11 Pacemaker Rhythms

Learning Outcomes

11.1 Identify the various types and functions of pacemakers.

11.2 Analyze pacemaker rhythms and their effect on the patient, including basic patient care and treatment.

11.3 Summarize pacemaker complications relative to the ECG tracing.

Key Terms

- atrial pacing
- atriobiventricular pacing
- atrioventricular delay
- atrioventricular sequential pacing
- coronary sinus
- electrical capture
- electronic pacemaker
- inherent rhythm
- loss of capture (failure to depolarize)
- malfunctioning (failure to pace)
- malsensing (failure to sense)
- mechanical capture
- oversensing
- pacemaker competition
- pacing spike
- undersensing
- ventricular pacing

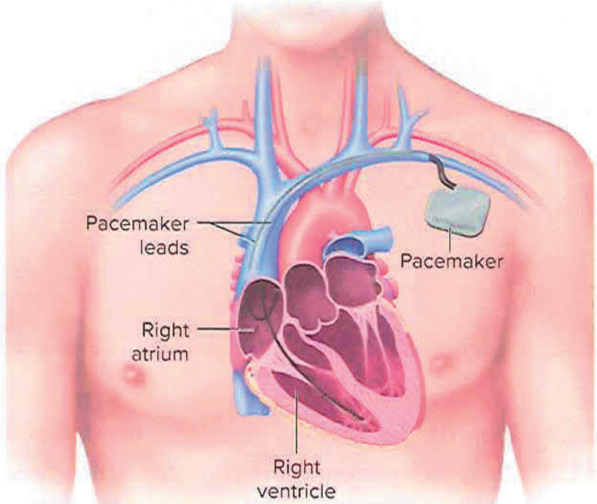
11.1 Introduction to Pacemakers

electronic pacemaker An artificial source of electrical current causing depolarization of the myocardium; artificial pacemakers are electronic.

Electronic pacemakers, also known as *artificial pacemakers*, are devices that deliver an electric impulse to the myocardium to cause the cells to depolarize. These devices consist of two parts: a generator and one to three wires (leads). The electrical generator provides small amounts of electric current at predetermined intervals to mimic the normal pacemaker of the heart. The lead wires are placed to stimulate or *pace* the atria, ventricles, or both sets of chambers. Pacemakers are sometimes temporary but are usually surgically implanted under the skin (Figure 11-1) to correct dysrhythmias.

Although many different types of electronic pacemakers are implanted, the mode in which they function varies in only a few ways. Because of the variety of pacemakers available on the market, it is recommended that you check in advance regarding the proper procedure for performing an ECG on a patient with a pacemaker.

Figure 11-1 Implanted pacemaker.



Safety & Infection Control

Pacemaker

The pacemaker's electric current is not dangerous to you or other people who encounter the patient. The amount of current emitted by the pacemaker is so low that it is not perceptible on the surface of the skin.

Pacemaker Function

As you know, the fastest pacemaker in the heart controls the heart rate, whether it is an inherent pacemaker, such as the SA node, an abnormal one (as, e.g., in ventricular tachycardia), or an artificial one. Electronic pacemakers work based on this principle. For example, when a patient is experiencing a bradycardic dysrhythmia, an artificial pacemaker is used and is typically set at a rate of between 70 and 72 beats per minute. This artificial pacemaker becomes the fastest pacemaker in the heart and thus controls the heart rate.

The basic function of a pacemaker is to initiate depolarization in order to stimulate a contraction. Pacemakers can speed up a slow heart rhythm, help control an abnormal or fast heart rhythm, or coordinate electrical signaling within the heart. For example, if the patient is experiencing problems with the conduction system in the ventricles, a ventricular pacemaker is surgically implanted with a pacing wire that is threaded into and embedded into the endocardial layer within the ventricle. This device delivers direct stimulation to the ventricles to produce a ventricular contraction. This is **ventricular pacing. Atrial pacing** is used alone when the conduction system from the atrioventricular node through the ventricles is intact and functioning. The resulting atrial impulses are conducted normally through the ventricles, causing ventricular contraction.

Atrioventricular pacing provides direct stimulation of the atria and right ventricle in a sequence pattern known as **atrioventricular sequential pacing.** This pacing option mimics the normal cardiac conduction system. It stimulates the atria first, pauses to allow for atrial kick, then stimulates the ventricle. The atria contract completely prior to the ventricles to allow for an atrial kick. (Remember that the atrial kick provides the extra blood

ventricular pacing Electrical stimulation is delivered to the ventricle(s) to stimulate ventricular depolarization and result in ventricular contraction.

atrial pacing Electrical stimulation is delivered to the atria to cause conduction from the AV node through the ventricles resulting in ventricular contraction.

atrioventricular sequential pacing A pacemaker stimulation of the atria and then the lower part of the right ventricle in a sequence that mimics the normal cardiac conduction system and allows for atrial kick.

supply needed for approximately 10% to 30% of the normal cardiac output.) Atrioventricular pacing is used frequently because it mimics normal cardiac function and provides the atrial kick needed.

Another type of atrioventricular sequential pacing is atriobiventricular pacing, which is used commonly in patients with heart failure. **Atriobiventricular pacing** stimulates both ventricles to contract instead of the typical stimulation of only the right ventricle.

atriobiventricular pacing A sequential pacemaker stimulation of the atria and then both ventricles, rather than just the right ventricle. Also known as *biventricular pacing.*

Pacemakers are programmed to work in different ways: fixed-rate, demand, and rate-responsive. A *fixed-rate* (asynchronous) pacemaker delivers electrical stimulation at a constant rate. This type of programming is now uncommon. In this fixed-rate mode, there is a small risk of producing dangerous dysrhythmias if the impulse coincides with the vulnerable period (downslope) of the T wave. A *demand* (synchronous) pacemaker detects ventricular activity and either suppresses or discharges stimulation from the pacemaker generator in order to make the impulse fall within the safe period of the QRS complex. A *rate-responsive* pacemaker may speed up or slow down the heart rate based upon the metabolic demands of the body. It monitors things such as the sinus node rate, breathing, and blood temperature.

Types of Pacemakers

Although all pacemakers have a generator and one to three lead wires, there are different types. The name and types are based on where the leads are placed and how they function. Single chamber pacemakers have a single lead placed in the heart; either in the right atrium or the right ventricle. These types of pacemakers are used when the SA node is not functioning (atrial single chamber pacemaker) or the AV node is not functioning (ventricular single chamber pacemaker).

Dual-chamber pacemakers have pacing electrodes in both the right atrium and the right ventricle and provide for coordination of the atria and ventricles. A newer type is known as *dual-site atrial pacing.* It has two leads: one in the right atrium and the other at or near the **coronary sinus.** This system may be used to treat one type of atrial fibrillation. This system may be used to treat one type of atrial fibrillation. Atriobiventricular pacemakers have three implanted leads; one pace in the right atrium, one pace in the right ventricle, and the third lead is positioned to pace the left ventricle (via the coronary sinus vasculature). These systems are used for heart failure.

coronary sinus An area located on the back of the heart where the left atrium and left ventricle come together called the sulcus (groove). This structure is where the coronary veins return blood from the heart itself to the circulating blood in the right atrium.

Another type of pacemaker is designed to treat a cardiac tachydysrhythmia directly. It is known as an implantable cardioverter-defibrillator. When implanted, the device senses a ventricular rate that exceeds the programmed cutoff rate; then the defibrillator performs defibrillation/cardioversion. The device may also be programmed to attempt to pace rapidly for a number of pulses (usually 10) to attempt pace-termination of ventricular tachycardia.

In order to help prevent confusion when dealing with pacemakers, the *North American Society of Pacing and Electrophysiology* and the *British Pacing and Electrophysiology Group* have developed a code to describe various pacing modes. The system usually consists of three letters but some systems use four or five. The letters are discussed below and in Table 11-1.

TABLE 11-1 Pacemaker Codes

Letter Position I	Letter Position II	Letter Position III	Letter Position IV	Letter Position V
(Paced Chamber)	(Sensed Chamber)	(Response to Sensed Event)	(Programmability, Rate-Responsive)	(Multisite Pacing)
0 = none	0 = none	0 = none	0 = none	0 = none
A = atria	A = atria	I = inhibited	R = rate-responsive	A = atria
V = ventricles	V = ventricles	T = triggered		V = ventricles
D = (A + V)	D = (A + V)	D = (I + T)		D = (A + V)

- Letter I represents the chamber that is paced: atria (A), ventricles (V), or dual-chamber (D).
- Letter II refers to the location where the pacemaker senses native cardiac electrical activity. This can also be A, V, D, or in some cases 0, meaning there is no sensing.
- Letter III refers to the response to how the pacemaker senses native cardiac activity. Triggered (T) means the sensed activity results in a paced activity. Inhibited (I) means the sensed activity results in an inhibition or pacing activity.
- Letter IV, if seen, indicates the rate-responsive feature. As discussed, with rate-responsive pacemakers, sensors may measure and respond to variables including vibration, respiration, or acid-base status and alter the rate to meet metabolic demands.
- Letter V, if seen, indicates multiple stimulation sites within one anatomical area. For example, it may indicate more than one pacing site with the atria or biatrial pacing.

In practice, it is common to refer to the first three letters such as VVI (ventricle, ventricle, inhibited). Using all five letters, a **DDDRO** pacemaker is one that has these characteristics:

D: The pacemaker is capable of pacing both the atria and ventricles.

D: The pacemaker is capable of sensing intrinsic cardiac activity in both the atria and ventricles.

D: The pacemaker is capable of triggered pacing (rarely used) and inhibiting itself in response to sensed events.

R: The pacemaker is rate responsive (increasing rate during periods of increased metabolic demand).

O: It is not a multisite pacemaker. (It is not used for resynchronization therapy.)

Checkpoint Questions (LO 11.1)

1. When is an atrial pacemaker used alone?

____

____

2. What is the advantage of atrioventricular sequential pacing?

____

____

3. What is a rate-responsive pacemaker?

____

____

11.2 Evaluating Pacemaker Function

electrical capture Evidence of the heart's activity on an ECG tracing, including the spacing of spikes and waveforms.

mechanical capture The heart's ability to respond to electrical impulses delivered by a natural or electronic pacemaker.

Pacemaker function can be evaluated based on the ECG tracings. Several different ECG characteristics must be identified prior to evaluating the pacemaker function. The most important aspect of care is to verify the effectiveness of the pacemaker and determine the presence of a pulse with each captured beat. The term *capture* is used to mean two different things. **Electrical capture** refers to the evidence we see when viewing the cardiac tracing on the heart monitor or ECG machine (the spacing of spikes and associated waveforms). **Mechanical capture** refers to the heart's ability to respond (contract) to the electrical impulses that are being delivered to the heart.

Evidence of mechanical capture is observed when obtaining the patient's pulse and blood pressure. It is important to note that just because we see electrical evidence on a heart monitor, it does not mean that the heart is actually pumping well enough to sustain life. *Always remember to check the patient!*

Pacing Spike

pacing spike A thin spike on the ECG tracing that results from the pacemaker stimulation impulse.

The **pacing spike** on an ECG tracing results from the discharge of electric current from the pacemaker. The current is a quick delivery and is reflected as a thin spike (Figure 11-2). Immediately after a pacing spike, a tracing of a P wave or a wide QRS complex or both will appear, depending on which chamber is being paced.

Interpret-TIP

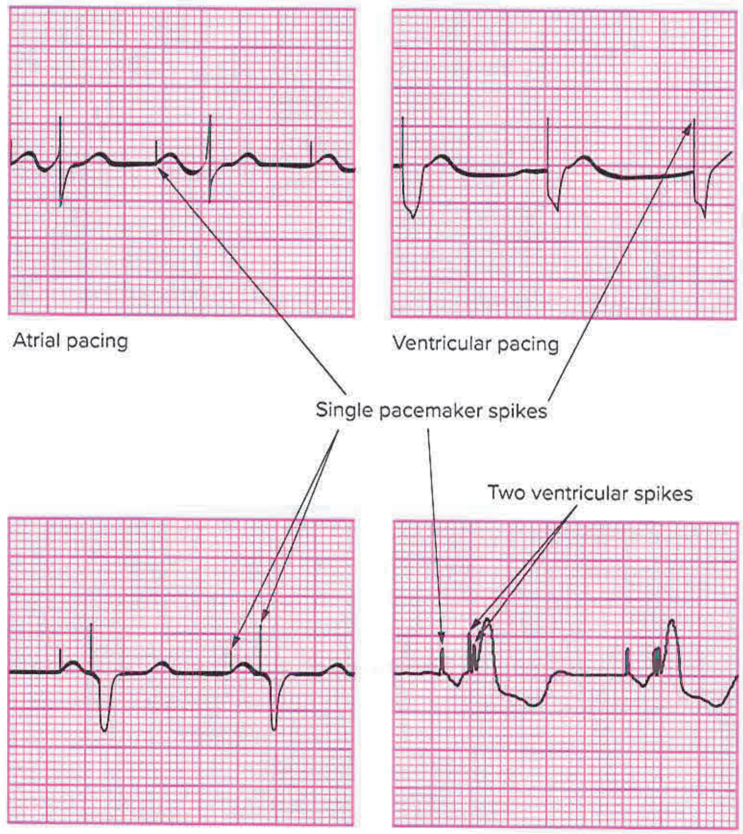
Pacemaker Rhythms

Pacemaker rhythms are distinguished by the conspicuous presence of a spike prior to the waveform of the portion of the heart that is being paced. For example, a spike before the P wave indicates that the pacemaker is initiating the atrial depolarization.

Chamber Depolarization Characteristics

If the pacemaker delivers atrial pacing, the pacing spike will be immediately followed by a P wave. When the pacemaker delivers ventricular pacing, the pacing spike(s) will be immediately followed by a wide QRS complex, which typically looks similar to a left bundle branch block (LBBB) pattern with a ventricular pacemaker or a right bundle branch block (RBBB) with a biventricular pacemaker. The ventricles are stimulated low, causing the

Figure 11-2 The pacing spike is atrial, ventricular, or both depending on the type of pacemaker.



myocardium to depolarize slowly. The complex is wide and shaped differently from a natural QRS complex. The complex will look similar to either an RBBB or an LBBB, depending on the ventricular pacing device implanted.

AV Delay

atrioventricular delay The measurement from the atrial spike to the ventricular spike, or from the beginning of the P wave to the ventricular spike on a pacemaker tracing.

The AV sequential and atriobiventricular pacemaker tracings have an **atrioventricular delay.** An atrioventricular delay is similar to the measurement of the PR interval on a normal rhythm tracing. It is measured from the atrial spike to the ventricular spike. Usually, this programmed time frame is somewhere between 0.12 and 0.20 second, similar to a normal PR interval.

If the patient has a normal P wave and a pacemaker-induced ventricular complex, the atrioventricular delay is determined from the beginning of the P wave to the ventricular spike. If the patient has a pacemaker-induced atrial complex and a normal QRS measurement, the measurement from the pacing spike to the beginning of the QRS complex should be less than the set atrioventricular delay time frame. The set AV delay is usually for a PRI of 0.20 second.

Evaluating a Pacemaker ECG Tracing

Evaluating a pacemaker rhythm involves seven steps, which are similar to those used to evaluate a nonpaced rhythm. In addition, it is important to estimate the frequency of the pacemaker initiating the rhythm compared

inherent rhythm
The patient's own heart rhythm.

to the patient's **inherent rhythm.** The estimates are usually referred to in 25% intervals. If the entire rhythm strip displays an atrioventricular paced rhythm, it is referred to as 100% atrioventricular pacing (1:1). When less than 100% paced rhythm occurs, identify the patient's inherent rhythm, and then include an estimate of the ratio or percentage of paced beats and the type of pacing function as seen on the rhythm strip.

Step 1. *Evaluate the rate and regularity of the paced rhythm.*

The spacing of the pacemaker spikes should be exactly the same, resulting in a regular rhythm. Only if the patient's own rhythm becomes faster than the pacemaker will the spacing be different. The rate of the pacemaker rhythm should be measured between two consecutive pacer spikes and should be exactly the number at which the pacemaker was set. Often the rate is set at 70 beats per minute.

Step 2. *Evaluate the rate and regularity of the intrinsic (native) rhythm (the patient's own rhythm).*

When the patient's own heart rate beats faster than the pacemaker rhythm, the patient's intrinsic rhythm will control the heart rate. The patient's own rhythm should be noted on the ECG tracing. The rate and regularity will depend on the patient's inherent rhythm.

Step 3. *For AV sequential and atriobiventricular pacemakers only, determine if the atrial lead sensing is appropriate.*

Evaluate the ECG tracing for the presence of atrial spikes with the P wave immediately following the spike. Occasionally, the patient's own SA node or an atrial ectopic focus will initiate atrial contraction as evidenced by a P wave without an atrial spike.

Step 4. *For atrial, AV sequential, and atriobiventricular pacemakers, determine if the atrial capture is present.*

Every atrial spike should have a P wave immediately following the spike to indicate that the electrical current is causing the atrial cells to depolarize. The P wave after the spike indicates that the atrial capture occurred.

Step 5. *For AV sequential and atriobiventricular pacemakers, determine if the atrioventricular delay is appropriate.*

Measuring from the atrial spike to the ventricular spike, or from the beginning of the P wave to the ventricular spike, will give you the atrioventricular delay interval. This time frame should be the same as the atrioventricular delay set on the pacemaker program. This information should be available on the patient's medical record or pacemaker information card. It is usually set at a normal PRI of 0.20 second.

Step 6. *Determine if the ventricular sensing is appropriate.*

The ECG tracing needs to be evaluated for the presence of ventricular spikes with a wide QRS complex following each spike. Occasionally, the patient's own conduction system will work appropriately, as evidenced by a normal P wave and/or QRS complex. If the ventricular depolarization occurs normally before the pacemaker sends a ventricular impulse, the pacemaker generator is inhibited, or stopped. This is evidenced by the absence of a ventricular spike.

Step 7. *Determine if the ventricular capture is present.*

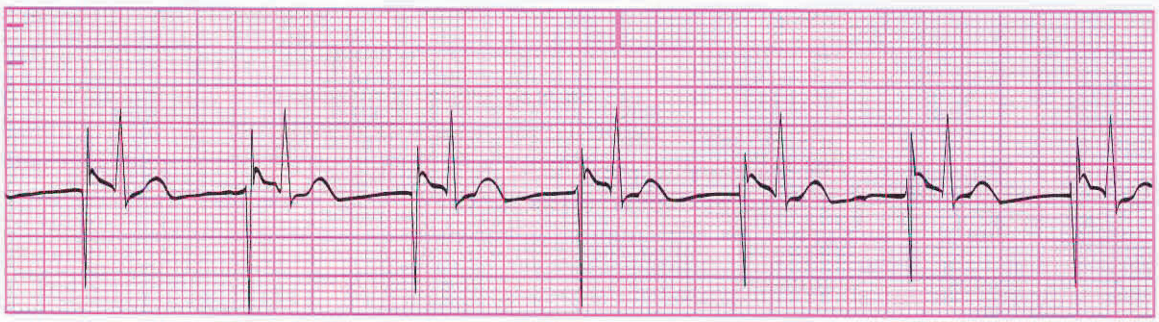
Every ventricular spike should have a wide QRS complex immediately after it to indicate that the electrical current caused the ventricular cells to depolarize. Appearance of the QRS complex after the spike indicates that ventricular capture occurred.

Checkpoint Questions (LO 11.2)

1. Using the criteria for classification, select the rhythm that most closely resembles atrial pacemaker rhythm.

A.

B.



Which distinguishing feature(s) led you to make the selection?

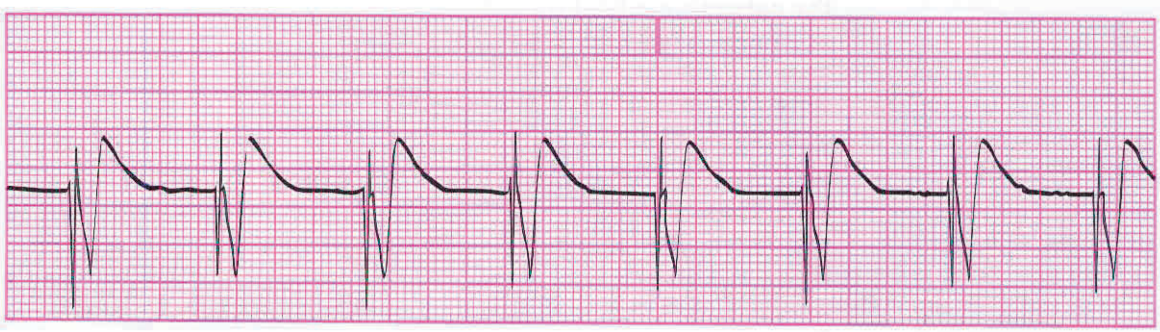
____

____

____

2. Using the criteria for classification, select the rhythm that most closely resembles ventricular pacemaker rhythm.

A.



B.

Which distinguishing feature(s) led you to make the selection?

____

____

____

3. Using the criteria for classification, select the rhythm that most closely resembles atrioventricular (AV sequential) pacemaker rhythm.

A.

B.

____

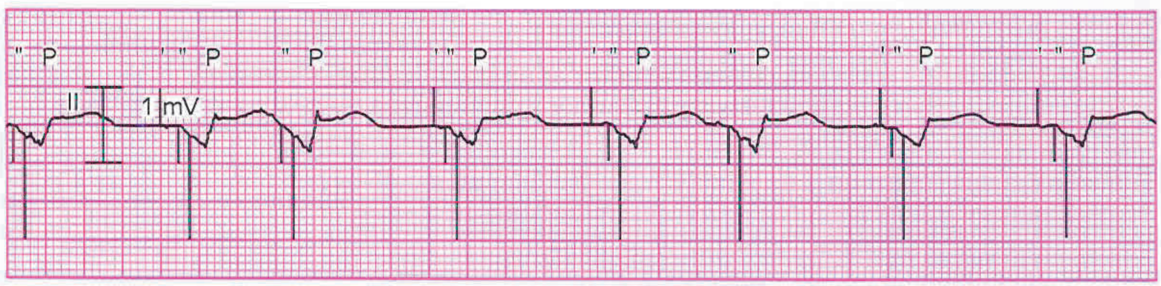
____

____

4. Using the criteria for classification, select the rhythm that most closely resembles atriobiventricular (AV sequential) pacemaker rhythm.

A.

B.



Which distinguishing feature(s) led you to make the selection?

____

____

____

11.3 **Pacemaker Complications Relative to the ECG Tracing**

Pacemaker generators use lithium batteries to create an electrical impulse. As with any battery, the charge of the battery eventually decreases to the point at which the battery needs to be replaced. Batteries last between 5 and 15 years with an average life of 6 to 7 years. Battery replacement is usually done under a local anesthetic and the original leads typically do not need to be replaced.

pacemaker competition Competition between the pacemaker generator and the heart's inherent rate over control of the myocardium.

malfunctioning Failure of a pacemaker to send electrical impulses to the myocardium; also called *failure to pace.*

If a pacemaker is losing its ability to function properly from a low battery or other reasons, this failure will be evident in the rhythms shown on the ECG tracings. These changes in rhythms are often referred to as *complications* of the pacemaker. Complications include slower firing rates than set, less effective sensing capabilities, and lower electrical current than predetermined.

Another pacemaker complication is related to the functioning of the pacemaker generator when the sensing capability is too low. If sensing capability is low, the pacemaker will not be able to "see" the normal contractions occurring in the sensing chamber. Therefore, electrical impulses will not be

malsensing The pacemaker does not recognize or sense the patient's own inherent cardiac electrical activity; also called *failure to sense.*

loss of capture The pacing activity continues to occur without evidence that the electrical activity has depolarized or captured the myocardium. Also called *failure to depolarize.*

oversensing The pacemaker senses electrical current from other muscle movements or electrical activity outside of the body as the electrical current in the patient's heart.

undersensing The pacemaker is unable to detect any electric activity and never turns off.

inhibited but may actually be triggered, sending an impulse to the myocardium because the normal electrical current of the heart's conduction system was not "detected," resulting in **pacemaker competition** with the patient's native electrical impulses. This can be a very dangerous situation. It can result in an electrical impulse being delivered during the "vulnerable" period of repolarization (R-on-T phenomenon). This event can result in electrical destabilization in the myocardium and a life-threatening dysrhythmia such as ventricular tachycardia.

There are several different reasons for pacemaker complications, but only five basic changes are evident on the ECG tracing from these complications: **malfunctioning** (failure to pace), **malsensing** (failure to sense), **loss of capture** (failure to depolarize), **oversensing** (perceiving electrical current from sources other than the heart), and **undersensing** (unable to detect any electrical activity) (Table 11-2).

Responsibility in caring for patients with pacemakers requires recognizing normal pacemaker rhythms and possible complications. When you are performing an ECG or monitoring a pacemaker, you should be aware of the differences in the ECG waveforms, including the presence of a pacing spike, chamber depolarization characteristics, and atrioventricular delay. If you observe complications of a pacemaker rhythm, immediately notify licensed personnel for appropriate treatment and interventions. Remember that when an AED is used on a patient with a pacemaker, the AED pads should not be placed over the pacemaker site. The American Heart Association recommends the defibrillator pads be placed at least 1 inch (2.5 cm) away from the implanted device.

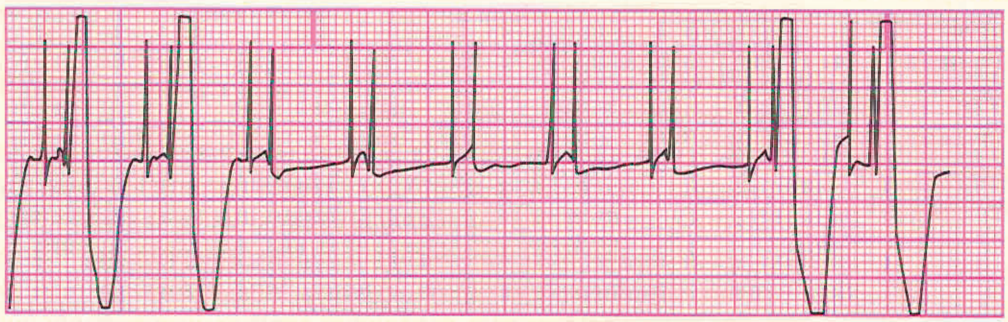
TABLE 11-2 Pacemaker Complications

Complication	Cause	What Occurs	Patient Symptoms
Malfunctioning (failure to pace)	Pacemaker does not send electrical impulse to the myocardium.	Pacemaker intervals are irregular and impulse is slower than set rate or no pacemaker spike is seen.	Patient may experience hypotension, lightheadedness, and blackout periods due to bradycardic conditions.
Malsensing (failure to sense)	Pacemaker does not sense the patient's own inherent rate.	Pacemaker may send current to heart during relaxation (repolarization) phase; also known as pacemaker competition with the patient's own heart.	With atrial pacing, atrial fibrillation can occur; with ventricular pacing, ventricular tachycardia or ventricular fibrillation can occur.
Loss of capture (failure to depolarize)	Pacing activity occurs, but myocardium is not depolarized.	Pacing spikes will occur without a capture waveform, such as P wave or QRS complex (see Figure A on the next page).	Symptoms depend on the basic dysrhythmia and the patient's condition prior to the pacemaker insertion.
Oversensing	Pacemaker perceives electrical current from sources other than the heart.	Either (1) the patient's own heart rate is recorded and is slower than the set rate of the pacemaker or (2) the pacemaker spikes and captures at a slower rate than set (see Figure B on the next page).	Patient may have signs and symptoms of low cardiac output.

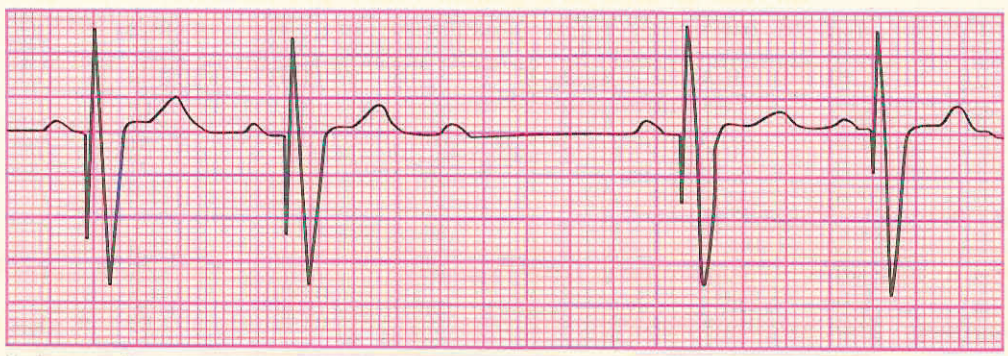
(Continued)

TABLE 11-2 Continued

Complication	Cause	What Occurs	Patient Symptoms
Undersensing	Pacemaker is unable to detect any electrical activity.	Pacemaker never turns off. Results in competition between the intrinsic and electronic pacemakers, which can lead to life-threatening complications, including cardiac arrest as a result of R-on-T pacing.	Patient may have signs and symptoms of low or no cardiac output, depending on the severity of the cardiac rhythm.



A. Loss of capture



B. Oversensing

Communicate & Connect

Pacemaker: What the Patient Should Know

A pacemaker is a lifesaving device that requires some attention from the patient. Before patients leave the hospital with a new pacemaker, they should be taught specifics about the pacemaker they have had implanted including: the upper and lower heart rate, how to check the pulse, exactly what medications to take and when, any activity limitations or restrictions, and when to return to see the physician.

Patients may be fearful of how the pacemaker will affect their lifestyle and will need to know the following information about pacemakers. In general, they should avoid close or prolonged contact with electrical devices or devices that have strong magnetic fields. This includes cell phones, MP3 players, microwave ovens, metal detectors, high-tension wires, industrial welders, and electrical generators. The likelihood of the pacemaker being disrupted depends upon how long and how close the pacemaker is to the device so the following basic guidelines should be followed:

- Do not put a cell phone or MP3 player in the shirt pocket over your pacemaker when the device is turned on.
- Hold your cell phone up to the ear opposite the pacemaker or strap the MP3 player on the opposite arm.
- Stand near operating microwaves or use older non-grounded household appliances.
- Notify security staff if you have a pacemaker.
- Walk through security system metal detectors at a normal pace.
- Do not allow handheld metal detectors to be held over the pacemaker for too long.
- Avoid sitting or standing near a security system metal detector for a prolonged period.
- Avoid medical procedures that can disrupt the pacemaker. If you must undergo a medical procedure such as an MRI (magnetic resonance imaging), shock-wave lithotripsy for kidney stones, or electrocauterization to stop bleeding, make sure to notify the procedural staff that you have an implanted pacemaker or cardioverter-defibrillator prior to these procedures.
- Notify all medical practitioners, including dentists, that you have an implanted pacemaker or cardioverter-defibrillator.
- Carry a device implant wallet card (provided by the device manufacturer) or a Medic alert necklace or bracelet in case of emergency.

Checkpoint Question (LO 11.3)

1. Name and describe five different reasons for pacemaker complications.

___

___

___

Chapter Summary

Learning Outcomes	Summary	Pages
11.1 Describe the various pacemaker rhythms.	Electronic pacemakers, also known as artificial pacemakers, are devices that deliver an electrical impulse to the myocardium to cause the cells to depolarize. Pacemakers can be used to stimulate the atria, the ventricles, or both. Atrial pacing is used alone when the conduction system from the atrioventricular node through the ventricles is intact and functioning. Ventricular pacemakers are inserted to deliver direct stimulation to the ventricles and produce a ventricular contraction. Atrioventricular pacing provides direct stimulation of the atria and ventricles and mimics the normal cardiac conduction system. Atriobiventricular pacing is similar to atrioventricular pacing but stimulates both ventricles instead of just the lower right ventricle.	**253–257**
11.2 Analyze pacemaker rhythms and their effect on the patient, including basic patient care and treatment.	Pacemaker function can be evaluated based on the ECG tracings. The most important aspect of care is to verify the effectiveness of the pacemaker and determine the presence of a pulse with each captured beat. If a pacemaker is losing its ability to function properly, this failure will be evident on the ECG tracings.	**257–262**
11.3 Summarize pacemaker complications relative to the ECG tracing.	Caring for patients with pacemakers requires recognizing normal pacemaker rhythms and possible complications. When performing an ECG or monitoring a patient with a pacemaker, you should be aware of the differences in the ECG waveforms, including the presence of a pacing spike, chamber depolarization characteristics, and atrioventricular delay.	**262–265**

Chapter Review

Multiple Choice

Circle the correct answer(s). More than one can apply.

1. Which pacemaker rhythms have a pacing spike immediately before P waves? (Select 2.) (LO 11.2)
   - a. Atrial pacemaker rhythm
   - b. Ventricular pacemaker
   - c. Atrioventricular pacemaker
   - d. Normal sinus rhythm
2. Which pacemaker rhythms have a pacing spike immediately before QRS complexes? (Select 2.) (LO 11.2)
   - a. Atrial pacemaker rhythm
   - b. Ventricular pacemaker
   - c. Atrioventricular pacemaker
   - d. Normal sinus rhythm
3. Which type of pacing stimulates both ventricles to contract? (LO 11.1)
   - a. Atrial pacemaker
   - b. Ventricular pacemaker
   - c. Atrioventricular pacemaker
   - d. Atriobiventricular pacemaker
4. Which pacemaker complication shows a pacing spike but no waveform immediately following it? (LO 11.2)
   - a. Failure to sense
   - b. Failure to capture
   - c. Oversensing
   - d. Normal sinus rhythm
5. Which of the following is *not* one of the components to be evaluated on a pacemaker tracing? (LO 11.2)
   - a. The presence of atrial and/or ventricular spikes
   - b. The QT interval
   - c. The characteristic patterns of the chambers captured after the spikes
   - d. The atrioventricular delay period
6. Which of the following pacemaker functions may result in pacemaker competition? (LO 11.3)
   - a. Malfunctioning
   - b. Malsensing
   - c. Oversensing
   - d. Undersensing

7. Which pacemaker complication occurs when a pacemaker is functioning normally but the patient's heart does not depolarize? (LO 11.3)
   a. Malsensing
   b. Loss of capture
   c. Oversensing
   d. Undersensing

8. A patient's pacemaker changes the rate of the heart based upon the patient's sinus node rate, breathing, and blood pressure. Which of the following is the most likely type of pacemaker? (LO 11.1)
   a. Demand
   b. Fixed-rate
   c. Rate-responsive
   d. Variable-rate

9. A dual-chamber pacemaker has (LO 11.1)
   a. the ability to defibrillate the heart.
   b. electrodes in the right atrium and right ventricle.
   c. a pacing wire in the right ventricle only.
   d. leads in the right atrium and the ventricles.

10. If a pacemaker is paced and sensed in the atria and pacing is not initiated when native atrial activity occurs, what would be the correct code? (LO 11.1)
   a. AAIOO
   b. AATRO
   c. DDIOO
   d. DDTRD
   e. ADIRO

Matching

Match the terms related to electronic (artificial) pacemakers on the left with their definitions on the right. (LO 11.3)

_______ 11. pacemaker competition

_______ 12. pacemaker (electronic)

_______ 13. loss of capture

_______ 14. undersensing

_______ 15. malsensing

_______ 16. malfunctioning

_______ 17. oversensing

_______ 18. pacing spike

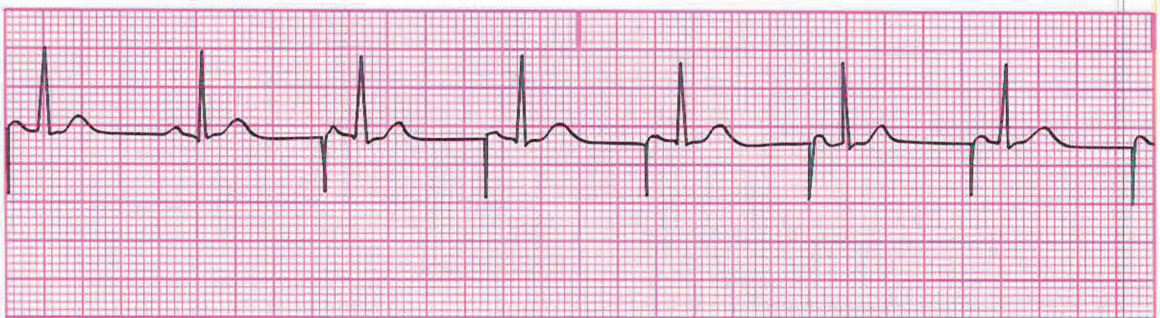
_______ 19. mechanical capture

a. thin vertical line that results from the pacemaker stimulation impulse
b. heart muscle responds to electrical stimulation and depolarizes (contracts)
c. device that delivers electrical impulse to cause depolarization (contractions)
d. pacing activity occurs but is not captured by the myocardium
e. pacemaker does not recognize the patient's inherent heart rate
f. electrical current from muscle movements or other electrical sources are interpreted by the pacemaker as cardiac in origin
g. pacemaker fails to send electrical impulse to the heart
h. pacemaker fails to detect any intrinsic electrical activity
i. rivalry between the intrinsic and electronic pacemakers, which can lead to life-threatening complications

Critical Thinking Application *Rhythm Identification*

Review the dysrhythmias pictured and, using the criteria for classification provided in the chapter as clues, identify each rhythm and provide what information you used to make your decision. (LO 11.2)

20.



Rhythm (regular or irregular): ____________ PR interval: ____________
Rate: ____________ QRS: ____________
P wave: ____________ Interpretation: ____________

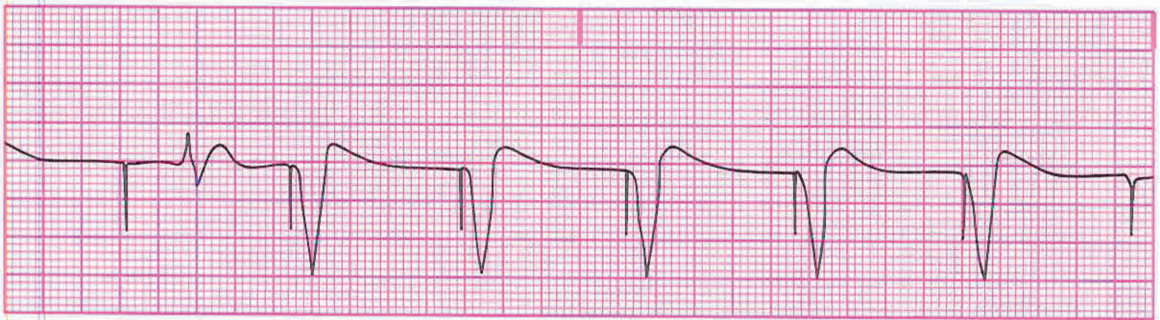
21.

Rhythm (regular or irregular): ____________ PR interval: ____________
Rate: ____________ QRS: ____________
P wave: ____________ Interpretation: ____________

22.

Rhythm (regular or irregular): ____________ PR interval: ____________
Rate: ____________ QRS: ____________
P wave: ____________ Interpretation: ____________

23.

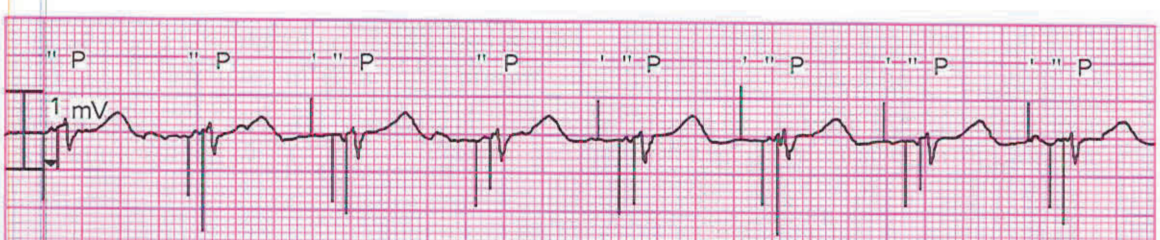


Rhythm (regular or irregular): ______ PR interval: ______
Rate: ______ QRS: ______
P wave: ______ Interpretation: ______

24.

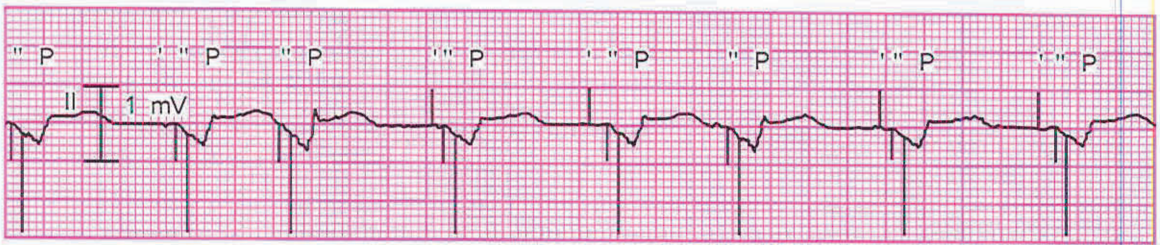
Rhythm (regular or irregular): ______ PR interval: ______
Rate: ______ QRS: ______
P wave: ______ Interpretation: ______

25.



Rhythm (regular or irregular): ______ PR interval: ______
Rate: ______ QRS: ______
P wave: ______ Interpretation: ______

26.

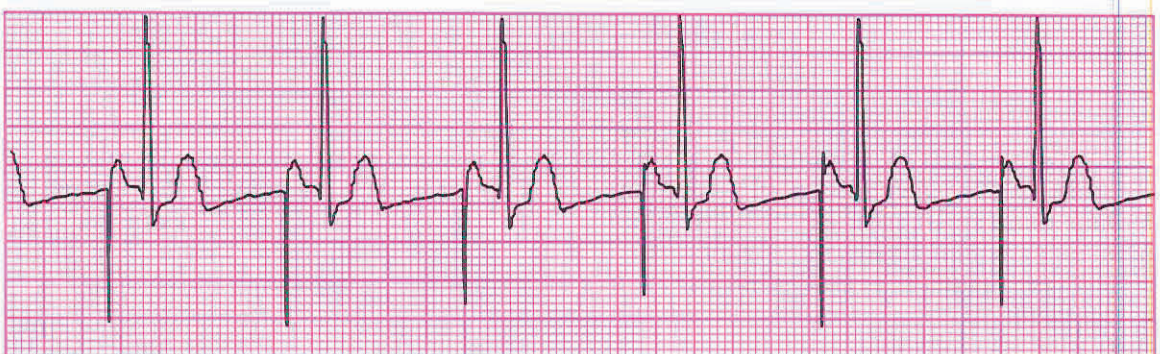


Rhythm (regular or irregular): ____________ PR interval: ____________

Rate: ____________ QRS: ____________

P wave: ____________ Interpretation: ____________

27.



Rhythm (regular or irregular): ____________ PR interval: ____________

Rate: ____________ QRS: ____________

P wave: ____________ Interpretation: ____________

28.

Rhythm (regular or irregular): ____________ PR interval: ____________

Rate: ____________ QRS: ____________

P wave: ____________ Interpretation: ____________

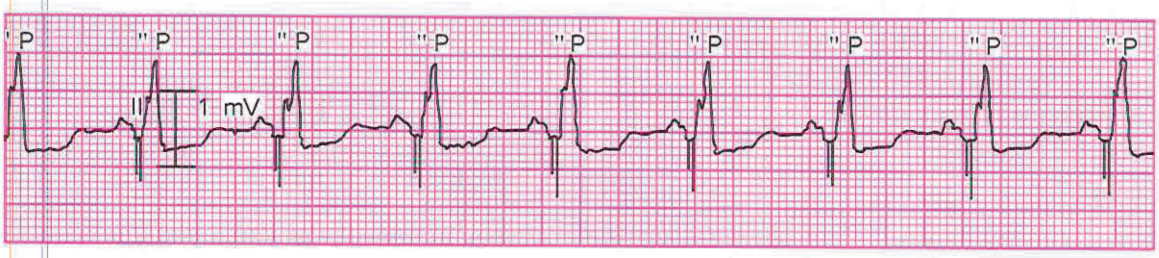
29.

Rhythm (regular or irregular): ______________ PR interval: ______________
Rate: ______________ QRS: ______________
P wave: ______________ Interpretation: ______________

30.

Rhythm (regular or irregular): ______________ PR interval: ______________
Rate: ______________ QRS: ______________
P wave: ______________ Interpretation: ______________

31.



Rhythm (regular or irregular): ______________ PR interval: ______________
Rate: ______________ QRS: ______________
P wave: ______________ Interpretation: ______________

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

Competency Checklist

Use Competency Checklist 11-1 to practice and perform the skills presented in this chapter. (LO 11.2)

COMPETENCY CHECKLIST 11-1

Pacemaker Evaluation

	Practice		Practice		Practice		Mastered	
Procedure Steps (*Rationale*)	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Date**	**Initials**
Preprocedure								
1. Gather supplies and equipment - Calipers - Calculator - Pen								
Procedure								
1. Assess rhythm regularity. *Rhythm is typically regular when the pacemaker is functioning appropriately. However, when the pacemaker is under- or oversensing or there are battery or programming issues, the rhythm may be irregular.*								
2. Determine the heart rate using the most accurate technique based on the regularity of the rhythm.								
3. Assess the P wave. Atrial, atrioventricular, and atriobiventricular pacemaker rhythms each present with a telltale spike prior to the P wave. *They all share in common the placement of an atrial lead wire in the right atrium. P waves should be described as always with the additional comment of "with spike" if one is present.*								
4. Assess the PR interval from the beginning of atrial depolarization to the beginning of ventricular depolarization. *The presence of pacing spikes actually makes this easier. If it is an atrial pacemaker, measure from the atrial spike to the beginning of the QRS. If it is a ventricular pacemaker, measure from the beginning of the P wave to the ventricular spike. If it is an atrioventricular pacemaker, measure from the atrial spike to the ventricular spike.*								
5. Assess the QRS complex. *Measure from the spike to the end of the QRS complex. Ventricular, atrioventricular, biventricular, and atriobiventricular pacemaker rhythms each present with a telltale spike or spikes prior to the QRS complex. They share in common the placement of a ventricular lead wire in the right ventricle. Describe QRS complexes as always (narrow, uniform, wide, bizarre) with the additional comment of "with spike(s)" when present.*								

(Continued)

Procedure Steps (*Rationale*)	Practice		Practice		Practice		Mastered	
	Yes	No	Yes	No	Yes	No	Date	Initials
Procedure (*continued*)								
6. Interpretation: *Atrial pacemaker rhythm:* Spike prior to P wave only. *Ventricular pacemaker rhythm:* Spike prior to the QRS complex only. *Atrioventricular pacemaker rhythm:* Spike prior to the P wave and prior to the QRS complex. *Biventricular pacemaker rhythm:* Two closely timed spikes prior to the QRS complex. *Atriobiventricular pacemaker rhythm:* Spike prior to the P wave and two closely timed spikes prior to the QRS complex.								
Postprocedure								
1. Report and document the rhythm.								

Comments: ______________________________

____

____

____

____

____

Signed

Evaluator: ______________________________

Student: ______________________________