Capital Health

LEARNING MODULE
FOR
CARDIAC MONITORING

Skin Preparation & Lead application is a
Post-Entry Level Competency for LPNs

Cardiac Rhythm Assessment is a
Post-Entry Level Competency for RN’s
CC 10-013

Developed by: Carol Harrietha, Nurse Educator
Sharon McNamara, Nurse Educator
Betty Hodgson, Nurse Educator

Date: May 2006
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Introduction</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prerequisites</td>
<td>3</td>
</tr>
<tr>
<td>Learning Objectives</td>
<td>3</td>
</tr>
<tr>
<td>Method</td>
<td>4</td>
</tr>
<tr>
<td>Theory / References</td>
<td>5</td>
</tr>
<tr>
<td>Self-test</td>
<td>16</td>
</tr>
<tr>
<td>Proficiency Standard Skills Checklist</td>
<td>19</td>
</tr>
</tbody>
</table>

---

Cardiac Monitoring:  
Cardiac Rhythm Assessment and Telemetry Monitoring  
Learning Module
Introduction:

- This Learning Module is a resource to assist:
  - LPNs develop proficiency in the Post-Entry Level Competency of Skin Preparation and Lead Application for Cardiac Monitoring. The learning process for this Post-Entry Level Competency should include assessment of the LPNs skill utilizing the standards outlined in the attached Proficiency Skills Checklist: Skin Preparation & Lead Placement.
  
  - RN’s in applicable units / areas, utilize a systematic approach for the Post-Entry Level Competency, Cardiac Rhythm Assessment. The learning process for this Post-Entry Level Competency should include assessment of the RN’s skill utilizing the standards outlined in the attached Proficiency Skills Checklist: Cardiac Rhythm Assessment.

- A variety of additional learning resources which includes text books, CD’s, educational programs and workshops, and on-line learning sites may also be used by the RN to assist with skill development for Cardiac Rhythm Assessment.

Prerequisites:

Basic knowledge of cardiac anatomy and physiology, and cardiac electrophysiology.

Learning Objectives:

Following completion of this Learning Module and reference readings, the LPN will be able to:

1. Correctly prepare skin, apply cardiac electrodes and connect the cable to the monitor or telemetry unit following unit protocol or manufacturers instructions.


Following completion of this Learning Module and reference readings, the RN in applicable units / areas will be able to:

1. Utilize a systematic approach to assess cardiac rhythm strips.

2. Record assessment of cardiac electrical activity.

3. Assist in recognition of cardiac ischemia.

4. Identify arrhythmias.

5. Identify life-threatening arrhythmias.
6. Identify artificial pacemaker rhythms.

7. Determine effect of drugs and/or electrolytes on the heart’s electrical system.

8. Utilize V5 in 6 lead monitoring for ST depression monitoring.

9. Identify artifact.

10. Initiate emergency response for life threatening arrhythmias.


Method:

LPNs

a. Review the policy and procedure.
b. Review relevant operational / equipment manual for operation for unit or site specific cardiac monitoring equipment.
c. Observe an RN or preceptor delegate prepare skin and apply electrodes for cardiac monitoring.
d. Complete the attached self-test.
e. Be observed by a RN delegate / preceptor successfully completely all skills outlined in the Proficiency Skills Checklist for Lead Application.

RN’s

a. Review the policy and procedure.
b. Review relevant operational / equipment manual for operation for unit or site specific cardiac monitoring equipment.
c. Review theory related to key principles of cardiac monitoring and systematic assessment of rhythm.
d. Theory review may include content in this learning module, or additional resources available on unit that cover key concepts.
e. Complete the attached self-test.
f. Be observed by a RN / preceptor successfully completely all skills outlined in the Proficiency Skills Checklists.

Theory:

1. **Cardiac Conduction System**
The heart’s electrical conduction system is an automatic sequential pathway, equipped with pacemaker nodal cells. The electrical impulse of the heart is the stimulus for cardiac contraction. The conduction system is responsible for the initiation of the electrical impulse and its sequential spread through the atria, atrioventricular (AV) junction, and ventricles.

**The SA Node:** in the normally functioning heart, the sino-atrial (SA) node is the initial point of electrical impulse generation, causing the heart to beat 60 – 100 beats/minute (bpm). The SA node is considered the natural pacemaker of the heart. The SA node is located high in the right atrium. The electrical impulse spreads through internodal pathways of the atrium causing atrial contraction.

**The AV Node:** the heart’s second major electrical station is the atrioventricular (AV) node, located in the low right atrium near the tricuspid valve. The AV node has three main functions:

1. conduction delay to allow adequate time for optimal ventricular filling from atrial contraction
2. it has a rate of 40 to 60 bpm and can function as a backup pacemaker if the SA node fails and
3. it screens out rapid atrial impulses to protect the ventricles from dangerously fast rates when the atrial rate is very fast.

**The Bundle of His:** the Bundle of His is located at the bottom of the AV node leading to the bundle branches. The electrical impulse is transmitted to both bundle branches.

**Bundle Branches:** the bundle branches are bundles of fibers that rapidly conduct the impulse into the right and left ventricles. The right bundle branch travels along the right side of the interventricular septum and carries the impulse into the right ventricle. The left bundle branch has two main divisions, the anterior fascicle and the posterior fascicle, which carry the impulse into the left ventricle.

**Purkinje Fibers:** the Purkinje fibers are hair-like fibers that rapidly conduct the impulse to the ventricular muscle cells. The cells will fire at a rate of 20 to 40 bpm and can function as a backup pacemaker if all other pacemakers fail.

2. **Basic Principles of Electrophysiology**

The heart’s electrical activity produces currents that radiate through the surrounding tissue to the skin. When electrodes are attached to the skin, they sense those electrical currents and transmit them to an electrocardiograph (ECG) monitor. The currents are then transformed into waveforms that represent the heart’s depolarization-repolarization cycle. The ECG can be recorded and/or monitored continuously on a cardiac monitor.

3. **ECG Paper Time and Voltage**

ECG paper consists of horizontal and vertical lines forming a grid. A piece of ECG paper is called an ECG strip or tracing.
Time is measured horizontally. Each small block equals 0.04 seconds and five small blocks form a large block, which equals 0.2 seconds. When determining a patient’s heart rate, a 6-second strip is used which consists of 30 large blocks. ECG paper is usually marked every 3-seconds.

Voltage is measured vertically. Each small block equals 1 mm or 0.1 mV and five small blocks form a large block, which equals 5 mm or 0.5 mV. To determine voltage of a wave, segment or interval, count the number of small blocks from the baseline to the highest or lowest point of the waves, segment or interval.

4. **Cardiac Rhythm Analysis**

A systematic approach to evaluation of a rhythm strip is required, followed by specific criteria for common arrhythmias encountered in clinical practice.

A systematic approach:

a. **Determine Atrial Rhythm**
   - Determination of regularity of the P wave by use of calipers or pencil and paper.

b. **Determine Atrial Rate**
   - There are three methods for determining the heart rate; the six second count, heart rate calculator and triplicate method. These are described later.

c. **Evaluate P wave**
   - Represents atrial depolarization
   - Is the first component of a normal ECG waveform and precedes the QRS complex
   - Usually rounded and upright in lead II

d. **Determine P-R interval**
   - Represents the time required for the impulse to travel through the atria, AV junction and Purkinje fibers.
   - The normal duration is 0.12 – 0.20 seconds. This is done by measuring from the start of the P wave to the beginning of the following QRS, measuring from left to right. Compare different P-R intervals and determine relationship of P waves and QRS.

e. **Determine Ventricular Rhythm**
• Determination of regularity of the QRS by use of calipers or pencil and paper.

d. **Determine Ventricular Rate**
   • There are three methods for determining the heart rate; the six second count, heart rate calculator and triplicate method.

g. **Evaluate QRS Complex and Duration**
   • The QRS complex follows the P wave and represents depolarization of the ventricles.
   • Identify the QRS complexes, examine the QRS duration and shape and compare the QRS complexes.
   • The normal QRS duration is 0.06 to 0.10 seconds and is measured where it leaves the baseline to where it returns to the baseline.

h. **Evaluate the T wave**
   • The T wave represents ventricular recovery or repolarization.
   • Follows the QRS complex, typically round and smooth and usually upright.

i. **Evaluate the ST segment**
   • The ST segment represents the end of ventricular conduction or depolarization and the beginning of ventricular recovery or repolarization. The point that marks the end of the QRS complex and the beginning of the ST segment is known as the J point. Observe the ST segment 0.08 mm from the J point.
   • The ST segment should be at the isoelectric line and gently curve up into the T wave.
   • A depressed ST segment (greater than 2 small boxes or 0.2 mV below the isoelectric line) may indicate myocardial ischemia or digoxin toxicity.
   • An elevated ST segment (greater than 2 small boxes or 0.2 mV above the isoelectric line) may indicate myocardial injury.

j. **Determine QT interval**
   • The QT interval represents ventricular depolarization and repolarization.
   • The normal duration is 0.36 to 0.42 seconds and is measured from the beginning of the QRS complex to the end of the T wave.

k. **Determine the pacemaker site**
   • Analyze the P waves and QRS complexes. Determine the relationship of P waves and QRS complexes.
   • If the P wave appears upright and rounded then the pacemaker site is the SA node.

l. **Determine the significance**
   • Correlate the rhythm assessment to the patient’s clinical condition.

5. **Determine the rhythm**

The purpose of determining the rhythm is to evaluate if a rhythm is regular or irregular. You
can use either of the following methods to determine atrial or ventricular rhythm.

a. **Paper-and pencil method**
   - With a pencil, mark a separate piece of paper at the P wave (atrial) or R wave (ventricular).
   - Next, move the paper across the strip, aligning the two marks with succeeding P-P interval or R-R intervals.
   - If the distance is the same over 6 seconds or varies by less than 0.12 seconds, the rhythm is considered regular.
   - If the distance varies, the rhythm is irregular.

b. **Calipers**
   - Place one point of the caliper on the peak of the first P wave or R wave.
   - Adjust the caliper legs so the other point is on the peak of the next R wave.
   - Pivot the first point of the caliper toward to the third P wave or R wave and note whether it falls on the peak of the wave.
   - Check succeeding intervals the same way.
   - If they are the same, the rhythm is considered regular.
   - If they vary, the rhythm is irregular.

6. **Determine the Rate**

   There are three methods to determine atrial and ventricular heart rate. Do not rely on these methods alone. Always check a pulse to correlate it with the heart rate on the ECG. The methods are:

a. **The Six Second Count** is simple and most common method. This method can be used with a regular or irregular rhythm
   - To determine the atrial rate, count the P waves in a 6-second strip, multiply by 10 for 1 minute rate.
   - Calculate ventricular rate the same way, using the R waves.

b. **The Heart Rate Calculator** is fast and accurate.
   - To determine the rate follow the calculator directions.

c. **The Triplicate Method** requires you to memorize a sequence of numbers.
   - To determine the ventricular rate, identify a R wave on a dark vertical line
   - Identify the first R wave to the right and label the dark vertical lines from left to right 300, 150, 100, 75, 60, 50. Put 300 on the dark vertical line to the right. Estimate rate by the number closest to R wave.
   - Determine the atrial rate the same way, using the P wave.

7. **Determine Normal Sinus Rhythm**

   The first step in rhythm assessment is recognizing normal sinus rhythm. It is the
standard to compare all other rhythms to normal sinus rhythm.

The characteristics of normal sinus rhythm include:

- **Heart rate**: 60 –100
- **Rhythm**: atrial and ventricular rhythm regular
- **Pacemaker site**: SA node
- **P wave**: identical, precede each QRS, positive in lead II
- **PR interval**: 0.12 –0.20 seconds
- **QRS**: after each P wave, 0.10 seconds or less
- **T waves**: upright and round
- **ST segment**: flat
- **QT interval**: 0.36 – 0.42 seconds

8. **Classes of arrhythmias**

Arrhythmias are classified by the pacemaker site. The different classes of arrhythmias are: sinus node, atrial, junctional, ventricular and atrioventricular blocks. You should be familiar with various the arrhythmias.

**Sinus node arrhythmias** occur when the electrical impulse originate in the sinoatrial (SA) node. The various sinus node arrhythmias include:

- Sinus arrhythmia
- Sinus bradycardia
- Sinus tachycardia
- Sinus arrest
- Sick sinus syndrome

**Atrial arrhythmias** occur when the electrical impulse originate from an ectopic focus in the atria, somewhere other than the SA node. These arrhythmias are the most common cardiac rhythm disturbances. The various atrial arrhythmias include:

- Premature atrial contractions (PAC)
- Atrial tachycardia
- Atrial flutter
- Atrial fibrillation
- Supraventricular tachycardia (SVT)
**Junctional arrhythmias** occur when the electrical impulse originates in the atrioventricular (AV) junction, the area around the AV node and the bundle of His. The various junctional arrhythmias include:

- Premature junctional contraction (PJC)
- Junctional escape rhythm
- Accelerated junctional rhythm
- Junctional tachycardia

**Atrioventricular (AV) heart blocks** are caused by an interruption in the conduction of impulses between the atria and ventricles. The various atrioventricular blocks include:

- First degree AV block
- Second degree AV block type I (Wenckebach or Mobitz type I)
- Second degree AV block type II (Mobitz type II)
- Three degree AV block

**Ventricular arrhythmias** occur when the electrical impulse originate in the ventricles below the Bundle of His. Although ventricular arrhythmias may be benign, they can be potentially life threatening. It is vital that you can determine a life threatening situation and initiate emergency response according to hospital protocol. The various ventricular arrhythmias include:

**Premature Ventricular Contraction (PVC)**

- Premature ectopic impulse originates in the ventricles
- P wave is not associated with the PVC
- QRS is wide, bizarre, abnormal and premature
- ST and T usually opposite of the QRS main deflection
- Pause usually compensatory
- Have a variety of patterns – bigeminy, multifocal, coupling
- PVCs may be benign or a warning sign of impending lethal arrhythmias. Treatment for PVCs varies with the cause and the patient’s symptoms.

**Ventricular Tachycardia (V Tach)**

- Originates in ectopic ventricular pacemaker
- Rate 110 – 250
- QRS abnormal, bizarre and wide greater than 0.12 seconds
• 3 or more PVC’s
• This arrhythmia is an extremely unstable rhythm. The rhythm can severely compromise cardiac output and create an emergency situation. It can occur in short bursts lasting fewer than 30 seconds and causing few or no symptoms.

Ventricular Tachycardia

Torsades de Pointes
• QRS complex twist
• Associated with prolonged QT
• Ventricular rate often greater than 200
• Ventricular fibrillation often follows V-tach
• This arrhythmia is an extremely life-threatening rhythm and requires emergency response.

Ventricular Fibrillation (v-fib)
• Originates in many ventricular ectopic sites
• Rapid abnormal ventricular fibrillation (f) waves
• No QRS
• Rhythm is grossly irregular and chaotic
• The pattern may be coarse or fine
• V-fib is an extremely life-threatening rhythm and requires emergency response.
Asystole
- There is no electrical activity in the ventricles
- Heart rate is 0
- No ventricular pacemaker
- P waves present or absent
- QRS absent
- Appears as a flat line on the ECG strip
- Asystole is an extremely life-threatening rhythm and requires emergency response.

Pulseless Electrical Activity (PEA)
- Detectable pulse and blood pressure is absent
- Electrical activity in heart present
- ECG rhythm present
- No mechanical response
- PEA is an extremely unstable rhythm and requires emergency response.

9. **Artificial pacemaker rhythms**

A pacemaker is an artificial device that electrically stimulates the myocardium to depolarize in the absence of the natural pacemaker; refer to pacemaker policy.
10. **Documentation**

A cardiac rhythm strip should be documented at the beginning of each shift, with rhythm changes and with changes in patient condition. Refer to unit protocol, if applicable. Documentation is to include: heart rate, rhythm, PR, QRS, QT, ST and rhythm assessment. Any patient assessment and interventions should also be documented.

**Theory / References**

- Marquette Medical Systems Inc., Milwaukee, Wisconsin, USA.
Test:

RNs and LPNs:

1. Skin preparation, washing, drying and shaving the skin, prior to placing the electrodes for cardiac monitoring is important to:
   a) Improve electrical conduction between the skin and the electrode gel
   b) Improve adhesion of the electrode to the skin
   c) Decrease discomfort when the electrode is removed
   d) All of the above

2. To monitor using 5 leads, you would place the electrodes:
    a) RA and LA at the second ICS of the R and L mid clavicular line; the RL and LL at the R and L lower rib cage and the V lead at the 4th ICS R sternal border.
    b) RA and LA at the second ICS of the R and L mid clavicular line; the RL and LL at the R and L lower rib cage and the V lead at the 6th ICS R sternal border.
    c) RA and LA at the second ICS of the R and L mid clavicular line; the RL and LL at the R and L torso below the rib cage and the V lead at the 4th ICS L sternal border.

RNs only:

3. Atrial activity and conduction is revealed on the monitor strip by:
   a) The QRS interval
   b) The QT interval
   c) The p wave and PR interval
   d) The R wave and ST segment

4. The appearance of artifact on the cardiac monitor can indicate:
   a) Displaced lead
   b) Electrical interference
   c) Increased patient activity
   d) Dried out gel on an electrode
   e) Any or all of the above
5. The normal pacemaker of the heart is the:
   a) SA node
   b) AV node
   c) Bundle branches

6. The appearance of cardiac rhythm changes that require patient assessment and notification of physician include:
   1) ↑ or ↓ ST segments, flattened or inverted T waves
   2) Frequent alarms and baseline artifact
   3) Frequent PVC’s, couplets and short runs of VT
   4) Tachycardia or bradycardia
      a) 1, 2, 3
      b) 1, 3, 4
      c) 2, 3, 4
      d) All of the above

7. Which method is best when determining the rate when the rhythm is irregular?
   a) Six second count
   b) Heart rate calculator
   c) Triplicate method

8. In Lead II, a normally conducted heartbeat should produce on the monitor:
   a) positive p wave, negative R wave, depressed ST segment and positive T wave
   b) negative p wave, negative Q wave, elevated ST segment, positive T wave
   c) positive p wave, positive R wave, isoelectric ST segment, positive T wave
   d) positive p wave, positive QRS, elevated ST segment, positive T wave

9. The VT alarm sounds on the monitor; the monitor is showing a rapid wide complex pattern; you can see the patient sitting up, talking to a visitor. You would immediately:
   a) shut off the alarm; it is probably just artifact
   b) call a code
   c) assess the patient for symptoms; get assistance and
   d) notify the physician
   e) wait until the visitor leaves and notify the physician
Answers:

1. d
2. a
3. c
4. e
5. a
6. b
7. a
8. c
9. c
PROFICIENCY STANDARDS SKILLS CHECKLIST
TITLE: Lead Application and Cardiac Rhythm Assessment

Note: The Proficiency Standard Skills Checklists are tools to assess technical competence. For complete information on the concepts discussed in the checklist, the reference readings, or resources & must be utilized.

<table>
<thead>
<tr>
<th>RN and LPN: Lead Application</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Identifies patient and explains procedure.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Prepares skin as recommended</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Applies electrodes and lead wires using correct anatomical landmarks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Secures lead wire with a stress loop</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Connects cable to monitor or telemetry unit as per manufacturer instructions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Instruct telemetry patient to use graph button &amp; reinforce need to use call-bell.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RN only: Cardiac Rhythm Assessment</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. Selects monitoring features &amp; sets alarm parameters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Utilizes trouble-shooting methods to obtain tracing with minimal artifact.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Systematically assesses cardiac rhythm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Determine atrial rhythm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Determine atrial rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Evaluate p wave</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Determine P-R interval</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Determine ventricular rhythm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Determine ventricular rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Evaluate QRS complex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Evaluate the T wave</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Determine the ST segment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Determine QT interval</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Determine the pacemaker site</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Determine the significance of the rhythm in relation to</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
the clinical picture
- Determine the rhythm

9. Able to recognize life-threatening arrhythmias and knowledgeable of emergency response procedures

10. Documents rhythm analysis, patient assessment & interventions

11. Utilizes unit specific protocols as applicable