

CHAPTER 37

ELECTROCARDIOGRAPHY

Overview

Medical assisting students are introduced to the electrical conduction system of the heart and learn the proper procedures for obtaining electrocardiograms (ECGs), which present graphic representations of the heart's electrical activity. Electrocardiograms are important diagnostic tools that help providers diagnose cardiac diseases and conditions.

Lesson Plan

I. LEARNING OUTCOMES	ABHES	CAAHEP
A. Define, spell, and pronounce the key terms as presented in the glossary.		
B. Follow the circulation of blood through the heart starting at the vena cavae.	MA.A.1.2.b	I.C.5
C. Describe the electrical conduction system of the heart.	MA.A.1.2.b	I.C.5
D. State three reasons why patients may need an electrocardiogram (ECG).	MA.A.1.9.m	I.P.6; I.A.1
E. Identify the various positive and negative deflections and describe what each represents in the cardiac cycle.	MA.A.1.2.b	I.C.5
F. Explain the purpose of standardization of the ECG.	MA.A.1.9.o	I.P.5
G. Identify the 12 leads of an ECG and describe what area of the heart each lead represents.	MA.A.1.9. o(1)	I.P.5
H. State the function of ECG graph paper, electrodes (sensors), and electrolyte.	MA.A.1.9. o(1)	I.P.5
I. Describe various types of ECGs and their capabilities.	MA.A.1.9. o(1)	I.P.5
J. Explain each type of artifact and how each can be eliminated.		I.P.5
K. Name and describe the purposes of the various cardiac diagnostic tests and procedures as outlined in this chapter.		I.P.6
L. Identify the placement of Holter monitor electrodes.	MA.A.1.9. o(1)	I.P.5
M. Describe the reason for a patient activity diary during ambulatory electrocardiography.		III.A.2
N. Identify six arrhythmias and explain the cause of each.	MA.A.1.2.d	I.C.6
O. Explain how to calculate heart rates from an ECG tracing.	MA.A.1.9. o(1)	I.P.5
P. Identify a common coding system used to code each lead on an ECG tracing.		
Q. Describe the procedure for mounting an ECG tracing.	MA.A.1.9. o(1)	
R. Analyze the professionalism questions and apply them to this chapter's content.		

II. PROFESSIONALISM QUESTIONS

A. Communication

1. Did you introduce yourself? Did you identify the patient through name and birth date or other identifying feature?
2. Did you speak at the patient's level of understanding?
3. Did you allay patients' fears regarding the procedure being performed and help them feel safe and comfortable?
4. Did you demonstrate empathy in communicating with patients, family, and staff?
5. Did you accurately and concisely update the provider on any aspect of the patient's care?

B. Presentation

1. Did you attend to any special needs of the patient? Did you ask first if assistance was needed, rather than taking charge?
2. Were you courteous, patient, and respectful to the patient?
3. Did you display a calm, professional, and caring manner?

C. Competency

1. Did you pay attention to detail?
2. Were you knowledgeable and accountable?
3. Did you apply critical thinking skills in performing patient assessment and care?

D. Initiative

1. Were you flexible and dependable?
2. Did you direct the patient to other resources when necessary or helpful, with the approval of the provider?

E. Integrity

1. Did you protect personal boundaries?
2. Did you protect and maintain confidentiality?

III. REFERENCES

- A. Lindh, Wilburta Q., Pooler, Marilyn S., Tamparo, Carol D., Dahl, Barbara M., & Morris, Julie A. *Delmar's Comprehensive Medical Assisting: Administrative and Clinical Competencies*, 5e
- B. Text Chapter 37, References/Bibliography
- C. Any other teacher-preferred reference material

IV. VISUAL AIDS

- A. Computer access to identified Internet resources
- B. Any teacher-preferred visual aids (PowerPoint, etc.)
- C. Video tutorials at <http://ecgteacher.com/>

V. EQUIPMENT AND MATERIALS

- A. Computer, TV monitor, and Internet access
- B. Holter monitor
- C. ECG tracing paper
- D. ECG leads, electrodes, and electrolyte
- E. Electrocardiograph
- F. Heart model
- G. See IV: Visual Aids

VI. SAFETY

- A. Establish basic classroom procedures.
- B. Follow Standard Precautions.
- C. Maintain confidentiality of diagnostic reports and other patient information.
- D. Attend to patient.
- E. Follow CLIA and OSHA regulations.
- F. Check all electrical wiring before use.

VII. PREPARATION

- A. Arrange for visual aids equipment.
- B. Collect materials.
- C. Review Chapter 37 in the text, the Study Guide, the Competency Manual, and the Instructor's Manual.

VIII. INTRODUCTORY REMARKS/ACTIONS

- A. Read Learning Outcomes in the text with students to introduce the chapter.
- B. Introduce topic to students as follows: “Remember seeing a movie or TV program in which a patient is in a hospital bed with a heart monitor hooked up so you could see the heartbeat? Today we are going to begin to learn about cardiology procedures and in a short time learn how to obtain an ECG. You will see the heartbeat print out on paper!”

IX. PRESENTATION

- A. Anatomy of the Heart
 - 1. Four chambers
 - a. Two upper chambers known as atria
 - b. Two lower chambers known as ventricles
 - 2. Deoxygenated blood
 - 3. Oxygenated blood
 - 4. Coronary arteries
- B. Electrical Conduction System of the Heart
 - 1. Sinoatrial (SA) node
 - 2. Atrioventricular (AV) node
 - 3. Bundle of His and Purkinje fibers
 - 4. Systole and diastole
 - 5. Impulses can be recorded on ECG paper or displayed on oscilloscope
- C. The Cardiac Cycle and the ECG Cycle
 - 1. Baseline or isoelectric line
 - 2. Positive deflection
 - 3. Negative deflection
 - 4. P, QRS, and T waves
 - 5. Each cardiac cycle takes about 0.8 second
 - 6. Calculation of Heart Rate on ECG Graph Paper
 - a. Description of ECG graph paper
 - b. Every fifth line is darker than other lines
 - c. Time is measured on horizontal line
 - d. Formula for calculating heart rate
 - e. Voltage is measured on the vertical line
- D. Types of Electrocardiographs
 - 1. Single-Channel ECG (see Procedure 37-1 in the text)
 - 2. Multichannel ECG
 - 3. Automatic ECG Machines
 - 4. ECG Telephone Transmissions
 - 5. Facsimile Electrocardiograph
 - 6. Interpretive Electrocardiograph
- E. ECG Equipment
 - 1. Electrocardiograph Paper
 - a. Black or dark blue
 - b. Wax- or plastic-coated
 - c. Heat and pressure sensitive
 - d. Heat of stylus can be adjusted to obtain a sharp tracing
 - 2. Electrolytes
 - a. Help pick up electrical current produced by contraction and relaxation of heart
 - b. Manufactured in form of gel, lotion, paste, or presaturated pads
 - c. Disposable sensors
 - 3. Sensors or Electrodes
 - a. Detect electrical impulses on body surface from the myocardium and relay them through cables
- F. Lead Coding
 - 1. Necessary for identification and mounting purposes
 - 2. Automatic coding
- G. The electrocardiograph and Lead placement
 - 1. Twelve leads record heart's electrical activity
 - 2. Allows for three-dimensional interpretation of activity

3. Amplification of electrical activity
4. Galvanometer changes voltage into mechanical motion
5. Stylus records motion
6. Placement of electrodes
7. Types of leads
 - a. Standard limb or bipolar leads (I, II, III)
 - b. Augmented leads (aV_R , aV_L , aV_F)
 - c. Chest leads, precordial leads, or V leads (V_1 to V_6)
- H. Standardization of the electrocardiograph
 1. Value of recording depends on accuracy
 2. Universal measurements
 3. One millivolt of cardiac electrical activity will deflect stylus exactly 10 mm high (discuss the Critical Thinking box)
- I. Standard Resting electrocardiography
 1. Performing 12-lead electrocardiogram, single channel (see Procedure 37-1 in the text)
- J. Mounting the ECG Tracing
 1. Commercially prepared mounting forms
 2. Mount completed tracing after provider has reviewed entire recording
 3. Individually cut, mount, and identify each lead
 4. Identify patient, date, age, blood pressure, height and weight, and cardiac medications
- K. Interference or Artifacts
 1. Somatic Tremor Artifacts (discuss the Critical Thinking box)
 2. Alternating Current (AC) Interference
 3. Wandering Baseline Artifacts
 4. Interrupted Baseline Artifacts
- L. Cardiac conditions and diseases
 1. Myocardial Infarctions (Heart Attack)
 - a. Primary cause of death in United States
 - b. Offer patient health tips as part of patient education
 2. Atherosclerosis
 3. Angina pectoris
 4. Health behaviors to adopt for a healthy heart
- M. Cardiac Arrhythmias
 1. Atrial Arrhythmias
 - a. Premature atrial contractions (PACs)
 - b. Paroxysmal atrial tachycardia (PAT)
 - c. Atrial fibrillation
 2. Ventricular Arrhythmias
 - a. Premature ventricular contractions (PVCs)
 - b. Ventricular tachycardia
 - c. Ventricular fibrillation
- N. Defibrillator
 1. Electrical device that applies countershocks to heart through electrodes or pads placed on chest wall (automated external defibrillator [AED])
 2. Can convert cardiac arrhythmia into normal sinus rhythm
- O. Other cardiac diagnostic tests and procedures
 1. Holter Monitor (portable ambulatory electrocardiograph) (see Procedure 37-2 in the text)
 - a. Portable continuous recording of cardiac activity for a 24-hour period
 - b. Noninvasive test
 - c. Helps diagnose cardiac arrhythmias by correlating them with patient's symptoms
 - d. Medical assistant's role
 - (1) Preparing patient (discuss the Critical Thinking box)
 - (2) Instructing patient
 - (3) Applying and removing monitor
 - e. Holter monitor attachment

- f. Patient activity diary
 - (1) Records all activities and emotional states and time of their occurrence
 - (2) Records chest pain and other symptoms and times of their occurrence
 - g. Holter monitor removal
 - (1) Patient returns to office
 - (2) Tape is analyzed by scanner or computer
 - (3) Written report sent to provider
 - 2. Treadmill Stress Test or Exercise Tolerance ECG
 - a. Done to diagnose heart disorders and probable cause of patient's chest pain and to assess patient's cardiac ability following cardiac surgery
 - b. Noninvasive test
 - c. Patient exercises on treadmill at varying rates of speed
 - 3. Thallium Stress Test
 - 4. Echocardiography
 - a. Noninvasive test
 - b. Uses ultrasound to image internal structures of heart
 - c. Transducer receives high-frequency sound waves when held against chest wall
 - d. Useful in diagnosing heart disease
 - 5. Coronary angioplasty with and without stent
 - a. Balloon inflated inside coronary artery with or without stent
 - b. Keeps artery open
 - 6. Coronary artery atherectomy
 - a. Cutting away of plaque in blocked coronary artery
 - 7. Coronary artery bypass
 - a. Vein transplanted into blocked coronary artery(ies)
 - b. Blood supply reestablished to myocardium
 - 8. Cardiac computed tomography and cardiac magnetic resonance imaging
- X. APPLICATION
- A. Use the Learning Outcomes at the beginning of Chapter 37 in the text as questions to assess comprehension.
 - B. See the Classroom Activities section below for numerous application activities.
 - C. Assign students to complete Chapter 37 in the Study Guide.
 - D. Complete the Procedures in Chapter 37, using the Competency Manual to evaluate.
- XI. EVALUATION
- A. Evaluate any assigned application activities.
 - B. Evaluate student participation during classroom activities.
 - C. Grade responses to Chapter 37 in the Study Guide.
 - D. Evaluate student performance on Chapter 37 Procedures.

Classroom Activities

1. Have students identify the structures of the heart on an anatomic model.
2. Have students trace the flow of blood on an anatomic chart, naming all the structures through which it passes.
3. Contact a surgeon who implants pacemakers to obtain one that has been removed or one that is nonfunctional to show to your students.
4. Show an appropriate film on the circulatory system. An old but excellent film by Disney Studios entitled *Hemo the Magnificent* may be available through your local library or health department. It illustrates, in animated form, the circulatory system and explains how it functions. The students will probably benefit more after they have studied this chapter; it really reinforces your instruction.
5. Contact a provider's office to borrow a Holter monitor apparatus or request someone to speak to the class and demonstrate its use. It might be possible for a student to wear the monitor for a day and then have the speaker explain how it is "read" by a computer.
6. Allow for lab time to have students practice electrocardiography techniques.

7. Arrange to have a representative from a medical equipment company speak to the class about stress testing, heart monitoring, and the latest in ECG equipment. Usually, the speaker will show slides or a video, offer a demonstration, and possibly supply pamphlets or other types of information.
8. Ask a cardiologist to explain heart catheterization procedures and other surgical procedures to the class.
9. Have students role-play the medical assistant explaining diagnostic tests and procedures to a patient.

Answers to Critical Thinking Boxes

Explain the significance of the small and large boxes on ECG paper. There are 2.5 large boxes between each cardiac cycle. What is the heart rate in beats per minute?

The small boxes on ECG paper denote time (in the horizontal) and voltage (in the vertical). One small square = 0.04 second. The large box comprises 25 small squares and measures 5 mm wide by 5 mm high. One large square = 0.04×5 , or 0.2 second. The heart rate is 120 beats per minute.

You have just performed an annual ECG on your patient, Ms. Cantrell. The tracing looks alarming. However, Ms. Cantrell is alert, oriented, and talking. What is your best course of action?

Remain calm. The medical assistant should always treat the patient, not the data. If the ECG demonstrates an abnormal tracing, first assess the patient's level of consciousness and vital signs. Then adjust the leads, check all connections, etc., until a reliable tracing can be obtained.

State three purposes for using a Holter monitor and give the instructions that the patient will need to know while wearing the monitor.

Any three of the following purposes of a Holter monitor: (1) to diagnose cardiac arrhythmias by correlating them with the patient's symptoms; (2) to diagnose sporadic arrhythmias; (3) to assess the function of an artificial pacemaker; (4) to assess the effectiveness of antiarrhythmia medications.

The instructions the patient needs to know while wearing the monitor are as follows: (a) Record activities in the activity diary. (b) Record symptoms such as chest pain, dizziness, shortness of breath, and palpitations. (c) When symptoms occur, press the event button in order to place a mark on the tracing to enable the person who is interpreting the tracing to look for an abnormality or a significant event. (d) Do not shower, bathe, or swim while wearing the monitor. (e) Do not handle the electrodes. (f) Do not remove the recorder from its case. (g) Do not use an electric blanket. (h) Return monitor in its case in 24 hours.

Answers to Case Studies

Case Study 37-1

Refer to the scenario at the beginning of the chapter. Wanda can empathize better with her patients now that she herself has had a baseline ECG.

1. The feelings Wanda had while having her tracing are experienced by many patients. Explain what you can do for your patients to allay their fears when they are getting ready for an ECG and during the tracing.

The explanation should include the information that the electrode pads have a gel backing that, at room temperature, will feel cold to the skin. In order to obtain the most accurate tracing, the patient should be still, not speak, and try not to cough or laugh as it will interrupt the baseline of the tracing. The procedure is not painful and will be brief.

Wanda can allay the patient's fears in several ways, such as:

- Giving the patient a step-by-step explanation of the purpose of an ECG, the procedure, and the equipment that will be used
- Making sure the patient is warm or cool enough and is comfortable lying on the ECG table
- Explaining to the patient that he will not experience any unusual sensations on or within his body
- Continuing to reassure the patient during the tracing that it is going along well and will soon be completed

Case Study 37-2

Abigail Johnson, who is in her mid-70s, arrives at the urgent care center reporting chest pain. She has been seen on two other occasions for similar pain and has a history of diabetes, hypertension, arteriosclerotic heart disease, and angina pectoris. Medical assistant Wanda Slawson immediately alerts Dr. Rice of Mrs. Johnson's chest pain and then takes her into the cardiac examination and treatment room. Dr. Rice tells Wanda to have Mrs. Johnson take one of her nitroglycerin tablets and to perform an ECG on her. Mrs. Johnson is restless and anxious as Wanda

prepares for the ECG and while the tracing is in progress. There is significant somatic tremor. Wanda attempts to allay Mrs. Johnson's apprehension to obtain a good quality ECG. The patient's pain subsides within a few minutes and she begins to feel better.

1. What immediate action could Wanda have taken if Mrs. Johnson's pain had not subsided?

Call emergency medical services—911—for transport to the hospital emergency room. Under Dr. Rice's direction, Wanda would prepare to administer oxygen and other medications as directed, frequently check blood pressure and pulse, place patient in semi-Fowler's position, assist Dr. Rice as needed, comfort and reassure the patient, and perform CPR if necessary.

2. Mrs. Johnson tells Wanda that Dr. Rice explained arteriosclerotic heart disease and angina pectoris to her, but that she was nervous and understood little and that she is embarrassed to admit that to Dr. Rice. How can Wanda explain, in language that the patient can comprehend, what causes arteriosclerotic heart disease and angina, and what Mrs. Johnson experiences during an attack of angina? What strategies can Wanda teach Mrs. Johnson to promote healthier habits and prevent more serious heart problems?

Using either hand-drawn pictures or an anatomic model of the heart, Wanda can explain the location of the coronary arteries on the myocardium of the heart and their significance as the major supplier of oxygenated blood to the heart itself. She could explain that the lining of the arteries build up with fatty deposits that harden over time and begin to block the flow of blood to the heart. Blood flow to the heart muscle is diminished (especially during periods of increased activity), and the heart's muscle tissue responds with symptoms of pain or pressure beneath the sternum into the neck, jaw, shoulder, or throat. Rest usually relieves the pain of angina. Pain that does not subside may indicate a complete obstruction of the coronary arteries. No blood flow to nourish the heart muscle results in a heart attack, a much more serious situation that requires immediate medical attention.

Some strategies and healthy habits about which Wanda can remind Mrs. Johnson are: (a) avoid tobacco, (b) take medications as prescribed, (c) report unusual symptoms or problems to Dr. Rice, (d) eat a low-fat, low-cholesterol, low-sodium diet, (e) exercise regularly with Dr. Rice's permission, (f) get adequate rest, (g) keep weight under control and at an acceptable level, (h) encourage family members to take a CPR course, and (i) practice stress reduction behaviors.

3. Research what community resources are available for persons with Mrs. Johnson's heart condition. Explain how Mrs. Johnson can locate them and how she could benefit from them.

Some resources that can benefit Mrs. Johnson are:

- American Heart Association, for educational materials to learn about arteriosclerotic heart disease and ways to prevent and manage it.
- American Diabetes Association, for educational materials and classes held in local clinics and hospitals regarding the relationship between diabetes and heart disease. Balance among exercise, diet, and insulin is stressed.
- American Dietetic Association, for educational materials on proper diet for diabetic control and prevention of further fatty deposits on artery linings of the heart.
- American Red Cross, for classes to learn CPR. A patient and family members benefit from learning CPR in the event that the patient suffers a myocardial infarction and goes into cardiac arrest.
- Weight control centers such as Weight Watchers for learning healthy eating and exercise behaviors for weight reduction and control. Portion control, low-fat, low-sodium food choices are stressed.
- YWCA (under Dr. Rice's direction), for enrolling in regularly scheduled exercise classes to strengthen her heart, lower blood cholesterol levels, and help reduce emotional stress. Yoga or meditation classes are also available for stress reduction.

Case Study 37-3

George Matthews, a 79-year-old patient of Dr. Abbott, has a history of cardiovascular heart disease. He tells Dr. Abbott that today he has been experiencing "palpitations and slow and fast heartbeats and sometimes dizziness." Dr. Abbott orders a resting ECG that shows no evidence of arrhythmia and decides that a Holter monitor electrocardiograph for Mr. Matthews might be helpful in diagnosing a cardiac arrhythmia.

1. Describe why Dr. Abbott ordered Holter monitor electrocardiography for Mr. Matthews.

The symptoms that Mr. Matthews has been experiencing—palpitations, fast and slow heartbeats, and dizziness—are symptoms of cardiac arrhythmia. Because Mr. Matthews's resting ECG showed no evidence of arrhythmia, Dr. Abbott orders a Holter monitor to record Mr. Matthews's cardiac activity for a 24-hour period. By going about his normal activities while wearing the monitor, should Mr. Matthews again experience similar symptoms, the monitor will pick up the abnormality.

2. What instructions will you give to Mr. Matthews about wearing the monitor?

Instructions to Mr. Matthews include:

- a. Keep a daily diary of all activities, symptoms, and emotions and note the time they occur.
- b. Do not shower or swim. The recording could be interrupted and the monitor damaged.
- c. Do not handle the electrodes. It could cause artifacts to occur.
- d. Do not remove the recorder from its case.
- e. Do not use an electric blanket. It can cause interference, another artifact.
- f. Depress the event marker only briefly and when experiencing a significant symptom. Overuse of the marker can mask the ECG tracing.

3. Mr. Matthews says he is not certain what activities should be recorded in the patient activity diary. Explain what they are and the reason for their importance.

Activities that should be recorded in the patient's diary include:

- a. Eating meals
- b. Sexual activity
- c. Medications taken
- d. Times of sleep
- e. Smoking
- f. Bowel movements
- g. Physical exercise
- h. Any symptoms

Answers to Certification Review

- 1. a. Somatic tremor
- 2. d. Parkinson's disease
- 3. d. 0.8 second
- 4. a. QRS complex
- 5. a. precordial
- 6. b. 10 leads
- 7. d. All of the above
- 8. a. deliver a countershock to restore normal heart rhythm
- 9. b. avoid stimulants like coffee, caffeine, and tobacco
- 10. c. percutaneous transluminal coronary angioplasty

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