

Cardiac Stress Testing

12

Learning Outcomes

- 12.1 Describe exercise electrocardiography and identify its other names.
- 12.2 Identify uses of exercise electrocardiography.
- 12.3 Describe other types of cardiac stress testing.
- 12.4 Prepare a patient for exercise electrocardiography.
- 12.5 Summarize safety measures that are used before, during, and after exercise electrocardiography.
- 12.6 Explain the responsibilities of a healthcare professional during exercise electrocardiography.
- 12.7 Compare common protocols followed in exercise electrocardiography.
- 12.8 Explain the responsibilities of a healthcare professional after exercise electrocardiography.

Key Terms

angina	hypertension
beta blockers	hyperventilation
cardiologist	maximal exercise
chemical stress echocardiogram	noninvasive
chemical stress test	nuclear stress test
congestive heart failure (CHF)	radiologist
coronary artery disease (CAD)	rate pressure product (RPP)
echocardiogram	sick sinus syndrome
false positive	stress echocardiogram
gamma camera	submaximal exercise
gate	target heart rate (THR)

12.1 Cardiac Stress Testing

Often a patient has symptoms of cardiac problems that do not show up on a resting ECG. In order to obtain an accurate diagnosis, the licensed practitioner may order cardiac stress testing. Exercise electrocardiography is one type of cardiac stress testing that has been used for more than 50 years. This test is known by many names, such as exercise tolerance test, treadmill stress test, stress ECG, or exercise treadmill test. It is most commonly known as a treadmill stress test because the exercise is usually

noninvasive Procedure that does not require entrance into a body cavity, tissue, or blood vessel.

cardiologist A physician who specializes in the study of the heart.

performed on an exercise treadmill (Figure 12-1). Although treadmill testing is most common, other evaluation techniques are sometimes used, including cycle (stationary bicycle) or arm-ergometry (arm cycle or crank).

This **noninvasive** procedure—meaning that it does not require entrance into a body cavity, tissue, or blood vessel—is an effective means of aiding in the diagnosis of cardiac disorders. The patient is carefully monitored throughout the testing. The procedure is typically performed with a **cardiologist** present. According to guidelines, in some facilities trained advanced cardiac life support (ACLS) certified professionals may perform the stress testing with a cardiologist immediately available in the case of an emergency.

During exercise electrocardiography, the patient is asked to walk on a treadmill (Figure 12-2). While the person is exercising, their ECG is continuously monitored. The level of exertion of exercise is increased as the test progresses. In addition to monitoring the ECG, the blood pressure, heart

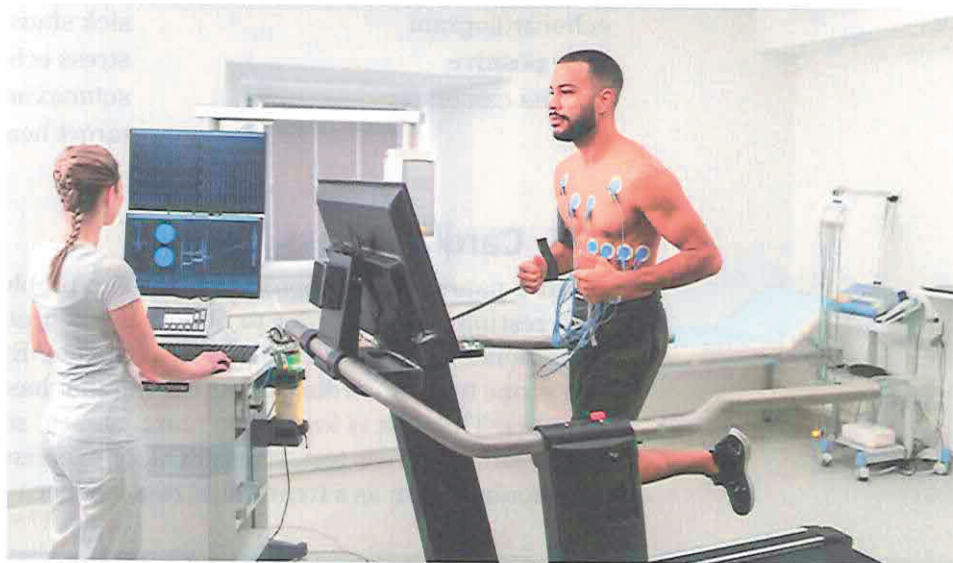
Figure 12-1 Common exercise electrocardiography equipment includes a treadmill, an ECG machine, and a monitor.

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Figure 12-2 The goal during the treadmill test is to exercise the heart and evaluate how it responds to the stress of exercise.

Tashi-Delek/Getty Images



rate, oxygen saturation (SpO₂), and physical appearance are also assessed. Blood pressure and a 12-lead ECG are taken for shortness of breath, or with any changes in the ECG pattern. Toward the end of each exercise stage and during the recovery stage, a blood pressure and a 12-lead ECG are obtained. During the test, the patient is asked to report any chest pain, dizziness, shortness of breath, or any other symptoms. Abnormalities, physical changes, or complaints could indicate a problem that requires treatment.

As a healthcare professional, you may be responsible for providing patient instructions and monitoring the patient during the procedure by taking the blood pressure and other measurements. You will observe for pain, discomfort, fatigue, or difficulty breathing. You will also apply and remove the electrodes. Your most important responsibilities are to provide for safety and to be prepared in case an emergency should arise. You should know the location of the closest crash cart and/or AED. The following is a basic list of responsibilities during an exercise electrocardiograph:

- Provide for safety and prepare for emergencies.
- Explain, obtain consent, and prepare the patient prior to the procedure.
- Attach the electrodes properly.
- Instruct the patient to report symptoms.
- Monitor the patient, including blood pressure and 12-lead ECG.
- Report abnormalities and document the procedure.

Communicate & Connect



Report Abnormal Blood Pressure

Failure to report an abnormal blood pressure or other complications to the licensed practitioner, such as tachycardia or tachypnea (increased respiration rate), during exercise electrocardiography could lead to severe patient problems and inaccurate test results.

Checkpoint Questions (LO 12.1)

1. Why is exercise electrocardiography considered noninvasive?

2. Name at least three responsibilities you will have during exercise electrocardiography.

12.2 Why Is Exercise Electrocardiography Used?

Exercise electrocardiography is used to evaluate how the heart and blood vessels respond to physical activity. Specifically, it is used for the following purposes:

- Help diagnose cause of chest pain
- Determine functional capacity of the heart after surgery or myocardial infarction

- Screen for heart disease (particularly in males over age 35) when no symptoms are present
- Help set limitations for an exercise program
- Identify cause of abnormal heart rhythms that develop during physical exercise
- Evaluate effectiveness of heart medications
- Assess how well patient blood pressure is maintained during exercise
- Help determine patient risk of myocardial infarction

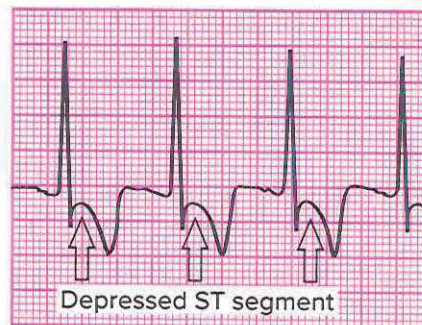
Treadmill stress testing is typically performed when the licensed practitioner suspects a cardiac problem, most commonly coronary artery disease. **Coronary artery disease (CAD)** is usually due to atherosclerosis, which occurs when plaque forms in the blood vessels from an accumulation of excess fat. When the heart is exercised, it requires additional blood to provide sufficient oxygen to the myocardium (heart muscle). The exercise increases the myocardial oxygen demand. If a patient has narrowed or obstructed arteries due to CAD, blood flow to the heart will not increase in response to the exercise. This additional workload may change the ECG tracing.

One such change in the ECG tracing is ST segment depression, as shown in Figure 12-3. ST depression may indicate myocardial ischemia or infarction and should be reported to the healthcare practitioner. Certain medications, hypothermia, and hypokalemia may also cause ST segment depression. The exercise may also produce symptoms of **angina** (chest pain) weakness, shortness of breath, palpitations, or dizziness.

coronary artery disease (CAD) Narrowing of the coronary blood vessels, causing a reduction in the blood flow to the heart.

angina An oppressive pain or pressure that occurs in the chest when the heart muscle does not receive enough oxygen due to partial or complete blockage of a coronary artery.

Figure 12-3 ST segment depression is an abnormally low ST segment below the normal baseline of the ECG. It may indicate myocardial ischemia, which can occur during exercise electrocardiography.



Checkpoint Question (LO 12.2)

1. What conditions do exercise electrocardiography help identify?

chemical stress test Stress test performed after administering medications that cause the heart rate to increase or the coronary blood vessels to dilate; performed on patients who cannot perform the exercise required in a regular stress test.

12.3 Other Types of Cardiac Stress Testing

In addition to exercised electrocardiography, a **chemical stress test** is another type of cardiac stress testing. A chemical stress test is used when the patient is unable to run or walk on a treadmill or use an exercise bike due to age, injury, or physical defect. The licensed practitioner determines whether the patient requires a regular stress test or a chemical stress test prior to the patient's arrival in the stress lab.

radiologist A physician who specializes in the use of radioactive substances to diagnose and treat disease.

nuclear stress test A stress test in which radionuclides (radioactive tracers) are administered to trace the path of blood through the heart.

gamma camera A camera that records the gamma radiation emitted by the radioactive tracers in a patient's blood.

Chemical stress tests can be conducted using nuclear testing or in combination with echocardiography. Under the guidance of a cardiologist or **radiologist**, depending on the test, the patient is monitored in the same way as for a regular exercise stress test. However, instead of using a treadmill, a chemical stress test requires one or more IVs for the introduction of a stressing chemical such as Adenocard (adenosine), Persantine (dipyridamole), dobutamine, or Lexiscan (regadenoson) (Table 12-1). These drugs mimic the stresses placed on the heart during exercise.

For a **nuclear stress test**, a nuclear medicine technologist first injects the patient with a stressing chemical. Then, prior to the completion of the stressing cycle, the technologist injects a radioactive tracer. The patient is then scanned using a **gamma camera**. In this procedure, the patient lies on their back, or in some cases sits upright, with arms above the head while the camera rotates around the patient to produce a multidimensional image. An additional feature of nuclear testing is that a three-lead electrocardiogram can be used

TABLE 12-1 Common Cardioactive Medications*

Medication	Effect	Contraindications
Adenocard (adenosine)	Cardiac vasodilator Causes slowing of heart rhythm and dilation of coronary vessels, which results in increased blood velocity and flow rate in normal vessels and less of a response in stenotic (narrowed) vessels	• Second or third-degree heart block in patients who do not have an artificial pacemaker. • Breathing problems, such as asthma. • Sinus node disease, such as sick sinus syndrome, in patients who do not have an artificial pacemaker.
Persantine (dipyridamole)	Cardiac vasodilator Causes increase heart rate and dilation of coronary vessels, which results in increased blood velocity and flow rate in normal vessels and less of a response in stenotic (narrowed) vessels	• Patients with active bronchospasm or patients being treated for reactive airway disease. • Patients with more than first-degree heart block (without a ventricular demand pacemaker) should not undergo dipyridamole infusion because this may lead to worsening of the heart block. • Patients with a systolic blood pressure of less than 90 mmHg should not undergo dipyridamole stress testing because of the potential for further lowering of the blood pressure. • Patients with a history of reactive airway disease (COPD/asthma).
Dobutamine	Cardiac inotrope (force of contractions) and chronotrope (speed of contractions); the heart responds to dobutamine similarly to the way it responds to exercise	• Patients with recent (1 week) myocardial infarction; unstable angina; significant aortic stenosis or obstructive cardiomyopathy; atrial tachydysrhythmias with uncontrolled ventricular response; history of ventricular tachycardia, uncontrolled hypertension, or thoracic aortic aneurysm; or left bundle branch block should not undergo dobutamine stress testing.
Lexiscan (regadenoson)	Cardiac vasodilator Causes rapid increase in coronary blood flow in normal coronary arteries with little or no increase in stenotic arteries. Thus, myocardial perfusion imaging shows greater perfusion in normal relative to stenosed arteries.	• Regadenoson should not be administered to patients with second- or third-degree atrioventricular block or sinus node dysfunction, unless these patients have a functioning artificial pacemaker.

Source: Information adapted from www.medscape.com and www.drugs.com.

sick sinus syndrome

A disease that affects the function of the SA node. It can result in bradycardia, tachycardia, or even cause pauses in the conduction such as sinus arrest.

gate A selective technique in which a gamma camera is triggered by specific events captured by a three-lead ECG monitor.

echocardiogram Noninvasive diagnostic test that uses sound to study the heart, heart valves, and blood vessels.

stress echocardiogram

A test that combines an exercise stress test with an echocardiogram to assess left ventricular wall motion both before and immediately after exercise.

to **gate** the study, triggering the camera to record at specific points during the cardiac cycle. This produces not only the multidimensional image, but also an image in which the heart beats, so heart wall motion can be evaluated.

Depending on the protocol used, the patient may be scanned prior to stressing or 3 to 24 hours after stressing to provide a resting image series for a comparison. This can help minimize false positives caused by stress-induced ischemia. Actual scan times can vary from 15 minutes to an hour for each phase, with gated studies on patients who have an irregular heart rate taking the longest time.

Certain factors can affect the results of this test. The patient's diet should be restricted before and during this test. Eating causes the increased blood flow through the stomach, which reduces the concentration of the radionuclide in the heart tissue. Additionally, the female breast can also cause imaging differences.

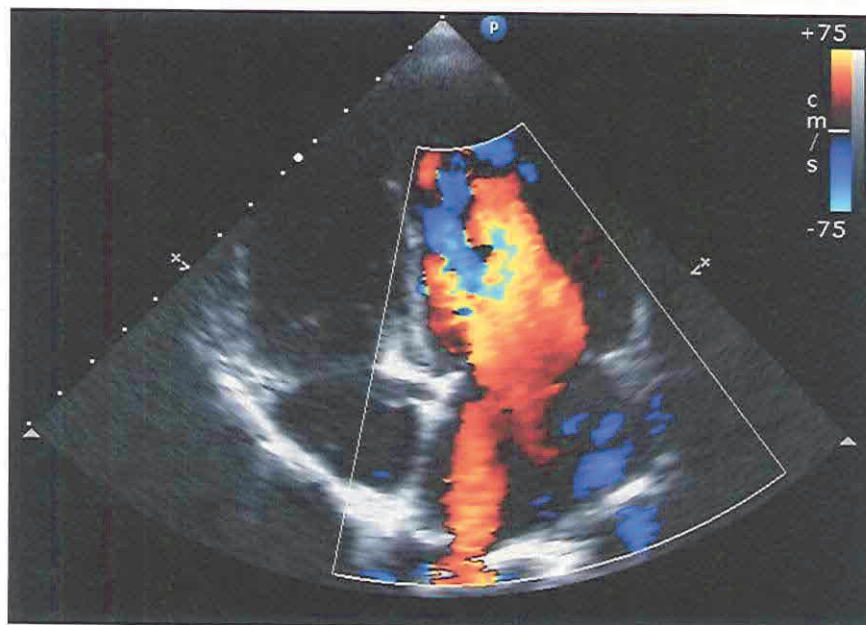
An **echocardiogram** uses sound to study the heart, its valves, and the major blood vessels surrounding the heart (see Figure 12-4). The **stress echocardiogram** combines an exercise stress test or chemical stress test with an echocardiogram to assess left ventricular wall motion, both before and immediately after exercise. A stress echocardiogram is considered normal if left ventricular wall motion is normal both at rest and within 45 to 60 seconds of achieving the target heart rate poststress. Ischemia is suspected when a change is seen in left ventricular wall shape or contractility with exercise.

The stress echocardiogram is divided into a resting echocardiogram phase, an immediate postexercise scan, and a recovery phase scan. All three phases require an experienced sonographer with a high level of skill and speed to obtain these images within a specific time frame. During the resting phase, the sonographer acquires four specific left ventricular wall motion images with the patient lying on their left side, with the head slightly elevated. The resting phase is then followed by either the regular stress test or chemical stress test.

As soon as the patient achieves 85% to 100% of the target heart rate during the exercise portion, the treadmill is stopped. The patient immediately and safely moves from the treadmill to the echo bed while still attached to

Figure 12-4 Echocardiography of the heart showing hypertrophy of the left ventricle. Echocardiography directs beams of ultrasonic waves through the chest wall, which are echoed by the heart tissues providing motion pictures of the heart.

kalus/Getty Images



chemical stress echocardiogram A stress echocardiogram in which the heart is stressed by chemicals, rather than physical exercise.

the ECG leads. The sonographer then has 45 to 60 seconds to obtain the same four left ventricular images as in the resting phase. This is the postexercise scan. A stress technician, nurse, or other licensed practitioner is present to perform the stress test and assess ischemic changes on the ECG during the postexercise and recovery phases.

If a **chemical stress echocardiogram** is ordered, the patient remains on the echo table, on the left side with head slightly elevated, for all three phases of the stress echocardiogram. While a nurse infuses the stress chemical according to the specific protocol for the medication, the sonographer obtains the same four left ventricular wall motion images at specific intervals throughout the infusion.

When the patient's heart rate returns close to the resting heart rate, the same four left ventricular wall motion images are acquired to complete the recovery phase. The test is terminated after the recovery scan is completed, when the ECG shows no ischemic changes and the patient's blood pressure and heart rate have returned to resting levels.

The cardiologist then views the side-by-side images of the resting, postexercise, and recovery images. The cardiologist assesses for changes in left ventricular motion and contractility, which can predict the presence of ischemia in one or more coronary arteries.

Communicate & Connect



Complete Explanation Is Necessary

Patient education brochures are valuable to help the patient understand the procedure. However, they may not be enough. The physician or other licensed practitioner should explain the purpose for the test, but it is your responsibility to ensure that the patient understands what will occur during the test and what the patient should report while the test is in progress.

Checkpoint Question (LO 12.3)

1. Why would it be necessary to use chemical stress testing?

12.4 Preparing the Patient for Exercise Electrocardiography

When scheduling a patient for exercise electrocardiography, you will need to make sure the patient comes prepared for the test (Table 12-2). Describe the procedure, and ensure that the patient understands what will happen. Explain the guidelines for eating, drinking, and consumption of alcohol, caffeine, and tobacco to the patient. For example, the patient should not consume alcohol or caffeine for 24 hours prior to the test and should not use tobacco on the day of the test. They should also be advised not to eat or drink anything except water for at least 4 hours before the test. The patient should be instructed to bring or wear comfortable clothing and shoes. Tennis shoes and loose pants will make the exercise portion of the test easier for the patient.

TABLE 12-2 Stress Test Procedure Example: Bruce Protocol**Before the Test**

- Verify that the medical history is complete.
- Explain the procedure, including the reason for the test, possible complications, and safety measures that will be followed during the procedure.
- Explain “informed consent,” and ask the patient to sign the consent form.
- Inform patients that on the day of the test they should wear comfortable clothing (shorts, tennis shoes, etc.). Female patients should not wear an underwire bra. The patient should be instructed on consumption of alcohol, caffeine, and tobacco before the test and should be given guidelines related to eating and drinking. Follow the specific guidelines as outlined by the facility where you are employed.
- Check the licensed practitioner’s orders against the patient’s medication list to provide information as to what medications the patient should not take the day of the test.
- Go over all instructions and information with the patient. Encourage questions; make sure the patient fully understands the procedure.
- Provide a detailed list of instructions, making sure that your facility telephone number and your name appear on the list. Encourage patients to call if they have any questions prior to test day.

Day of Appointment

- Verify that equipment is in working order and supplies are on hand. (Ensure that plenty of tracing paper is available, inspect cables, check that the treadmill is working, and verify the computer setup and correct protocol.)
- Gather supplies—electrodes, alcohol, gauze sponges, razor, adhesive tape, blood pressure cuff, and so on.
- Check that the crash cart is ready and fully supplied and the defibrillator is working.
- Verify the licensed practitioner’s order, that the medical history is complete, and that the informed consent is signed.
- Bring the patient into the room.
- Formally identify the patient and verify that they have complied with all instructions.
- Unless the patient needs assistance, provide the patient with privacy to change into a gown. Instruct the patient to put on the gown with the opening in the front.
- *Remember: During all aspects of the procedure, always provide for the safety of the patient!*
- Assist the patient to lie down on the table. Prep the patient’s skin and apply electrodes as indicated by the protocol of the facility or the equipment manual.
- Connect cables, apply the blood pressure cuff, and check the ECG tracing for artifact. Check and set the artifact filters as necessary.
- Obtain the patient’s blood pressure and ECG while the patient is sitting or lying down. Assist the patient as necessary and provide for safety.
- Demonstrate the treadmill (posture, hand grip, etc.).
- Explain the test protocol, making sure the patient understands that the speed and incline will increase every 3 minutes during the test phase.
- *Be sure the patient understands that they are to report any pain, shortness of breath, faintness, tingling sensations, numbness, or extreme fatigue immediately. Monitor the patient closely during the test looking for visual signs of any of the above. Ask the patient repeatedly during the procedure how they feel. Providing for patient safety is your number one priority.*
- Explain again that the test will be completed when the submaximal target heart rate is reached or when the patient cannot continue due to fatigue or other symptoms. The target heart rate (THR) is 220 minus the patient’s age multiplied by a percentage that ranges between 60 and 85, depending on which testing protocol is being followed:
 - $\text{THR} = [(220 - \text{age}) \times 0.60]$ to
 - $\text{THR} = [(220 - \text{age}) \times 0.85]$
- Inform the qualified healthcare practitioner that the patient is ready to begin the test. The physician should be present and immediately available.
- When the licensed practitioner is in the room, assist the patient to the treadmill, making sure the patient’s feet are on the rail next to the moving belt, not directly on the belt. Start treadmill, first stage. tell the patient to get used to the speed and then to step onto the belt. Ask the patient if they are ready to begin, explaining again that the belt speed and incline will increase.
- At the end of the first minute (beginning of second minute) of each stage, a blood pressure and ECG should be recorded.
- At the 2½-minute mark of each phase, a blood pressure is taken and recorded. Remind the patient before every transition to a new phase. Be ready to assist the patient as needed.
- When the treadmill phase of the test is complete (the target heart rate is reached or the patient cannot continue), assist the patient to a waiting chair.

(Continued)

TABLE 12-2 Stress Test Procedure Example: Bruce Protocol (Continued)

Post-test
• Continue to monitor and observe the patient's condition closely, taking the patient's blood pressure, entering data, and then taking an ECG tracing every 3 to 5 minutes for 10 to 15 minutes. • When the cool-down period is completed, remove the cables and electrodes; wipe off any remaining gel or adhesive. • Allow the patient to dress (assist if needed). • Explain to the patient that they should avoid nicotine, caffeine, and alcohol for at least 3 hours. The patient should avoid extreme temperature changes, including hot showers or baths, for 2 hours. The patient should rest and recuperate after the test. • Explain that the physician who ordered the test should have the results within 24 to 48 hours (refer to local policy for the specific turnaround time of your organization). Thank the patient for their cooperation. • File your report per the protocol of the facility. • Make sure all information from the patient chart is maintained confidentially within the medical record. • Prepare for the next patient.



Law & Ethics

Informed Consent

Informed consent is required for surgery, HIV testing, and other procedures, including exercise electrocardiography. Informed consent affirms that the patient understands the treatment, why it is being performed, any risks to the patient, alternative treatments and their risks, and the risk involved if the patient refuses treatment. Table 12-3 lists the typical reasons patients refuse the test and suggestions for resolving the problem.

What happens when you ask the patient to sign an informed consent form and they refuse?

TABLE 12-3 Handling a Patient's Refusal to Grant Consent

Reason for Refusal	Possible Solution
Patient does not understand why the consent form is necessary.	Explain the legal requirement of an informed consent, and refer the patient to the physician for questions, if necessary.
Patient does not understand the procedure.	Notify the licensed practitioner, and provide a brochure for the patient to review while they are waiting for an explanation of the procedure.
Patient is illiterate and unable to sign their name.	Have a witness present (preferably a family member), and have the consent form marked with an X by the patient and signed by the witness and yourself.
Patient is unable to sign because glasses are not available or because the patient is blind.	Make every attempt to obtain the glasses and then have the patient sign; if this is not possible, have the patient sign to the best of their ability after the form is read to them. Be certain to have a witness (preferably a family member) sign the form as well.

beta blockers Drugs used to treat hypertension.

Sometimes certain medications should not be taken prior to the test. The patient may need instruction regarding medications that can affect the test results and should not be taken. Always check the licensed practitioner's order. If it is not written on the chart or order, ask the practitioner. When asking, have a list of the patient's current medications or the patient's chart available for the licensed practitioner to review. Medications commonly known as **beta blockers**—drugs used to treat hypertension—are frequently stopped for several hours prior to an exercise electrocardiography test because this type of medication could affect the test results or delay the test. See the appendix *Cardiovascular Medications* for more information. Facility policy dictates what medications should be stopped. Remember, it is your responsibility to ensure that the patient comes to the office or clinic properly prepared for the exercise electrocardiography test.

A complete patient history may need to be recorded before beginning the test. A standard form should be used. The information you need to obtain from the patient includes the medical history, medications currently being taken, cardiovascular risk factors (see the chapter *Electrocardiography*), and the reason for this examination. Much of this information may already be on the patient's chart. In addition, an informed consent form must be signed and witnessed (Figure 12-5). The patient should understand the procedure, its risks, and the reason the test has been ordered before signing the informed consent form.

The patient should be informed that exercise electrocardiography is not a “timed” test. The length of time the test takes depends on several factors, including the patient's age, degree of conditioning or health status, other medical problems, and medications. You should inform the patient that the test will take approximately 45 minutes up to 3 hours depending on the type of test being done. Carefully explain the safety precautions provided during the procedure to help alleviate any fears the patient may have.

Checkpoint Questions (LO 12.4)

1. Stress testing is a noninvasive procedure. Why is informed consent necessary?

2. Why should you obtain a list of the current medications the patient is taking before the stress test procedure?

12.5 Providing Safety

Exercise electrocardiography is performed on patients who are already at risk. At-risk patients may have just recently had a myocardial infarction (MI), may currently be experiencing some type of chest pain or other symptoms, or they may have a history of coronary vascular disease. Exercise electrocardiography does place stress on the patient's heart. There is some risk of an MI or cerebrovascular accident (CVA) during the procedure that should

Figure 12-5 Your patient must sign an informed consent for exercise electrocardiography. Most facilities use a standardized form such as the one pictured here.

Consent Form for Exercise/Chemical Stress Testing

A stress test is being performed to provide information about the blood supply to your heart, as well as to assess your ability to do various activities.

The information obtained will help your licensed practitioner recommend treatment options regarding your cardiovascular health. The test that you will undergo will be performed on a treadmill with the amount of effort increasing gradually as the test progresses. This increase in effort will continue until either a predetermined heart rate is achieved or symptoms such as fatigue, shortness of breath, or chest discomfort appear, which indicate to you to stop. An alternative type of stress test may be administered in which a medication may be used to "stress" or exercise the heart. During the performance of the test, trained staff will closely monitor your pulse, blood pressure, and electrocardiogram.

If performed as part of a nuclear myocardial perfusion study, a small amount of radioactive material (thallium) will be injected followed by imaging of the heart. The amount of radioactivity you will be exposed to is about equivalent to a chest x-ray.

There is always the possibility of certain changes occurring during the test. They include abnormal blood pressure, fainting, shortness of breath, abnormal heart rhythms (too rapid, too slow, or ineffective), and very rare instances of heart attack. Every effort will be made to minimize them by the preliminary examination and by observations during and immediately after testing. Emergency equipment and highly trained personnel are available to manage any unusual situations that may arise.

In order to determine an appropriate plan of medical management, I hereby consent to voluntarily engage in a myocardial stress test to determine the state of my heart and circulation.

I have read the above information and understand the procedures, as well as any possible complications or risks. I understand that in rare instances, heart attack or stroke has been reported. I acknowledge that my licensed practitioner has explained my condition and the nature and purpose of this test, as well as alternative tests, and that all questions asked about my care and its attendant risks have been answered in a satisfactory manner. I understand that any question(s) I still may have can be answered by my licensed practitioner or clinic staff members at any time. I hereby accept the risk of harm, if any, in hopes of obtaining the desired beneficial diagnostic information.

Signed:

Patient	Date
Patient Name Printed	Witness
Licensed Practitioner Supervising Test	

be considered. You should follow the safety measures and be prepared for emergencies (Table 12-4).

In order to provide for safety, certain rules must be followed. A physician *must* be in the building and immediately available during the procedure, in case of an emergency. Emergency equipment must be in the room or nearby, including a crash cart with emergency medications and supplies. You must know the location of this equipment. In addition, the patient should be monitored at all times, and they must understand the need to report any abnormal symptoms when they occur.

TABLE 12-4 Preparing for Emergencies During Exercise Electrocardiography

• Inform the patient of how they can expect to feel during the test, including mild fatigue, increased heart rate, perspiration, and increased respiratory rate.	
• Explain to the patient the need to report signs and symptoms such as chest or other pain, dizziness, weakness, or extreme fatigue.	
• Make sure the patient knows to stop the exercise if any pain or extreme fatigue is felt.	
• Make sure the physician or other licensed practitioner is present during the entire procedure.	
• Check to see that emergency equipment is close by, including a code or crash cart with defibrillator or AED (automatic external defibrillator).	
• Observe and monitor the patient, and report any symptoms to the physician or other licensed practitioner immediately.	

hypertension High blood pressure.

congestive heart failure (CHF) Failure of the heart to pump an adequate amount of blood to the body tissues. Includes symptoms of shortness of breath (SOB), edema, pale skin, increased respiratory rate, potential frothy sputum.

Some health conditions prevent patients from participating in exercise electrocardiography. These conditions include but are not limited to

- a change in the resting ECG.
- abnormal heart rhythms, including uncontrolled ventricular or atrial dysrhythmia or a third-degree AV block.
- inflammation surrounding the heart or heart muscle (pericarditis or myocarditis).
- uncontrolled **hypertension** (high blood pressure).
- certain cardiovascular conditions such as severe aortic stenosis, aneurysm, thrombophlebitis, and systemic or pulmonary embolism.
- **congestive heart failure (CHF)** (the heart's failure to pump an adequate volume of blood).
- acute infection.
- significant emotional stress (psychosis).
- unsteady gait (treadmill stress test only).
- leg amputation (treadmill stress test only).

The physician or other licensed practitioner should be aware of any of these conditions. Make sure that the health history is current and complete for the physician or other licensed practitioner to review. For example, a recent myocardial infarction or severe angina may prevent a patient from having exercise electrocardiography. If it is performed, extreme caution must be used.

Safety & Infection Control



hyperventilation
To breathe at an increased rate and depth of inspiration and expiration.

Observe Patients Carefully

Observe your patient carefully when they change position and during **hyperventilation** for dizziness and potential for a syncopal (fainting) episode. Many patients will have cardiac, pulmonary, and/or vascular disease that increases the chances for these symptoms.

**Checkpoint
Question
(LO 12.5)**

1. Can everyone have a standard stress test? Why or why not?

12.6 Performing Exercise Electrocardiography

Assemble and prepare the equipment before the patient's arrival. You will need

- blood pressure equipment.
- skin prep solution.
- clippers (for excessive hair on chest).
- 2 × 2 or 4 × 4 gauze.
- chest electrodes.
- stress test unit.
- lead wires.
- treadmill or cycle ergometer.
- adhesive tape.
- belt (used to attach monitoring unit) or mesh vest.
- crash cart.

Safety & Infection Control



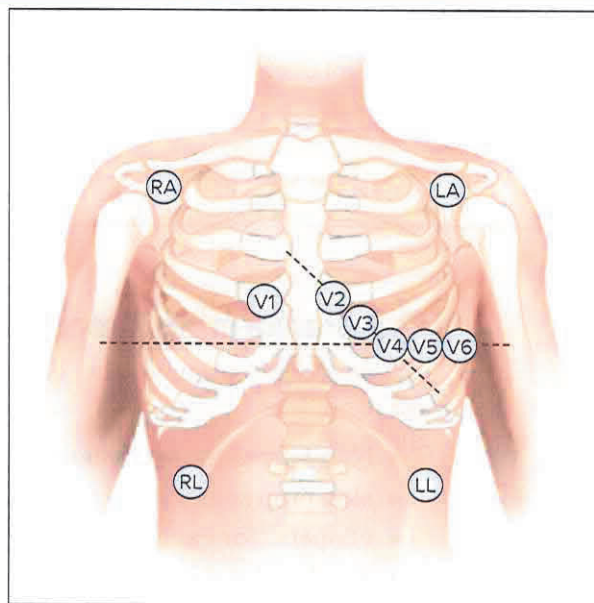
CPR Required

As a healthcare professional, you should know cardiopulmonary resuscitation (CPR) and be prepared to respond to cardiac or respiratory emergencies.

When the patient arrives for the test, make sure they have followed the facility's guidelines for intake of food, drink, alcohol, caffeine, and tobacco. If not, report this to your supervisor or the licensed practitioner, the test may need to be rescheduled. Observe whether the patient is dressed appropriately and verify that medications were stopped, if required. Complete the patient's medical history, and make sure the informed consent form has been signed.

Next, prepare the electrode sites for placement. If the sites are hairy, the preferred method or hair removal is to use a clipper. Shaving the hair causes microabrasions on the skin surface that could lead to the introduction of bacteria into the abrasions causing infection. After clipping the hair, prep the skin briskly with approved prep solution, allow the areas to dry then follow with the electrode placement.

Figure 12-6 Because machines may vary, check the manufacturer's instructions for proper placement of the electrodes for the exercise electrocardiograph machine you are using. The placement shown here is the Mason-Likar application technique.



Attach the blood pressure cuff and electrodes. Check the manufacturer's instructions for the system you are using and the policy at your facility for correct placement of the electrodes (Figure 12-6). Typical placement of precordial leads for stress testing is almost the same as for the traditional 12-lead ECG. The difference is that the limb sensors must be moved from the arms and legs to the upper chest and torso because of the exercise component. *Note:* In order to minimize artifact, avoid placing the leg sensors in a location on the abdomen where they will contact the belt that is placed around the patient's waist. This placement also increases safety by reducing the chance of tripping and falling over the lead wires. This placement technique is referred to as the Mason-Likar attachment. Many exercise electrocardiography monitors include leads for both chest and back.

Check and set the artifact filters before running the stress test. These filters help reduce small signals caused by muscle movements from the ECG tracing during the test. Review the manufacturer's instructions to ensure the proper setting.

Prior to the exercise test, a resting/baseline blood pressure and 12-lead ECG are always obtained. In some facilities, a series of blood pressures and 12-lead ECGs may be obtained with the patient in different positions. The following is an example. Check the policy where you are employed.

First: A resting ECG and blood pressure are obtained while the patient is supine.

Second: The patient is asked to sit up, and another blood pressure and ECG are obtained.

Third: The patient is asked to breathe quickly and deeply to produce a state of hyperventilation for about 30 seconds. Then another blood pressure and ECG are taken. This ECG is done to identify ECG changes caused by breathing. These changes could be misinterpreted as being related to heart disease if they occurred during the stress test.

Fourth: The patient is asked to stand, and the final pre-exercise blood pressure and ECG are obtained.

Think It Through



Reporting Problems

If your patient has any complaints or problems during exercise electrocardiography, you should be prepared to respond. Keep in mind that while the physician or other licensed practitioner should be in the room, they may not always be aware of the patient's complaints or problems. Any symptom that the patient reports, such as extreme fatigue, dizziness, shortness of breath, or chest pain, should be immediately reported to the practitioner.

What should you do if the patient collapses?

Checkpoint Question (LO 12.6)

1. What equipment must be assembled before exercise electrocardiography can be performed?

12.7 Common Protocols

The stress test is divided into stages of 2 or 3 minutes each. Each stage is based on stress test protocols. The protocols include the length of time of exercise and the incline of the treadmill. The physician or other licensed practitioner determines the protocol or length and incline of each stage of exercise (Table 12-5 and Figure 12-7).

Communicate & Connect



Reducing the Patient's Fears

You can help reduce the patient's fears by maintaining a sense of confidence, answering questions, and following safety precautions during exercise electrocardiography.

The entire exercise period lasts up to 15 minutes. The time may vary based on the patient's cardiac risk factors and level of fitness. At the end of each minute, (beginning of second minute) of each stage, the patient's blood pressure and a 12-lead ECG are recorded and the level of exercise is increased.

Most people exercise to the point of fatigue or symptoms of chest discomfort or shortness of breath. The supervising practitioner may halt the test because of blood pressure, ECG, or heart rhythm changes that are not perceived by the patient. In other words, though the patient may not complain of any symptoms, the licensed practitioner may identify changes in the blood pressure, heart rate, or ECG tracing that may lead to complications and may order that the test be stopped.

TABLE 12-5 Common Stress Testing Protocols

Bruce Protocol: Most commonly utilized stress test. Uses 3-minute stages.

Stage	Speed (mph)	Grade (%)
1	1.7	10
2	2.5	12
3	3.4	14
4	4.2	16
5	5.0	18
6	5.5	20
7	6.0	22

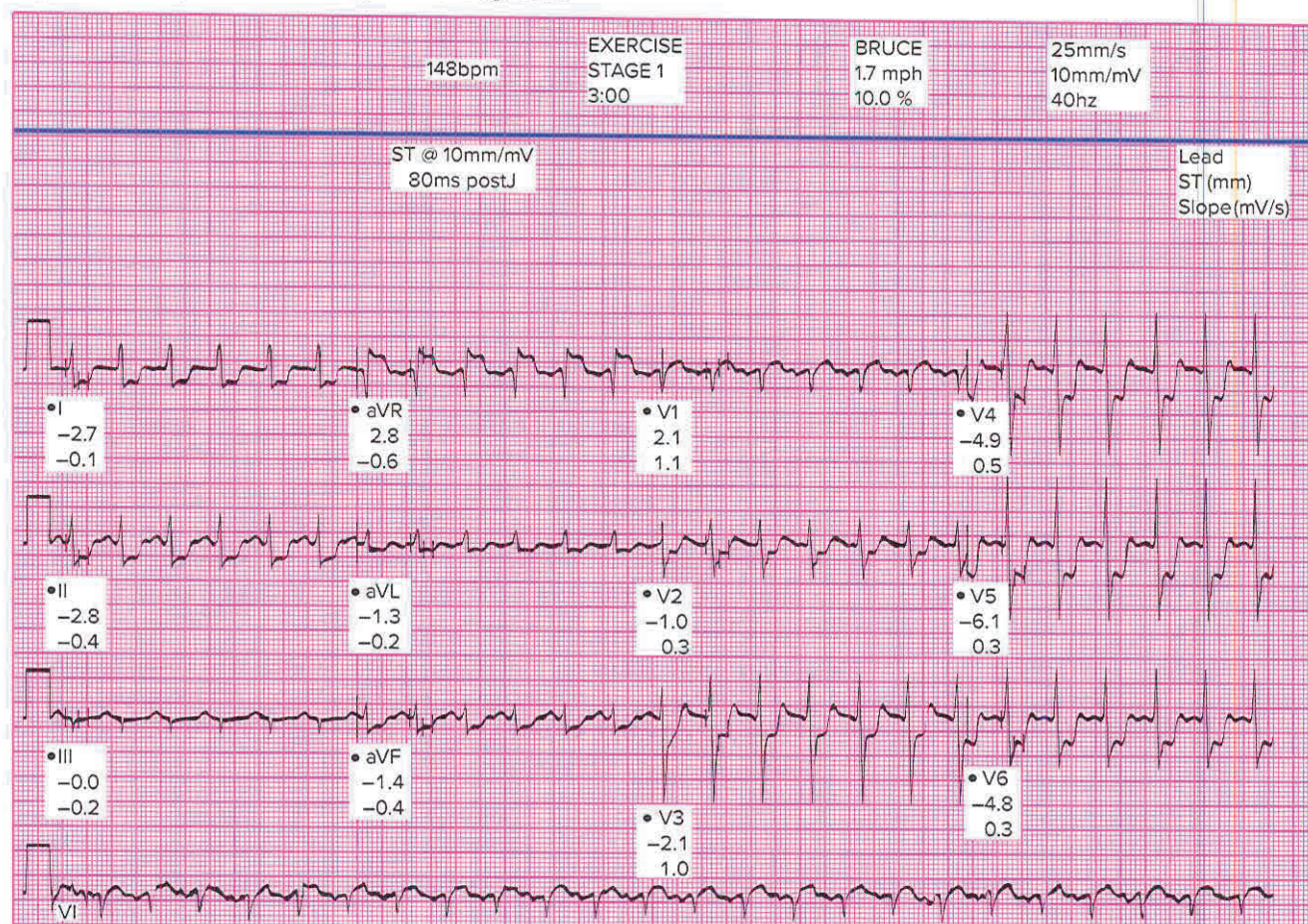
“Modified” Bruce Protocol: Most often used in older individuals or those whose exercise capacity is limited by cardiac disease. Uses 3-minute stages.

Stage	Speed (mph)	Grade (%)
1	1.7	0
2	1.7	5
3	1.7	10
4	2.5	12
5	3.4	14
6	4.2	16
7	5.0	18
8	5.5	20

Naughton Protocol: Better suited for sicker patients; more gradual increase in intensity. Speed stays at 2 mph. Uses 2-minute stages.

Stage	Grade (%)
1	0.0
2	3.5
3	7.0
4	10.5
5	14.0
6	17.5
7	21.0

Figure 12-7 During a Bruce protocol stress test, ECG recordings are made continuously during and after exercise. This image shows ST segment depression and depicts a positive test (identifies a problem). This result coupled with any patient complaints would support the diagnosis.



target heart rate (THR)

Heart rate measurement needed to truly exercise the heart.

submaximal exercise

Target heart of 220 minus the age multiplied by a percentage between 60 and 85. $THR = [(220 - \text{age}) \times 0.60]$ to $THR = [(220 - \text{age}) \times 0.85]$

maximal exercise Target heart rate of 220 minus the age of the patient.

During the test, the goal is to achieve the **target heart rate (THR)** without symptoms or complications such as a dysrhythmia. The target heart rate is 220 minus the patient's age multiplied by a percentage that ranges between 60 and 85, depending on which testing protocol is being followed (often referred to as **submaximal exercise**). This is different from the target heart rate for aerobic exercise, which is simply 220 minus the age of the person without using an additional multiplier (often referred to as **maximal exercise**).

The THR is the rate that the patient should not be allowed to exceed during the test. Achieving the THR without symptoms or abnormalities is a good indication that the heart is functioning well. Generally, the closer the patient is to the target heart rate, the more reliable the test results.

Instruct the patient to report any symptoms—such as shortness of breath, chest pain, dizziness, or weakness—they experience during the procedure because you are responsible for monitoring and recording this information. You will need to monitor blood pressure, pulse, and any signs of cardiac distress. You may also be monitoring the patient's blood oxygen level on the monitor screen.

rate pressure product (RPP) Systolic blood pressure multiplied by the heart rate; also known as *double product*.

Rate pressure product (RPP) or *double product* is a measurement that may be asked for by the doctor. To find the RPP, multiply the systolic blood pressure by the patient's heart rate. This is one technique used to estimate oxygen utilization or myocardial work. For example:

Systolic blood pressure (SYS BP) = 118

Heart rate (HR) = 88

$\text{SYS BP} \times \text{HR} = \text{RPP}$

$118 \times 88 = \text{RPP}$

10,384 = RPP

During exercise, the heart rate and systolic blood pressure are the two main factors determining the workload on the heart. If these factors increase, the heart has to work harder and requires more oxygen and nutrients to keep going, thus putting stress on the heart. The response of the heart rate and blood pressure to a fixed level of exercise tends to decrease with regular exercise. So a person with good blood supply and a strong heart muscle should have a lower RPP than a person who has a disruption of the blood supply to the heart muscle and a weaker heart muscle. Thus the RPP is an index of the myocardial oxygen requirement and helps determine the work placed on the heart, as well as the heart's response.

Watch the patient closely, including skin color, breathing pattern, amount of perspiration, and facial expressions. Many times a patient is hesitant to report a symptom. If you suspect a problem, ask the patient and then report your suspicion to the supervising practitioner.

Checkpoint Questions (LO 12.7)

1. Identify which stress-test protocol would most likely be used for each of the following patients:
 - a. A 76-year-old, 285-pound male who has recently had a heart attack
 - b. A 46-year-old airline pilot during a yearly physical
 - c. A 65-year-old patient with hypertension and complaints of chest pain
2. What is the target range for the heart rate of a patient who is 49 years old?

12.8 After Exercise Electrocardiography

When the patient has completed the exercise portion of the test, monitoring will continue during a "cooling-off" period. This will last from 6 to 15 minutes, depending on the protocol at your place of employment and the physician or other licensed practitioner's preference and the patient's ability to recover. The goal is for the patient's blood pressure and heart rate to return to the pretest numbers, without complications. You will need to stay with the patient during this time and continue to monitor the patient for any changes.

Many factors are used to interpret the results of exercise electrocardiography. The most important factors are the presence of ECG changes and symptoms. Other factors include heart rate and rhythm, blood pressure, and changes in oxygen saturation. If a patient has no abnormal ECG changes or unusual elevations in blood pressure, this usually means the risk for coronary vascular disease is low. If the test is stopped early because of ECG or blood pressure changes or patient symptoms, this is a sign of abnormal test results. When the results of the test are inconclusive or abnormal, additional tests may be performed. An inconclusive test is one with questionable results, meaning it does not necessarily show an abnormality or eliminate the potential for an abnormality. Additional testing is needed to either identify or eliminate any abnormalities.

Communicate & Connect



Exercise Electrocardiography Results

As an unlicensed healthcare professional, you are not responsible for reporting the results of exercise electrocardiography to the patient. If the patient asks you about the results, refer the patient to the licensed practitioner.

Law & Ethics



Secure Patient Testing Information

Remember to save and secure all patient testing information upon completion.

After exercise electrocardiography, the patient should be given some instructions, including

- rest for several hours.
- avoid extreme temperature changes.
- avoid stimulants, such as caffeine, tobacco, or alcohol, for at least 3 hours.
- do not take a hot shower or bath for at least 2 hours.
- when to expect the test results.
- discuss the results with the licensed practitioner.

Stress testing is considered a good method to detect early coronary vascular disease. However, it is interesting to note that research suggests that 5% to 15% of healthy adults may have **false positive** results, meaning that the test may indicate that disease is present when it is not. Research has shown that false positives occur more frequently in females than in males, though researchers are not sure why. False positives can cause unnecessary fears and the need for additional expensive tests. As a healthcare professional, you should be aware of this problem and be sensitive to the patient when concerns arise. However, the physician or other licensed practitioner is responsible for providing additional information to the patient regarding false positive test results and any additional testing that may be required.

false positive When a diagnostic test indicates that disease is present but, in reality, no disease is present. A false positive is never considered a negative result. It is a positive result, albeit a falsely positive one.

Checkpoint Question (LO 12.8)

1. Name at least three instructions you would give a patient after exercise electrocardiography.

Chapter Summary

Learning Outcomes	Summary	Pages
12.1 Describe exercise electrocardiography and identify its other names.	Exercise electrocardiography is the recording of an ECG and monitoring of a patient during active or medication-induced exercise to diagnose problems that do not occur when the patient is at rest.	275–276
12.2 Identify uses of exercise electrocardiography.	Exercise electrocardiography is used to screen for heart disease, assist in diagnosing the cause of chest pain, and determine the functional capacity of the heart (ability to respond to physical stress) after MI or heart surgery.	276–278
12.3 Describe other types of cardiac stress testing.	Chemical stress tests are variations of exercise electrocardiography that include the injection of medications before the procedure. A stress echocardiogram combines an exercise or chemical stress test with an echocardiogram to assess left ventricular wall motion before and after exercise.	278–281
12.4 Prepare a patient for exercise electrocardiography.	To prepare a patient for exercise electrocardiography, you must schedule the appointment, prepare the patient, obtain a consent form, and document what you have completed. The patient needs to be taught about the procedure, its complications, what to wear, what medications or other substances can and cannot be taken, and what to report during the procedure itself.	281–284
12.5 Summarize safety measures that are used before, during, and after exercise electrocardiography.	Providing for safety before, during, and after exercise electrocardiography includes following standard precautions, preparing the crash cart, monitoring the patient, providing complete patient instructions, and making sure a licensed practitioner is present during the entire exercise portion of the procedure.	284–287
12.6 Explain the responsibilities of a healthcare professional during exercise electrocardiography.	As an assistant during the procedure, you may be responsible for safety, education, and preparation of the patient; attachment of the electrodes; instructions on reporting symptoms; and monitoring the patient, including taking the blood pressure.	287–289
12.7 Compare common protocols followed in exercise electrocardiography.	Common protocols for exercise electrocardiography include Bruce, modified Bruce, and Naughton.	289–292
12.8 Explain the responsibilities of a healthcare professional after exercise electrocardiography.	After exercise electrocardiography, the patient will need to be monitored during the cooling-off period and provided with additional education and information about when the results will be ready.	292–294

Chapter Review

Multiple Choice

Circle the correct answer.

1. What is your most important responsibility during exercise electrocardiography? (LO 12.5)
 - a. Providing for safety
 - b. Applying the leads
 - c. Monitoring the ECG tracing
 - d. Taking the patient's blood pressure
2. Which of the following conditions would be a reason that a patient should *not* perform exercise electrocardiography? (LO 12.5)
 - a. Coronary vascular disease
 - b. Previous heart attack
 - c. Congestive heart failure
 - d. Previous symptoms of angina
3. What type of test would be performed on a patient who is unable to stand or exercise? (LO 12.3)
 - a. Chemical (pharmacologic) stress test
 - b. Blood pressure test
 - c. Treadmill stress test
 - d. Stress echocardiogram
4. During exercise electrocardiography, your patient appears to be short of breath. After informing the licensed practitioner of your suspicions, what would you do? (LO 12.6)
 - a. Continue the test.
 - b. Take the patient's blood pressure.
 - c. Ask the patient to stop the exercise portion of the test.
 - d. Discretely count the respiratory rate and compare to the previous rate.
5. Patient A is on several medications and is scheduled for an exercise electrocardiography test tomorrow. What should you do first to determine if they should take their medications prior to the test? (LO 12.5)
 - a. Check the chart or order.
 - b. Ask the licensed practitioner.
 - c. Instruct the patient not to take their beta blocker medications.
 - d. Patient A should take all of their medications because they are necessary for their treatment.
6. A beta blocker is (LO 12.5)
 - a. a protocol for exercise electrocardiography.
 - b. a medication for hypertension.
 - c. necessary when performing exercise electrocardiography.
 - d. a type of ultrasound.

7. Which of the following is measured during exercise electrocardiography? (LO 12.6)
- Blood pressure and temperature
 - Blood pressure and weight
 - 12-lead ECG and weight
 - 12-lead ECG and blood pressure
8. When educating the female patient for exercise electrocardiography, you should instruct her *not* to wear (LO 12.4)
- shorts.
 - tennis shoes.
 - an underwire bra.
 - comfortable clothing.

Patient Education

You are assigned to teach Patient B about exercise electrocardiography. From the following list, determine which are correct patient instructions for exercise electrocardiography and which are not. Place a capital **C** beside the correct statements and a capital **I** beside the incorrect statements. For each of the incorrect (**I**) statements, write the correct instructions for the patient.

- _____ 9. Patients should avoid alcohol, tobacco, and caffeine for at least 8 hours prior to exercise electrocardiography. (LO 12.4)
- _____ 10. Patients should be encouraged to report any symptoms such as shortness of breath, weakness, dizziness, or fatigue during exercise electrocardiography. (LO 12.6)
- _____ 11. After exercise electrocardiography, the patient should not take a hot bath or shower for at least 2 hours. (LO 12.8)
- _____ 12. You should discuss the results of exercise electrocardiography with the patient as soon as the results are available. (LO 12.8)
- _____ 13. Patients should wear comfortable, casual clothing on the day of the test, including tennis shoes and loose-fitting pants. (LO 12.4)
- _____ 14. You should attach the leads to the chest at the same sites as you would for an ambulatory monitor. (LO 12.6)
- _____ 15. Emergency equipment should be available in the room or nearby during exercise electrocardiography. (LO 12.6)

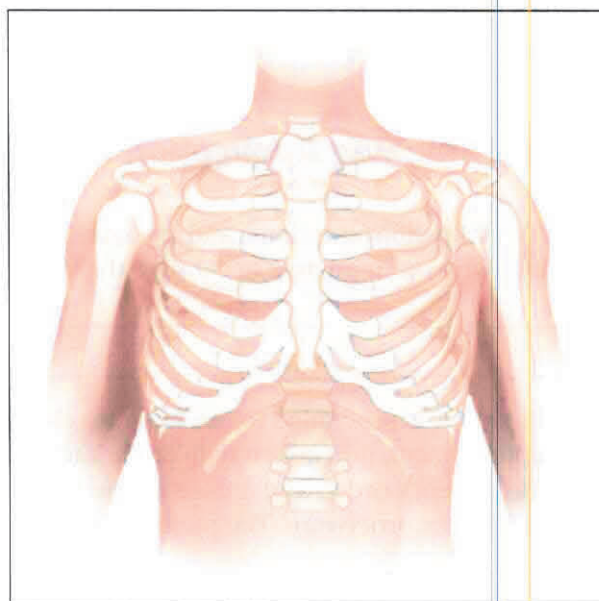
Matching

Match the terms on the left with their definitions on the right.

- | | |
|---|---|
| _____ 16. chemical stress test
(LO 12.3) | a. medication used to treat hypertension |
| _____ 17. myocardium
(LO 12.2) | b. chest pain caused by reduced blood flow to the heart |
| _____ 18. hypertension
(LO 12.5) | c. failure of the heart to pump an adequate amount of blood to the tissue |
| _____ 19. beta blocker
(LO 12.4) | d. abnormal cardiac rhythm |
| _____ 20. nuclear stress test
(LO 12.3) | e. a physician who specializes in the study of the heart |
| _____ 21. angina (LO 12.2) | f. stress test in which radioactive tracers are injected to trace the path of blood through the heart |
| _____ 22. dysrhythmia
(LO 12.7) | g. accumulation of plaque and fatty deposits in the coronary arteries that results in reduced blood flow and oxygenation of the heart |
| _____ 23. cardiologist (LO 12.3) | h. noninvasive diagnostic test that uses ultrasound waves to provide images of the heart and blood vessels |
| _____ 24. congestive heart failure (LO 12.5) | i. a diagnostic test result that indicates that disease is present when in reality no disease is present |
| _____ 25. coronary vascular disease (LO 12.2) | j. high blood pressure |
| _____ 26. echocardiogram
(LO 12.3) | k. middle layer of the heart, composed of muscle tissue |
| _____ 27. false positive
(LO 12.8) | l. calculated by subtracting the patient's age from 220, then multiplying that number by a percentage between 60 and 85 |
| _____ 28. THR (LO 12.7) | m. exercise electrocardiography that is invasive because of the injection of a substance to chemically place stress on the heart |

Lead Placement

29. Draw and label the electrodes for exercise electrocardiography in the figure below.
(LO 12.6)



True/False

Read each statement and determine if it is true or false. Circle the T or F. For false (F) statements, correct them on the lines provided.

- T F 30.** A noninvasive procedure requires entrance into a body cavity, tissue, or blood vessel. (LO 12.1)

- T F 31.** Naughton is most utilized for a stress test protocol. (LO 12.7)

- T F 32.** A modified Bruce protocol is most often used during a stress test for patients with an exercise capacity limited by cardiac disease. (LO 12.7)

- T F 33.** A 12-lead ECG is obtained toward the beginning of each stage of exercise electrocardiography. (LO 12.7)

- T F 34.** After a stress test, the patient should avoid alcohol, tobacco, and caffeine for at least 3 hours. (LO 12.8)

- T F 35.** A patient should take all of their prescribed medications on the day of their stress test unless the physician directs otherwise. (LO 12.1)

Critical Thinking Application *What Should You Do?*

Read the following situations, and use your critical thinking skills to determine how each should be handled. Write your answer in detail in the space provided.

- 36.** Patient C is scheduled for an exercise electrocardiography test on Friday. When scheduling the appointment, you notice they are taking several heart medications, including atenolol. You check the patient's order, and it does not mention whether any of the medications should not be taken before the procedure. The patient is getting ready to leave. What should you do? (LO 12.4)

37. During an exercise electrocardiography procedure, your patient complains of weakness and shortness of breath. They suddenly collapses on the treadmill. What should you do? (LO 12.6)

38. Patient D just had an exercise electrocardiography procedure performed. You are responsible for providing instructions to them before they leave. After you review the instructions, they tell you they are going to go for a walk to have a cigarette while they wait for their ride. It is about 97 degrees Fahrenheit outside. What should you do? (LO 12.8)

39. Patient E is required to have a chemical stress test at the outpatient clinic where you are employed. They are a very busy business executive and request to have the test during lunch hour. What would be the best response? (LO 12.4)



connect

Now that you have completed the material in the textbook, go to Connect and complete any chapter activities you have not yet done.

Competency Checklist

Use the following Competency Checklist 12-1 to practice and perform the skills presented in this chapter. (LO 12.4, 12.5, 12.6, 12.7, and 12.8)

COMPETENCY CHECKLIST 12-1

Assisting with Exercise Electrocardiography (Stress Testing)

Procedure Steps (Rationale)	Practice		Practice		Performed		Mastered	
	Yes	No	Yes	No	Yes	No	Date	Initials
Preprocedure								
1. Verify that the medical history is complete (to ensure safety and accurate testing).								
2. Explain the procedure, including the reason for the test, possible complications, and all safety measures that will be followed during the procedure.								
3. Explain "informed consent," and ask the patient to sign the consent form.								
4. Inform the patient that on the day of the test he or she should wear comfortable clothing (shorts or gym suit, tennis shoes). The patient should refrain from use of tobacco, caffeine, or alcohol according to facility guidelines. (The effects of tobacco, caffeine, or alcohol could affect the results of the test.) Ensure that the patient knows the guidelines for eating and drinking on the day of the test.								
5. Check the physician's order against the patient's medication list to provide information as to what medications the patient should <i>not</i> take on the day of the test. (Certain medications can affect the results of the test.)								
6. Go over all instructions and information with the patient. Encourage questions, and ask the patient to repeat important information back to you (to make sure the patient fully understands the procedure).								
7. Provide a copy of the detailed list of instructions, making sure the facility telephone number and your name appear on the list. Encourage the patient to call if they have any questions prior to test day.								
Procedure: Day of Appointment								
1. Verify that the equipment is in working order and supplies are on hand, including plenty of tracing paper. Be certain to inspect the cables; make sure the treadmill and computer are working and the correct protocol is determined (to prevent problems during the procedure when the patient and physician are present).								

(Continued)

Procedure Steps (<i>Rationale</i>)	Practice		Practice		Performed		Mastered	
	Yes	No	Yes	No	Yes	No	Date	Initials
Procedure: Day of Appointment (<i>continued</i>)								
2. Gather all supplies, including electrodes, skin prep solution, gauze sponges, clippers if needed, adhesive tape, and blood pressure cuff.								
3. Check that the crash cart is ready and fully supplied and that the defibrillator is working.								
4. Verify the physician's order, that the medical history is complete, and that the informed consent is signed.								
5. Bring the patient into the room.								
6. Formally identify the patient and verify they have completed with all instructions.								
7. Provide the patient with privacy to change into the gown with the opening in the front. Assist if necessary. (The opening needs to be in the front in order to place leads.)								
8. Assist the patient onto the examination table (provides for patient safety).								
9. Prepare the skin, and apply electrodes as indicated by the protocol of the facility or equipment manual.								
10. Connect the cables, apply the blood pressure cuff, and check the ECG tracing for artifact (ensures proper results during the examination).								
11. Obtain the patient's blood pressure and ECG and record.								
12. Demonstrate the treadmill, including the proper posture and holding the hand grip (prevents falls).								
13. Explain the test protocol, making sure the patient understands that the speed and incline will increase every 3 minutes during the test phase.								
14. Be sure the patient understands that they are to report any pain, shortness of breath, faintness, tingling sensations, numbness, or extreme fatigue immediately (provides for patient safety).								
15. Watch the patient closely during the test, looking for visual signs of any pain, shortness of breath, faintness, tingling sensations, numbness, or extreme fatigue (provides for patient safety).								

(Continued)

Procedure Steps (<i>Rationale</i>)	Practice		Practice		Performed		Mastered	
	Yes	No	Yes	No	Yes	No	Date	Initials
Procedure: Day of Appointment (<i>continued</i>)								
16. Ask the patient repeatedly during the procedure how they feel (provides for patient safety).								
17. Explain to the patient again that the test will be completed when the target heart rate (THR) is reached: $THR = [(220 - \text{age}) \times 0.60]$ to $THR = [(220 - \text{age}) \times 0.85]$ or when the patient cannot continue due to fatigue or other symptoms.								
18. Inform the practitioner who will be in the room that the patient is ready to begin the test. (The physician must be present during the procedure.)								
19. When the physician is in the room, assist the patient to the treadmill, making sure the patient's feet are not on the belt.								
20. Start the belt; tell the patient to get used to the speed and then to step onto the belt. Ask the patient if they are ready to begin, explaining again that the belt speed and incline will increase. Begin the test phase.								
21. At the end of the first minute (beginning of the second minute) of each stage, take the blood pressure, and enter the data into the computer. Remind the patient before every transition to a new phase, and be ready to assist the patient as needed (provides for patient safety).								
22. When the treadmill phase of the test is complete either because the THR has been reached or because the patient cannot continue, assist the patient to the waiting chair (provides for patient safety).								
Postprocedure								
1. Continue to monitor and observe the patient's condition closely, taking the blood pressure, entering the data, and then taking an ECG tracing every 3 to 5 minutes for 10 to 15 minutes (verifies the patient's condition and tolerance of the testing procedure).								
2. After the 10- to 15-minute cool-down period, remove the cables and electrodes and wipe off any remaining gel or adhesive.								
3. Allow the patient to dress (assist if needed).								

(Continued)

Procedure Steps (<i>Rationale</i>)	Practice		Practice		Performed		Mastered	
	Yes	No	Yes	No	Yes	No	Date	Initials
Postprocedure (<i>continued</i>)								
4. Explain to the patient that they should avoid tobacco, caffeine, and alcohol for at least 3 hours. The patient should avoid extreme temperature changes, including a shower or bath, for 2 hours. The patient should rest and recuperate after the test (provides for patient safety).								
5. Explain when the results will be available based on the facility's protocol. Thank the patient for their participation.								
6. File the results and report per the protocol of the facility.								
7. Make sure all information from the patient chart is returned to its proper place (maintains HIPAA).								
Comments: _____								

Signed _____								
Evaluator: _____								
Student: _____								