoms: cardiac symptoms (chest pain,shortness of breath lightheadedness), general symptoms (joint pains, faintness with exercise)
4. No exercise while ill, wait for 2 d after illness has passed No exercise in environmental extremes,
5. Avoid extreme heat and humidity, Avoid extreme cold
6. Exercise indoors in winter: Wear warm clothing Use a face mask
7. Exercise early in the morning or in the evening
8. No exercise after eating, Wait 2 h after meals

Absolute contraindications to exercise testing and training for patients with MI include:

1. acute MI,
2. unstable angina,
3. moderate to severe aortic stenosis,

4. resting systolic blood pressure above 200 mmHg or diastolic pressure above 110 mmHg,
5. uncontrolled arrhythmias, tachycardia above 100 beats/minute,
6. third-degree heart block (without pacemaker),
7. resting ST displacement >3 mm.
8. active pericarditis or myocarditis,
9. recent embolism or thrombophlebitis,
10. uncontrolled diabetes.

Relative contraindications include:

1. significant arterial or pulmonary hypertension,
2. moderate valvular or myocardial heart disease,
3. electrolyte abnormalities,
4. left main coronary obstruction,
5. hypertrophic cardiomyopathy
6. psychiatric disease.

Cardiac rehabilitation for patients with Angina Pectoris

Indication: **stable anginal syndrome.**

The goal of rehabilitation in angina is to use the training effectively to improve the efficiency of exercise performance below the anginal threshold. The primary goal of rehabilitation in this group of patients is aimed at increasing the work capacity.

The benefit from exercise in angina is derived from the combination of the fact that the actual MVO2 (and thus the maximum HR) at which angina occurs will not change with conditioning, while the work done to achieve the anginal heart rate will increase substantially. Reduction of atherosclerotic lesions and increased cardiac collateralization that is cardioprotective and symptom reducing.

The rehabilitation program can begin at phase II-III, and the primary and/or secondary prevention program is very important.

Cardiac Rehabilitation After Revascularization Procedures

Post–Coronary Artery Bypass Grafting

Many patients who undergo CABG or percutaneous revascularization procedures often have not had a recent MI and make excellent candidates for cardiac rehabilitation.

For patients who have had CABG, the exercise test can be safely performed at 3 to 4 weeks after surgery. The purpose of the exercise test is to determine the maximal functional capacity, maximal HR, exercise blood pressure response, exercise-induced arrhythmias, and anginal threshold. The initiation of a cardiac rehabilitation program also allows for the initiation of the education program to help modify risk factors.

Cardiac rehabilitation after CABG can be thought of as being similar to the post-MI rehabilitation program.

Phase I is the immediate postoperative period. The in-hospital first stage is usually in the first week or so postoperatively, as patients are usually sent home within a week. The phase I program has three stages: (a) intensive mobilization in the immediate postoperative period; (b) progressive ambulation and daily exercises; (c) discharge planning and exercise prescription for the maintenance stage.

Unless the patient has an unstable postoperative course, or severe heart failure, intensive mobilization begins in the intensive care unit on postoperative day 1. The program starts with sitting upright, active leg exercises, and mobilization out of bed.

Early intervention has several benefits including decreasing the deleterious effects of bed rest (DVT, PE, pulmonary complications and cardiac deconditioning). The program then rapidly progresses with supervised ambulation for distances of 150 to 200 ft, advancing to most patients beginning independent ambulation by the third day.

The phase II program for a post-CABG patient is usually conducted at home or as an outpatient. Patients usually are stratified to low, moderate, or high intensity programs depending on their level of capacity.

A low-intensity program is a progressive walking program with 2 to 4 MET energy expenditures and a target HR of 65% to 75% of maximum HR.

Moderate-intensity programs are usually a progressive walk to walk-jog program from 3 to 6.5 MET, with target HRs of 70% to 80% of maximum HR.

High-intensity programs progress from walk-jog state to jogging from 5 to 8.5 MET with a target HR of 75% to 85% maximum HR.

Benefits of Cardiac Rehabilitation After Bypass Surgery:

1. Increased ischemic threshold
2. Improved left ventricular function
3. Increased coronary collaterals
4. Ameliorated serum lipids
5. Decreased serum catecholamines
6. Decreased platelet aggregation and increased fibrinolysis
7. Improved psychological status

Cardiac rehabilitation for patients with Cardiomyopathy

Due to poor LV function, these patients have increased complications with a higher risk of sudden death, depression, and chronic cardiac disability.

Due to decreased CO, heart failure patients demonstrate inconsistent responses to exercise.

The normal physiological response to exercise is often absent, and there can be a decline in ejection fraction, a decrease in SV, with resultant exertional hypotension, and syncope. In the most severe cases, CO may not increase sufficiently to generate a dynamic exercise response at all.

low endurance and fatigue are frequently seen and prolonged postexercise fatigue is common, often lasting for hours to days after achieving a high aerobic workload.

These limitations to exercise are often exacerbated in patients with CHF when atrial fibrillation, fluid overload, or medication noncompliance is also present.

Contraindications to cardiac rehabilitation:

1. unstable angina,
2. decompensated CHF,
3. and unstable arrhythmias

Due to the poor adaptation to exercise seen in CHF patients, long warm-ups and cool-down periods are required with exercise being performed with a limited workload. It is important to remember that dynamic exercise is preferable to isometric exercise, with a target HR of 10 bpm below any significant endpoint found with cardiopulmonary exercise testing, such as exertional hypotension, marked dyspnea, or sustained arrhythmia.

Because of possible increased diastolic pressure with subsequent increase in cardiac afterload, isometric exercise should be avoided where possible and limited to 2-minute intervals for those exercises performed.

Self-monitor CHF patients include closely following body weight (to observe for fluid accumulation) and blood pressure and HR responses to exercise.

Valvular Heart Disease

In valvular heart disease, the major problem is often deconditioningalong with CHF. In patients receiving surgical correction of the valvular disease, a post-CABG-type program is used.

Training can increase the physical work capacity, decrease rating of perceived exertion (RPE) on the Borg scale, and decrease the RPP by 15%. An issue that is present in many patients after valve replacement is the presence of anticoagulation postoperatively for patients with mechanical valves. When patients are on anticoagulant therapy, the exercise program has to avoid high-impact exercises to avoid hemarthrosis and bruising and include a component of education regarding injury avoidance.

AMERICAN HEART ASSOCIATION DIET RECOMMENDATIONS

1. Eat a variety of nutritious foods from all the food groups. Nutrient-rich foods have minerals, protein, whole grains and other nutrients but are lower in calories. They may help to control weight, cholesterol and blood pressure.
2. Eat an overall healthy dietary pattern that emphasizes: a variety of fruits and vegetables, whole grains, low-fat dairy products, skinless poultry and non-fried fish nuts and legumes non-tropical vegetable oils.
3. Limit saturated fat, trans fat, sodium, red meat, sweets and sugar-sweetened beverages. If you choose to eat red meat, compare labels and select the leanest cuts available.

4. One of the diets that fits this pattern is the DASH (Dietary Approaches to Stop Hypertension) eating plan. Most healthy eating patterns can be adapted based on calorie requirements and personal and cultural food preferences.
5. Eat less of the nutrient-poor foods. Limit foods and beverages high in calories but low in nutrients. Also limit the amount of saturated fat, trans fat and sodium you eat. Read Nutrition Facts labels carefully — the Nutrition Facts panel tells you the amount of healthy and unhealthy nutrients in a food or beverage.

As you make daily food choices, base your eating pattern on these recommendations:

1. Eat a variety of fresh, frozen and canned vegetables and fruits without high-calorie sauces or added salt and sugars. Replace high-calorie foods with fruits and vegetables.
2. Choose fiber-rich whole grains for most grain servings.
3. Choose poultry and fish without skin and prepare them in healthy ways without added saturated and trans fat. If you choose to eat meat, look for the leanest cuts available and prepare them in healthy and delicious ways.
4. Eat at least 8 ounces of non-fried fish each week, which may be divided over two 3.5- to 4-ounce servings. Choose oily fish such as salmon, trout and herring, which are high in omega-3 fatty acids.
5. Select fat-free (skim) and low-fat (1%) dairy products.
6. Avoid foods containing partially hydrogenated vegetable oils to reduce trans fat in your diet.
7. Limit saturated fat and trans fat and replace them with the better fats, monounsaturated and polyunsaturated. If you need to lower your blood cholesterol, reduce saturated fat to no more than 5 to 6 percent of total calories. For someone eating 2,000 calories a day, that’s about 13 grams of saturated fat.
8. Cut back on beverages and foods with added sugars.
9. Choose foods with less sodium and prepare foods with little or no salt. To lower blood pressure, aim to eat no more than 2,300 milligrams of sodium per day. Reducing daily intake to 1,500 mg is desirable because it can lower blood pressure even further. If you can’t meet these goals right now, even reducing sodium intake by 1,000 mg per day can benefit blood pressure.
10. If you drink alcohol, drink in moderation. That means no more than one drink per day if you’re a woman and no more than two drinks per day if you’re a man.

TABLE 41.5 With Sample METS

Energy Costs of Activities of Daily Living	METs		
Sitting at rest	1	Walking 3.5 mph	3.5–4
Dressing	2–3	Walking 4 mph	5–6
Eating	1–2	Climbing up stairs	4–7
Hygiene (sitting)	1–2	Bed making	2–6
Hygiene (standing)	2–3	Carrying 18 lb upstairs	7–8
Sexual intercourse	3–5	Carrying suitcase	6–7
Showering	4–5	Housework (general)	3–4
Tub bathing	2–3	Mowing lawn (push power mower)	3–5
Walking 1 mph	1–2	Ironing	2–4
Walking 2 mph	2–3	Snow shoveling	6–7
Walking 3 mph	3–3.5		
Energy Costs of Avocational Activities	**METs**		
Backpacking (45 lb)	6–11	Running 12 min/mile	8–9
Baseball (competitive)	5–6	Running 11 min/mile	9–10
Baseball (noncompetitive)	4–5	Running 9 min/mile	10–11
Basketball (competitive)	7–12	Skiing cross-country 3 mph	6–7
Basketball (noncompetitive)	3–9	Skiing cross-country 5 mph	9–10
Card playing	1–2	Skiing downhill	5–9
Cycling 5 mph	2–3	Skiing water	5–7
Cycling 8 mph	4–5	Swimming (backstroke)	7–8
Cycling 10 mph	5–6	Swimming (breaststroke)	8–9
Cycling 12 mph	7–8	Swimming (crawl)	9–10
Cycling 13 mph	8–9	Television	1–2
Karate	8–12	Tennis (singles)	4–9
Energy Costs of Vocational Activities	**METs**		
Assembly line work	3–5	Painting	4–5
Carpentry (light)	4–5	Sawing hardwood	6–8
Carry 20–44 lb	4–5	Sawing softwood	5–6
Carry 45–64 lb	5–6	Sawing (power)	3–4
Carry 65–85 lb	7–8	Shoveling 10 lb, 10/min	6–7
Chopping wood	7–8	Shoveling 14 lb, 10/min	7–9
Desk work	1.5–2	Shoveling 16 lb, 10/min	9–12
Digging ditches	7–8	Tools (heavy)	5–6
Handyman	5–6	Typing	1.5–2
Janitorial (light)	2–3	Wood splitting	6–7
Lift 100 lb	7–10		

Adapted from Dafoe WA. Table of energy requirements for activities of daily living, household tasks, recreational activities, and vocational activities. In: Pashkow FJ, Dafoe WA, eds. *Clinical Cardiac Rehabilitation: A Cardiologist's Guide*. Baltimore, MD: Wiiliams and Wilkins; 1993:359–376.

TABLE 41.10 Activity Classification

Activity Class	Clinical Characteristics	Activity Guidelines	ECG and BP Monitoring	Supervision Required
Class A Healthy individuals No need for cardiac rehab program	<40 y old No known heart disease No symptoms of heart disease Normal ETT	No restrictions	None needed	None
Class B Known stable heart disease Low risk from cardiac exercise CAD Valvular heart disease Congenital heart disease Cardiomyopathy ETT abnormalities that are not Class C and D	NYHA class 1 or 2 Exercise capacity >6 METs No clinical Heart failure No ischemia or angina at rest or on ETT at ≤6 METs Appropriate rise in BP with exercise No high-grade ventricular ectopy Ability to self-monitor activity	Individualized with exercise prescription by qualified personnel or restricted to walking	Only during prescriptive exercises, usually 6–12 sessions	Medical supervision during prescriptive sessions Nonmedical supervision for other exercise prescriptions
Class C Same as Class B and unable to self-regulate or monitor activity Unable to understand prescribed activity levels	Same as Class B except unable to self-monitor activity	Individualized with exercise prescription by qualified personnel and supervised by nonmedical personnel trained in CPR	Only during prescriptive exercises, usually 6–12 sessions	Medical supervision during prescriptive sessions Nonmedical supervision for other exercise prescriptions
Class D Moderate to high risk for complications during exercise CAD Valvular heart disease Cardiomyopathy ETT abnormalities not directly related to ischemia Previous V-Fib or sudden death not related to acute ischemia or car- diac procedure High grade ventricular arrhythmias that are uncontrolled at mild to moderate work intensities Left main disease or three vessel disease EF <30%	Two or more MI NYHA class 3 or greater Exercise capacity <6 METs Angina with exercise Down sloping or horizontal ST depression of more than 4 mm Fall in systolic BP with exercise Life-threatening medical problems Previous episodes of primary cardiac arrest Ventricular tachycardia at loads of less than 6 METs	Individualized with exercise prescription by qualified personnel	Continuous during rehabilitation sessions until safety is established, usually 6–12 sessions	Medical supervision during all rehabilitation sessions until safety is established

Class E Unstable disease which restricts activity Unstable ischemia Uncontrolled heart failure Uncontrolled arrhythmia Severe symptomatic aortic stenosis Other conditions that can be aggravated by exercise	Unstable disease which restricts activity Unstable ischemia Uncontrolled heart failure Uncontrolled arrhythmia Severe symptomatic aortic stenosis Other conditions that can be aggravated by exercise	No activity is recommended for conditioning purposes Try to achieve class D or better through medical management Daily activities as prescribed	No conditioning program	No conditioning program

RATE OF PERCEIVED EXERTION (RPE)

BORG RPE	MODIFIED RPE	BREATHING	TRAINING ZONE	% of MHR*	EXERCISE TYPE
6	0	No Exertion	1	50%-60%	Warm up
7		Very Light			
8	1				
9					
10	2	Deeper but comfortable breathing. Able to hold a conversation.	2	60%-70%	Recovery
11					
12	3				
13		Aware that breathing is harder; able to talk but difficult to hold conversation	3	70%-80%	Aerobic
14	4				
15	5	Starting to breathe hard and getting uncomfortable	4	80%-90%	Anaerobic
16	6				
17	7	Deep and forceful breathing. Uncomfortable and not wanting to talk	5	90-100%	VO^2 Max
18	8				
19	9	Extremely hard			
20	10	Maximum exertion			

* % of maximum heart rate