

Performing an ECG

4

Learning Outcomes

- 4.1 Carry out preparation of the patient, room, and equipment for an ECG.
- 4.2 Describe the communication needed during the ECG procedure, including the actions to take if a patient refuses to allow an ECG to be performed.
- 4.3 Identify at least three ways to provide for safety during the ECG procedure.
- 4.4 Demonstrate the procedure for applying the electrodes and lead wires for a 12-lead ECG and cardiac monitoring.
- 4.5 Describe the procedure for recording a 12-lead ECG.
- 4.6 Identify types of artifact and how to prevent or correct them.
- 4.7 Describe how to report the ECG results.
- 4.8 Identify the steps for cleaning and caring for the ECG equipment.
- 4.9 Explain variations for a pediatric ECG procedure.
- 4.10 Distinguish between a routine ECG and cardiac monitoring.
- 4.11 Summarize special patient circumstances when performing an ECG.
- 4.12 Recall the steps for handling an emergency during the ECG.

Key Terms

alternating current (AC)
interference
angle of Louis
anterior axillary line
body mechanics
dextrocardia
intercostal space (ICS)
interrupted baseline
midaxillary line

midclavicular line
midscapular line
paraspinous line
posterior axillary line
seizure
somatic tremor
suprasternal notch
wandering baseline

4.1 Preparation for the ECG Procedure

Now that you understand how the ECG is used, the anatomy of the heart, and the electrocardiograph, the next step is to record an ECG. The ECG experience should be pleasant for the patient and not produce anxiety. The ECG procedure must be done correctly, and the tracing must be accurate.

Prior to performing the ECG, you will need to prepare the room. Certain conditions in the room where the ECG is to be performed should be considered. For example, external sources of electricity can interfere with the tracing. If possible, choose a room away from other electrical equipment and X-ray machines. Turn off any nonessential electrical equipment that is in the room during the tracing. The ECG machine should be placed away from other sources of electrical currents, such as wires or power cords.

An ECG must be ordered by a physician or other licensed personnel. The order must be completed prior to the procedure. A printed form such as *requisition* or *consult* or an electronic order in the EHR is used. The order should include why the ECG was ordered and the following identifying information:

- Patient name, identification number or medical record number, and birth date
- Location and date of recording
- Patient age, sex, race, and cardiac and other medications the patient is currently taking
- Weight and height
- Any special condition or position for the patient during the recording

The ECG order is frequently entered through this system. Entering the patient's identifying information into the computer will produce the order form and generate patient charges. Without a computer system, the information should be handwritten on the order form, consult, or requisition, whichever your facility uses.

The patient's identifying information should also be entered through the LCD panel on the ECG machine prior to the recording. If the ECG machine does not allow you to enter the information or there isn't time due to an emergency situation, you should write it on the completed ECG. Most importantly, all information should be handwritten legibly or entered accurately no matter what type of ECG machine or order system you are using.

Before taking the ECG machine into the room where the patient is located, make sure it has a good supply of paper loaded in it. If a red line appeared across the bottom of the last tracing, you should replace the paper in the ECG machine before beginning. Review the operator's manual or consult your supervisor if you are unsure how to insert the new ream of paper. Most ECG machines have a release button or lever that opens the ECG equipment so the paper can be inserted. Place the paper inside the machine correctly. Thread it through the roller to the outside of the machine and align it properly. Close the paper-loading compartment and run the machine to check for proper functioning and alignment (Figure 4-1).

Figure 4-1 Make sure the ECG paper is properly loaded and aligned before recording an ECG.

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Communicate & Connect



Cardiac Medications

Certain cardiac medications can change the ECG tracing. Prior to the ECG procedure, determine if your patient is on any cardiac medications and, if so, inform the physician and write the names of the medications on the ECG report. See the appendix *Cardiovascular Medications* for examples of common cardiac medications.

Checkpoint Questions (LO 4.1)

1. Name four important aspects of preparing for the ECG procedure.

2. What information must be included on the ECG requisition?

4.2 Communicating with the Patient

Prior to performing any procedure, always ensure that you are performing the procedure on the correct patient. Correctly identifying the patient is the first step in ensuring that you are providing patient safety. The Joint Commission (TJC) has stated that every patient must be identified by two forms of identification. Introduce yourself by stating your name and job title. Ask the patient to state their full name and date of birth. Check the name on the patient identification band or patient's chart to verify the information. Often patients have

similar names, but their birth dates and medical record numbers will distinguish the correct patient. If the patient's information is incorrect, notify your immediate supervisor and request instructions for how to proceed.

After you verify that you have the correct patient, explain what you are about to do and obtain consent. State, "I am going to perform an electrocardiogram on you today. Have you ever had an ECG done before?" Stating both ECG and electrocardiogram helps the patient understand that they are the same. If the patient has not had an ECG, explain the procedure in more detail. Assure the patient that the procedure is harmless and painless. Avoid using words that may frighten the patient such as *electrodes*, *electricity*, or *wires*. Patients, particularly children, who have not had an ECG before may be afraid of the machine and wires. The patient should be relaxed and comfortable. Maintaining a calm, competent manner and answering the patient's questions will help the patient relax.

Law & Ethics



Legal Record

The ECG is part of the medical record. Enter the patient information thoroughly and accurately. Remember, the patient's medical record can be used as part of a medical professional liability case.

If the patient refuses an ECG, determine the cause of the refusal. Some people may have fear or concern about the procedure. Provide any information or reassurance the patient may need. Sometimes, patients see the wires and think the machine will shock them. Be sure you explain carefully that you are only going to measure the electricity that is already inside their body. If the patient still refuses, notify your supervisor and/or the ordering licensed practitioner and document the patient's reason for refusing the procedure.

In preparing for an ECG, provide the patient with privacy by pulling a curtain around the bed or closing the examination room door. Because many patients are fearful and/or feel they lack privacy, inform them that closing the door or curtain is for their privacy. The patient should remove any clothing above the waist and empty pant pockets. Provide the patient with a drape, such as a sheet or blanket. It is especially important to drape a female patient's breasts for comfort and to prevent embarrassment. A sheet or blanket will also keep the patient warm and prevent chills. Chills may produce shivers that could interfere with the tracing. The patient may also wear a hospital-type gown with the opening in the front.

The patient should remove any jewelry or items that would interfere with the electrode placement or touch the electrodes. This may include necklaces, watches, bracelets, knee highs, pantyhose, belt buckles, or ankle bracelets. In addition, ask the patient to turn off and remove all electronic devices such as cell phones.

Communicate & Connect



Explain the Procedure

Remember, even if a patient is not able to respond, they may still hear you. Always explain the procedure before beginning the ECG.

Make sure that the bed or exam table is not touching the wall or any electrical equipment or power cords and that the patient is not touching any metal. If the exam table is especially narrow or the patient is large, you may use blankets, sheets, or pillows to prevent direct contact with the rails, thus reducing the potential for artifact.

The patient should be positioned as comfortably as possible on their back (supine position) and should remain relaxed and still throughout the procedure. To ensure comfort, place a small pillow under the patient's head and an extra pillow under the knees, if preferred. In some facilities, you may need to document the use of pillows. Be aware of the policy at the place where you are working.

Safety & Infection Control



Proper Patient Identification

You must always check the patient's name and medical record or patient identification number and verify it with the patient's birth date prior to performing any procedure on a patient.

The position of the patient is important during an ECG. Expose the patient's chest and extremities where you will be placing the leads. If possible, work from the patient's left side, since this is where a majority of the sensors and cables are attached to the patient. Working from this side will prevent unnecessary reaching over the patient. Ensure that the patient's arms and legs are well supported on the exam table or bed.

Checkpoint Questions (LO 4.2)

1. What should you indicate to the patient when closing the door or pulling the curtain before performing an ECG?

2. What should you do if a patient refuses an ECG?

4.3 Safety

body mechanics Using movements that maintain proper posture and avoid muscle and bone injuries.

To perform an ECG, you need to be able to transport and operate the ECG machine. You must have the ability to lift and move the patient, if necessary. These actions require using proper body mechanics and getting assistance when needed. **Body mechanics** is using movements that maintain proper posture and avoid muscle and bone injuries (Table 4-1).

Safety & Infection Control



Body Mechanics

Practice proper body mechanics at all times to protect yourself from injuries when moving or lifting patients or other large or awkward items.

TABLE 4-1 Proper Body Mechanics

Movement	Your Action
Maintain a wide base of support.	Keep your feet shoulder-width apart at all times.
Avoid twisting.	Face the direction in which you intend to move.
Protect your back.	Bend at your hips and knees. Keep your back straight at all times.
Use stronger muscles for lifting.	Lift with your legs, not your back. Use both arms.
Maintain body alignment.	Keep your chin up and shoulders back, and avoid unnecessary reaching. Keep heavy weights as close to your body as possible.

Practice general safety guidelines and safety measures specific to the ECG procedure at all times. Before beginning the procedure you must identify, verify, and ensure that you are performing the procedure on the correct patient. Table 4-2 summarizes other techniques required to maintain the patient's safety and your safety during the ECG procedure.

Assist the patient to dress and undress as needed to provide for comfort and safety. Once the procedure is complete, you should clean the lead wires, leads, and machine. If you performed an ECG on a patient in isolation or with a contagious disease, you will need to clean the equipment according to prevent the spread of infection. Observe the guidelines at your place of employment and the manufacturer's directions for the correct cleaning technique. Once you have completed the entire procedure, including cleanup, you should wash your hands. Remember to thank the patient and ask if they need any further assistance.

Safety & Infection Control



Isolation Precautions

Isolation precautions include specific guidelines for caring for patients in isolation. For more information about the three types of isolation precautions, see the chapter *Electrocardiography* and the appendix *Standard and Isolation Precautions*.

TABLE 4-2 Maintaining Safety During an ECG

- Check that the grounding prong is securely attached to the plug.
- Plug in the machine securely, making sure the cord is not separating from the receptacle.
- Ensure that the power cord insulation is intact.
- Remove the plug by pulling it out by the prong connection, not by pulling on the electrical cord.
- Raise the bed to a working height and return it to low position when completed.
- Keep the side rail up on the opposite side of the bed or exam table.
- Perform hand hygiene and wear gloves or other personal protective equipment as required. See the chapter *Electrocardiography* for more information about these and other infection control topics.
- Use proper body mechanics at all times. Have the patient assist, if able, or obtain assistance when necessary.



Checkpoint Questions (LO 4.3)

1. Name at least three things to do to ensure safety during an ECG.

2. What is the purpose of maintaining good body mechanics?

4.4 Applying the Electrodes and Leads

Once you have properly positioned the patient on the bed or exam table, you will need to place the electrodes on the limbs and chest. Attach the limb leads first because the ECG machine will not run without the limb leads being attached. This mnemonic will be helpful to remember the correct placement.

- Black and white go left and right (left and right arms)
- Smoke over fire (left arm over left leg)
- Clouds over grass (right arm over right leg)

The chest leads are applied second. However, the ECG machine will run if the limb leads are attached and the chest leads are not. The machine will provide the first six views of the 12-lead ECG. This is important in the event that a patient is having a cardiac crisis. A tracing from the frontal plane is better than nothing. The physician could be looking at this tracing while you connect the precordial (chest) leads and run the full 12-lead ECG.

Placing the Limb Electrodes

The limb electrodes are placed on the underside of the forearms toward the wrist or on the upper arms and the lower legs just above the ankles. You should pick a fleshy area with the least amount of hair. Sometimes the placement of the arm leads on the patient's forearm is not possible due to injury, amputation, IV placement, casts, or other reasons. The alternate site of placement for arm leads is on the deltoids (shoulders). Place the leads on the same site on each arm so that the placements are mirror images of each other. For example, if a patient has burns, a cast, or an IV on the left forearm, you will need to move *both* the left and right electrodes to the shoulders.

When placement of the leg leads on the patient's lower legs or ankles is not possible, the alternate site for placement is on the upper legs (thighs). The leads should be placed as close to the trunk as possible. This may be necessary when the patient has an amputation, injury, or bandage on one of the lower legs. The leads should be placed symmetrically (at the same site) on each leg: If you place the left leg lead above the knee, then you should also place the right leg lead above the knee.



Relocating Electrodes

If you place the electrodes in an alternate location for any reason, including amputation or bandages, be sure to document the location and reason on the 12-lead ECG recording.

midclavicular line

An imaginary line on the chest that runs vertically through the center of the clavicle.

anterior axillary line

An imaginary vertical line starting at the front axilla that extends down the left side of the chest.

midaxillary line An imaginary vertical line that starts at the middle of the axilla (armpit) and extends down the side of the chest.

intercostal space

(ICS) The space between two ribs.

suprasternal notch

The dip you feel at the anterior base of the neck just above the manubrium, where the clavicle attaches to the sternum.

angle of Louis A ridge about an inch or so below the suprasternal notch where the main part of the sternum and the top of the sternum, known as the manubrium, are attached.

Anatomical Landmarks for the Chest Electrodes

Each chest lead, V1 to V6, must be placed on the correct site on the chest. To identify these sites, you must understand the underlying anatomy and use a set of imaginary lines on the exterior of the chest.

The bones of the chest include the clavicle, the sternum, and the ribs. The imaginary lines include the midclavicular line, the midaxillary line, and the anterior axillary line. On most patients, the **midclavicular line** starts in the center of the clavicle and passes vertically either through the nipple line or just medial to the nipple line. The left **anterior axillary line** starts in the front of the axilla (armpit) and runs down the left side of the chest. The left **midaxillary line** starts in the middle of the axilla and runs down the left lateral side of the chest.

Other sites on the chest you must be able to locate include the intercostal spaces, the suprasternal notch, and the angle of Louis (sternal angle). To feel the **intercostal space (ICS)**, or space between two ribs, locate the sternum. Press your fingers to the edge of the sternum on the left or right side. The outer edge of the sternum is known as the *sternal border*. Between each connected rib you should feel a dip or dent. Feeling as close to the sternal border as possible will make it easier. The **suprasternal notch** is the dip you feel at the anterior base of the neck just above the manubrium (top of the sternum), where the clavicle attaches to the sternum. The **angle of Louis** is a ridge about an inch or so below the suprasternal notch. It is where the main part of the sternum and the manubrium attach. To the right and left of the angle of Louis are the second ribs. Below each rib is the corresponding ICS (Figure 4-2).

Placing the Chest Electrodes

Before applying the electrodes on the chest, make sure the skin at the sites is clean and dry. If the patient has a great deal of chest hair, you may shave small areas of the chest so the electrodes will adhere to the skin properly. However, the preferred method is to clip the hair instead of shaving. This prevents the patient from scratching the electrode site as the hair grows in and reduces the risk of infection as a result of small microcuts that may be caused by a razor blade. Table 4-3 summarizes the procedure for applying chest leads correctly.

Start by applying the V1 electrode. First, locate the angle of Louis; then locate the second rib, which is adjacent to this landmark. Each intercostal space is felt between the ribs with the corresponding intercostal space below the rib location. The fourth intercostal space is the dent you feel between the fourth and fifth ribs. Chest lead V1 is placed at the right sternal border at this location. V2 should be placed at the fourth intercostal space on the left sternal border. Skip V3 and place V4 next. V4 is placed at the fifth intercostal space

Figure 4-2 Anatomical landmarks for chest lead placement.

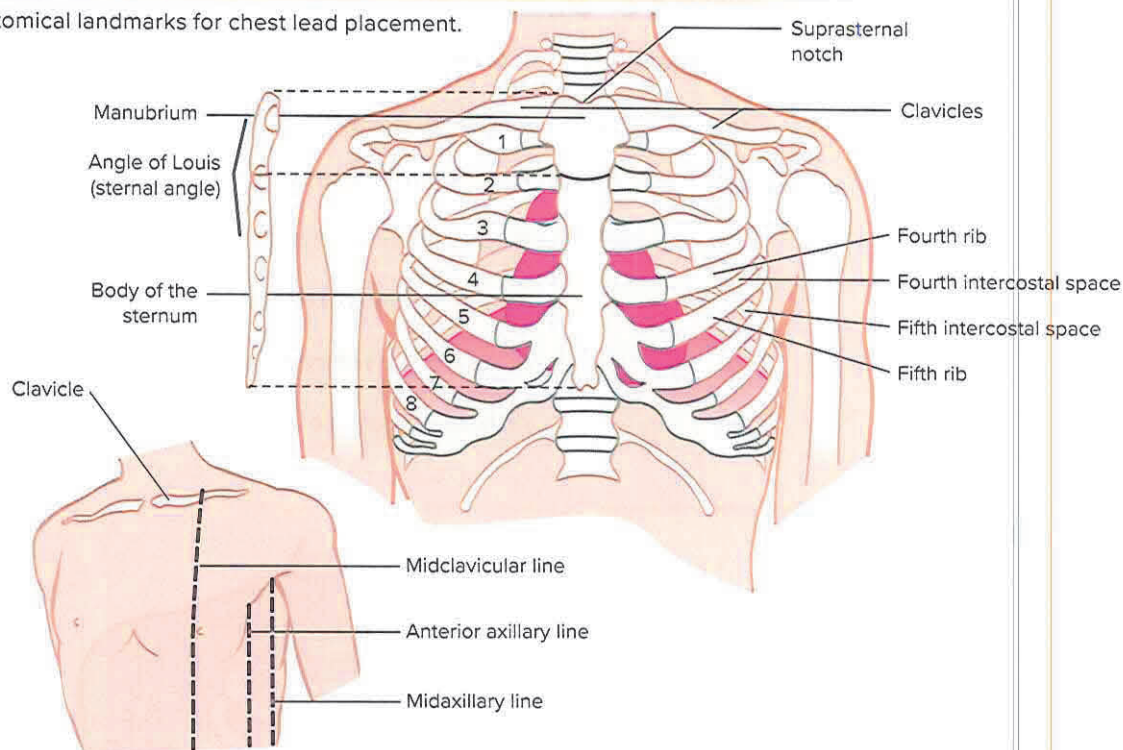


TABLE 4-3 Applying Leads Correctly

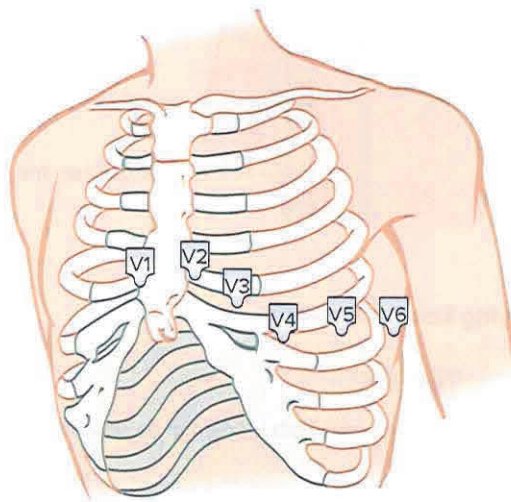
- Choose a flat, nonmuscular area.
- Use the forearms and ankles for the limb leads if at all possible.
- Alternate sites include the upper arms near the shoulders (deltoids) and upper legs.
- When necessary, cleanse the electrode sites with an alcohol pad or mild soap and water.
- Dry the skin completely before applying the electrodes.
- If the patient is diaphoretic (sweaty), consider using antiperspirant, tincture of benzoin, or mastisol to help pads remain adhered to the patient's skin.
- Clip hair, instead of shaving. Use tape to remove cut hairs.
- Dry shave the hair from the site only if necessary, such as during an emergency.

on the left midclavicular line. Locate the site of the intersection between the fifth intercostal space and the midclavicular line. In young people, this site is directly below the nipple. Now place V3 midway between V2 and V4. Continuing in the fifth intercostal space on the same horizontal level as V4, place V5 at the anterior axillary line. Place V6 at the midaxillary line on the same horizontal line as V4 (Table 4-4 and Figure 4-3). (Another method of placement for V5 and V6 is to place V6 first, then place V5 midway between V4 and V6.) Always locate the anatomical landmarks when placing chest electrodes. Do not place them visually.

The procedure is the same when placing the chest electrodes on a female. If the patient has large breasts, you can ask the patient to move their

TABLE 4-4 Chest Lead Placement

Lead Name	Lead Placement
V1	Fourth intercostal space, right sternal border
V2	Fourth intercostal space, left sternal border
V3	Halfway between V2 and V4
V4	Fifth intercostal space at the left midclavicular line
V5	At the anterior axillary line on the same horizontal level as V4
V6	At the midaxillary line on the same horizontal level as V4

Figure 4-3 Chest lead placement.

own breasts (if able); or, using the back of your gloved hand, simply lift the left breast and place the electrodes in the closest position possible. The breast may sit on top of the electrode, but the electrode cannot sit on top of the breast. Leads V3, V4, and V5 will be the most affected by breast tissue. Electrodes should be placed as close as possible to the proper placement

Think It Through



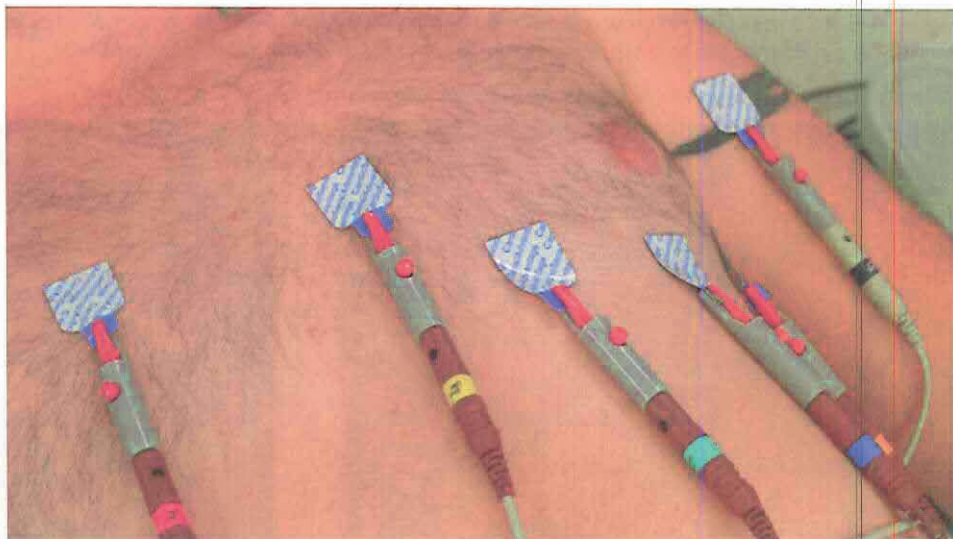
The Midclavicular Line

When locating the midclavicular line for chest lead placement, keep in mind that the midclavicular line does not always run directly through the nipple line. This is most often the case with patients who are obese, geriatric females, patients who have gained and lost weight, females after childbirth, or females with large breasts.

When applying the V4 electrode to a patient who weighs 326 pounds, you have difficulty finding the midclavicular line. What should you do?

Figure 4-4 Color and letter coding identify the lead wires for an ECG machine.

McGraw Hill



without placing the electrodes directly on the breast tissue because breast tissue is a poor conductor of electricity. In the event of large breasts, V3 may not be perfectly in line but should be as close as possible to the midpoint halfway between V2 and V4. Make sure that all nonstandard electrode placements are documented. Note where the sensors were placed and why, that is, breast tissue, burns, or dressings, if post-operative.

After all of the electrodes have been properly positioned, attach the lead cable wires. Identify the correct cable for each electrode based on the letter or color abbreviations. For example, the chest leads are marked V1 to V6 (Figure 4-4). The correct cable must be attached to the corresponding electrode to ensure an accurate tracing.

When using electrodes with tabs on which alligator-type clips are used, chest and arm electrodes are placed with the tabs pointing downward toward the feet; the lower extremity electrodes are placed with the tabs pointing toward the head. Utilizing this technique reduces tension on the electrodes and provides a “cleaner,” artifact-free tracing. Ultimately, refer to the manufacturer’s directions in the operator’s manual for the optimum placement technique recommended for your equipment. In all cases, the electrodes should be secure and the lead wires should be supported.

The ECG lead wire cables should follow the contours of the body when attached to the ECG electrodes. Avoid crossing or looping the wires outside of the body, and check each wire once it is connected to ensure that there is no tension on the electrodes or leads. Individual loops may be used to take up slack and prevent looping outside the body, thus reducing tension on the electrode (Figure 4-5).

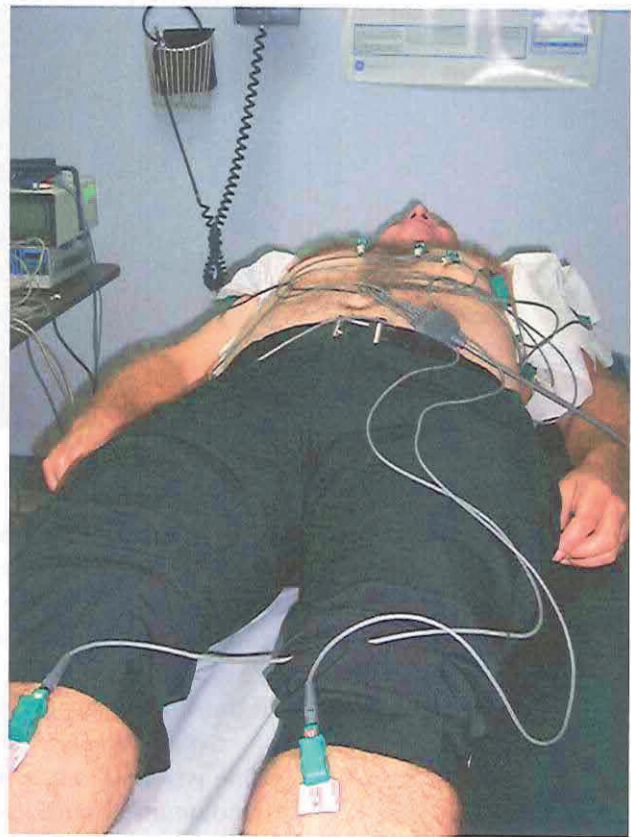
Note that in some facilities, the lead wires are attached to the electrodes before the electrodes are placed on the patient. This is possible only if the electrodes are the type that can be snapped onto the lead wires. This method avoids the need to apply potentially bruising pressure to the patient’s body to attach the lead wires to the electrodes. It is particularly appropriate for patients who are elderly or very young.

Figure 4-5 Correct (A) and incorrect (B) lead cable placement. Avoid looping the wires outside the body and check each wire once it is connected to ensure that there is no tension on the electrodes or leads.

A. Total Care Programming, Inc., B. Total Care Programming, Inc.



A.



B.

Checkpoint Questions (LO 4.4)

1. Which anatomical landmark starts in the middle of the axilla and runs down the side of the chest?

2. Where is the angle of Louis?

3. How can you be certain you are attaching the lead wires to the electrodes properly?

4. Why should you place the limb electrodes before the chest electrodes?

4.5 Operating the ECG Machine

Before operating the ECG machine, make sure you have done the following:

- Identified and communicated with the patient
- Prepared the patient and the room
- Provided for patient privacy
- Provided for safety and infection control
- Located and checked the equipment for functioning
- Loaded the ECG graph paper, if necessary
- Attached the electrodes and leads

Now you should be ready to operate the ECG machine. For an automatic ECG, simply press the Run or Auto button. Check the LCD display for errors. If the ECG machine provides an interpretation, it will print out along with the tracing. This process takes only about 15 to 20 seconds.

For a manual ECG machine, make sure the equipment is standardized and set to lead II. You may need to run a few complexes (complete ECG waveforms) and then insert a standardization mark. The mark should be set between the T wave of one complex and the P wave of the next. Follow specific directions provided in the operator's manual or do this according to your institution's policy and procedure.

Checkpoint Questions (LO 4.5)

1. What must be done before you run the actual ECG tracing?

2. Describe how you run the ECG machine to create the lead tracings.

4.6 Checking the ECG Tracing

Certain problems can occur when obtaining an ECG tracing. General troubleshooting guidelines should be followed to avoid these problems (Table 4-5). The most frequent problem is unwanted marks on the ECG. These marks are called *artifact*. The marks are not caused by the heart activity; they are caused by some other source of movement or electrical activity. When an

TABLE 4-5 Troubleshooting Techniques During an ECG

- Perform good skin preparation.
- Use new (unused) electrodes and clean clips.
- Make sure personal electronic devices are turned off and removed from the patient.
- Ensure that the bed or examination table is not touching the wall or any electrical equipment.
- Ensure that the patient is not touching the frame, side rail, or any metal part of the bed or examination table.
- Always check the insulation on the lead wires for cracks before use.
- Ensure that there is no stress on the lead wires or electrodes.

ECG tracing has these unwanted marks, it may be difficult or impossible to read. You are responsible for producing a correct tracing without artifact. In order to do this, you must first recognize artifact and then be able to eliminate it. The three most common causes of artifact are somatic tremor, wandering baseline, and alternating current interference. See Table 4-6 for ways to correct these causes of artifact.

TABLE 4-6 Correcting Artifact

Type of Artifact	Cause	Correction
Somatic tremor	Involuntary muscle movement: cold, shivering, muscle tension, pain, fear Voluntary movement: talking, coughing, chewing gum Movement due to neuromuscular disorder such as Parkinson's disease	Reassure the patient, warm the patient, provide the patient with a blanket, and encourage them to take slow, deep breaths. Remind the patient not to make any movement during the procedure. Have the patient put their hands, palms down, under the buttocks.
Wandering baseline	Improperly applied electrodes or poor skin preparation Pulling on electrodes from unsupported lead wires Oil, lotion, dirt, or hair on the skin under the electrodes Too little or dried-out electrode gel	Apply electrodes securely, make sure that the entire surface is in contact with the patient's skin. Remove tension from lead wires. Clean the skin with alcohol and gauze, soap and water, or an alcohol prep pad. Use new disposable electrodes and store unused ones in a sealed plastic bag; if using gel, apply plenty of new solution to electrodes.
Alternating current (AC) interference	Improper grounding Other electrical equipment Lead wires crossed and not pointed toward the hands and feet Electrical wiring in the walls or ceiling	Ensure that the plug has three prongs and is plugged into a grounded electrical outlet. Wait until any other procedure is done, if possible, and unplug equipment. Reposition the lead wires to ensure that they follow limbs and are pointed in the proper direction. Move the patient's bed away from the wall (use a 45-degree angle if necessary). Ensure that the patient's pockets are emptied of electronic devices.
Interrupted baseline	Corroded or dirty "clips" Damaged cable	Clean the leads after each use. Inspect cables and connections before each use.

Think It Through



Multiple ECGs

If your hospitalized patient requires daily ECGs for comparison by the physician, the ECG tracing may look different if the electrodes are placed in different sites on the chest and limbs. Each time you record an ECG on the patient, place the leads on the same site or as close as possible to the placement from the previous ECG. Some facilities will permit placing small marks on the patient to ensure that electrode placement will be consistent for multiple (serial) ECGs.

You are about to do an ECG on a patient who has had two previous ECGs yesterday and the day before. You are new on this shift, and you do not know where the electrodes were previously placed. What should you do?

somatic tremor Voluntary or involuntary muscle movement; also known as *body tremor*.

Somatic Tremor

Sometimes a patient's muscles will move, either voluntarily or involuntarily, which can produce **somatic tremor**, also known as body tremor. Movement of the muscles of the body is controlled by electrical voltages. These voltages are erratic, unlike the cardiac voltage, which is consistent. Somatic tremor appears as small erratic spikes on the ECG tracing (Figure 4-6).

Muscle movements, also known as *somatic tremor*, can be due to cold, tension, coughing, fear, gum chewing, talking, uncomfortable position, or pain. You should identify the correct cause before proceeding with the ECG. Knowing the cause will help you eliminate the artifact. Warm or reassure the patient if they are cold or frightened. Encourage slow, deep breaths to help calm the patient. Remind the patient to refrain from moving or talking.

Sometimes involuntary muscle movements are due to Parkinson's disease or other neuromuscular disorders. These are more difficult to control. Have patients with neuromuscular disorders put their hands, palms down, under their buttocks. This will decrease the tremor and improve the tracing. If a patient has this type of tremor, make a note of it on the ECG tracing.

wandering baseline Artifact in which the tracing drifts away from the center of the graph paper. Also known as *baseline shift*.

Wandering Baseline (Baseline Shift)

Wandering baseline, or baseline shift, occurs when the tracing drifts away from the center of the graph paper (Figure 4-7). Baseline shift can have many causes. Typically, it is due to the patient taking a deep breath and improper electrode application such as the following:

- Too loose or incorrect electrode application
- Tension or pulling on electrode lead wires

Figure 4-6 Somatic tremor appears as small erratic spikes on the ECG tracing.



Figure 4-7 Wandering baseline occurs when the baseline of the ECG tracing drifts away from the center of the ECG graph paper.



- Too little electrode gel or solution
- Old or dried-out electrode gel or solution
- Oil, lotion, dirt, or hair under the electrodes
- Poor or no skin preparation

To avoid problems with wandering baseline, apply the electrodes securely and make sure they are not too loose or too tight. Be certain that the entire surface is in contact with the patient's skin. Check the lead wires and remove any tension from them. Use fresh electrode gel or new disposable electrodes. Make sure that previously opened electrodes have been stored in a plastic bag or container. Clean the reusable leads after each use. Clean the patient's skin carefully before applying electrodes.

Alternating Current (AC) Interference

Alternating current is normally present in all electrical equipment and wiring in the walls. Sometimes the wires can radiate or leak a small amount of energy into the immediate surrounding area. When a patient is present in this area, the patient's body may pick up some of the current. This current is then registered on the ECG and is called **alternating current (AC) interference**. AC interference appears as uniform small spikes on the ECG tracing (Figure 4-8).

Many different things can cause AC interference artifact. These include improper grounding, other electrical equipment, or, on rare occasions, lead wires crossed. Eliminating sources of electrical current, ensuring proper grounding of the machine, and attaching the lead wires correctly can reduce AC interference.

The cause of AC interference is sometimes difficult to determine. You may still have AC interference even after you have checked that the machine is properly grounded, the lead wires are correct, and the other equipment is turned off. In order to find the source, time permitting, you can try this technique. Run leads I, II, and III and look for interference. Evaluate each strip for interference to determine the direction or source of interference (Table 4-7). For example, if you have the most interference in leads II and III, the source is probably near or on the left leg. You may need to rotate the bed or exam table at a 45-degree angle away from the source. Also, do not forget the proper placement of the lead cables. They should follow the body contours and be lying flat against the skin. In addition, the power cord should not touch the bed or exam table frame. This is another possible source of electrical interference.

alternating current (AC) interference Unwanted markings on the ECG caused by other electrical current sources.

Figure 4-8 Alternating current (AC) interference appears as uniform small spikes, resulting from rapid oscillation of the waveform on the ECG tracing. The tracing takes on a fuzzy appearance, almost like a caterpillar.



TABLE 4-7 Troubleshooting AC Interference

Leads with Most AC Interference Noted	Source of Interference or Direction
Leads I and II	Right arm
Leads I and III	Left arm
Leads II and III	Left leg

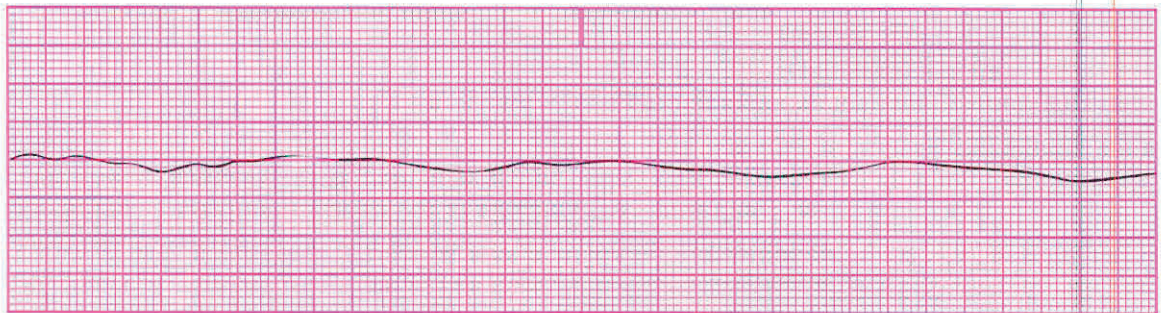
Artifact can also be caused by other sources. High-tension wires and transformers on a power pole and diathermy machines that use high-frequency currents to provide heat for heat treatments can cause AC interference. Electrocautery, IV pumps, feeding tubes, and X-ray machines can also interfere if they are in the room or an adjacent room. Even the electrical wires in the walls, ceiling, and floor, although they are not visible, can cause artifact. Most ECG machines have a battery that allows you to unplug the machine from the electrical outlet and still perform the ECG. Unplugging the machine eliminates any AC interference that may be produced from the electrical outlet.

Think It Through



Handling a Flat-Line Tracing

If a flat line without deflections occurs during the tracing, it could be asystole (absence of a heartbeat). Remain calm and check the patient first because the patient is your number one concern. If the patient is able to respond, check the electrodes, gain, lead wires, and cables.



Your patient sees the above tracing on the ECG monitor and is in a panic. What should you say and/or do?

Other Problems

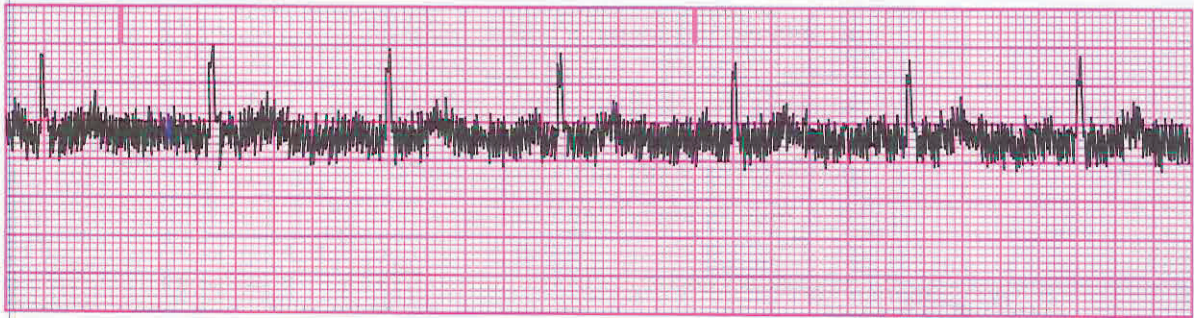
There are some additional problems you may encounter when obtaining an ECG. One example is an **interrupted baseline** on one or more leads. This appears as a flat line on the tracing. This could occur when a wire is not plugged in correctly or is loose. If a flat line occurs on more than one lead, it may be that the wires have been switched. Check your machine cables and connections. Ensure that the machine is set to obtain a tracing. Do not forget to check for loose or broken lead wires, which may also cause a break in the tracing or an interrupted baseline.

interrupted baseline When one or more leads appear as a flat line on the ECG tracing. Usually caused by loose or unplugged leads.

After troubleshooting any problem, if you cannot correct it, report it to your supervisor. If it is an AC interference problem, the biomedical engineering department, if available, may need to track down the source of the interference. It could also be that the machine requires service. In this case, the manufacturer should be called for information and assistance.

Checkpoint Questions (LO 4.6)

1. What is the most likely cause of the following artifact?



2. Name three causes of wandering baseline.

4.7 Reporting ECG Results

When you have completed an ECG, use the method your facility requires for reporting the results. Check your facility policy to be certain you are placing the completed ECG tracings in the appropriate place. Printed copies may be required depending upon the facility. A printed copy or electronic tracing is added to the patient's record and flagged to be read by the consulting physician. In an acute care setting, the tracing may be transferred to a computer for evaluation in the ECG laboratory. In an ambulatory care facility, a printed copy may be attached to the front of the chart and/or placed on the physician's desk.

Some facilities have a computer that can read the ECG electronically and store it in a central database for future reference. In addition, sometimes ECG tracings are electronically sent to other locations. These procedures may require special equipment and training.

If the ECG was ordered stat (immediately), you will need to give the results directly and immediately to your superior or the physician. If your supervisor is not available, ensure that the results are with the medical record, then find your supervisor or the ordering physician and notify them that the ECG has been completed. Remember, in a stat situation the patient may have a condition that needs immediate treatment, and no time should be wasted.

Billing is another issue to consider when reporting completion of an ECG. When you enter the data into the machine or on the designated form, they must be complete and accurate. If the patient is not charged for the

procedure, this can have an adverse effect on the facility's finances and subsequently on your job. Check the facility policy to be certain you have completed the necessary steps to ensure that the patient will be charged.

In many facilities, the information is entered into the EHR to be sent to the billing department. You may need to enter the patient's diagnosis, which is provided by the physician and is found on the chart. Each diagnosis has a special diagnostic code, known as an ICD-10 code. In most cases, you will need to identify the correct ICD-10 code when entering the information for the billing department. In addition to the diagnosis code, a CPT code indicating a 12-lead ECG tracing or rhythm tracing is being performed may need to be entered. Using these codes help ensure that the facility is reimbursed for the procedure. In addition, often patients with Medicare will need to sign an Advance Beneficiary Notice (ABN) stating that the patient is responsible for any balance the insurance may not cover. The ABN needs to be signed by the patient prior to the procedure being performed.

Checkpoint Questions (LO 4.7)

1. How should you report a stat ECG?

2. Why is it critical to enter the correct and complete data into the computer when performing an ECG?

4.8 Equipment Maintenance

Care and maintenance of the ECG machine is your responsibility. Become familiar with the manufacturer's instructions for operation and maintenance of the ECG machine. The operator's manual for the machine you are using will include specific directions about routine care and maintenance. General day-to-day care and maintenance include cleaning the ECG machine and stocking the supplies, such as electrodes, skin preparation items, ECG paper, and cleaning supplies.

Safety & Infection Control



Cleaning and Maintaining the ECG Equipment

Cleaning the ECG equipment is necessary to prevent infections. Patients who have a low resistance to infection (immunocompromised) can easily become infected with a pathogen that is left on the ECG cables. Maintaining the supplies is necessary for efficient ECG recording and accurate tracings.

Keep the ECG machine clean to prevent transmission of infection and to create a positive image of yourself and the facility where you are employed. Use a small amount of nonabrasive cleaner on the equipment case, cover, and

control panel. Wipe the machine dry with a soft cloth. Follow the specific directions in the operator's manual for the disinfection procedure.

The cables and electrode clips should be disinfected between patients. Use a soft cloth moistened with disinfectant and wipe the entire cable and clip. You can also use packaged disinfectant wipes if they are available. To determine the type of disinfectant you should use, check the policy at the facility where you are working. Keep these cleaning supplies available on the ECG cart. Do not place the cables or ECG machine in fluid or use heat sterilization. Do not use acetone, ether, or other harsh chemicals or solvents. Always follow the manufacturer's directions for the best results.

Carefully maintain the clips used to attach the lead wires to the electrodes. Check them to ensure that the pins fit snugly on the electrode. Check for small amounts of electrolyte gel that may cling to the clips. These bits of paste may prevent good contact with the electrodes (Figure 4-9).

Wipe down the patient cables and lead wires with a damp cloth. Replace them neatly on the ECG machine for storage (Figure 4-10). Inspect them regularly for cracks or fraying. Replace any cables that are damaged. See Procedure Checklist 4-1 at the end of this chapter to practice recording an ECG.

Figure 4-9 This alligator-type clip may be used to attach lead wires to the electrodes. Wipe the clips clean after use to prevent electrolyte gel or paste from getting stuck between the teeth of the clip.

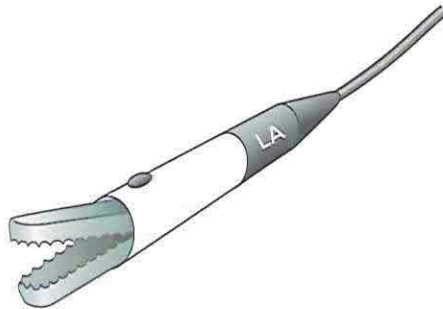
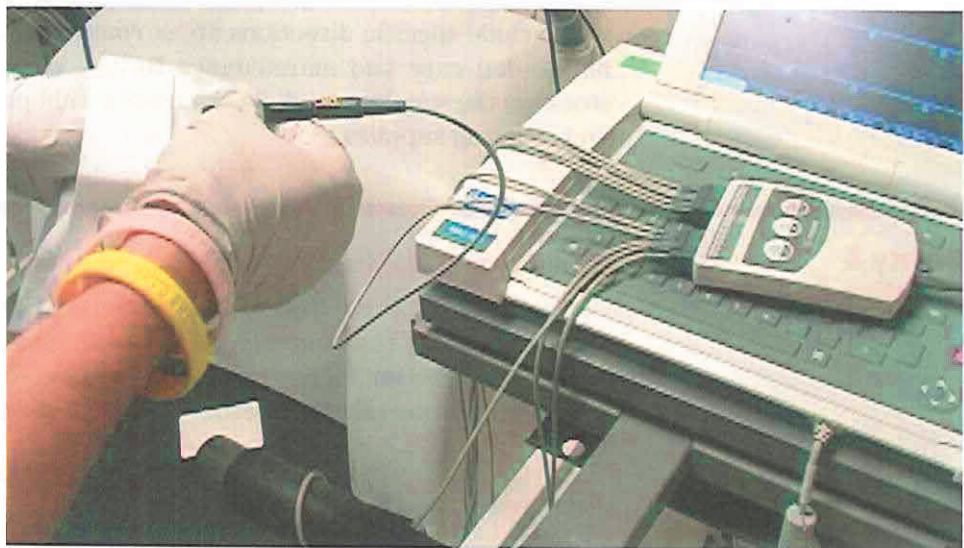


Figure 4-10 Before storing, clean each lead wire and clip with disinfectant. For safety, inspect each wire for cracks or fraying.

Total Care Programming, Inc.



**Checkpoint
Question
(LO 4.8)**

1. Why should you know how to troubleshoot and maintain the equipment for an ECG?

4.9 Pediatric ECG

When preparing a child for an ECG, it is important to give simple directions that they can understand. Identify yourself and explain what you are going to do. Allow the child to ask questions. Avoid technical words like *electrodes* and *electrocardiogram*. Use the word *stickers* to describe electrodes. If the child is fearful of the “stickers,” allow them to place the stickers on a toy, doll, or parent. This will show the child that the procedure does not hurt. Explain that you are going to take a “picture” of the child’s heart. Because children can usually identify with picture taking, this will help them understand that they need to be still during the “picture.”

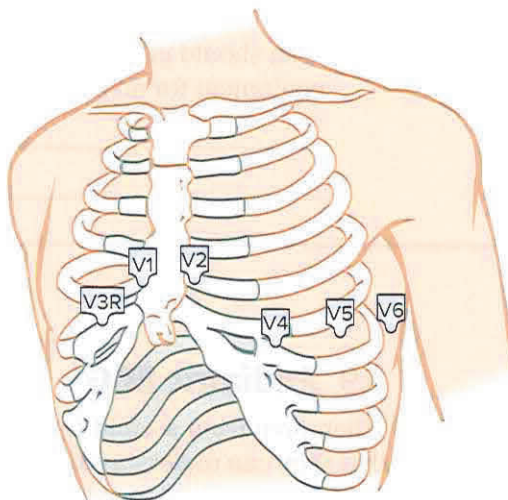
Always identify the child by name and check their identification wristband. If the parents are present, you may allow them to stay. For a small child or infant, the parent can assist by letting the child lie quietly in their arms. A fussy infant may be soothed using a pacifier. If you are unable to soothe an irritable infant, you may need to wait until they fall asleep. For older children, you can allow them to apply their own arm and leg electrodes. Adolescents may prefer to be alone during the procedure. Follow your facility’s policy with regard to patient care of an adolescent. If appropriate ask them if they would like their parent to stay or leave.

When the ECG tracing is completed, talk about the procedure. Give verbal praise and be supportive. Reward the child with an age-appropriate item or activity such as stickers or a special trip to the playroom.

Smaller, pediatric electrodes are available and should be used for pediatric patients. In addition, for infants or children with very fast heart rates, you may find it necessary to adjust the paper speed to 50 mm/sec. This will allow the physician to view each of the deflections on the ECG tracing. If you make this adjustment, don’t forget to note on the ECG recording when completed.

An ECG for a child is performed with the same lead placement as for an adult. The chest lead V6 must be placed exactly on the midaxillary line. Because of the small size of the chest, correct placement becomes even more important. Small differences in placement can make a difference in the ECG tracing. Because of crowding on the chest, it may be necessary to move the V3 or V4 lead to the right side of the chest. It should be placed on the right side in the same location as it normally would be on the left. This is known as a V3 or V4 right (V3R) or (V4R) (Figure 4-11). The electrodes may also be cut in half to avoid overlap on the child’s chest. If this method is done, V3R can be skipped.

Figure 4-11 For infants and small children, place V3R on the right side of the chest to prevent crowding of the chest electrodes. This is known as V3R and is sometimes used on adults as well. Moving V4 to the right may also be done making it a V4R.

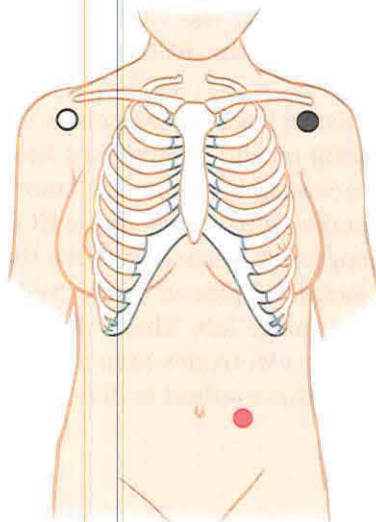


Checkpoint Questions (LO 4.9)

1. Why do you frequently need to adjust the paper speed to 50 mm/sec for infants and small children?

2. When you change the paper speed to 50 mm/sec, what else should you do?

Figure 4-12 Placement of leads for three lead cardiac monitoring.



4.10 Cardiac Monitoring

Patients may require continuous cardiac monitoring (see Figure 1-3) at the scene of an emergency, in the hospital during or after surgery, or when they have cardiac, pulmonary, or electrolyte problems. In addition to the cables, monitor, and disposable supplies (electrodes), the monitoring systems used in a hospital may include devices that monitor the heart rate and rhythm, blood pressure, cardiac output, and arterial blood oxygen saturation.

During continuous cardiac monitoring, typically either lead II or a modified chest lead (MCL) is used because they provide the best ability to view the atrial activity (P wave). Exact placement of the electrodes affects the view of the heart and the resulting waveform. Three electrodes are placed, and the placement may vary depending on the system used.

- White cable with electrode (labeled RA) at the right arm location
- Black cable with electrode (labeled LA) at the left arm location
- Red cable with electrode (labeled F or LL) at the left leg location

You can remember the placement of the three electrodes by using the following mnemonic devices: “Black and white go left and right,” and “Smoke (black) goes over fire (red)” (see Figure 4-12).

During continuous cardiac monitoring, a 12-lead ECG also can be performed. See Procedure Checklist 4-2 at the end of this chapter to review and practice this procedure.

**Checkpoint
Question
(LO 4.10)**

1. What is the difference between continuous cardiac monitoring and a routine ECG?

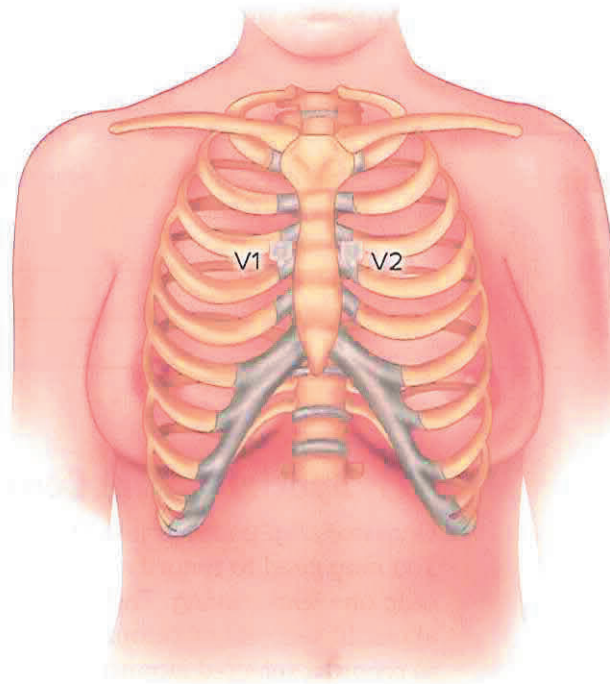
4.11 Special Patient Considerations

Occasionally, you will need to record lead tracings other than the basic 12. You may need to record a heart rhythm strip, which is a single strip showing only one lead tracing. The heart rhythm is usually produced in lead II and is about 10 seconds of running time. Many ECG machines can be programmed to record a selected monitoring view, such as Lead II, across the bottom of the 12-lead tracing or following the completion of the 12-lead recording. A rhythm strip is used to check for heart rhythm abnormalities. You may also be asked to provide a V4R (a tracing run with V4 placed on the right side of the chest) on an adult for cases of suspected right ventricular infarction.

You may encounter other circumstances that require you to make modifications to the basic 12-lead procedure. When changes in the placement of leads are necessary for any reason, it is critical that you indicate any modification in electrode placement. The position of the electrodes affects the ECG tracing because the electrodes are focused on different aspects of the heart and could potentially provide the wrong information if the change in their positions is not noted. Consider the following when placing leads and recording tracings in a patient's chart:

- V1 and V2 may have to be placed higher due to breast implants or patients with large breasts (see Figure 4-13).
- Do not place the electrode on a female's breast. Move the breast with the back of your gloved hand and place the electrode under it. If this is done, note on the ECG tracing that the electrodes (V3, V4, and V5) are placed lower than required.
- If a female has had a mastectomy, be careful placing the electrodes—the skin may be fragile. Note that the patient had a mastectomy and which breast is affected on the ECG tracing: “(L), (R), or bilateral mastectomy.”
- For a patient with an amputation, place the limb leads on the upper chest and lower abdomen instead of on the arms and legs. Make sure the leads are in the same place on each side of the body.
- Alternate locations may be necessary due to interference from burns, wounds or post-operative dressings, chest tubes, and so on. Remember to document if electrodes are moved to a different location and why.
- A pregnant female should have the lower limb leads placed on the thighs, not the abdomen. Place the patient on her left side slightly, by using a

Figure 4-13 Leads V1 and V2 are placed higher on the chest for patients with large breasts.



small rolled towel under the right hip to reduce pressure on the inferior vena cava. Document on the ECG that the patient is pregnant and the number of months.

- Geriatric patients generally have thin skin, which is part of the normal aging process. Apply the electrodes carefully and remove them gently to prevent damage to their skin. You may need to use adhesive remover to break the adhesive bond of the sensors. This significantly reduces the risk of tearing the skin. Geriatric patients may have some readings on the ECG tracing that are age-related and are considered normal.
- If the patient is unable to lie on their back, be sure to indicate on the tracing the position of the patient during the tracing. For example, a patient who has difficulty breathing or is heavily pregnant may need to have an ECG done in Fowler's or semi-Fowler's position, which requires the head of the bed to be elevated (see Figure 4-14).
- When someone is in a permanent fetal position with arms drawn tightly over the chest, you may need to place the electrodes on the back. They will need to be positioned over the heart on the left side of the back. Today's small, thin, disposable electrodes are easier to place under a patient's arms, so place them on the back only if necessary.
- When the heart is on the right side of the chest rather than on the left, a condition known as **dextrocardia**, the physician will order a right-side 12-lead ECG (described below). A right-side 12-lead ECG is also used to obtain a direct view of the right ventricle. In this case, the aVR tracing will produce a positive deflection. On the ECG tracing report, you should indicate that you did a right-side ECG.

dextrocardia When the heart is on the opposite or right side of the chest.

Figure 4-14 With some patients, it is necessary to record an ECG with the head of the bed elevated as shown here.

Tom O'Brien



You may be asked to perform a right-side or posterior ECG as ordered by the physician. These expanded data tracings enable the physician to detect problems with the right ventricle and posterior wall of the left ventricle.

The right-side 12-lead ECG has chest leads placed in a “mirror image” of the standard 12-lead ECG. They are placed at the same anatomic levels but on the opposite side of the chest. V1 is placed on the fourth intercostal space, left sternal margin; V2 is placed on the fourth intercostal space, right sternal margin; and so on, continuing to the patient’s right (see Figure 4-15). The chest leads are commonly identified as V1R, V2R, V3R, V4R, V5R, and V6R. These additional leads are periodically requested by the physician after a standard 12-lead ECG has been obtained.

Figure 4-15 Use these lead placements for patients with dextrocardia, a condition in which the left ventricle, left atrium, and aortic arch are located on the right side of the chest.

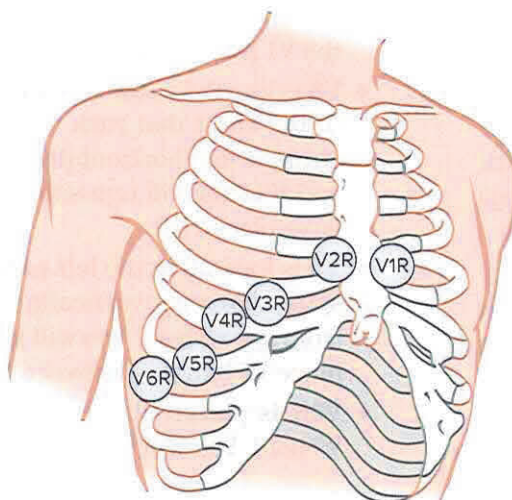
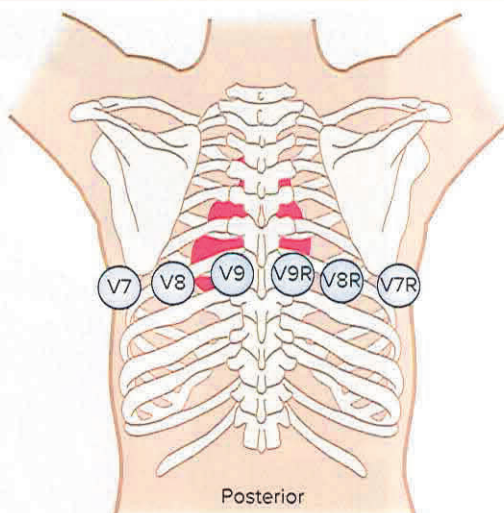


Figure 4-16 Posterior 12-lead locations. Cables V1 through V6 are placed going from the patient's posterior left in order to the patient's posterior right.



- V7** Left posterior axillary line, V6 level (Use Cable V1)
- V8** V8 (skip) place at midpoint on a horizontal line between V7 and V9 (Use Cable V2)
- V9** Left paraspinous border, V6 level (Use Cable V3)
- V9R** Right paraspinous border (Use Cable V4)
- V8R** V8R (skip) place at midpoint on a horizontal line between V7R and V9R (Use Cable V5)
- V7R** Right posterior axillary line (Use Cable V6)

The *posterior 12-lead ECG* (or leads on the patient's back) focuses on the posterior aspect of the heart. As shown in Figure 4-16, the chest leads are identified as V7, V8, and V9 (posterior left chest) and V9R, V8R, and V7R (posterior right chest) and are placed as follows:

posterior axillary line

Imaginary line on the back that runs vertically from the shoulder down on the outer edge of the rib cage.

midscapular line

Imaginary line on the back that runs vertically through the center of the scapula.

paraspinous line

Imaginary line on the spine that runs vertically through the side of the spine.

- **V7** is located at the left **posterior axillary line** (an imaginary line on the back of the chest that runs vertically from the shoulder down on the outer edge of the rib cage) in a straight line from V6. You will reposition the V1 lead to this location.
- **V8** is located at the left **midscapular line** (an imaginary line on the back of the chest that runs vertically through the center of the scapula) in a straight line horizontally from V7; it will be placed halfway between V7 and V9. You will reposition the V2 lead to this location. Skip V8 until you have placed V9.
- **V9** is located at the left **paraspinous line** (an imaginary line next to the spine that runs vertically along the side of the spine) in a straight line from the V7 lead. You will move the V3 lead to this location. (Go back and place V8 halfway between V7 and V9 in a straight line.)
- **V9R** is placed at the right paraspinous line in a straight line from the V9 lead. You will reposition the V4 lead to this location.

- **V8R** is located at the right midscapular line in a straight line from V7; it will be placed halfway between V7R and V9R. You will reposition the V5 lead to this location. Skip V8R until you have placed V7R.
- **V7R** is located at the right posterior axillary line. You will reposition the V6 lead to this location (see Figure 4-16). (Go back and place V8R halfway between V7R and V9R.)

Some facilities have specialized equipment for these less common tracings, but it is not essential. You can obtain the ECG tracing by adding these leads with the standard 12-lead ECG machine. This procedure can be simple when you know where to place the electrodes. First, run a standard 12-lead ECG as described earlier. Second, using the precordial cables (V1–V6), place additional electrodes in the appropriate locations and run a second 12-lead ECG. It is important that you do not forget to write on the labels of the new leads.

Note: Limb lead cables and electrode locations do not change. Only the chest leads and electrodes are changed.

Communicate & Connect



Documenting Modifications

It is absolutely necessary to record any modifications to the ECG recording, such as electrode placement or the patient's condition or position when performing an ECG. These changes can affect the interpretation of the results and must be noted to prevent any errors.

Checkpoint Questions (LO 4.11)

1. Describe the process for recording a right-side or posterior ECG.

2. What additional ECG procedure may the doctor order for a patient with dextrocardia? Why?

4.12 Handling Emergencies

Cardiac or Respiratory Arrest

During a cardiac or respiratory arrest, frequently called a Code Blue emergency, be ready to perform the tracing as quickly and efficiently as possible. An ECG is usually ordered “stat” in these situations. If possible, enter the patient's information into the ECG machine. Remain available but out of the way until the ECG is needed. You may need to remove the machine from the cart and take just the machine into the room, if space is limited.

Because the patient's condition changes frequently during a Code Blue emergency, you may need to perform multiple ECGs in a row. Perform the first ECG and leave the electrodes in place in order to perform subsequent ECGs quickly. Indicate on the tracing "repeat ECG—same lead placement." This will make the physician aware that the electrodes were not removed between tracings.

Seizure

seizure An interruption of the electrical activity in the brain that causes involuntary muscle movement and sometimes unconsciousness.

If a patient has a **seizure** during the ECG, stay with them. Call for help and protect the patient from injury. Consider the following emergency steps:

1. Remove any objects that may cause injury.
2. Do not try to hold the patient still.
3. Loosen restrictive clothing and never place anything in the patient's mouth.
4. If possible, position the patient on their side with the head turned to the side to help keep the airway open and unobstructed by the tongue. This also facilitates the drainage of oral secretions. Do not use a bite block. This position is especially important if the patient vomits, to prevent aspiration of vomitus into the lungs.

Once the seizure is over, perform the ECG again and write on the ECG strip "postseizure."

Checkpoint Question (LO 4.12)

1. What should you do if your patient has a seizure while you are starting to record an ECG?

Chapter Summary

Learning Outcomes	Summary	Pages
4.1 Carry out preparation of the patient, room, and equipment for an ECG.	The patient, the room, and the equipment must be properly prepared prior to performing an ECG.	88–89
4.2 Describe the communication needed during the ECG procedure, including the actions to take if a patient refuses to allow an ECG to be performed.	When a patient refuses an ECG, you should identify the cause, alleviate any fears, and, if the patient still refuses, notify your supervisor and document the refusal on the medical record.	89–91

(Continued)

Learning Outcomes	Summary	Pages
4.3 Identify at least three ways to provide for safety during the ECG procedure.	To ensure safety during an ECG: • Check the plug and power cord. • Raise the bed and keep the side rail up. • Use two patient identifiers before the procedure. • Perform hand hygiene and wear PPE as required. • Use proper body mechanics at all times.	91–93
4.4 Demonstrate the procedure for applying the electrodes and lead wires for a 12-lead ECG and cardiac monitoring.	In order to place the electrodes properly for an ECG, you must be able to locate anatomical landmarks, including the midclavicular line, anterior axillary line, intercostal spaces, suprasternal notch, and angle of Louis. An ECG is performed using the ECG machine, lead wires, and electrodes. The patient must be identified correctly, the tracing must be correct, and safety must be maintained during the procedure.	93–98
4.5 Describe the procedure for recording a 12-lead ECG.	The ECG procedure includes identifying, communicating with, and preparing the patient; maintaining safety, privacy, and infection control; checking and preparing the room and equipment; attaching the electrodes and leads; and then operating the ECG machine and reporting the results.	99
4.6 Identify types of artifact and how to prevent or correct them.	Three types of artifact include: • Somatic tremor caused by muscle movement. • Wandering baseline, usually caused by improperly applied electrodes or poor skin prep. • AC interference, caused by some type of electrical interference.	99–104
4.7 Describe how to report the ECG results.	ECGs are recorded electronically and in paper fashion. Although they may be “read” by the machine, they must be provided promptly in a proper format to the practitioner who will be interpreting them.	104–105
4.8 Identify the steps for cleaning and caring for the ECG equipment.	Upon completion of an ECG, the equipment must be cleaned and stored properly according to your facility guidelines and the manufacturer’s recommendations.	105–107
4.9 Explain variations for a pediatric ECG procedure.	During a pediatric ECG, the chest lead V3 may need to be placed on the right side of the chest due to the small size of the chest or the electrode may be cut in half.	107–108
4.10 Distinguish between a routine ECG and cardiac monitoring.	Cardiac monitoring uses three leads with different placements.	108–109
4.11 Summarize special patient circumstances when performing an ECG.	Many special patient considerations can occur during an ECG, such as for female patients, patients who are pregnant, patients with amputations, and geriatric patients.	109–113
4.12 Recall the steps for handling an emergency during the ECG.	During a cardiac or respiratory arrest, perform the ECG stat; in some cases, take just the machine into the room and be prepared to run two ECGs in a row. During a seizure, remain calm, do not restrain the patient, and call for help.	113–114

Chapter Review

Matching I

Match the landmarks on the left with their locations on the right. (LO 4.4)

- | | |
|----------------------------------|--|
| _____ 1. suprasternal notch | a. extends from the sternum to the scapula |
| _____ 2. fifth intercostal space | b. the space between the fifth and sixth ribs |
| _____ 3. manubrium | c. the top portion of the sternum |
| _____ 4. right clavicle | d. the dip at the base of the neck just above where the clavicle attaches to the sternum |

Match the leads on the left with their correct placement on the right. (LO 4.4)

- | | |
|--------------|---|
| _____ 5. V1 | a. fifth intercostal space, at the anterior axillary line |
| _____ 6. V2 | b. fourth intercostal space, left sternal border |
| _____ 7. V3 | c. fifth intercostal space at the midaxillary line |
| _____ 8. V4 | d. fifth intercostal space at the midclavicular line |
| _____ 9. V5 | e. fourth intercostal space, right sternal border |
| _____ 10. V6 | f. halfway between V2 and V4 |

Match the imaginary lines on the left with their locations on the right. (LO 4.4)

- | | |
|----------------------------------|---|
| _____ 11. midclavicular line | a. front of the axilla |
| _____ 12. midaxillary line | b. middle of the axilla |
| _____ 13. anterior axillary line | c. usually passes through the nipple line |

Multiple Choice

Circle the correct answer.

14. For placement of the electrodes, how is the ICS located? (LO 4.4)
- Locating the sternum and feeling for a dip at the edge.
 - Finding the ribs near the nipple line.
 - Locating the clavicle and feeling for a dent directly below it.
 - Locating the space between the clavicle and V4.
15. What would be the first and most appropriate thing to say if a patient refuses an ECG? (LO 4.2)
- "Will you tell me why you don't wish to have an ECG done?"
 - "Don't worry; it takes only a few seconds."
 - "Your doctor has ordered this test, and it must be done."
 - "I will have to report your refusal to my supervisor."

16. When applying chest leads, V4 is placed (LO 4.4)
 - a. midway between V3 and V5.
 - b. at the fourth ICS, right sternal border.
 - c. at the fifth ICS, left midclavicular line.
 - d. at the fourth ICS, left sternal border.
17. When applying chest leads, V2 is placed (LO 4.4)
 - a. midway between V3 and V5.
 - b. at the fourth ICS, right sternal border.
 - c. at the fifth ICS, left midclavicular line.
 - d. at the fourth ICS, left sternal border.
18. To prevent disease transmission during an ECG, you should (LO 4.3)
 - a. check the ground prong.
 - b. wash your hands.
 - c. raise the side rail.
 - d. lower the bed.
19. Which of the following would *not* be done prior to performing an ECG? (LO 4.1)
 - a. Receive and validate the order.
 - b. Write ECG variations on tracing.
 - c. Check and change paper if necessary.
 - d. Enter patient data into the machine.
20. When applying chest leads, V1 is placed (LO 4.4)
 - a. midway between V3 and V5.
 - b. at the fourth ICS, right sternal border.
 - c. at the fifth ICS, left midclavicular line.
 - d. at the fourth ICS, left sternal border.
21. Marks on the ECG tracing caused by another source of activity are (LO 4.6)
 - a. asystole.
 - b. conduction marks.
 - c. artifact.
 - d. arrhythmias.
22. Somatic tremors are caused by (LO 4.6)
 - a. electrical current leak.
 - b. tracing drifts away from the center.
 - c. muscle movement.
 - d. contact with another electrical device.
23. You noticed a wandering baseline on the ECG tracing. What measure(s) should you take to correct the problem? (LO 4.6)
 - a. Apply new electrodes.
 - b. Reposition the electrodes.
 - c. Ensure that the wires are not crossed.
 - d. All of the answers are correct.
24. You notice that leads I and II have a lot of artifact while recording a 12-lead ECG. Which electrode is probably not placed appropriately? (LO 4.5)
 - a. Right arm
 - b. Left arm
 - c. Left leg
 - d. None of the answers are correct.

25. Which of the following are ways to correct AC interference? (LO 4.6)
 - a. Unplug electrical equipment; move bed away from wall.
 - b. Apply electrodes securely; remove tension from lead wires.
 - c. Have patient place hands under their buttocks; remind patient not to move.
 - d. Replace loose electrodes; have the patient turn slightly to the side.
26. Which of the following are ways to correct somatic tremor? (LO 4.6)
 - a. Unplug electrical equipment; move bed away from wall.
 - b. Apply electrodes securely; remove tension from lead wires.
 - c. Have patient place hands under their buttocks; remind patient not to move.
 - d. Replace loose electrodes; have the patient turn slightly to the side.
27. Which of the following are ways to correct wandering baseline? (LO 4.6)
 - a. Unplug electrical equipment; move bed away from wall.
 - b. Apply electrodes securely; remove tension from lead wires.
 - c. Have patient place hands under their buttocks; remind patient not to move.
 - d. Replace loose electrodes; have the patient turn slightly to the side.
28. When applying chest leads, V6 is placed (LO 4.4)
 - a. in line with V4 on the midaxillary line.
 - b. at the fourth ICS, right sternal border.
 - c. at the fifth ICS, left midclavicular line.
 - d. at the fourth ICS, left sternal border.
29. If your patient has a left lower leg amputation, where should you place the electrodes? (LO 4.10)
 - a. LL on left upper leg, RL on right lower leg
 - b. LL on left thigh, RL on right thigh
 - c. LL on left lower abdomen, RL on right upper leg
 - d. LL on left lower abdomen, RL on right lower leg
30. When performing a 12-lead ECG on an infant or small child, do all of the following *except* (LO 4.9)
 - a. speak in children's terms.
 - b. use smaller ECG electrodes.
 - c. perform a V3R tracing.
 - d. use a special ECG machine.
31. Approach the patient from the _____ when performing an ECG. (LO 4.5)

a. left side	c. top
b. right side	d. bottom

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 32. Natural skin oils, moisturizers, and perspiration can contribute to artifact on an ECG tracing. (LO 4.6)

T F 33. The letter *R* is placed after any tracing when the electrode is not in its usual position and has been placed on the right side of the patient's chest. (LO 4.10)

Matching II

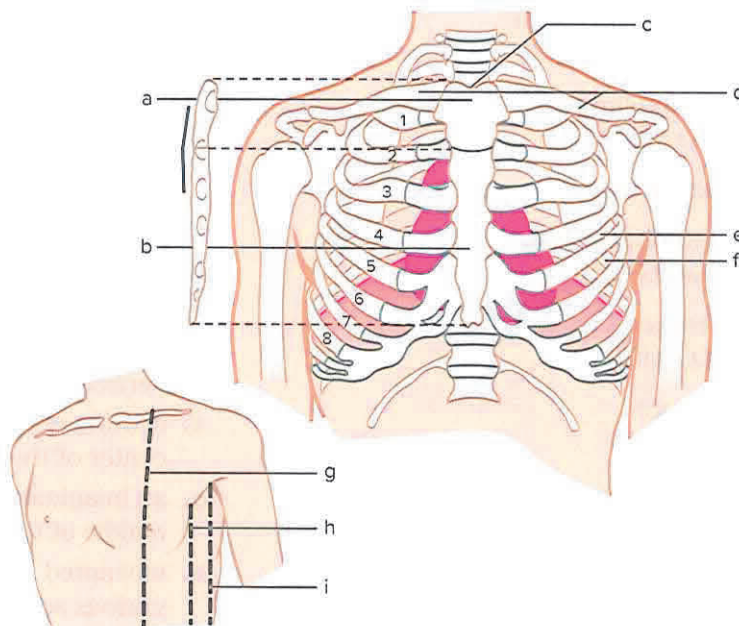
Match the terms on the left with their definitions on the right.

- | | |
|--|--|
| _____ 34. intercostal space (ICS) (LO 4.4) | a. an interruption of the electrical activity of the brain that causes involuntary muscle movement and sometimes unconsciousness |
| _____ 35. midaxillary line (LO 4.4) | b. a bony prominence located approximately 1 inch below the suprasternal notch, where the manubrium and the body of the sternum are joined |
| _____ 36. stat (LO 4.11) | c. outer edge of the sternum |
| _____ 37. anterior axillary line (LO 4.4) | d. the space between two ribs |
| _____ 38. artifact (LO 4.6) | e. an imaginary line on the chest that runs vertically through the center of the clavicle |
| _____ 39. seizure (LO 4.11) | f. drifting of an ECG tracing away from the center of the paper; also called baseline shift |
| _____ 40. midclavicular line (LO 4.4) | g. an imaginary vertical line that starts in the middle of the axillary region (armpit) |
| _____ 41. somatic tremor (LO 4.6) | h. unwanted marks on the ECG caused from various sources other than the heart |
| _____ 42. angle of Louis (LO 4.4) | i. unwanted markings on the ECG tracing caused by other electrical sources |
| _____ 43. AC interference (LO 4.6) | j. an imaginary vertical line on the back that starts in the middle of the scapula |
| _____ 44. wandering baseline (LO 4.6) | k. immediately |
| _____ 45. sternal border (LO 4.4) | l. voluntary or involuntary muscle movement; also known as body tremor |
| _____ 46. dextrocardia (LO 4.10) | m. an imaginary vertical line starting at the edge of the chest where the axillary region begins |
| _____ 47. midscapular line (LO 4.4) | n. condition in which the heart is on the right side of the chest |

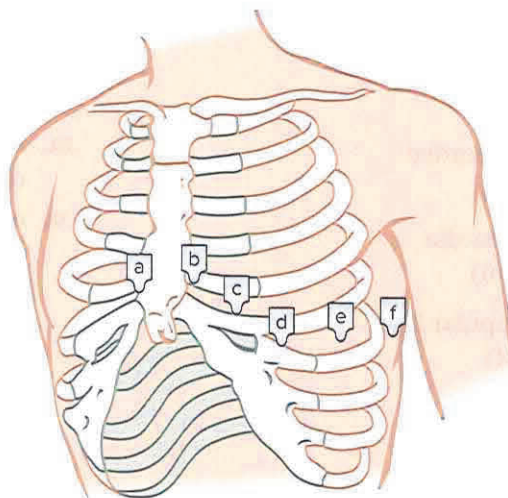
Identification

48. (1–9.) Identify the landmarks on the chest drawing by writing the names on the lines provided. (LO 4.4)

- a. _____
- b. _____
- c. _____
- d. _____
- e. _____
- f. _____
- g. _____
- h. _____
- i. _____



49. Identify each lead and describe its location for a 12-lead ECG by writing on the lines provided. (LO 4.4)



- a. _____
- b. _____
- c. _____
- d. _____
- e. _____
- f. _____

Critical Thinking Application *What Should You Do?*

Read the following situations and use your critical thinking skills to determine how you would handle each. Write your answer in detail in the space provided.

50. You are working in a local hospital and are called to perform an ECG on a patient who is in a coma and was admitted to the hospital because of a myocardial infarction. You set up the machine and begin to run the ECG, and the tracing is a flat line. You know that a flat line is serious. What would be the first thing you do? (LO 4.7)
-
-
51. Your patient has Parkinson's disease. During the procedure, you notice a lot of artifact. What kind of artifact would you expect it to be? How could you reduce the artifact? (LO 4.7)
-
-
52. You are performing an ECG on a patient, and they begin to complain of chest pain. What should you do? (LO 4.12)
-
-
53. When you finish performing an ECG, the patient asks you for a copy. What do you do? (LO 4.8)
-
-



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 Checklists

Use the following Competency Checklists 4-1 and 4-2 to practice and perform the skills presented in this chapter. (LO 4.5, 4.6, and 4.7)

COMPETENCY CHECKLIST 4-1

Recording an Electrocardiogram

Procedure Steps (<i>Rationale</i>)	Practice		Practice		Test		Mastered	
	Yes	No	Yes	No	Yes	No	Date	Initials
Preprocedure								
1. Receive and validate the order.								
2. Check the machine for proper functioning, including electrical cord, lead wires, and paper.								
3. Read the specific information from the manufacturer's instructions.								
4. Obtain the necessary supplies.								
5. Ensure that adequate paper is available.								
6. Change or add paper if necessary.								
7. Enter the data into the ECG machine if available.								
Procedure								
1. Identify the patient using two forms of identification.								
2. Explain the procedure.								
3. Wash hands.								
4. Position and prepare the patient. Ask the patient to turn off and remove electronics. (Prevents artifact)								
5. Provide for privacy and prevent exposure. (Provides comfort, alleviates stress)								
6. Ensure that the bed or exam table is not touching the wall. (Prevents artifact)								
7. Move the bed or exam table away from electrical equipment. (Prevents artifact)								
8. Ensure that the patient is not touching the headboard, footboard, or side rails. (Prevents artifact)								
9. Cleanse and prepare the skin as necessary.								
10. Apply electrodes to the limbs and chest.								

Procedure Steps (<i>Rationale</i>)	Practice		Practice		Test		Mastered	
	Yes	No	Yes	No	Yes	No	Date	Initials
Procedure (<i>continued</i>)								
11. Attach the lead wires, ensuring that no tension is on the wires. Make a stress loop. (Prevents discomfort to the patient and helps prevent artifact)								
12. Enter the additional patient data in the LCD panel if necessary.								
13. Press the Run button.								
14. Check the tracing for quality. Observe for artifact.								
15. Run the additional ECG if necessary.								
16. Observe the LCD display for errors.								
17. Turn off the machine and unplug it when completed.								
18. Remove the electrodes and clean the skin, if necessary.								
19. Assist the patient to a safe and comfortable position.								
Postprocedure								
1. Write on ECG tracing any variations in lead placement, reason for poor-quality tracing, or change in tracing speed. (Ensures accurate evaluation)								
2. Provide the results to the licensed practitioner.								
3. Place the completed ECG tracing in the appropriate area.								
4. Clean the leads.								
5. Drape the lead wires of the machine in an orderly fashion.								
6. Return the machine to the designated storage location.								
7. Perform hand hygiene.								
Comments:								
Signed								
Evaluator:								
Student:								

COMPETENCY CHECKLIST 4-2

Continuous Cardiac Monitoring

Procedure Steps (<i>Rationale</i>)	Practice		Practice		Test		Mastered	
	Yes	No	Yes	No	Yes	No	Date	Initials
Preprocedure								
Gather the supplies and equipment:								
• Cardiac monitor (check monitor before applying to the patient) • Cable and lead wires • Electrodes • Skin prep supplies (i.e., alcohol, gauze pads, razor as necessary) • Gloves								
Procedure								
1. Identify the patient.								
2. Introduce yourself.								
3. Explain what you are going to do to the patient, and ask if the patient has any questions.								
4. Ask the patient to undress from the waist up (assist as necessary). Provide the patient with a gown or drape to use for privacy.								
5. Wash your hands and don medical exam gloves.								
6. Expose only the areas necessary to perform the procedure (maintain patient privacy).								
7. Select appropriate locations and prep the skin. (Brisk circular rub with dry gauze, rasp, or alcohol; let alcohol dry.) <i>Note:</i> Avoid bony prominences. • Right arm—just under the clavicle and medial to the right shoulder • Left arm—just under the clavicle and medial to the left shoulder • Left leg—upper abdomen at the margin where the abdomen and lowest rib meet								
8. Shave or clip hair if necessary (follow facility policy).								
9. Attach the electrodes to the ends of the cables.								
10. Place the white cable with electrode (labeled RA) on the right arm location.								
11. Place the black cable with electrode (labeled LA) on the left arm location.								

Procedure Steps (<i>Rationale</i>)	Practice		Practice		Test		Mastered	
	Yes	No	Yes	No	Yes	No	Date	Initials
Procedure (<i>continued</i>)								
12. Place the red cable with electrode (labeled F or LL) on the left leg location.								
<i>Note:</i> Remember to press around the outer edge of the electrode to ensure good adhesive contact with the skin. <i>Note:</i> Remember to press around the center of the electrode to ensure good gel-to-skin contact with conductive media (reduces artifact). <i>Note:</i> It may be necessary to make stress loops and tape them directly to the patient.								
13. Attach the cable clip to the sheet or patient gown to reduce tugging on electrodes (reduces artifact).								
14. Turn the cardiac monitor on and select lead II.								
15. Select the heart rate limits according to local policy.								
16. Observe the heart rate and rhythm—troubleshoot if artifact is noted.								
17. Print a rhythm strip for further analysis and reporting to licensed healthcare practitioner.								
Postprocedure								
1. Remove gloves and wash hands.								
2. Document the procedure.								
Comments:								
Signed								
Evaluator:								
Student:								

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