CHAPTER 2

Preparticipation Health Screening and Risk Stratification

Numerous physiologic, psychologic, and metabolic health/fitness benefits result from participation in regular physical activity. As illustrated in Chapter 1, however, there are documented risks associated with physical activity. Although there is risk of acute musculoskeletal injury during exercise, the major concern is the increased risk of sudden cardiac death and myocardial infarction that is sometimes associated with vigorous physical exertion. A major public health goal is to increase individual participation in regular, moderate-to-vigorous physical activity. Pursuit of this goal must include a process for identifying individuals at increased risk for adverse exercise-related events. At the same time, the risk stratification process should not present a significant barrier to participation. This chapter presents guidelines for (a) evaluating an individual's risk for adverse exercise-related events and (b) making appropriate recommendations regarding the initiation, continuation, or progression of an individual's physical activity program to reduce the potential occurrence of these types of catastrophic events.

Potential participants should be screened for the presence, signs, symptoms, and/or risk factors of various cardiovascular, pulmonary, and metabolic diseases as well as other conditions (e.g., pregnancy, orthopedic injury) that require special attention (16,18,19) to (a) optimize safety during exercise testing and (b) aid in the development of a safe and effective exercise prescription. The purposes of the preparticipation health screening include the following:

- Identification of individuals with medical contraindications for exclusion from exercise programs until those conditions have been abated or are under control
- Recognition of persons with clinically significant disease(s) or conditions who should participate in a medically supervised exercise program
- Detection of individuals at increased risk for disease because of age, symptoms, and/or risk factors who should undergo a medical evaluation and exercise testing before initiating an exercise program or increasing the frequency, intensity, or duration of their current program
- Recognition of special needs of individuals that may affect exercise testing and programming

Risk stratification procedures initially take into consideration whether individuals are guiding themselves through the process or are consulting a healthcare or fitness professional. The self-guided individual will most likely need a relatively simple tool and decision-making process to determine if his or her risk is elevated to the extent that a physician should be consulted before initiating a physical activity program, particularly if the intended exercise intensity is vigorous (1,6,7). A healthcare or fitness professional should have a logical and practical sequence for gathering and evaluating an individual's health information, assessing risk, and providing appropriate recommendations about additional screening procedures and physical activity recommendations (e.g., the *F*requency, *I*ntensity, *T*ime, and *T*ype or FITT framework; see Chapter 7). The American College of Sports Medicine (ACSM) provides guidelines for risk stratification in this chapter, but recognizes guidelines for risk stratification published by other organizations such as the American Heart Association (AHA) (1,12,18,19) and the American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR) (4). Exercise and health/fitness professionals should also be familiar with these other guidelines when establishing individual and program-specific policies for preparticipation health screening and medical clearance, particularly for populations with known cardiovascular disease.

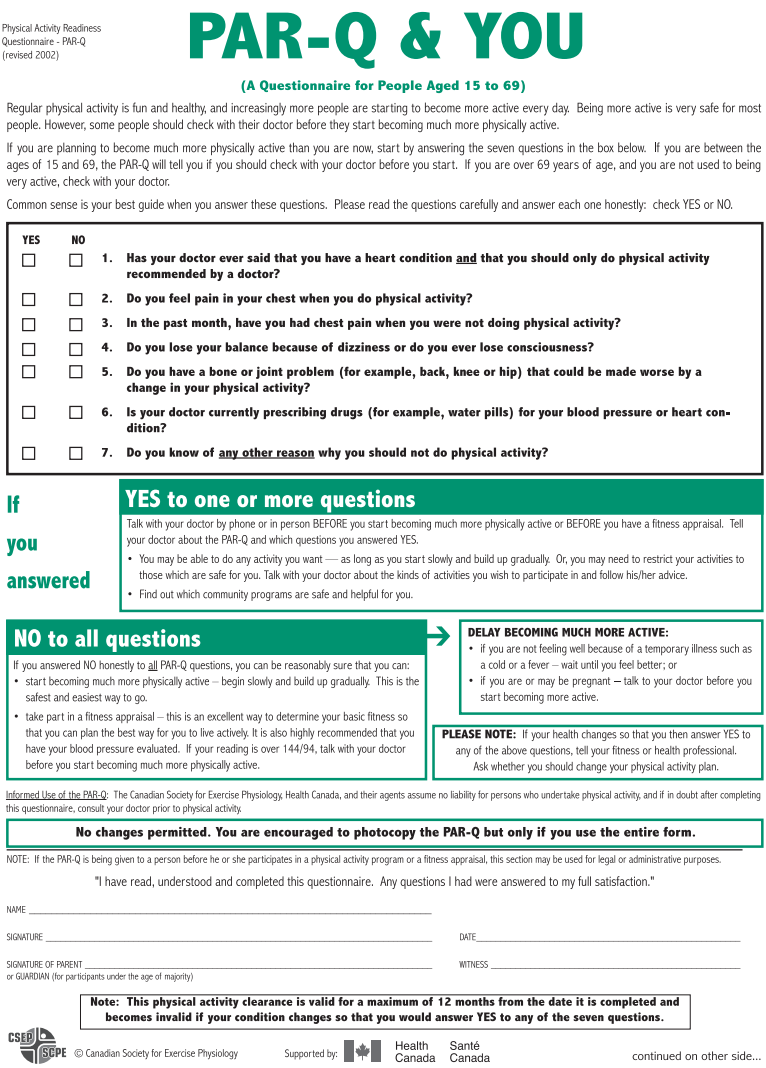
PREPARTICIPATION SCREENING

Preparticipation screening procedures and tools must be valid, providing relevant and accurate information about the individual's health history, current medical conditions, risk factors, signs/symptoms, current physical activity/exercise habits, and medications. Another consideration is the literacy level of the instrument used to obtain this information (i.e., participant education level and language).

SELF-GUIDED SCREENING FOR PHYSICAL ACTIVITY

A self-guided screening for physical activity program is initiated and guided by the individual with little or no input or supervision from an exercise or health/fitness professional. Individuals seeking to start a physical activity program on their own may have questions about whether it is appropriate and safe to do so. Therefore, they need an easy-to-use screening tool to guide them through the process. At the most basic level, participants may follow the recommendation of the Surgeon Generals' Report on Physical Activity and Health (1996) (23): "previously inactive men over age 40 and women over age 50, and people at high risk for cardiovascular disease (CVD) should first consult a physician before embarking on a program of vigorous physical activity to which they are unaccustomed." The participant may also use a self-guided questionnaire or instrument such as the Physical Activity Readiness Questionnaire (PAR-Q; Fig. 2.1) (9) or the AHA/ACSM Health/Fitness Facility Preparticipation Screening Questionnaire (Fig. 2.2), which serves to alert those with elevated risk to consult a physician (or other appropriate healthcare provider) before participation (6,7).

Other types of *self-administered* surveys that may be incorporated into the exercise screening process include (a) routine paperwork completed within the scope of a physician office visit, (b) entry procedures at health/fitness or clinical



Physical Activity Readiness Questionnaire - PAR-Q (revised 2002)

PAR-Q & YOU

(A Questionnaire for People Aged 15 to 69)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: check YES or NO.

YES	NO	
☐	☐	**1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor?**
☐	☐	**2. Do you feel pain in your chest when you do physical activity?**
☐	☐	**3. In the past month, have you had chest pain when you were not doing physical activity?**
☐	☐	**4. Do you lose your balance because of dizziness or do you ever lose consciousness?**
☐	☐	**5. Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?**
☐	☐	**6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?**
☐	☐	**7. Do you know of any other reason why you should not do physical activity?**

If you answered

YES to one or more questions

Talk with your doctor by phone or in person BEFORE you start becoming much more physically active or BEFORE you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

- You may be able to do any activity you want — as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you. Talk with your doctor about the kinds of activities you wish to participate in and follow his/her advice.
- Find out which community programs are safe and helpful for you.

NO to all questions

If you answered NO honestly to all PAR-Q questions, you can be reasonably sure that you can:

- start becoming much more physically active – begin slowly and build up gradually. This is the safest and easiest way to go.
- take part in a fitness appraisal – this is an excellent way to determine your basic fitness so that you can plan the best way for you to live actively. It is also highly recommended that you have your blood pressure evaluated. If your reading is over 144/94, talk with your doctor before you start becoming much more physically active.

DELAY BECOMING MUCH MORE ACTIVE:

- if you are not feeling well because of a temporary illness such as a cold or a fever – wait until you feel better; or
- if you are or may be pregnant – talk to your doctor before you start becoming more active.

PLEASE NOTE: If your health changes so that you then answer YES to any of the above questions, tell your fitness or health professional. Ask whether you should change your physical activity plan.

Informed Use of the PAR-Q: The Canadian Society for Exercise Physiology, Health Canada, and their agents assume no liability for persons who undertake physical activity, and if in doubt after completing this questionnaire, consult your doctor prior to physical activity.

No changes permitted. You are encouraged to photocopy the PAR-Q but only if you use the entire form.

NOTE: If the PAR-Q is being given to a person before he or she participates in a physical activity program or a fitness appraisal, this section may be used for legal or administrative purposes.

"I have read, understood and completed this questionnaire. Any questions I had were answered to my full satisfaction."

NAME _____

SIGNATURE _____ DATE _____

SIGNATURE OF PARENT or GUARDIAN (for participants under the age of majority) _____ WITNESS _____

Note: This physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if your condition changes so that you would answer YES to any of the seven questions.

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FIGURE 2.1. Physical Activity Readiness (PAR-Q) Form. (Source: Physical Activity Readiness Questionnaire [PAR-Q], Public Health Agency of Canada and the Canadian Society for Exercise Physiology, reproduced with the permission of the Minister of Public Works and Government Services Canada, 2007).

exercise program facilities, and (c) physical activity promotional materials designed for and distributed to the general public. When a participant completes a self-guided instrument and medical clearance is recommended from the questionnaire results, participants should consult their physician and obtain clearance before participation in a physical activity/exercise program. For self-guided physical

Assess your health status by marking all *true* statements

History

You have had:

_____ a heart attack
_____ heart surgery
_____ cardiac catheterization
_____ coronary angioplasty (PTCA)
_____ pacemaker/implantable cardiac defibrillator/rhythm disturbance
_____ heart valve disease
_____ heart failure
_____ heart transplantation
_____ congenital heart disease

Symptoms

_____ You experience chest discomfort with exertion
_____ You experience unreasonable breathlessness
_____ You experience dizziness, fainting, or blackouts
_____ You take heart medications.

Other health issues

_____ You have diabetes
_____ You have asthma or other lung disease
_____ You have burning or cramping sensation in your lower legs when walking short distances
_____ You have musculoskeletal problems that limit your physical activity
_____ You have concerns about the safety of exercise
_____ You take prescription medications
_____ You are pregnant

*If you marked any of these statements in this section, consult your physician or other appropriate health care provider before engaging in exercise. You may need to use a facility with a **medically qualified staff.***

Cardiovascular risk factors

_____ You are a man older than 45 years
_____ You are a woman older than 55 years, have had a hysterectomy, or are postmenopausal
_____ You smoke, or quit smoking within the previous 6 months
_____ Your blood pressure is >140/90 mm Hg
_____ You do not know your blood pressure
_____ You take blood pressure medication
_____ Your blood cholesterol level is >200 mg/dL
_____ You do not know your cholesterol level
_____ You have a close blood relative who had a heart attack or heart surgery before age 55 (father or brother) or age 65 (mother or sister)
_____ You are physically inactive (i.e., you get <30 minutes of physical activity on at least 3 days per week)
_____ You are >20 pounds overweight

*If you marked two or more of the statements in this section you should consult your physician or other appropriate health care provider before engaging in exercise. You might benefit from using a facility with a **professionally qualified exercise staff**[a] to guide your exercise program.*

_____ None of the above

You should be able to exercise safely without consulting your physician or other appropriate health care provider in a self-guided program or almost any facility that meets your exercise program needs.

[a]Professionally qualified exercise staff refers to appropriately trained individuals who possess academic training, practical and clinical knowledge, skills, and abilities commensurate with the credentials defined in Appendix D.

FIGURE 2.2. AHA/ACSM Health/Fitness Facility Preparticipation Screening Questionnaire (Modified from American College of Sports Medicine Position Stand and American Heart Association. Recommendations for cardiovascular screening, staffing, and emergency policies at health/fitness facilities. *Med Sci Sports Exerc.* 1998;30(6):1009–18.)

activity regimens conducted at low (<40% oxygen update reserve $\dot{V}O_2R$) to moderate (40%–60% $\dot{V}O_2R$) exercise intensity, little additional assessment is needed beyond the ACSM/AHA Questionnaires (1), provided that one adheres to all medical clearance recommendations contained within the form. Such regimens should incorporate the physical activity recommendations from the U.S. Surgeon General (6,23). A specific self-guided exercise regimen suitable for previously sedentary individuals may be found in the *ACSM Fitness Book* (6).

PROFESSIONALLY GUIDED SCREENING FOR PHYSICAL ACTIVITY

Professionally guided implies that the health fitness/clinical assessment is conducted by—and the exercise program is designed and supervised by—appropriately trained personnel who possess academic training and practical/clinical knowledge, skills, and abilities commensurate with the credentials defined in Appendix D.

Self-guided surveys are effective in identifying individuals who would benefit from medical consultation before participation in an exercise program (1). A more advanced process administered by professionally trained personnel provides greater detail regarding CVD risk factors and signs/symptoms and identifies a broader scope of chronic diseases and/or conditions that need special consideration before engaging in an exercise program. The professionally guided preparticipation screening process involves (a) the review of more detailed health/medical history information and specific risk stratification, and (b) detailed recommendations for physical activity/exercise, medical examination, exercise testing, and physician supervision.

Many health/fitness and clinical exercise program facilities use a more elaborate health/medical history questionnaire designed to provide additional details regarding selected health/fitness habits and medical history, such as the AHA/ACSM Questionnaire (1) (Fig. 2.2). This questionnaire may be used as a basic instrument for this process, but additional information needs to be obtained related to specific CVD risk factors.

RISK STRATIFICATION

Appropriate recommendations for medical examination, physical activity/exercise, exercise testing, and physician supervision are made based on a risk stratification process that assigns participants into one of three risk categories: (a) low, (b) moderate, or (c) high risk (Table 2.1). The process by which individuals are assigned to one of these risk categories is called risk stratification and is based on:

- The presence or absence of known cardiovascular, pulmonary, and/or metabolic disease
- The presence or absence of signs or symptoms suggestive of cardiovascular, pulmonary, and/or metabolic disease
- The presence or absence of CVD risk factors

Low risk: Individuals classified as low risk are those who do not have signs/symptoms of or have diagnosed cardiovascular, pulmonary, and/or metabolic disease and have no more than one (i.e., ≤1) CVD risk factor. The risk of an acute cardiovascular event in this population is low, and a physical

TABLE 2.1. ACSM RISK STRATIFICATION CATEGORIES FOR ATHEROSCLEROTIC CARDIOVASCULAR DISEASE

Low risk	Asymptomatic men and women who have ≤1 CVD risk factor from Table 2.3
Moderate risk	Asymptomatic men and women who have ≥2 risk factors from Table 2.3
High risk	Individuals who have known cardiovascular,[a] pulmonary,[b] or metabolic[c] disease *or* one or more signs and symptoms listed in Table 2.2

ACSM, American College of Sports Medicine; CVD, cardiovascular disease.

[a]Cardiac, peripheral vascular, or cerebrovascular disease.

[b]Chronic obstructive pulmonary disease, asthma, interstitial lung disease, or cystic fibrosis.

[c]Diabetes mellitus (type 1, type 2), thyroid disorders, renal, or liver disease.

activity/exercise program may be pursued safely without the necessity for medical examination and clearance (1,20,22,23).

Moderate risk: Individuals classified as moderate risk do not have signs/symptoms of or diagnosed cardiovascular, pulmonary, and/or metabolic disease, but have two or more (i.e., ≥2) CVD risk factors. The risk of an acute cardiovascular event in this population is increased, although in most cases, individuals at moderate risk may safely engage in low- to moderate-intensity physical activities without the necessity for medical examination and clearance. However, it is advisable to have a medical examination and an exercise test before participation in vigorous intensity exercise (i.e., >60% $\dot{V}O_2R$) (14,15).

High risk: Individuals classified as high risk are those who have one or more signs/symptoms of or diagnosed cardiovascular, pulmonary, and/or metabolic disease. The risk of an acute cardiovascular event in this population is increased to the degree that a thorough medical examination should take place and clearance given before initiating physical activity or exercise at any intensity.

The exercise or health/fitness professional may evaluate the individual's medical/health history information and follow a logical sequence considering this risk-stratification process to determine into which appropriate risk category an individual should be placed. Exercise or health/fitness professionals should have a thorough knowledge of (a) the criteria for known cardiovascular, pulmonary, and metabolic diseases; (b) the descriptions of signs and symptoms for these diseases; (c) the specific criteria that determine the CVD risk-factor schemes; and (d) the criteria for each risk category. The flow chart in Figure 2.3 may be used to move sequentially through the process to determine the risk-category placement for each individual.

UNDISCLOSED OR UNAVAILABLE CARDIOVASCULAR DISEASE RISK-FACTOR INFORMATION

Health/fitness and exercise professionals and clinicians are encouraged to adopt a conservative approach to CVD risk-factor identification for the purposes of risk stratification, especially when (a) risk-factor information is missing and/or (b) the criteria for identifying the presence or absence of a specific risk factor

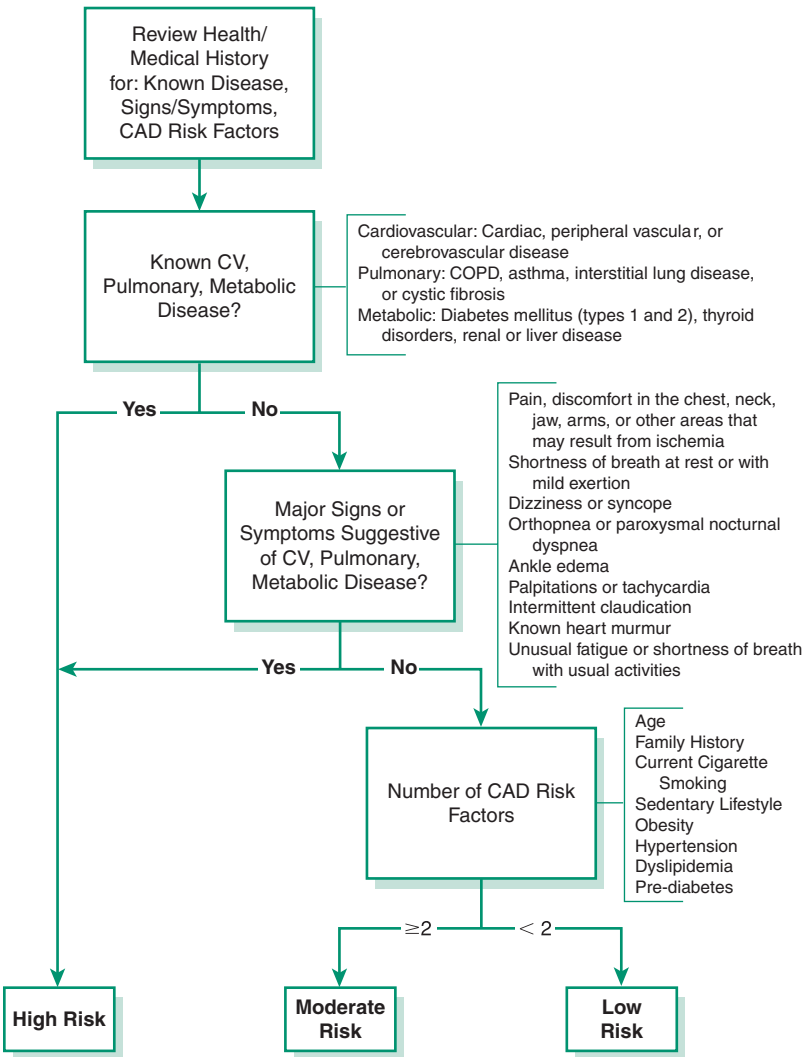


FIGURE 2.3. Logic model for risk stratification.

cannot be determined or is not available. If the presence or absence of a specific risk factor is not disclosed or is unavailable, the risk factor should be counted as a risk factor, except for prediabetes (8) (see Table 10.2 for diagnostic criteria for prediabetes). Missing or unknown criteria for prediabetes should be counted as a risk factor in the presence of age (≥45 years), particularly for those with a body mass index ≥25 $kg \cdot m^{-2}$, and for those who are younger, have a body mass index ≥25 $kg \cdot m^{-2}$, and have additional risk factors for prediabetes (8).

See Box 2.1 for case studies that involve undisclosed or unavailable CVD risk-factor information.

KNOWN CARDIOVASCULAR, PULMONARY, AND METABOLIC DISEASE

An individual has known cardiovascular, pulmonary, and/or metabolic disease if a physician has diagnosed one of the following conditions:

- Cardiovascular disease (CVD): cardiac, peripheral artery (PAD), or cerebrovascular disease
- Pulmonary disease: chronic obstructive pulmonary disease (COPD), asthma, interstitial lung disease, or cystic fibrosis (5)
- Metabolic disease: diabetes mellitus (type 1 or type 2), thyroid disorders, and renal or liver disease

MAJOR SIGNS/SYMPTOMS SUGGESTIVE OF CARDIOVASCULAR, PULMONARY, AND METABOLIC DISEASE

Table 2.2 presents a listing of major signs or symptoms suggestive of cardiovascular, pulmonary and/or metabolic disease in addition to information aiding the clinician in the clarification and significance of each sign or symptom. The presence of most of these signs/symptoms may be identified using the AHA/ACSM Questionnaire (1) (Fig. 2.2); however, a few signs/symptoms (i.e., orthopnea, ankle edema, and heart murmur) require a more thorough medical history and/or examination. These signs/symptoms must be interpreted within the clinical context in which they appear because they are not necessarily specific for cardiovascular, pulmonary, or metabolic disease.

ATHEROSCLEROTIC CARDIOVASCULAR DISEASE RISK FACTORS

ACSM risk stratification is based, in part, on the presence or absence of the CVD risk factors listed in Table 2.3 (2,3,8,10,23). The health/medical history should be reviewed to determine if the individual meets any of the criteria for positive risk factors shown in Table 2.3. The number of positive risk factors is then summed. Because of the cardioprotective effect of high-density lipoprotein cholesterol (HDL-C), HDL-C is considered a negative risk factor. For individuals having HDL-C $\geq$60 $mg \cdot dL^{-1}$ (1.55 $mmol \cdot L^{-1}$), one positive risk factor is subtracted from the sum of positive risk factors.

The risk factors in Table 2.3 should not be viewed as an all-inclusive list of factors associated with elevated risk for CVD. Rather, Table 2.3 contains *clinically relevant established CVD risk factor* criteria that should be considered collectively when making decisions about (a) the level of medical clearance, (b) the need for exercise testing before initiating participation, and (c) the level of supervision for both exercise testing and exercise program participation. The intended use for the CVD risk factor list in Table 2.3 is to aid in the identification of occult coronary

(*text continues on page 30*)

TABLE 2.2. MAJOR SIGNS OR SYMPTOMS SUGGESTIVE OF CARDIOVASCULAR, PULMONARY, OR METABOLIC DISEASE[a]

SIGN OR SYMPTOM	CLARIFICATION/SIGNIFICANCE
Pain, discomfort (or other anginal equivalent) in the chest, neck, jaw, arms, or other areas that may result from ischemia	One of the cardinal manifestations of cardiac disease, in particular coronary artery disease Key features *favoring an ischemic origin* include: • *Character:* Constricting, squeezing, burning, "heaviness" or "heavy feeling" • *Location:* Substernal, across midthorax, anteriorly; in one or both arms, shoulders; in neck, cheeks, teeth; in forearms, fingers in interscapular region • *Provoking factors:* Exercise or exertion, excitement, other forms of stress, cold weather, occurrence after meals Key features *against an ischemic origin* include: • *Character:* Dull ache; "knifelike," sharp, stabbing; "jabs" aggravated by respiration • *Location:* In left submammary area; in left hemithorax • *Provoking factors:* After completion of exercise, provoked by a specific body motion
Shortness of breath at rest or with mild exertion	Dyspnea (defined as an abnormally uncomfortable awareness of breathing) is one of the principal symptoms of cardiac and pulmonary disease. It commonly occurs during strenuous exertion in healthy, well-trained persons and during moderate exertion in healthy, untrained persons. However, it should be regarded as abnormal when it occurs at a level of exertion that is not expected to evoke this symptom in a given individual. Abnormal exertional dyspnea suggests the presence of cardiopulmonary disorders, in particular left ventricular dysfunction or chronic obstructive pulmonary disease.
Dizziness or syncope	Syncope (defined as a loss of consciousness) is most commonly caused by a reduced perfusion of the brain. Dizziness and, in particular, syncope *during* exercise may result from cardiac disorders that prevent the normal rise (or an actual fall) in cardiac output. Such cardiac disorders are potentially life-threatening and include severe coronary artery disease, hypertrophic cardiomyopathy, aortic stenosis, and malignant ventricular dysrhythmias. Although dizziness or syncope shortly *after* cessation of exercise should not be ignored, these symptoms may occur even in healthy persons as a result of a reduction in venous return to the heart.
Orthopnea or paroxysmal nocturnal dyspnea	Orthopnea refers to dyspnea occurring at rest in the recumbent position that is relieved promptly by sitting upright or standing. Paroxysmal nocturnal dyspnea refers to dyspnea, beginning usually 2–5 h after the onset of sleep, which may be relieved by sitting on the side of the bed or getting out of bed. Both are symptoms of left ventricular dysfunction. Although nocturnal dyspnea may occur in persons with chronic obstructive pulmonary

(*continued*)

TABLE 2.2. MAJOR SIGNS OR SYMPTOMS SUGGESTIVE OF CARDIOVASCULAR, PULMONARY, OR METABOLIC DISEASE[a] (*Continued*)

SIGN OR SYMPTOM	CLARIFICATION/SIGNIFICANCE
	disease, it differs in that it is usually relieved after the person relieves himself or herself of secretions rather than specifically by sitting up.
Ankle edema	Bilateral ankle edema that is most evident at night is a characteristic sign of heart failure or bilateral chronic venous insufficiency. Unilateral edema of a limb often results from venous thrombosis or lymphatic blockage in the limb. Generalized edema (known as anasarca) occurs in persons with the nephrotic syndrome, severe heart failure, or hepatic cirrhosis.
Palpitations or tachycardia	Palpitations (defined as an unpleasant awareness of the forceful or rapid beating of the heart) may be induced by various disorders of cardiac rhythm. These include tachycardia, bradycardia of sudden onset, ectopic beats, compensatory pauses, and accentuated stroke volume resulting from valvular regurgitation. Palpitations also often result from anxiety states and high cardiac output (or hyperkinetic) states, such as anemia, fever, thyrotoxicosis, arteriovenous fistula, and the so-called idiopathic hyperkinetic heart syndrome.
Intermittent claudication	Intermittent claudication refers to the pain that occurs in a muscle with an inadequate blood supply (usually as a result of atherosclerosis) that is stressed by exercise. The pain does not occur with standing or sitting, is reproducible from day to day, is more severe when walking upstairs or up a hill, and is often described as a cramp, which disappears within 1–2 min after stopping exercise. Coronary artery disease is more prevalent in persons with intermittent claudication. Patients with diabetes are at increased risk for this condition.
Known heart murmur	Although some may be innocent, heart murmurs may indicate valvular or other cardiovascular disease. From an exercise safety standpoint, it is especially important to exclude hypertrophic cardiomyopathy and aortic stenosis as underlying causes because these are among the more common causes of exertion-related sudden cardiac death.
Unusual fatigue or shortness of breath with usual activities	Although there may be benign origins for these symptoms, they also may signal the onset of, or change in the status of cardiovascular, pulmonary, or metabolic disease.

[a]These signs or symptoms must be interpreted within the clinical context in which they appear because they are not all specific for cardiovascular, pulmonary, or metabolic disease.

Modified from Gordon SMBS. Health appraisal in the non-medical setting. In: Durstine JL, King AC, Painter PL. *ACSM's resource manual for guidelines for exercise testing and prescription*. Philadelphia (PA): Lea & Febiger; 1993. p. 219–28.

TABLE 2.3. ATHEROSCLEROTIC CARDIOVASCULAR DISEASE (CVD) RISK FACTOR THRESHOLDS FOR USE WITH ACSM RISK STRATIFICATION

POSITIVE RISK FACTORS	DEFINING CRITERIA
Age	Men ≥45 yr; Women ≥55 yr
Family history	Myocardial infarction, coronary revascularization, or sudden death before 55 yr of age in father or other male first-degree relative, or before 65 yr of age in mother or other female first-degree relative
Cigarette smoking	Current cigarette smoker or those who quit within the previous 6 months or exposure to environmental tobacco smoke
Sedentary lifestyle	Not participating in at least 30 min of moderate intensity (40%–60% $\dot{V}O_2R$) physical activity on at least three days of the week for at least three months (20,23)
Obesity[a]	Body mass index ≥30 $kg \cdot m^2$ *or* waist girth >102 cm (40 inches) for men and >88 cm (35 inches) for women (2)
Hypertension	Systolic blood pressure ≥140 mm Hg and/or diastolic ≥90 mm Hg, confirmed by measurements on at least two separate occasions, *or* on antihypertensive medication (10)
Dyslipidemia	Low-density lipoprotein (LDL-C) cholesterol ≥130 $mg \cdot dL^{-1}$ (3.37 $mmol \cdot L^{-1}$) *or* high-density lipoprotein (HDL-C) cholesterol <40 $mg \cdot dL^{-1}$ (1.04 $mmol \cdot L^{-1}$) *or* on lipid-lowering medication. If total serum cholesterol is all that is available use ≥200 $mg \cdot dL^{-1}$ (5.18 $mmol \cdot L^{-1}$) (3)
Prediabetes	Impaired fasting glucose (IFG) = fasting plasma glucose ≥100 $mg \cdot dL^{-1}$ (5.50 $mmol \cdot L^{-1}$) but <126 $mg \cdot dL^{-1}$ (6.93 $mmol \cdot L^{-1}$) *or* impaired glucose tolerance (IGT) = 2-hour values in oral glucose tolerance test (OGTT) ≥140 $mg \cdot dL^{-1}$ (7.70 $mmol \cdot L^{-1}$) but <200 $mg \cdot dL^{-1}$ (11.00 $mmol \cdot L^{-1}$) confirmed by measurements on at least two separate occasions (8)
NEGATIVE RISK FACTOR	**DEFINING CRITERIA**
High-serum HDL cholesterol[†]	≥60 $mg \cdot dL^{-1}$ (1.55 $mmol \cdot L^{-1}$)

Note: It is common to sum risk factors in making clinical judgments. If HDL is high, subtract one risk factor from the sum of positive risk factors, because high HDL decreases CVD risk.

[a]Professional opinions vary regarding the most appropriate markers and thresholds for obesity; therefore, allied health professionals should use clinical judgment when evaluating this risk factor.

artery disease. The *scope* of the list and the *threshold* for each risk factor are not inconsistent with other risk-factor lists established by other health organizations that are intended for use in predicting coronary events prospectively during long-term follow up (24) . Furthermore, other risk factors, such as the inflammatory markers C-reactive protein and fibrinogen, also have been suggested as positive and emerging CVD risk factors (11,13), but are not included in this list. Refer to Case Studies in Box 2.1 for further explanation.

BOX 2.1 Case Studies to be Used to Establish Risk Stratification

CASE STUDY I

Female, age 21 years, smokes socially on weekends (~10–20 cigarettes). Drinks alcohol one or two nights a week, usually on weekends. Height = 63 in (160 cm), weight = 124 lb (56.4 kg), BMI = 22 $kg \cdot m^{-2}$. RHR = 76 $beats \cdot min^{-1}$, systolic/diastolic BP = 118/72 mm Hg. Total cholesterol = 178 $mg \cdot dL^{-1}$ (4.61 $mmol \cdot L^{-1}$), LDL-C = 98 $mg \cdot dL^{-1}$ (2.54 $mmol \cdot L^{-1}$), HDL-C = 57 $mg \cdot dL^{-1}$ (1.48 $mmol \cdot L^{-1}$), FBG unknown. Currently taking oral contraceptives. Attends group exercise class two to three times a week. Reports no symptoms. Both parents living and in good health.

CASE STUDY II

Male, age 54 years, nonsmoker. Height = 72 inches (182.9 cm), weight = 168 pounds (76.4 kg), BMI = 22.8 $kg \cdot m^{-2}$. RHR = 64 bpm, RBP = 124/78 mm Hg. Total cholesterol = 187 $mg \cdot dL^{-1}$ (4.84 $mmol \cdot L^{-1}$), LDL = 103 $mg \cdot dL^{-1}$ (2.67 $mmol \cdot L^{-1}$), HDL = 52 $mg \cdot dL^{-1}$ (1.35 $mmol \cdot L^{-1}$), FBG = 88 $mg \cdot dL^{-1}$ (4.84 $mmol \cdot L^{-1}$). Recreationally competitive runner, runs four to seven days per week, completes one to two marathons and numerous other road races every year. No medications other than OTC ibuprofen as needed. Reports no symptoms. Father died at age 77 years of a heart attack, mother died at age 81 years of cancer.

CASE STUDY III

Male, age 44 years, nonsmoker. Height = 70 inches (177.8 cm), weight = 216 pounds (98.2 kg), BMI = 31.0 $kg \cdot m^{-2}$. RHR = 62 bpm, RBP = 128/84 mm Hg. Total serum cholesterol = 184 $mg \cdot dL^{-1}$ (4.77 $mmol \cdot L^{-1}$), LDL = 106 $mg \cdot dL^{-1}$ (2.75 $mmol \cdot L^{-1}$), HDL = 44 $mg \cdot dL^{-1}$ (1.14 $mmol \cdot L^{-1}$), FBG unknown. Walks two to three miles two to three times a week. Father had type 2 diabetes and died at age 67 of a heart attack; mother living, no CVD. No medications; reports no symptoms.

CASE STUDY IV

Female, age 36 years, nonsmoker. Height = 64 inches (162.6 cm), weight = 108 pounds (49.1 kg), BMI = 18.5 $kg \cdot m^{-2}$. RHR = 61 bpm, RBP = 114/62 mm Hg. Total cholesterol = 174 $mg \cdot dL^{-1}$ (4.51 $mmol \cdot L^{-1}$), blood glucose normal with insulin injections. Type 1 diabetes diagnosed at age 7. Teaches dance aerobic classes three times a week, walks approximately 45 minutes four times a week. Reports no symptoms. Both parents in good health with no history of cardiovascular disease. >

> Box 2.1. continued

	CASE STUDY I	CASE STUDY II	CASE STUDY III	CASE STUDY IV
Known CV, Pulmonary, and/or Metabolic Disease?	No	No	No	Yes—diagnosed Type 1 diabetes
Major Signs or Symptoms?	No	No	No	No
CVD Risk Factors:				
Age?	No	Yes	No	No
Family History?	No	No	No	No
Current Cigarette Smoking?	Yes	No	No	No
Sedentary Lifestyle?	No	No	No	No
Obesity?	No	No	Yes—BMI $>30\ kg \cdot m^{-2}$	No
Hypertension?	No	No	No	No
Hyperchol-esterolemia?	No	No	No	No
Pre-diabetes?	Unknown—count as No in absence of Age or Obesity as risk factors	No	Unknown—count as Yes in presence of Obesity	Diagnosed Type 1 diabetes
Risk Stratification Category:	Low Risk—no known disease, no major signs or symptoms, 1 CVD risk factor	Low Risk—no known disease, no major signs or symptoms, 1 CVD risk factor	Moderate Risk—no known disease, no major signs or symptoms, 2 CVD risk factors	High Risk—diagnosed metabolic disease

BMI = body mass index, RHR = resting heart rate, FBG = fasting blood glucose, BP = blood pressure, LDL-C = low density lipoprotein cholesterol, HDL-C = high density lipoprotein cholesterol

EXERCISE TESTING AND PARTICIPATION RECOMMENDATIONS BASED ON RISK CATEGORY

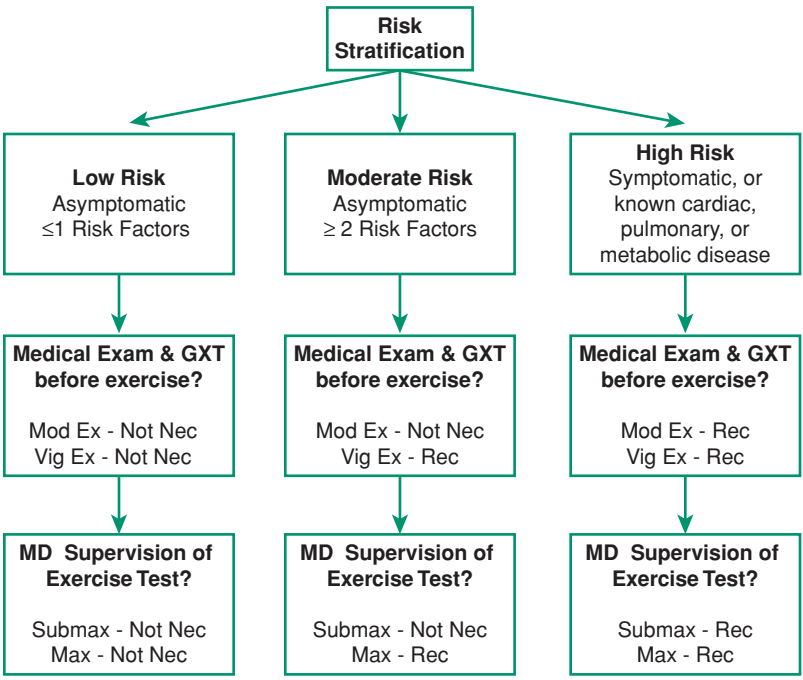
Once the risk category has been established for an individual as low, medium, or high, appropriate recommendations may be made regarding:

- The necessity for medical examination and clearance before initiating a physical activity/exercise program or substantially changing the FITT framework of an existing physical activity/exercise program
- The necessity for an exercise test before initiating a physical activity/exercise program or substantially changing the FITT framework of an existing activity program
- The necessity for physician supervision when participating in a maximal or submaximal exercise test

EXERCISE TESTING AND TESTING SUPERVISION RECOMMENDATIONS BASED ON RISK CATEGORY

No set of guidelines for exercise testing and participation covers all situations. Local circumstances and policies vary, and specific program procedures also are properly diverse. To provide guidance on the need for a medical examination and exercise test before participation in a moderate to vigorous intensity exercise program, ACSM suggests the recommendations presented in Figure 2.4 for determining when a medical examination and diagnostic exercise test are appropriate and when physician supervision is recommended. Although it is recommended that exercise testing for those individuals classified as low risk is not a necessity, the information gathered from an exercise test may be useful in establishing a safe and effective exercise prescription for these individuals. Recommending an exercise test for low-risk individuals should not be viewed as inappropriate if the purpose of the test is to design an effective exercise program. The exercise testing recommendations found in Figure 2.4 reflect the notion that the risk of cardiovascular events increases as a direct function of exercise intensity (i.e., vigorous > moderate > low exercise intensity) and the presence of risk factors. Although Figure 2.4 provides both absolute and relative thresholds for moderate and vigorous exercise intensity, health/fitness and exercise professionals should choose the most applicable definition (i.e., relative or absolute) for their setting and population when making decisions about the level of screening necessary before exercise training and for physician supervision during exercise testing. It should be noted that the recommendations for medical examination and exercise testing for individuals at moderate risk desiring to participate in vigorous-intensity exercise (Fig. 2.4) are consistent with those found within recent AHA Guidelines (1) (Box 2.2).

The degree of medical supervision of exercise testing varies appropriately from physician-supervised tests to situations in which there may be no physician present (12). The degree of physician supervision may differ with local policies



Mod Ex: Moderate intensity exercise; 40-60% of $\dot{V}O_{2max}$; 3-6 METs; "an intensity well within the individual's capacity, one which can be comfortably sustained for a prolonged period of time (~45 minutes)"

Vig Ex: Vigorous intensity exercise; > 60% of $\dot{V}O_{2max}$; > 6 METs; "exercise intense enough to represent a substantial cardiorespiratory challenge"

Not Nec: Not Necessary; reflects the notion that a medical examination, exercise test, and physician supervision of exercise testing would not be essential in the preparticipation screening, however, they should not be viewed as inappropriate

Rec: Recommended; when MD supervision of exercise testing is "Recommended," the MD shold be in close proximity and readily available should there be an emergent need

FIGURE 2.4. Exercise Testing and Testing Supervision Recommendations Based on Risk Stratification.

and circumstances, the health status of the patient, and the training and experience of the laboratory staff. Physicians responsible for supervising exercise testing should meet or exceed the minimal competencies for supervision and interpretation of results as established by the AHA (21). In all situations in which exercise testing is performed, site personnel should at least be certified at a level

BOX 2.2 American Heart Association (AHA) Risk Stratification Criteria

CLASS A: APPARENTLY HEALTHY INDIVIDUALS

- Includes the following individuals
  1. Children, adolescents, men <45 years, and women <55 years who have no symptoms of or known presence of heart disease or major atherosclerotic cardiovascular disease (CVD) risk factors
  2. Men ≥45 years and women ≥55 years who have no symptoms or known presence of heart disease and with less than two major CVD risk factors
  3. Men ≥45 years and women ≥55 years who have no symptoms or known presence of heart disease and with two or more CVD risk factors
- Activity guidelines: No restrictions other than basic guidelines
- Electrocardiogram (ECG) and blood pressure monitoring: Not required
- Supervision required: None, although it is suggested that persons classified as Class A-2 and particularly Class A-3 undergo a medical examination and possibly a medically supervised exercise test before engaging in vigorous exercise (12)

CLASS B: PRESENCE OF KNOWN, STABLE CARDIOVASCULAR DISEASE WITH LOW RISK FOR COMPLICATIONS WITH VIGOROUS EXERCISE, BUT SLIGHTLY GREATER THAN FOR APPARENTLY HEALTHY INDIVIDUALS

- Includes individuals with any of the following diagnoses:
  1. Coronary artery disease (myocardial infarction, coronary artery bypass graft surgery, percutaneous transluminal coronary angioplasty, angina pectoris, abnormal exercise test, and abnormal coronary angiograms) whose condition is stable and who have the clinical characteristics outlined below
  2. Valvular heart disease, excluding severe valvular stenosis or regurgitation with the clinical characteristics outlined below
  3. Congenital heart disease
  4. Cardiomyopathy; ejection fraction ≤30%; includes stable patients with heart failure with any of the clinical characteristics as outlined below but not hypertrophic cardiomyopathy or recent myocarditis
  5. Exercise test abnormalities that do not meet the criteria outlined in Class C
- *Clinical characteristics*:
  1. New York Heart Association Class 1 or 2
  2. Exercise capacity ≤6 METs
  3. No evidence of congestive heart failure
  4. No evidence of myocardial ischemia or angina at rest or on the exercise test at or below 6 METs >

> Box 2.2. continued

5. Appropriate rise in systolic blood pressure during exercise
6. Absence of sustained or nonsustained ventricular tachycardia at rest or with exercise
7. Ability to satisfactorily self-monitor intensity of activity

- *Activity guidelines*: Activity should be individualized, with exercise prescription by qualified individuals and approved by primary health-care provider
- *Supervision required*: Medical supervision during initial prescription session is beneficial. Supervision by appropriate trained nonmedical personnel for other exercise sessions should occur until the individual understands how to monitor his or her activity. Medical personnel should be trained and certified in advanced cardiac life support. Nonmedical personnel should be trained and certified in basic life support (which includes CPR).
- *ECG and blood pressure monitoring*: Useful during the early prescription phase of training, usually 6 to 12 sessions

CLASS C: THOSE AT MODERATE TO HIGH RISK FOR CARDIAC COMPLICATIONS DURING EXERCISE AND/OR UNABLE TO SELF-REGULATE ACTIVITY OR UNDERSTAND RECOMMENDED ACTIVITY LEVEL

- Includes individuals with any of the following diagnoses:
  1. CVD with the clinical characteristics outlined below
  2. Valvular heart disease, excluding severe valvular stenosis or regurgitation with the clinical characteristics outlined below
  3. Congenital heart disease; risk stratification should be guided by the 27th Bethesda Conference recommendations[a]
  4. Cardiomyopathy; ejection fraction ≤30%; includes stable patients with heart failure with any of the clinical characteristics as outlined below but not hypertrophic cardiomyopathy or recent myocarditis
  5. Complex ventricular arrhythmias not well controlled
- *Clinical characteristics*:
  1. NYHA class 3 or 4
  2. Exercise test results:
     - Exercise capacity <6 METs
     - Angina or ischemia ST depression at workload <6METs
     - Fall in systolic blood pressure below resting levels with exercise
     - Nonsustained ventricular tachycardia with exercise
  3. Previous episode of primary cardiac arrest (17) (i.e., cardiac arrest that did not occur in the presence of an acute myocardial infarction or during a cardiac procedure)
  4. A medical problem that the physician believes may be life threatening
     - *Activity guidelines*: Activity should be individualized, with exercise prescription provided by qualified individuals and approved by primary healthcare provider >

> Box 2.2. continued

- *Supervision*: Medical supervision during all exercise sessions until safety is established
- *ECG and blood pressure monitoring*: Continuous during exercise sessions until safety is established, usually ≥12 sessions

CLASS D: UNSTABLE DISEASE WITH ACTIVITY RESTRICTION[b]

- Includes individuals with
  1. Unstable ischemia
  2. Severe and symptomatic valvular stenosis or regurgitation
  3. Congenital heart disease; criteria for risk that would prohibit exercise conditioning should be guided by the 27th Bethesda Conference recommendations[a]
  4. Heart failure that is not compensated
  5. Uncontrolled arrhythmias
  6. Other medical conditions that could be aggravated by exercise
- *Activity guidelines*: No activity is recommended for conditioning purposes. Attention should be directed to treating the patient and restoring the patient to class C or better. Daily activities must be prescribed on the basis of individual assessment by the patient's personal physician.

[a]Fuster V, Gotto AM, Libby P. 27th Bethesda Conference: Matching the intensity of risk factor management with the hazard for coronary disease events. *J Am Coll Cardiol.* 1996;27:964–76.

[b]Exercise for conditioning purposes is not recommended.

Adapted from Fletcher GF, Balady GJ, Amsterdam EA, et al. Exercise standards for testing and training. A statement for health care professionals from the American Heart Association. *Circulation.* 2001;104:1694–1740.

of basic life support (CPR, cardiopulmonary resuscitation) and have automated external defibrillator (AED) training. Preferably, one or more staff members should also be certified in first aid and advanced cardiac life support (ACLS) (17).

Hypertension represents a unique risk factor in that it may be aggravated by acute exercise. Therefore, although it appears within Table 2.3, special consideration should be given to patients with hypertension when screening for exercise testing or training (see Chapter 10 for the special considerations in exercise testing for individuals with hypertension). Because hypertension is commonly clustered with other risk factors associated with CVD (i.e., dyslipidemia, obesity, diabetes mellitus, and the metabolic syndrome), most patients with hypertension presenting for exercise testing or training fall into the *moderate* or *high* risk category as defined in Table 2.1. For such individuals, the requisite medical examination in Table 2.3 is consistent with the screening recommendations for patients with hypertension outlined in JNC7

(10) and Chapter 10. However, in cases when hypertension is the only presenting risk factor from those listed in Table 2.3, prudent recommendations for preparticipation screening should be based on the severity of the hypertension (see Table 3.1 for JNC7 classifications) and the desired intensity of exercise.

RISK STRATIFICATION FOR CARDIAC PATIENTS

Cardiac patients may be further stratified regarding safety during exercise using published guidelines (4). Risk stratification criteria from the AACVPR are presented in Box 2.3 (4). The AHA has developed a more extensive risk-classification system for medical clearance of cardiac patients (Box 2.2) (12). The AHA guidelines provide recommendations for participant and/or patient monitoring and supervision and for activity restriction. Exercise program professionals should recognize that the AHA guidelines do not consider comorbidities (e.g., type 2 diabetes mellitus, morbid obesity, severe pulmonary disease, and debilitating neurologic or orthopedic conditions) that could result in modification of the recommendations for monitoring and supervision during exercise training.

BOX 2.3 American Association of Cardiovascular and Pulmonary Rehabilitation Risk Stratification Criteria for Cardiac Patients

LOWEST RISK

Characteristics of patients at lowest risk for exercise participation (all characteristics listed must be present for patients to remain at lowest risk)

- Absence of complex ventricular dysrhythmias during exercise testing and recovery
- Absence of angina or other significant symptoms (e.g., unusual shortness of breath, light-headedness, or dizziness, during exercise testing and recovery)
- Presence of normal hemodynamics during exercise testing and recovery (i.e., appropriate increases and decreases in heart rate and systolic blood pressure with increasing workloads and recovery)
- Functional capacity ≥7 METs

Nonexercise Testing Findings

- Resting ejection fraction ≥50%
- Uncomplicated myocardial infarction or revascularization procedure
- Absence of complicated ventricular dysrhythmias at rest >

> Box 2.3. continued

- Absence of congestive heart failure
- Absence of signs or symptoms of postevent/postprocedure ischemia
- Absence of clinical depression

MODERATE RISK

Characteristics of patients at moderate risk for exercise participation (any one or combination of these findings places a patient at moderate risk)

- Presence of angina or other significant symptoms (e.g., unusual shortness of breath, light-headedness, or dizziness occurring only at high levels of exertion [≥7 METs])
- Mild to moderate level of silent ischemia during exercise testing or recovery (ST-segment depression <2 mm from baseline)
- Functional capacity <5 METs

Nonexercise Testing Findings

- Rest ejection fraction = 40%–49%

HIGHEST RISK

Characteristics of patients at high risk for exercise participation (any one or combination of these findings places a patient at high risk)

- Presence of complex ventricular dysrhythmias during exercise testing or recovery
- Presence of angina or other significant symptoms (e.g., unusual shortness of breath, light-headedness, or dizziness at low levels of exertion [<5 METs] or during recovery)
- High level of silent ischemia (ST-segment depression ≥2 mm from baseline) during exercise testing or recovery
- Presence of abnormal hemodynamics with exercise testing (i.e., chronotropic incompetence or flat or decreasing systolic BP with increasing workloads) or recovery (i.e., severe postexercise hypotension)

Nonexercise Testing Findings

- Rest ejection fraction <40%
- History of cardiac arrest or sudden death
- Complex dysrhythmias at rest
- Complicated myocardial infarction or revascularization procedure
- Presence of congestive heart failure
- Presence of signs or symptoms of postevent/postprocedure ischemia
- Presence of clinical depression

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