Electrocardiography for Healthcare Professionals
Chapter 3: The Electrocardiograph

Learning Outcomes

3.1 Identify three types of leads, and explain how each is recorded.

3.2 Identify the functions of common ECG machines.

3.3 Explain how each ECG machine control is used.

3.4 Recognize common electrodes.

Learning Outcomes (Cont’d)

3.5 Describe the ECG graph paper.

3.6 Calculate heart rates using an ECG tracing.

3.1 Producing the ECG Waveform

■ The 12-lead ECG produces a complete picture of the heart’s electrical activity

3.1 12-Lead ECG

■ Utilizes 10 lead wires

■ Wires are color coded

■ Six chest leads

■ Four limb leads

■ Each lead is attached to an electrode

3.1 12-Lead ECG

3.1 Types of Leads

■ 10 lead wires

■ Produce 12 different views

■ Three standard leads

■ Three augmented leads

■ Six chest leads

3.1 Einthoven Triangle

3.1 Waveform Types

■ Isoelectric – flat, no current flowing

■ Positive – upright, current flows to positive electrode

■ Negative – downward, current flows away from positive electrode
3.1 Standard Limb Leads
- Lead I – records tracing from right arm (-) to left arm (+)
- Lead II – records tracing from right arm (-) to left leg (+)
- Lead III – records electrical activity from left arm (-) to left leg (+)

3.1 Augmented Leads
- aVR
  - Measures in direction of right arm
  - Records activity from heart to right arm
  - Usually produces a negative deflection
- aVL
  - Measures in direction of left arm
  - Records activity from heart to left arm
- aVF
  - Measures in direction of left foot
  - Records activity from heart to left leg

3.1 Chest Leads
- Also known as the precordial leads
- Placed on specific sites on chest
- Numbered V1 – V6

3.1 Chest Leads
- These leads are unipolar
- Numbered from V1 to V6
- Each lead tracing produces a slightly different picture of the heart

3.1 Producing the ECG Waveform
- Troubleshooting
  - Incorrectly attached lead wires produce unacceptable results and the ECG will have to be repeated.

3.1 Apply Your Knowledge
What are the names of the standard limb leads?

3.1 Apply Your Knowledge

What are the names of the standard limb leads?

ANSWER: Leads I, II, and III

3.1 Apply Your Knowledge

How many chest leads are there on a standard 12-lead ECG?

3.1 Apply Your Knowledge

How many chest leads are there on a standard 12-lead ECG?

ANSWER: Six

3.2 ECG Machines

- Weigh less than 10 pound
- Most have same basic parts
- Become familiar with the machine by reading instructions

3.2 Multi-channel Recorder

- Monitors leads three to six leads at a time
- Recording time is approximately 10 seconds

3.2 ECG Machine Functions

- Input
  - Signal processing
  - Output display

3.2 ECG Machine Functions (Cont’d)

- Computerized measurements and analysis
  - Storage
  - Communication
  - Interpretation

3.2 Apply Your Knowledge

What are the 3 major functions of an ECG machine?

3.2 Apply Your Knowledge

What are the 3 major functions of an ECG machine?

ANSWER: Input, signal processing, and output display
3.3 ECG Machine Controls

- **Speed**
  - Regulates speed of paper
  - Normally 25 mm/sec
  - Changes must be noted on ECG report
  - Troubleshooting – Very fast heart rates may require faster paper speed.

3.3 ECG Machine Controls

- **Gain**
  - Controls height of waveform
  - Normal setting is 10mm/mV
  - Changes must be noted on ECG report

3.3 ECG Machine Controls

- **Artifact filter**
  - Normal setting between 40 and 150 Hz
  - Can be used to reduce artifact or abnormal marks on tracing
  - Computer interpretation will be non-filtered

3.3 ECG Machine Controls

- **LCD display**
  - Area where patient info can be viewed
  - Newer machines may indicate incorrect lead placement in the display

3.3 ECG Machine Controls

- **Heart rate limits**
  - Machines may allow user to set heart rate limits which activate an audio alarm and marking on the tracing.

3.3 ECG Machine Controls

- **Lead selector**
  - Can be used if one or more leads needs to be repeated

3.3 Troubleshooting

- For excessive deflections on the ECG tracing
  - standardize the machine
  - adjust the gain control if necessary

3.3 Apply Your Knowledge

True or False: Very fast heart rates may require a faster paper speed.

ANSWER: True

3.3 Apply Your Knowledge

True or False: Very fast heart rates may require a faster paper speed.

ANSWER: True

3.3 Apply Your Knowledge

Which of the ECG controls can be used to reduce artifact?
3.3 Apply Your Knowledge

Which of the ECG controls can be used to reduce artifact?

ANSWER: Artifact filter

3.4 ECG Electrodes

- Sensors that pick up electrical activity, conducting to the ECG machine
- Ten electrodes are used for the 12-lead ECG
- Most electrodes are disposable type

3.4 Caution!!!

- Disposable electrodes are only used for one ECG
- Expiration date must be checked prior to use
- Never mix electrode types!

3.4 Apply Your Knowledge

How many electrodes are placed on a patient’s skin for a 12-lead ECG?

ANSWER: Ten electrodes

3.5 ECG Graph Paper

- Dot matrix
  - Requires less ink
  - Easier to read
  - Makes sharper photocopies

3.5 ECG Graph Paper

- Graph paper may be heat/pressure sensitive and easily erased
- Some graph paper requires no special handling/storage and is guaranteed for 50 years

3.5 ECG Graph Paper Essentials

- Paper supply
  - Keep extra paper on ECG cart
- Read directions
  - Know how to change the paper
- Law and ethics
  - Tracings must be kept seven years

3.5 Apply Your Knowledge

What substances can damage the ECG report?
Answer: Alcohol, plastic, sunlight, and x-ray film can erase the ECG tracing. Handle and store the ECG report with care.

3.6 Graph Paper Measurements
- Horizontal readings
  - Represent time
  - Measured in millimeters
- Vertical readings
  - Represent voltage
  - 1 cm = 1 millivolt

3.6 Graph Paper Measurements
- Each large box is 5mm x 5mm
- Each vertical heavy line is 0.2 seconds in time

3.6 Graph Paper Measurements
- Each horizontal heavy line is 5mm in voltage
- Each small box is 0.04 second in time and 1mm in voltage

3.6 Calculating Heart Rate
- R-R interval/300 method
- 6-second method
- 1500 method

3.6 Calculating Heart Rate: R-R Interval
- Divide 300 by the number of boxes between 2 R waves (note: 300 large boxes = 1 minute)
  - 300, 150, 100, 75, 60, 50

3.6 Calculating Heart Rate: 6-Second Method
- Identify a 6-second tracing
- Count the number of complete complexes seen in a 6-second strip
- Multiply the number of complexes by 10
- Do not count incomplete complexes

3.6 Calculating Heart Rate: 1500 Method
- Count the number of small squares between two R waves
- Divide into 1500

Each large box is equal to how many seconds?

ANSWER: 0.2 second
3.6 Apply Your Knowledge

3.6 The Heart Rate Is 70.

Chapter Summary
- The standard, augmented, and chest leads are used to produce the ECG
- Standard leads are bipolar, while augmented leads are unipolar

Chapter Summary (Cont’d)
- Input, signal processing, and output display are functions of the ECG
- ECG machines contain lead wires, LCD display, and paper for output
- Various types of ECG electrodes are used for ECG machines

Chapter Summary (Cont’d)
- ECG graph paper has boxes that measure both time and voltage
- Heart rate can be calculated using three different methods