



Setting the Pace: Pacemaker Principles

Two (2.0) Contact Hours

Expiration Date: 02/28/2020

First Published: 02/12/2014

Revised: 2/12/2017

Copyright © 2017 by RN.com

All Rights Reserved.

Reproduction and distribution of this material is prohibited without an RN.com content licensing agreement.

Acknowledgements

RN.com acknowledges the valuable contributions of...

...Suzan Miller-Hoover DNP, RN, CCNS, CCRN-K

Conflict of Interest

RN.com strives to present content in a fair and unbiased manner at all times, and has a full and fair disclosure policy that requires course faculty to declare any real or apparent commercial affiliation related to the content of this presentation. Note: Conflict of Interest is defined by ANCC as a situation in which an individual has an opportunity to affect educational content about products or services of a commercial interest with which he/she has a financial relationship.

The author of this course does not have any conflict of interest to declare.

The planners of the education activity have no conflicts of interest to disclose.

There is no commercial support being used for this course.

Purpose & Objectives

The purpose of this course is to provide nurses with an overview of temporary and permanent

Material Protected by Copyright

pacemakers. This course will introduce pacemaker anatomy and physiology, the international language of pacemakers, and the interpretation of pacer rhythms.

After successful completion of this course, you will be able to:

1. Review the basic conduction of the heart
2. Delineate types of pacemakers; atrial, ventricular, temporary, and permanent pacemakers
3. Enumerate the indications and contraindications for pacemaker
4. Designate pacemaker functions
5. Interpret pacemaker rhythm strips

Introduction

Pacemaker therapy is the most efficacious treatment for cardiac dysrhythmias. Current pacemakers treat heart block, bradycardia, tachycardia, and other dysrhythmias by continually monitoring the heart's innate rhythm and providing stimulation when needed. Without these small, implantable devices many patients would not survive or have an improvement in quality of life.

This course focuses on pacemakers and pacer rhythm interpretation. Standard lead selection, placement, tracings, treatment, and lethal arrhythmias are not covered in this course. If you need to review these topics, please refer to the Telemetry Interpretation and Lethal Arrhythmias: Advanced Rhythm Interpretation courses on RN.com.

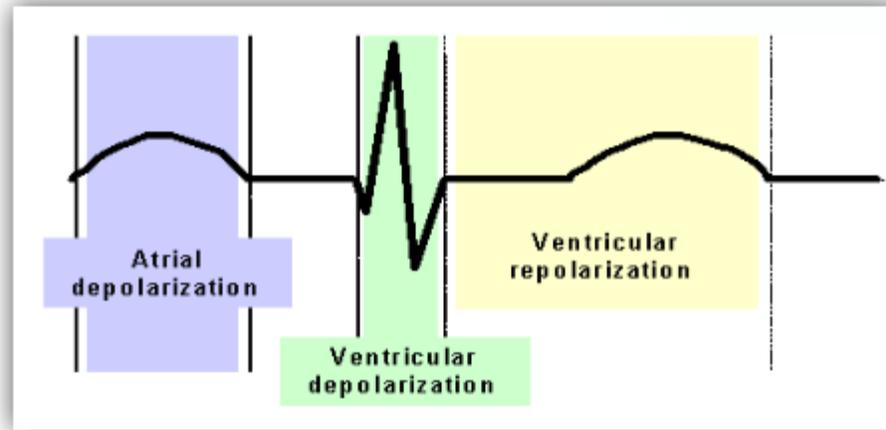
Review:

To understand the functions of a pacemaker, one must know the basic anatomy and physiology of the heart. The next several slides present a review of the fundamental knowledge needed to understand pacemaker management.

Electrophysiology:

Two distinct components must occur for the heart to be able to contract and pump blood. These components are: **(1) An electrical impulse and (2) A mechanical response to the impulse.**

1. The electrical impulse directs the heart to beat, through automaticity. Automaticity relates to, specialized cells within the heart that can discharge an electrical current without an external pacemaker or stimulus from the brain via the spinal cord.
2. The mechanical beating or contraction of the heart occurs in response to electrical stimulation. Specific mechanical (contracting) cells react to the stimulus of the electrical cells and contract. When the mechanical contraction occurs, the person will have both a heart rate and a blood pressure.

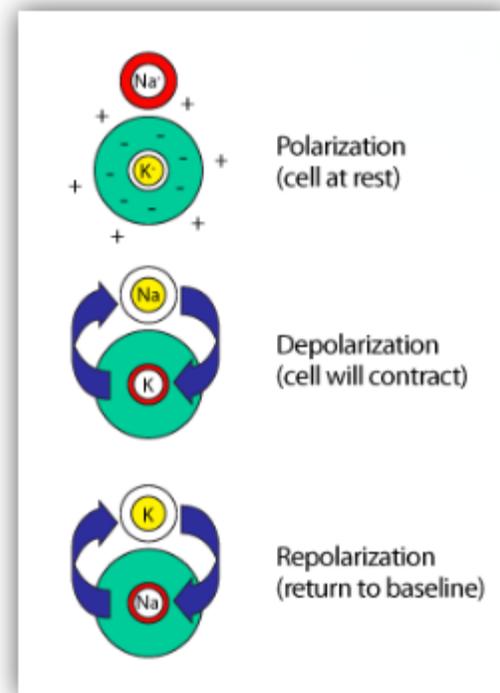


Depolarization & Repolarization

In a cardiac cell, two primary chemicals provide the electrical charges: sodium (Na^+) and potassium (K^+). In the resting cell, most of the potassium is on the inside, while most of the sodium is on the outside. This results in a negatively charged cell at rest; the interior of the cardiac cell is negative or polarized. When depolarized, the interior cell becomes positively charged and the cardiac cell will contract.

Depolarization occurs when potassium moves out of the cell and sodium moves across the cell membrane replacing the potassium within the cell; changing to a positively charged cell. As depolarization occurs, the change in membrane voltage triggers contraction of the cell.

- Depolarization moves a wave through the myocardium. As the wave of depolarization stimulates the heart's cells, they become positive and begin to contract. This cell-to-cell conduction of depolarization through the myocardium is carried by the fast-moving sodium ions.
- Repolarization is the return of electrical charges to their original state. This process must happen before the cells can be ready to conduct again.



Test Yourself

Repolarization is defined as:

- A. The positive charge of cells
- B. The system of conduction
- C. The return of electrical charges to their original state**

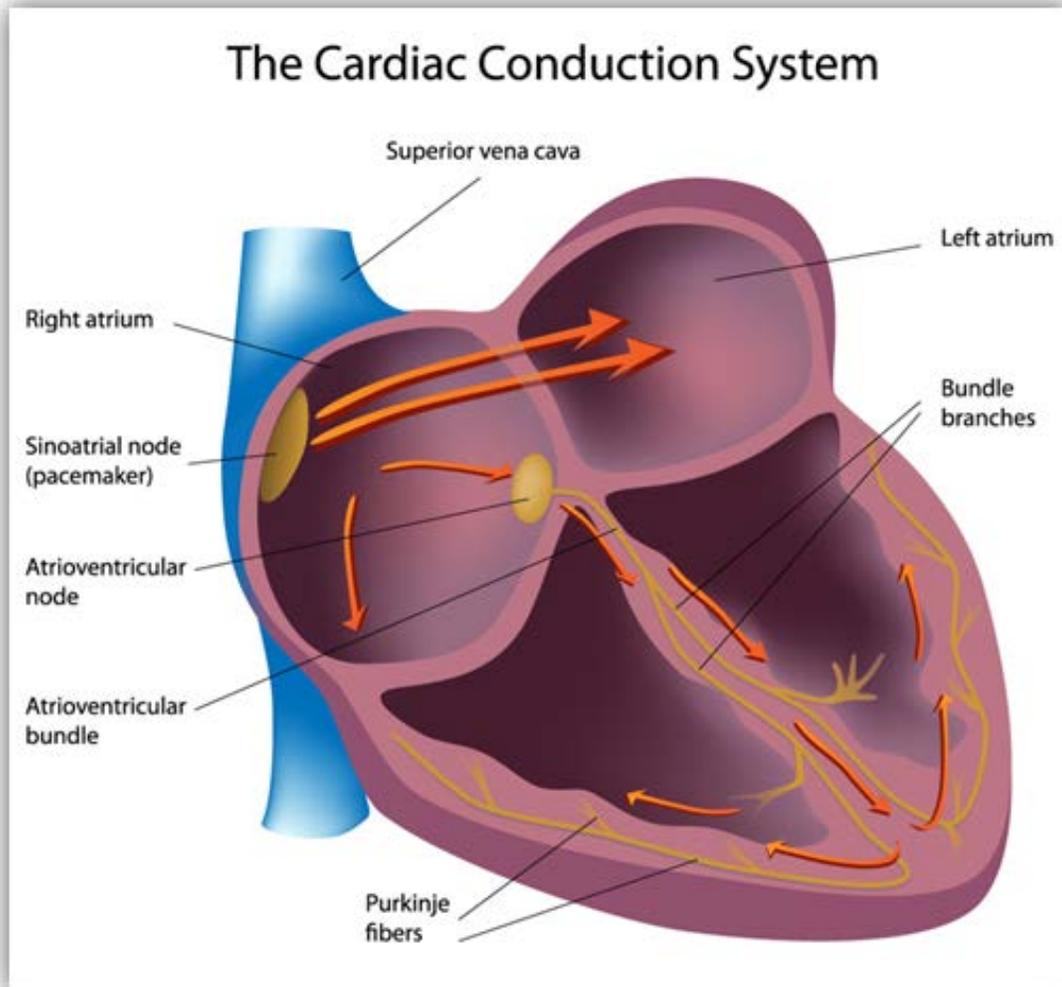
Remediation: Depolarization occurs when potassium moves out of the cell and sodium moves across the cell membrane replacing the potassium within the cell; changing to a positively charged cell. As depolarization occurs, the change in membrane voltage triggers contraction of the cell.

- Depolarization moves a wave through the myocardium. As the wave of depolarization stimulates the heart's cells, they become positive and begin to contract. This cell-to-cell conduction of depolarization through the myocardium is carried by the fast-moving sodium ions.
- Repolarization is the return of electrical charges to their original state. This process must happen before the cells can be ready to conduct again.

The Conduction System

The specialized electrical cells in the heart are arranged in a system of pathways called the conduction system. These specialized electrical cells and structures guide the wave of myocardial depolarization.

The conduction system consists of the sinoatrial node (SA node), atrioventricular node (AV node), bundle of His (also called the AV Junction), right and left bundle branches, and Purkinje fibers.



© Can Stock Photo Inc. / alila

The Sinoatrial (SA) Node

The sinoatrial node (also called the SA node or sinus node) is a group of specialized cells located in the posterior wall of the right atrium near the superior vena cava and atrial junction. The SA node normally depolarizes or paces more rapidly than any other part of the conduction system making it the cardiac pacemaker. It sets off impulses that trigger atrial depolarization and contraction.

After the SA node fires, a wave of cardiac cells begin to depolarize. Depolarization occurs throughout both the right and left atria (similar to the ripple effect when a rock is thrown into a pond). This impulse travels through the atria by way of inter-nodal pathways down to the next structure, which is called the AV node. Any malfunction of the sinoatrial node causes a sinus dysrhythmia.

The SA node normally fires at a rate of 60-100 beats per minute.

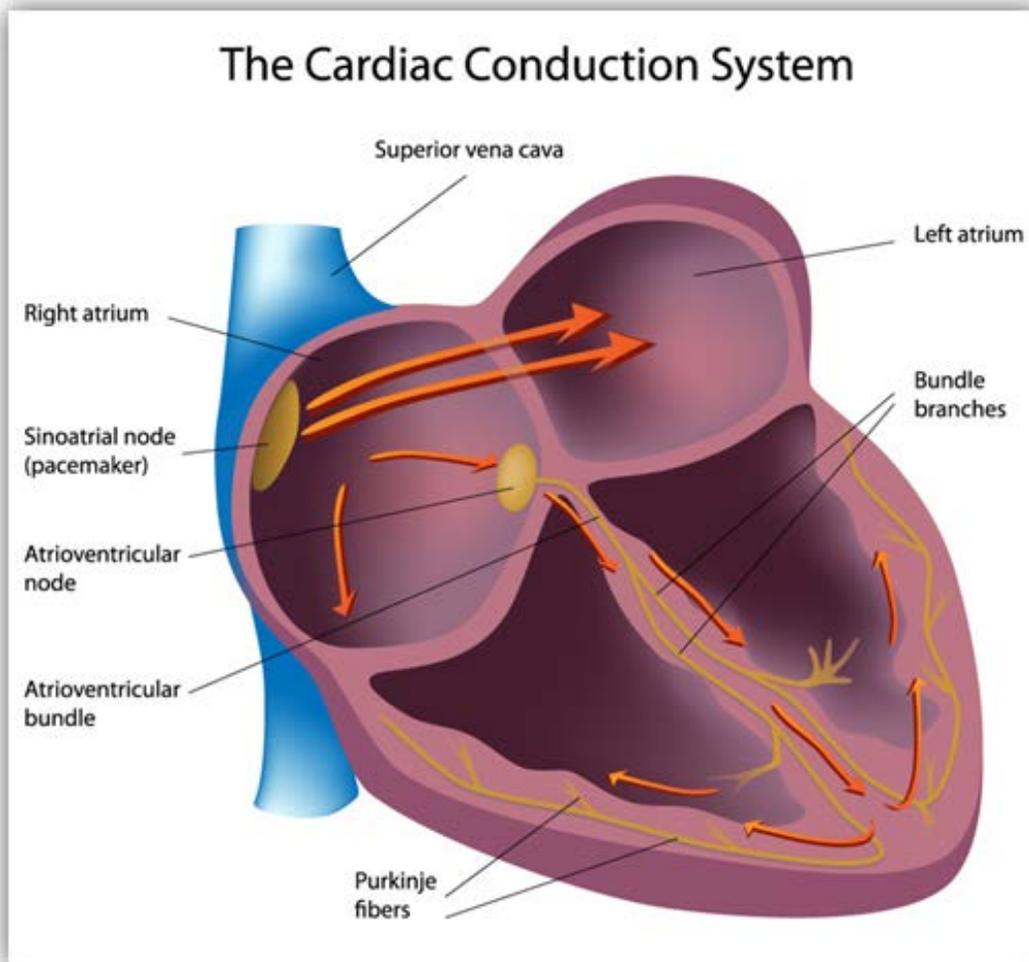
The Atrioventricular (AV) Node and AV Junction

The next area of conductive tissue along the conduction pathway is at the site of the atrioventricular

(AV) node. This node is a cluster of specialized cells located in the lower portion of the right atrium, above the base of the tricuspid valve. The AV node itself possesses no pacemaker cells.

The AV node has two functions. The first function is to DELAY the electrical impulse in order to allow the atria time to contract and complete the filling of the ventricles. The second function is to receive an electrical impulse and conduct it down to the ventricles via the AV junction and bundle of His. Any dysfunction of the AV node results in a junctional or supraventricular dysrhythmia. If the SA node becomes diseased or fails to function properly, the AV node is capable of discharging at an intrinsic rate of 40-60 beats per minute.

The AV node normally fires at a rate of 40-60 beats per minute.



© Can Stock Photo Inc. / alila

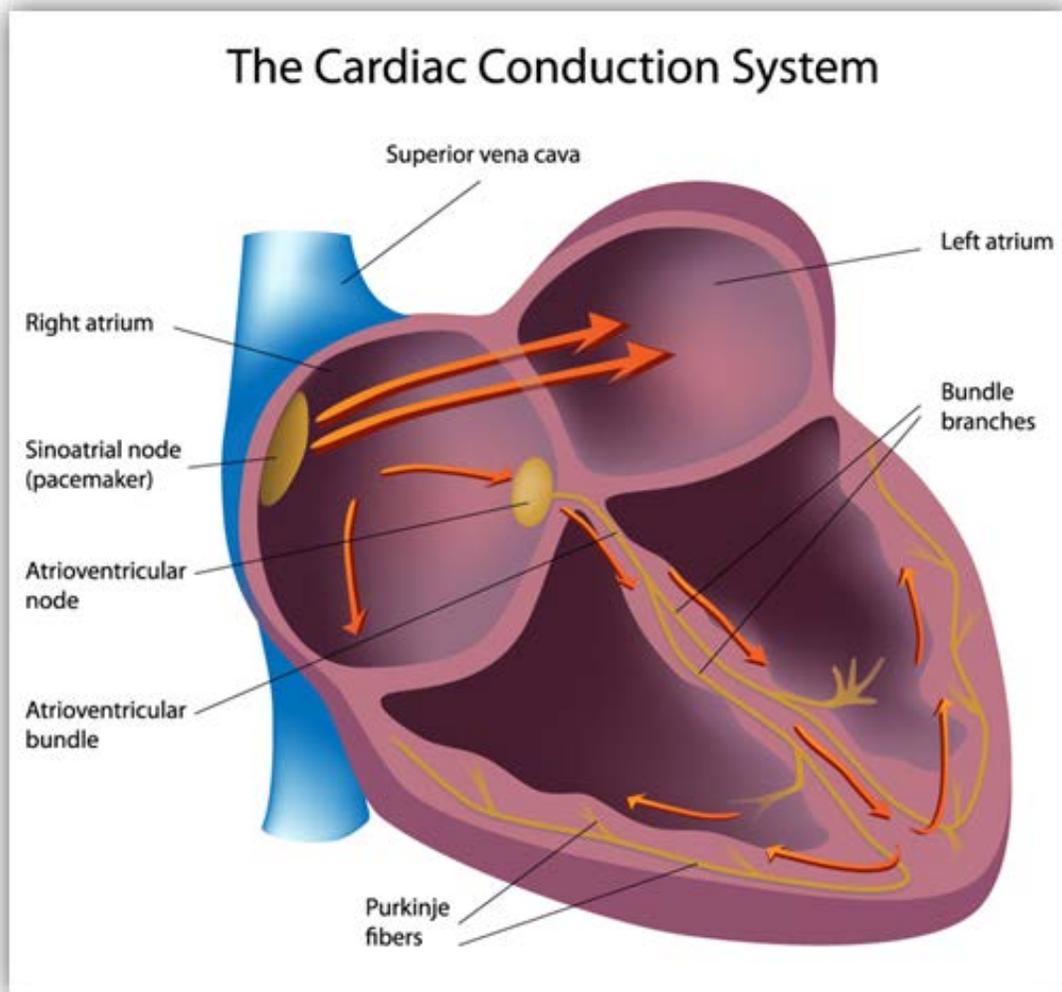
The Bundle of His

After passing through the AV node, the electrical impulse enters the bundle of His (also referred to as the common bundle). The bundle of His is located in the upper portion of the intraventricular septum and connects the AV node with the two bundle branches.

The AV node and the bundle of His are referred to collectively as the AV junction. The bundle of His conducts the electrical impulse down to the right and left bundle branches. The bundle branches further divide into Purkinje fibers. Any dysfunction of the Bundle of His results in a bundle branch block dysrhythmia.

Please note!

The Bundle of His is also known as the atrioventricular bundle, and consists of the right and left bundle branches.



© Can Stock Photo Inc. / alila

The Purkinje Fibers

At the terminal ends of the bundle branches, smaller fibers distribute the electrical impulses to the muscle cells, which stimulate contraction. This web of fibers is called the Purkinje fibers.

The Purkinje fibers penetrate 1/4 to 1/3 of the way into the ventricular muscle mass and then become continuous with the cardiac muscle fibers. The electrical impulse spreads rapidly through the right and left bundle branches and Purkinje fibers to reach the ventricular muscle, causing ventricular contraction, or systole.

The Purkinje fibers within the ventricles also have intrinsic pacemaker ability. Any dysfunction of the Purkinje fibers will result in a ventricular dysrhythmia.

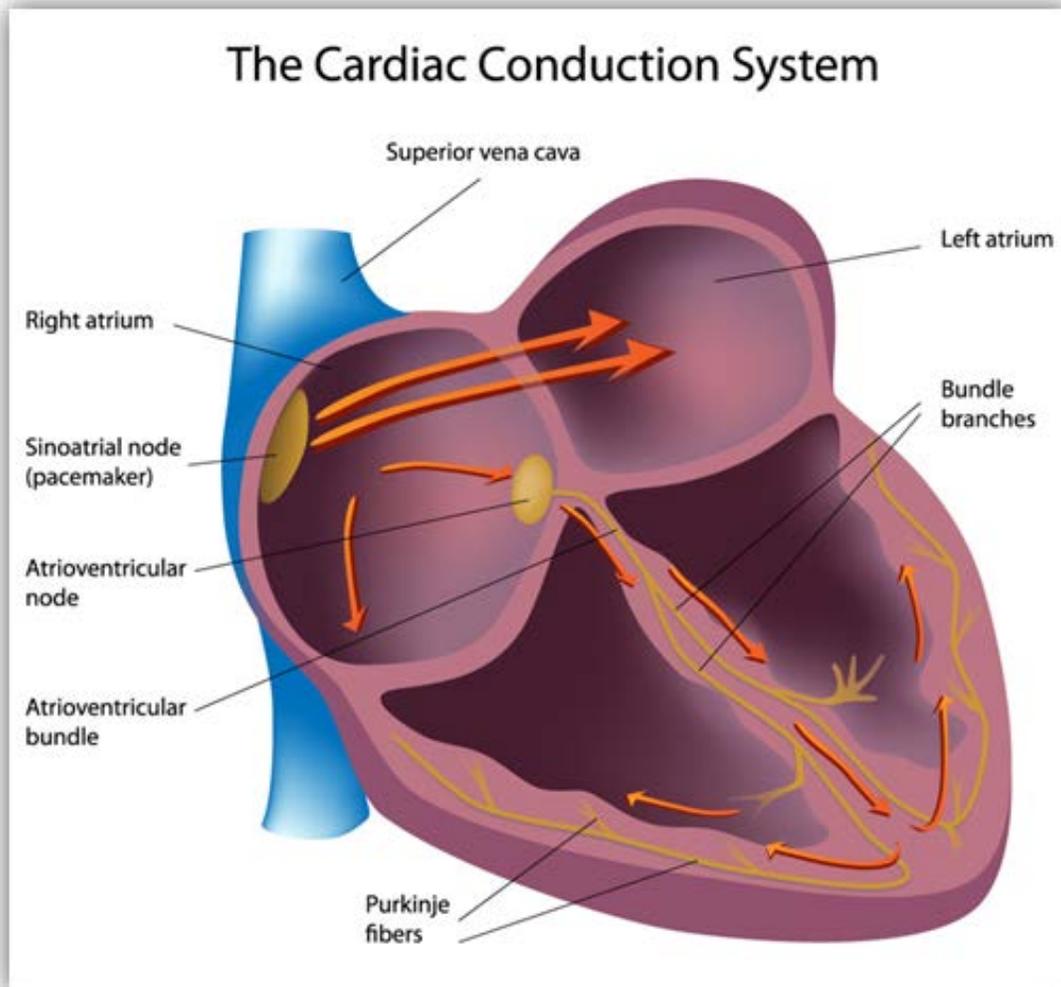
Did You Know?

The further you travel away from the SA node, the slower the backup pacemakers become. If you only have a heart rate of 30 (from the ventricular back-up pacemaker), blood pressure will likely be

Material Protected by Copyright

low and the patients will likely be quite symptomatic.

The Ventricles normally fire at a rate of 20-40 beats per minute.



© Can Stock Photo Inc. / alila

Test Yourself

The primary internal pacemaker of the heart is:

- A. AV node
- B. SA node**
- C. Bundle of His

Rationale: The sinoatrial node (also called the SA node or sinus node) is a group of specialized cells located in the posterior wall of the right atrium near the superior vena cava and atrial junction. The SA node normally depolarizes or paces more rapidly than any other part of the conduction system making it the cardiac pacemaker. It sets off impulses that trigger atrial depolarization and contraction.

History of Pacemakers

Literature written through the 17th and 18th century noted speculation and early experimentation of

electrical impulses in the human body. Various forms of electrical stimulation of the heart were noted throughout the 19th century to treat cardiac disorders. The electrocardiogram was also invented during the late 19th century and early 20th century, evolving until the 12-lead electrocardiogram was created in 1942 (Aquilina, 2006).

In the late 1920s and early 1930s, external cardiac pacemakers were developed in Australia and the United States; portable pacemakers were invented in the 1950s in Canada, the United States, and England. In the late 1950s and early 1960s, the first battery-operated pacemaker, the first totally implantable pacemaker, and the first long-term correction of heart block occurred (Aquilina, 2006).

The 1960s and 1970s had developments with the surgical techniques of implanting pacemakers, and improvements with the expected life of the electronic devices. Programming of pacemakers and creation of dual chambered devices occurred through the late 1970s. The 1980s showed transcutaneous external pacemakers, pacemaker leads that eluted steroids to decrease inflammatory responses, and rate-responsive devices. From the 1990s through today, improvements have been made with pacemaker algorithms, the ability of pacemakers to upload data, improved contraction, and the use of pacemakers for treatment of heart failure (Aquilina, 2006).

Artificial Pacemakers

An artificial pacemaker is a device; which, provides an electronic signal to make the heart contract when the body's intrinsic pacemakers (such as the SA node) fail. Pacing occurs with the electrical stimulus to the heart that causes the depolarization of the myocardium. The goal of an artificial pacemaker is to provide an appropriate atrial or ventricular rate of contraction; which, will maintain adequate end-organ perfusion and sufficient blood pressure (Mininni, 2012).

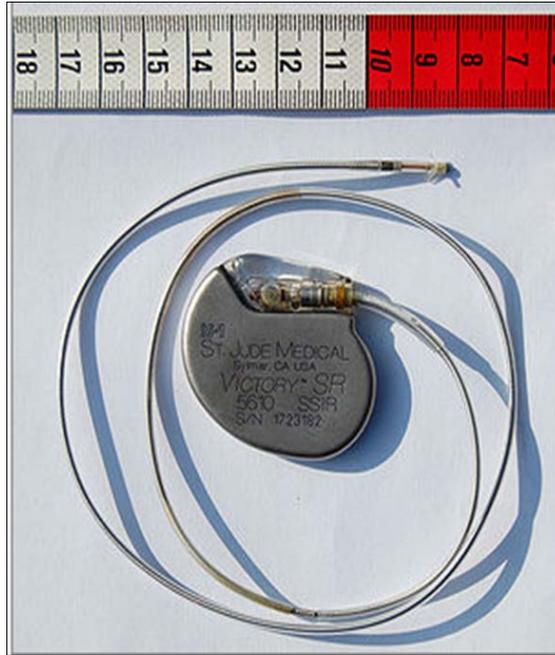


© Can Stock Photo Inc. / noimagination

Pacemaker Components

Components of a pacemaker include:

- Pulse generator: an electronic circuit and power source; which, produces the electrical impulses
- Leads: wires and cables that conduct the electrical impulses from the pulse generator to the heart
- Electrodes: the ends of the leads to sense the heart's electrical activity; may be external or internal



Fruitsmaak, S. (2007).

Image provided under the GNU Free Documentation License. Image retrieved from:
http://en.wikipedia.org/wiki/Artificial_cardiac_pacemaker

Did You Know?

Pacemaker leads can be either unipolar or bipolar.

Unipolar System:

A unipolar system uses one lead-wire with the electrode at the end of the wire; which, conducts the electrical current from the pulse generator through the lead-wire to the negative pole. The electrode then provides stimulus to the heart and returns to the pulse generator's metal surface (the positive pole) to complete the circuit. Use of a ground wire is necessary when unipolar lead-wires are used. Unipolar systems are more sensitive to electrical activity/artifact in the myocardium (Mininni, 2012).

A bipolar system includes a single lead-wire with two electrodes; one at the distal end of the wire and another about 2cm proximal. The electrical current flows from the pulse generator through the lead-wire to the negative electrode at the distal tip; providing stimulus to the heart and then flows back to the proximal/positive electrode to complete the circuit. Bipolar systems are less susceptible to artifact, such as magnetic fields and skeletal muscle contractions. The bipolar lead-wire may be used as unipolar or bipolar pacing depending on the type of pacemaker implanted, allowing for more flexible treatment options (Mininni, 2012).

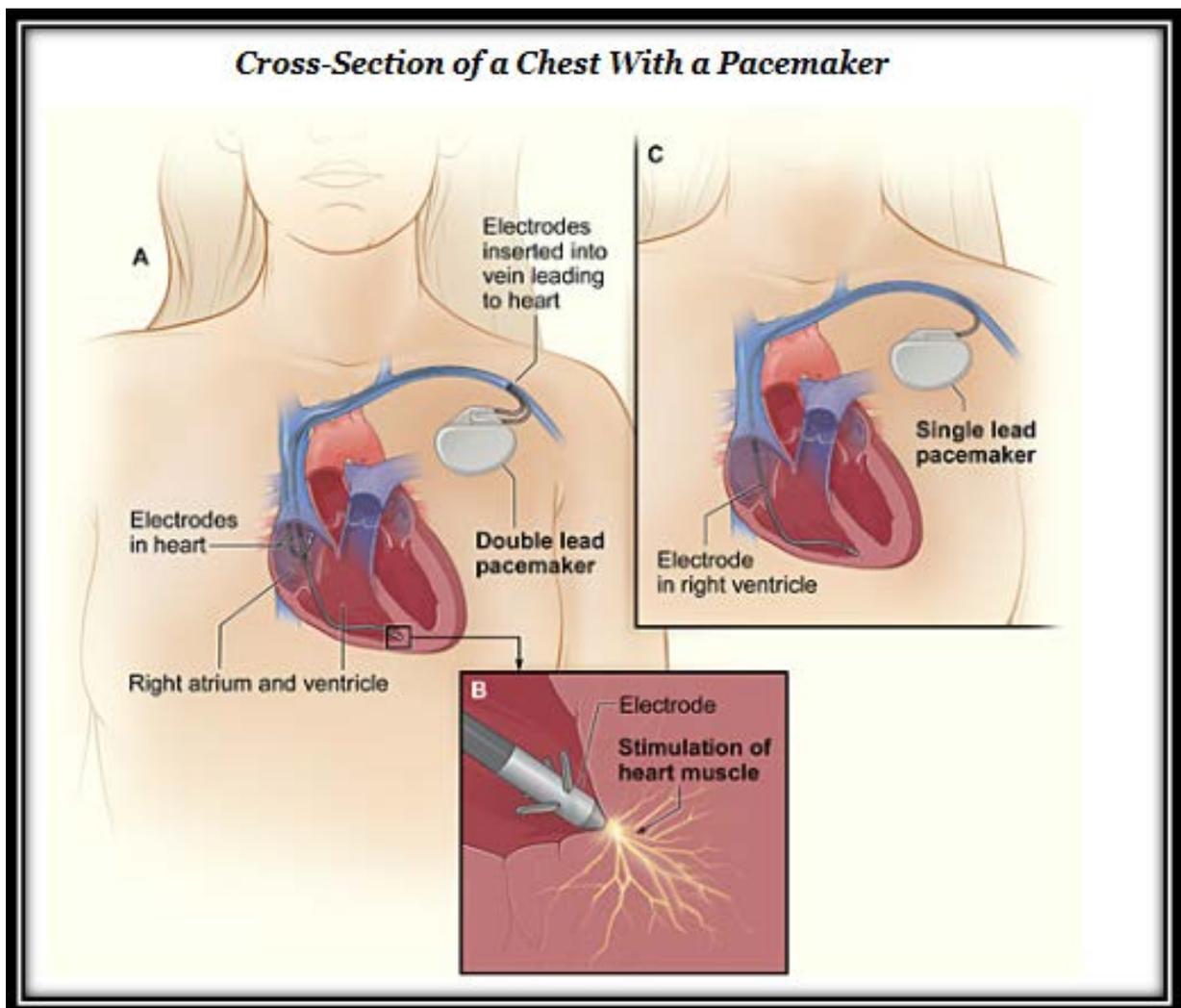


Image courtesy of National Heart Lung & Blood Institute [NHLBI], (2014).

Retrieved from: <http://www.nhlbi.nih.gov/health/health-topics/topics/pace/howdoes.html>

Pacemaker Principles

Material Protected by Copyright

Pacemaker therapy attempts to mimic the SA node function. A paced beat does not replace the heart's normal conduction. The very important "atrial kick" is left out when the heart is paced only by the ventricle. The amount of blood that flows from the atria to the ventricle is decreased without the "atrial kick." This decrease in blood flow may result in hemodynamic instability in some patients. A syndrome called "pacemaker syndrome," vertigo and hypotension, occur in these patients.

In the past, the only way to pace the heart was to pace the ventricle. However, now pacemakers can pace the atria, the ventricles, or both. This gives the provider the ability to minimize "pacemaker syndrome" by pacing the atria when necessary.

Types of Pacemakers

Artificial pacemakers can be either temporary or permanent, and atrial or ventricular; depending on the needs of the patient.

Temporary Pacemakers

Temporary pacemakers are used for urgent situations, during surgery, or while waiting for permanent placement. The situation of the patient determines the type of electrodes used for temporary pacing.

The types of electrode placement for temporary pacing are:

- Transcutaneous: external electrode pads are placed on the patient's chest wall. This commonly occurs during a "code" situation, where the defibrillator with pacing capabilities are utilized to maintain a sustainable rhythm until another type of pacemaker can be inserted. This type of pacing is very uncomfortable and results in seizure-like motions when the electrode fires.
- Transvenous (endocardial): electrode wires are inserted through a vein into the right ventricle. This method requires the use of fluoroscopy and practitioner experience to be successful. While more comfortable and effective than the transcutaneous, movement of the limb where the lead-wire is placed or other patient movement may dislodge the distal electrode, making the pacemaker non-functional.
- Epicardial: Electrodes are placed during an open-heart surgery and the lead-wires are brought to the surface through the sternal incision. The manual placement of the electrodes ensures sufficient contact to the atrial or ventricular myocardium. This type of pacemaker lead is the most efficacious of the temporary pacemaker leads. However, care must be taken when removing these leads as internal bleeding may occur.

These lead-wires connect to an external pacemaker generator. The practitioner can adjust the settings of the pacemaker to meet the on-going needs of the patient. The lead-wires may be disconnected from the generator and secured to the patient during a trial removal. When the pacemaker is determined to be no longer needed the electrodes can be removed at the bedside.

Indications for temporary pacing include:

- Hemodynamically unstable cardiac rates and rhythms are the primary indication for a pacemaker. **Hemodynamically unstable is the key phrase.** Bradycardia is not an absolute indicator. However, if the blood pressure becomes low or if the patient clinically deteriorates with a bradycardic rhythm, a pacemaker should be considered. Clinical deterioration is described as hypotension, dizziness, cerebral ischemia, exercise intolerance, rapid onset of congestive heart failure, and altered level of consciousness.
- Ventricular tachycardia when drug therapy fails. Over-drive pacing is a mechanism to allow the

SA node to reset and gain control of the heart rate.

Temporary pacemaker generators

There are a variety of temporary pacemaker generators in use, be sure to know your unit's generator; refer to the manufacturer's owner's manual and your institutional policies and procedures before you care for a patient requiring a temporary pacemaker.

There are general concepts common to all types of temporary pacemaker generators; we will discuss those concepts next.

Pacemaker Terminology:

- Rate: the number of heart beats to be delivered or sensed within one minute
- Interval: the number of milliseconds (mS) needed to ensue prior to the pacemaker delivering a pacing stimuli
- Output: the amount of energy, milliamperes (mA), delivered to the myocardium
- Sensitivity: the pacemaker's ability to "see" the intrinsic beats and artifact, measured in millivolts (mV)
 - Over-sensing: The sensitivity is set too low and the pacemaker sees ALL the intrinsic beats and artifact and delivers no paced beats
 - Under-sensing: The sensitivity is set too high and the pacemaker sees NONE of the intrinsic beats and delivers continuous paced beats

Consider this:

One way to remember sensitivity measurement is to picture a person standing behind a fence and looking into his neighbor's yard.

- If the fence is too high – he can see nothing happening in his neighbor's yard (under-sensing)
- If the fence is too low – he can see everything happening in his neighbor's yard (over-sensing)
- If the fence is the right height- he can see only what he is supposed to see, no more no less

Temporary Pacemaker Generator Set-Up

- The temporary pacemaker generator requires that a connecting cable be used to connect the lead-wires to the generator box.
 - The generator box should be in the "off" position when connecting the cable and wires
 - **In an emergency, the lead-wires may be connected directly to the generator box**
- Match the correct lead-wire to the correct position on the cable
 - Positive
 - Negative
- Most generator boxes have a self-test that appears when the device is turned on.
 - Do not use the pacemaker generator if the device fails the self-test
- Check the battery power indicator
 - If the battery voltage is low, change the batteries
- Settings:
 - Lower rate
 - Upper rate
 - AV interval – measured in milliseconds (ms)
 - Atrial output – measured in milliamperes (mA)
 - Atrial sensitivity – measured in millivolts (mV)
 - Ventricular output - measured in milliamperes (mA)

- Ventricular sensitivity - measured in millivolts (mV)

The patient's dysrhythmia will guide the provider's decision to pace one or both chambers.

- Pacing indicator: a green light will flash every time a pacing stimuli is delivered
- Sensing indicator: an orange light will flash every time the pacemaker senses the patient's heart beat
- Pacing modes: An indicator will appear denoting which type of pacing has been programmed into the generator
- Fixed rate pacing: The pacemaker generates a set rate of pacing stimuli without regard to the patient's underlying rhythm
 - The disadvantages of this type of pacing are:
 - R on T phenomena
 - Competition with the patient's intrinsic rate
- Sensing rate pacing: The pacemaker senses the patient's intrinsic rate and delivers a pacing stimuli only when necessary to maintain the programmed rate

Test your Knowledge

Match the following terms with the correct definition:

- | | |
|---------------------|---|
| a. mA | 1. The pacemaker sees all the intrinsic beats and artifact and delivers no paced beats |
| b. Sensitivity | 2. The amount of energy delivered to the myocardium |
| c. Under-sensing | 3. The number of impulses per minute delivered to the myocardium |
| d. Rate | 4. Pacer's ability to see the intrinsic rhythm |
| e. High sensitivity | 5. The pacemaker sees none of the intrinsic beats and delivers paced beats regardless of intrinsic rate |

Correct Answers:

- | | |
|-------------------|---|
| a. mA | 2. The amount of energy delivered to the myocardium |
| b. Sensitivity: | 4. Pacer's ability to see the intrinsic rhythm |
| c. Under-sensing: | 5. The pacemaker sees none of the intrinsic beats and delivers paced beats regardless of intrinsic rate |
| d. Rate: | 3. The number of impulses per minuted delivered to the myocardium |
| e. Over-sensing: | 1. The pacemaker sees all the intrinsic beats and artifact and delivers no paced beats |

Rationale:

Pacemaker Terminology:

- Rate: the number of heart beats to be delivered or sensed within one minute
- Interval: the number of milliseconds (mS) needed to ensue prior to the pacemaker delivering a pacing stimuli
- Output: the amount of energy, milliamperes (mA), delivered to the myocardium
- Sensitivity: the pacemaker's ability to "see" the intrinsic beats, measured in millivolts (mV)
 - Over-sensing: The sensitivity is set too low and the pacemaker sees ALL the intrinsic beats and artifact and delivers no paced beats
 - Under-sensing: The sensitivity is set too high and the pacemaker sees NONE of the intrinsic beats and delivers continuous paced beats

Permanent Pacemakers

Permanent pacemakers are implanted when the cardiac dysrhythmia is chronic and the patient is symptomatic.

This pacemaker system includes a pulse generator containing electronics, a battery, and one or more electrodes (leads). Pulse generators are placed in a subcutaneous "pocket" created in either a subclavicular site or underneath the abdominal muscles just below the ribcage.

A single chamber pacemaker system includes a pulse generator and one electrode inserted in either the atrium or ventricle. A dual chamber pacemaker system includes a pulse generator and one electrode inserted in the right ventricle and one electrode inserted in the atria or ventricle; or both ventricles.

Permanent pacemakers are surgically implanted. Indications for pacemaker placement will be discussed further. Types of permanent pacemakers include:

- Single-chamber- Atrial or Ventricular
- Dual-chamber- Atrial and Ventricular
- Biventricular

Temporary: Transcutaneous Pacing

Non-invasive transcutaneous pacing is a temporary use of pacing that is done in urgent situations, such as symptomatic bradycardia. The American Heart Association's Advanced Cardiac Life Support (ACLS) 2016 guidelines include the use of transcutaneous pacing with the following:

- Hemodynamically unstable bradycardia that continues despite adequate airway and breathing. This may include blood pressure changes (hypotension or hypertension), ongoing severe ischemic chest pain, acute altered mental status, congestive heart failure, syncope or other signs of shock
- Bradycardia with symptomatic ventricular escape rhythms
- Unstable clinical condition that is likely due to the bradycardia
- Overdrive pacing of tachycardias unresponsive to drug therapy or electrical cardioversion
- In preparation of pacing readiness (i.e. standby mode) with any of these rhythms:
 - Symptomatic sinus bradycardia
 - Mobitz type II second-degree AV block
 - Third-degree AV block
 - New left, right or alternating bundle branch block or bifascicular block

(American Heart Association (AHA), 2016; Mininni, 2012).

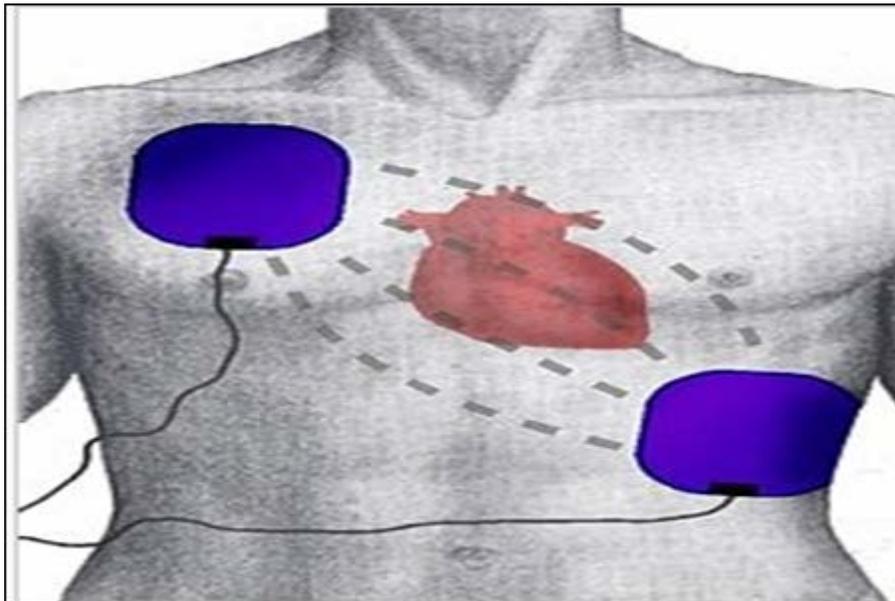
Most defibrillators have the ability for transcutaneous pacing through use of the hands-free defibrillation pads. Preferred pad placement is: one on the anterior of the chest wall and one posteriorly. Pads can also be placed with one anteriorly, and one laterally (Mininni, 2012).

Consider sedation when using this type of pacing.



Basic Defibrillator pack. Ernstl, 2007. Image published under the Creative Commons Attribution License. Image retrieved from: http://en.wikipedia.org/wiki/File:Defibrillator_Monitor.jpg

Pad Placement



Philipp, N. (2007). Image published under the GNU Free Documentation License. Retrieved from: http://en.wikipedia.org/wiki/File:Defibrillation_Electrode_Position.jpg

Temporary: Transvenous Pacing

A transvenous (or endocardial) pacemaker may be used in the following circumstances:

Material Protected by Copyright

- While waiting to implant a permanent pacemaker
- After either 24 hours of intermittent or 12 hours of continuous transcutaneous pacing
- While treating an acute episode of dysrhythmia

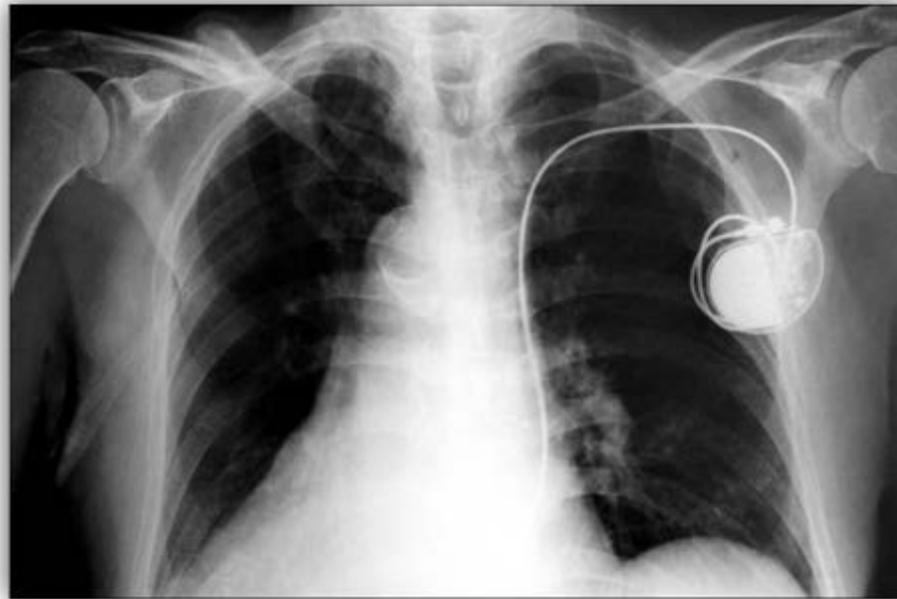
The lead-wire is placed in the myocardium through a large vein using fluoroscopy. Common veins include the jugular, subclavian, antecubital, basilic or femoral veins.

The lead-wires can be placed in the atrium, ventricle, or both. (Mininni, 2012).

Temporary: Epicardial Pacing

Cardiac surgery can cause complications such as sinus bradycardia, second degree atrioventricular (AV) blocks, third degree AV block, and even asystole. To treat these complications, epicardial pacing is done by attaching the electrodes to the epicardium during the intraoperative period. The leads are brought out through the incision wall, insulated, and coiled on to the patient's chest. Epicardial pacing can be used for both atria and ventricles. The leads can be removed when pacing is no longer needed (Mininni, 2012).

With surgical application, unipolar and bipolar wires may be used and sometimes simultaneously. If more than one wire is used, it is important to know where the lead was placed. There may be a ground wire, ventricular wire, atrial wire, or any combination of the three. Make sure each lead is labeled clearly. To connect the wires to the pacemaker, correct lead identification is essential.



© Can Stock Photo Inc. / khuruzero

Test Yourself

The type of temporary pacemaker that is often used with a defibrillator during resuscitation is:

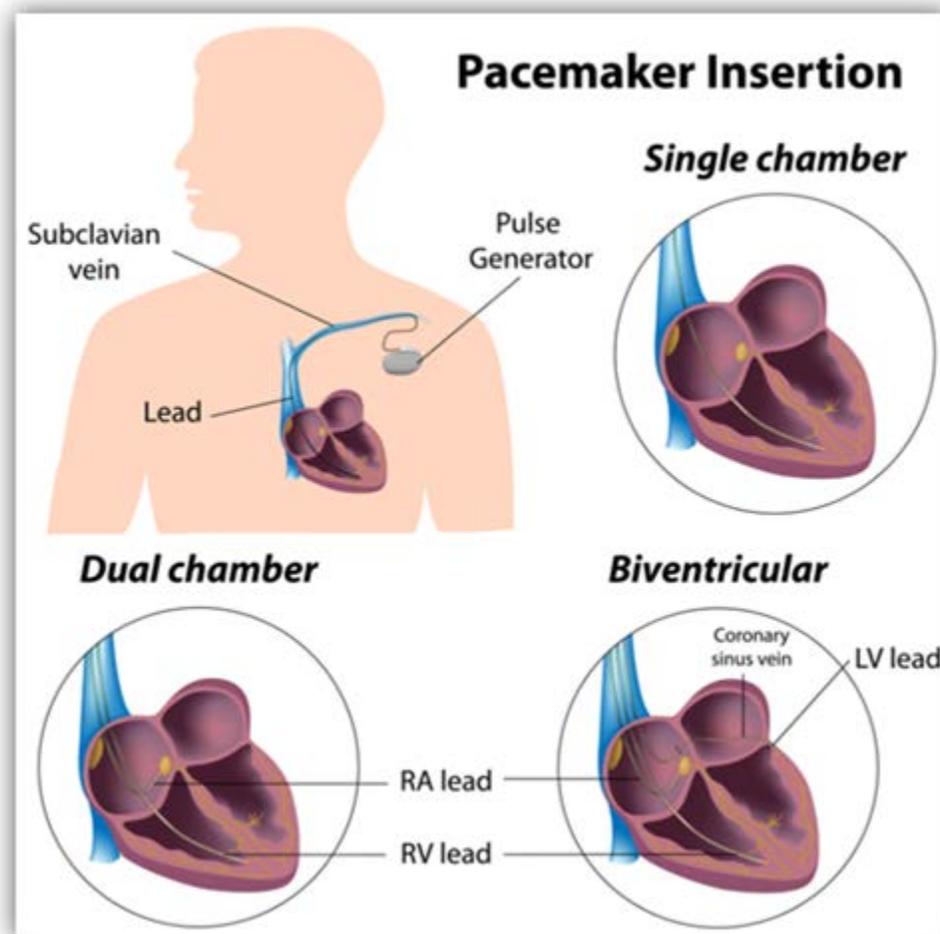
- Transcutaneous
- Epicardial
- Transvenous (endocardial)

Rationale:

- Transcutaneous: external electrode pads are placed on the patient's chest wall. This commonly occurs during a "code" situation, where the defibrillator with pacing capabilities are utilized to maintain a sustainable rhythm until another type of pacemaker can be inserted. This type of pacing is very uncomfortable and results in seizure-like motions when the electrode fires.
- Transvenous (endocardial): electrode wires are inserted through a vein into the right ventricle. This method requires the use of fluoroscopy and practitioner experience to be successful. While more comfortable and effective than the transcutaneous, movement of the limb where the lead-wire is placed or other patient movement may dislodge the distal electrode, making the pacemaker non-functional.
- Epicardial: Electrodes are placed during an open-heart surgery and the lead-wires are brought to the surface through the sternal incision. The manual placement of the electrodes ensures sufficient contact to the atrial or ventricular myocardium. This type of pacemaker lead is the most efficacious of the temporary pacemaker leads. However, care must be taken when removing these leads as internal bleeding may occur.

Permanent Pacemakers: Single Chamber

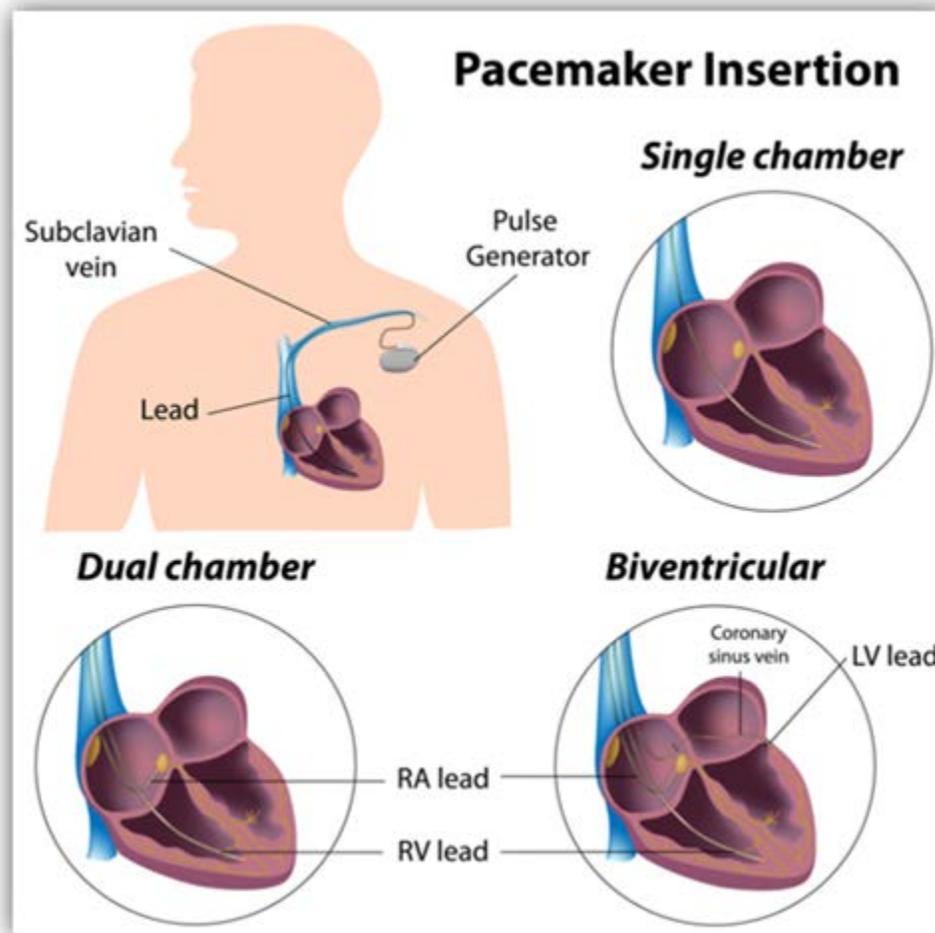
A single chamber pacemaker is a unipolar system, using only one lead. The lead is usually implanted in the right ventricle for pacing when the patient has an atrial arrhythmia, such as atrial fibrillation. If the patient's conduction through the AV junction is adequate (i.e. no AV block) the lead may be placed in the right atrium (Minnini, 2012).



© Can Stock Photo Inc. / alila

Permanent Pacemakers: Dual Chamber

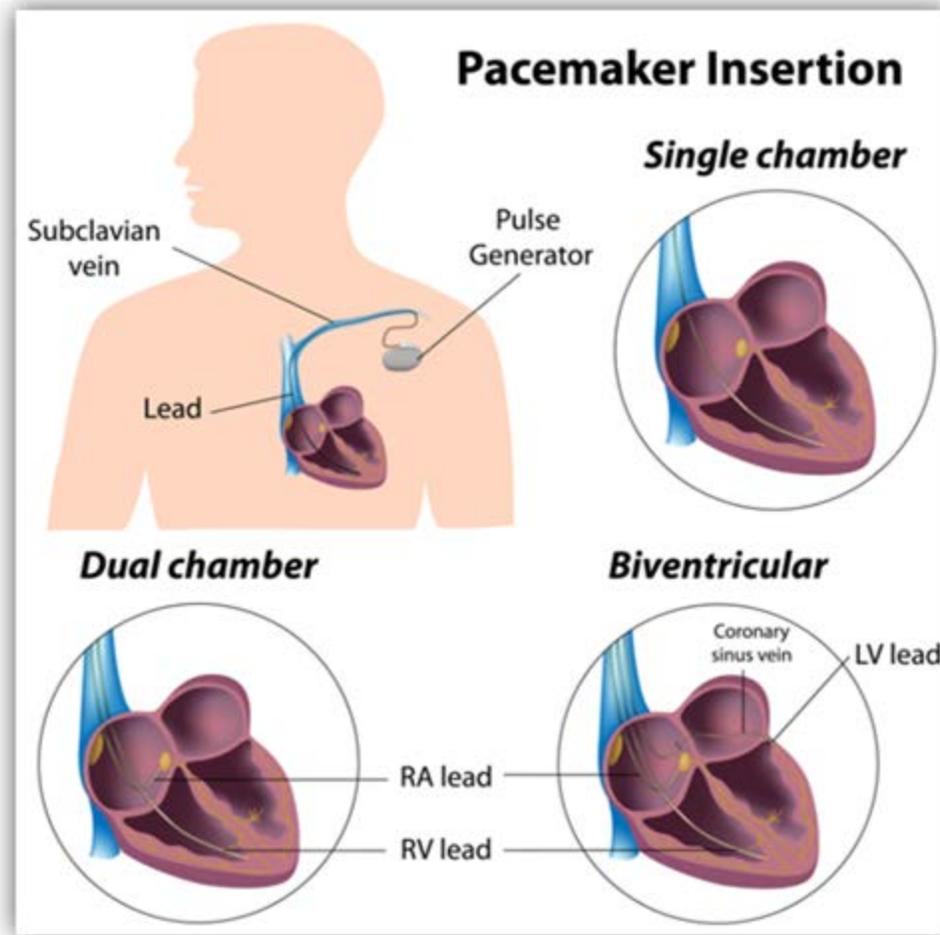
A dual chamber pacemaker is a bipolar system, using two leads. One lead is implanted in the right ventricle while the other is placed in the right atrium, allowing the rhythm to be synchronized between the atrium and ventricle. The pulse generator itself is implanted in the chest wall. The dual chamber pacemaker is used when there is AV node dysfunction or AV blocks (Minnini, 2012).



© Can Stock Photo Inc. / alila

Permanent Pacemakers: Biventricular

A biventricular pacemaker (or cardiac resynchronization therapy) uses three leads for the system. One lead is implanted in the right atrium, one is placed in the right ventricle, and the last lead is implanted in the coronary sinus of the left ventricle. This allows pacing of both ventricles at the same time, which improves cardiac output by contracting both ventricles simultaneously (Mininni, 2012).



© Can Stock Photo Inc. / alila

Test Yourself

With a dual chamber pacemaker, the leads are placed:

- A. In the right atrium
- B. In the left atrium and left ventricle
- C. In the right atrium and right ventricle**

Rationale: A dual chamber pacemaker is a bipolar system, using two leads. One lead is implanted in the right ventricle while the other is placed in the right atrium, allowing the rhythm to be synchronized between the atrium and ventricle. The pulse generator itself is implanted in the chest wall. The dual chamber pacemaker is used when there is AV node dysfunction or AV blocks

Indications for Permanent Pacing

Reasons that a patient may need a permanent pacemaker include:

- Atrial fibrillation with sinus (SA) node dysfunction
- Prevention of atrial arrhythmias, such as atrial tachyarrhythmias
- Sinus bradycardia
- Sick sinus syndrome
- Sinus arrest
- Tachy-brady syndrome
- Atrioventricular (AV) blocks in adults
- Carotid sinus syndrome
- Neurocardiogenic syncope
- Prolonged QT syndrome

(Brignole, Auricchio, Baron-Esquivias, Bordachar, Boriani...&Vargas, 2013; Mininni, 2012; Vardas, Simantirakis, & Kanoupakis, 2012)

Special conditions that may call for pacing include:

- Cardiac surgery, including heart transplantation
- Neuromuscular diseases
- Cardiac sarcoidosis
- Metabolic disorders
- Congenital heart disease
- Myocardial infarction

(Brignole et al., 2013; Mininni, 2012; Vardas et al., 2012)

Need for Pacing: Atrial Fibrillation with SA Node Dysfunction

Atrial fibrillation can be intermittent in some patients. Permanent atrial fibrillation that has poor or no control with the use of medications can result in heart failure. Patients may be asymptomatic, or experience palpitations, fatigue, syncope, confusion, hypotension, chest pain, and shortness of breath. The use of a pacemaker, particularly a biventricular model, can be used to control the heart rate and prevent heart failure (Brignole et al., 2013; Vardas et al., 2012).

Need for Pacing: Atrial Arrhythmias

Although atrial fibrillation is the most common atrial arrhythmia in which a pacemaker is used, other arrhythmias may benefit from pacing. Atrial tachycardia and atrial flutter, when prolonged or causing symptoms, may also be treated with a temporary or permanent pacemaker (Brignole et al., 2013; Vardas et al., 2012).



Need for Pacing: Sinus Bradycardia

One indication for a pacemaker is sinus bradycardia, whether continuous or intermittent, when the patient is symptomatic. Symptoms can include irritability, fatigue, syncope, hypotension, chest pain, decreased level of consciousness, shortness of breath, and palpitations. Patients who have continuous sinus bradycardia are rarely asymptomatic. A temporary or permanent pacemaker can be set at a rate to prevent bradycardia (Brignole et al., 2013; Mininni, 2012; Vardas et al., 2012).



Need for Pacing: Sick Sinus Syndrome

The term “sick sinus syndrome” refers to various disorders in which the SA node is dysfunctional. This can include bradycardia, tachycardia, tachy-brady syndrome, or sinus arrest. Patients with sick sinus syndrome that are symptomatic are frequent candidates for pacemaker implantation (Brignole et al., 2013; Vardas et al., 2012).

Need for Pacing: Sinus Arrest

In sinus arrest, there is an SA node dysfunction that prevents the node from firing. This prevents the atrium from depolarizing, followed by ventricular asystole. Frequent episodes of sinus arrest can progress to asystole. The use of a pacemaker, such as a single chamber model, can be used to fire when the SA node does not (Brignole et al., 2013; Vardas et al., 2012).

Need for Pacing: Tachy-Brady Syndrome

Tachycardia-bradycardia syndrome (also known as tachy-brady syndrome, or brady-tachy syndrome) is also the result of SA node dysfunction. This creates episodes of bradycardia and tachycardia, and is a form of sick sinus syndrome. Symptoms can include irritability, anxiety, fatigue, syncope, hypotension, chest pain, decreased level of consciousness, shortness of breath, and palpitations. The combination of slow and fast arrhythmias places patients at risk for developing an embolism. By controlling the heart rate and rhythm with a pacemaker, the risk is lowered and symptoms can be alleviated (Brignole et al., 2013; Vardas et al., 2012).

Test Yourself

The most common sinus arrhythmia that a pacemaker is used with is:

- A. Premature atrial contractions
- B. Atrial fibrillation**
- C. Atrial flutter

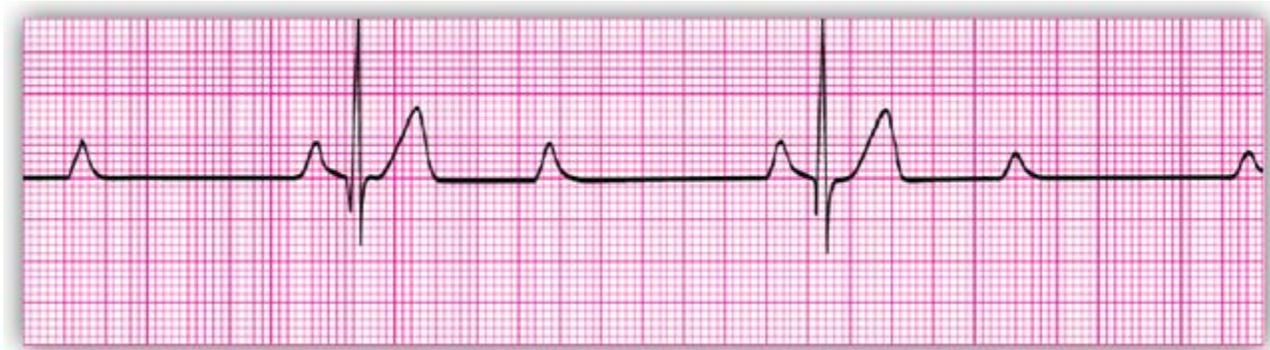
Rationale: Although atrial fibrillation is the most common atrial arrhythmia in which a pacemaker is used, other arrhythmias may benefit from pacing. Atrial tachycardia and atrial flutter, when prolonged or causing symptoms, may also be treated with a temporary or permanent pacemaker

Need for Pacing: AV Blocks

The most common AV blocks that require implantation of a permanent pacemaker are 2nd degree Type II and 3rd degree AV blocks.

Please note!

For further information on AV blocks, please refer to the RN.com course **Interpreting AV (Heart) Blocks: Breaking Down the Mystery**



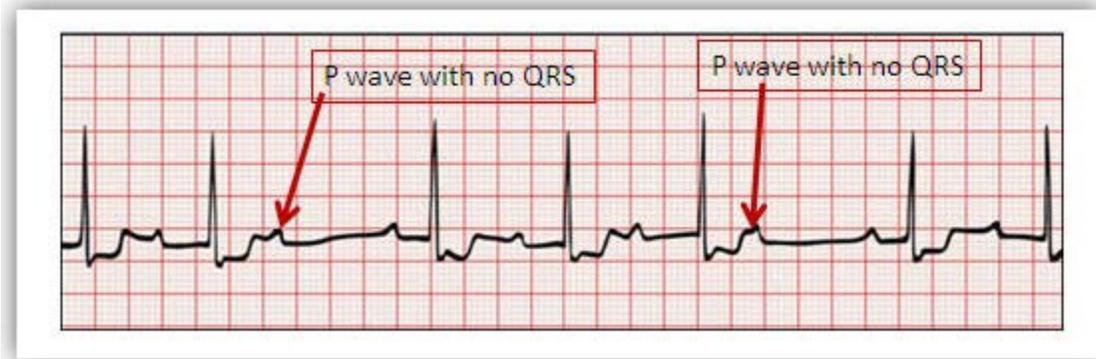
AV Blocks: First Degree

A first degree AV block is simply a delay in passage of the electrical impulse from atria to ventricles. This conduction delay usually occurs at the level of the AV node. This results in a prolonged PR interval. First-degree AV block rarely causes symptoms and is generally monitored only. In patients that display symptoms associated with bradycardia or if there is a worsening or severe prolonged PR interval, a temporary or permanent pacemaker may be used (Brignole et al., 2013; Maryniak, 2012; Vardas et al., 2012).



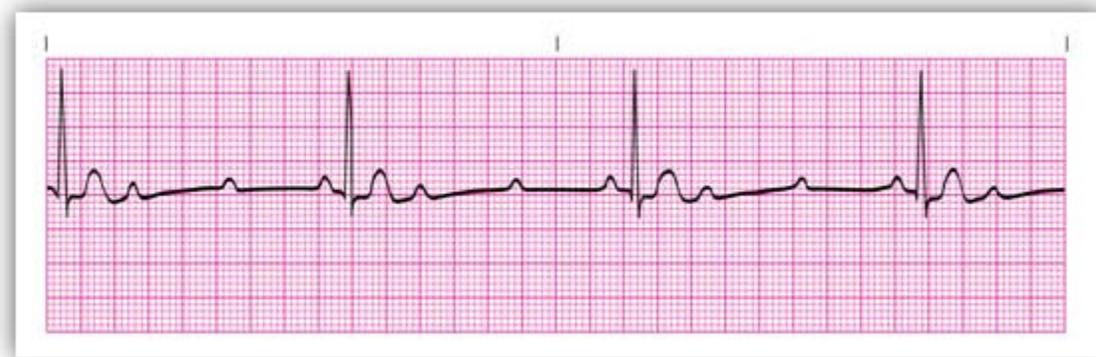
AV Blocks: Second Degree Type I

A second degree type I AV block is characterized by a progressive prolongation of the PR interval. The SA node fires appropriately, but the impulses traveling through the AV node take longer and longer to fully conduct, until one impulse is completely blocked. Patients are usually asymptomatic, and require monitoring only. Similar to a first degree AV block, if patients are symptomatic and/or the PR interval worsens, a temporary or permanent pacemaker may be considered (Brignole et al., 2013; Maryniak, 2012; Vardas et al., 2012).



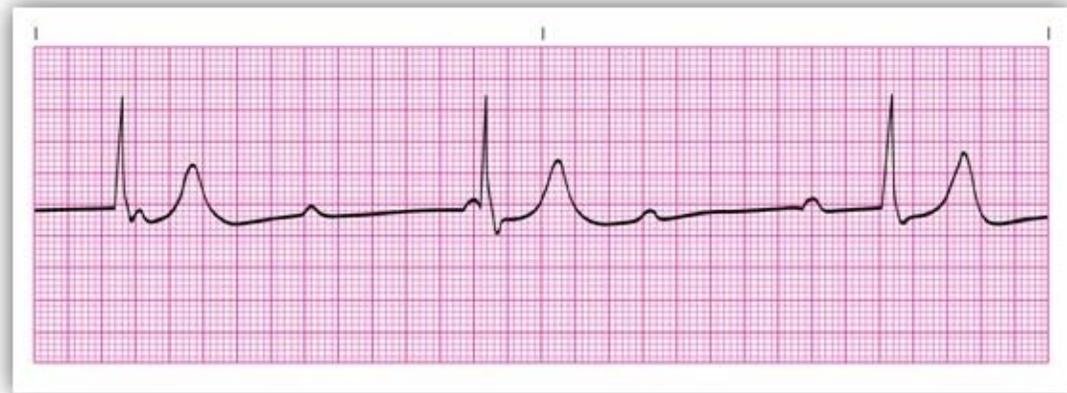
AV Blocks: Second Degree Type II, Third Degree

A second degree type II AV block has a conduction delay that occurs below the level of the AV node, either at the bundle of His or the bundle branches. There is a pattern of conducted P waves (with a constant PR interval), followed by one or more non-conducted P waves. The PR interval does not lengthen before a dropped beat. Since not all P waves are conducted into the ventricles, the ventricular response (HR) may be in the bradycardia range. Patients commonly demonstrate symptoms associated with bradycardia. This rhythm can quickly progress to a third degree AV block, so pacing (temporary to permanent) is recommended (Brignole et al., 2013; Maryniak, 2012; Minnini, 2012; Vardas et al., 2012).



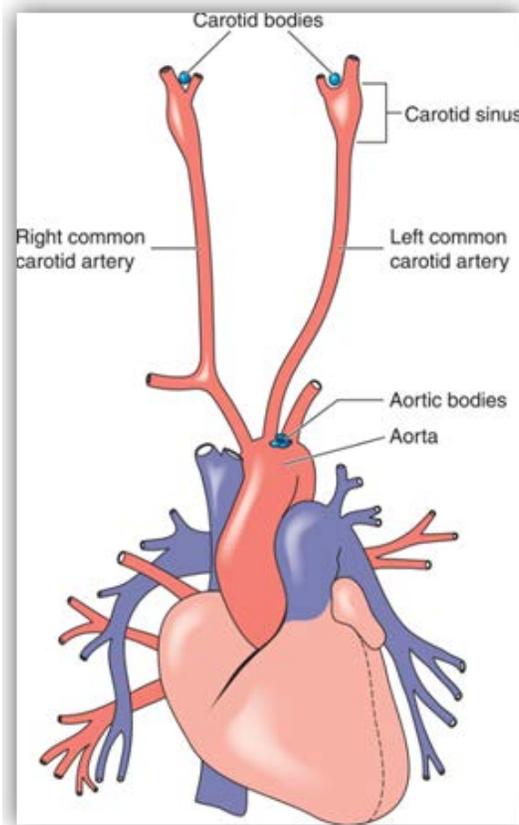
AV Blocks: Third Degree

A third degree AV block, also known as a complete heart block, occurs when there is a complete absence of conduction between atria and ventricles. The atrial rate is always equal to or faster than the ventricular rate. The block may occur at the level of the AV node, the bundle of His, or in the bundle branches. Symptoms of bradycardia are common with patients who have a third degree AV block, with poor cardiac output and hypotension. Temporary and then permanent pacing is highly recommended, regardless of the presence of symptoms (Brignole et al., 2013; Maryniak, 2012; Minnini, 2012; Vardas et al., 2012).



Need for Pacing: Carotid Sinus Syndrome

Carotid sinus syndrome (also known as reflex syncope) occurs when there is hypersensitivity to carotid sinus stimulation. This can produce bradycardia, hypotension, syncope, and sinus arrest. Although it is unclear what causes carotid sinus syndrome, increased vagal tone and vasodepression are components of this syndrome. Permanent pacemaker placement can improve the heart rate and prevent bradycardia (Brignole et al., 2013; Vardas et al., 2012).



© Can Stock Photo Inc. / Blambs

Need for Pacing: Neurocardiogenic Syncope

Neurocardiogenic syncope (also known as vasovagal syncope) occurs when the body is unable to maintain blood pressure and/or heart rate, causing syncopal episodes. This can be a result of poor peripheral blood return and effects of the sympathetic nervous system. Similar to carotid sinus syndrome, a pacemaker can improve the heart rate and prevent bradycardia and syncope (Brignole et al., 2013; Vardas et al., 2012).

Need for Pacing: Prolonged QT Syndrome

Prolonged QT syndrome (also known as long QT syndrome) is an inherited condition that causes prolonged QT intervals. This indicates a delay between the depolarization and repolarization of the ventricle. This syndrome can predispose a patient to developing the potentially lethal arrhythmia Torsades de Pointes. Bradycardia can create an even longer QT interval. The use of a permanent pacemaker in patients that are non-responsive to beta-blockers can prevent development of lethal arrhythmias (Brignole et al., 2013; Vardas et al., 2012).

Test Yourself

Which of the following AV blocks is more likely to require the use of a pacemaker?

- A. First degree
- B. Second degree type I
- C. Third degree**

Rationale: A third degree AV block, also known as a complete heart block, occurs when there is a complete absence of conduction between atria and ventricles. The atrial rate is always equal to or

faster than the ventricular rate. The block may occur at the level of the AV node, the bundle of His, or in the bundle branches. Symptoms of bradycardia are common with patients who have a third degree AV block, with poor cardiac output and hypotension. Temporary and then permanent pacing is highly recommended, regardless of the presence of symptoms

Need for Pacing: Special Conditions

There are some special conditions in which a temporary or permanent pacemaker may be used. As previously discussed, epicardial pacing is used with cardiac surgeries, which includes heart transplant.

Neuromuscular diseases, including muscular dystrophy, have cardiac disease as a common feature. This can cause bradyarrhythmias and impairment with cardiac conduction. Temporary or permanent pacemakers may be a treatment option.

Sarcoidosis is a multi-system disease in which granulomas form in the tissue. Some patients develop granulomas in the cardiac tissue, which is known as cardiac sarcoidosis. This places patients at risk for arrhythmias, including AV block. Pacemakers may be a consideration for patients unresponsive to medications.

(Brignole et al., 2013; Mininni, 2012; Vardas et al., 2012).

Some metabolic disorders, such as Anderson-Fabry disease, can cause SA node dysfunction and impairment of AV conduction of electrical impulses. Temporary or permanent pacemakers may be used in these situations.

Congenital heart disease may include a congenital AV block or other arrhythmias resulting from SA node dysfunction. Temporary or permanent pacemakers may be used in these situations, including infants, children, adolescents, or adults.

A myocardial infarction may impair conduction of electrical impulses and create SA node dysfunction or a new AV block development. These conditions may be temporary or permanent, and pacemakers can be indicated.

(Brignole et al., 2013; Mininni, 2012; Vardas et al., 2012).

Potential Complications of Pacemakers

As with any treatment, there are potential complications that may occur with implantation of pacemakers. These include:

- Infection
- Hematoma
- Venous thrombosis, embolism
- Pneumothorax
- Pectoral or diaphragmatic muscle stimulation from the pacemaker
- Arrhythmias
- Cardiac tamponade
- Heart failure
- Pacemaker malfunction

- Cardiac arrest
- Death (may be due to surgery or failure of the pacemaker to correct the underlying condition)

(Brignole et al., 2013)

Coding for Pacemakers

The capability of a pacemaker is described by a five-letter coding system, although three letters may be used.

- First letter: identifies which heart chamber(s) are being paced—V (ventricle), A (atrium), D (dual, ventricle and atrium), or O (none)
- Second letter: identifies which heart chamber(s) are where the pacemaker senses intrinsic activity—V (ventricle), A (atrium), D (dual, ventricle and atrium), or O (none)
- Third letter: indicates the pacemaker's mode of response to the intrinsic activity that it senses in atrium or ventricle—T (triggered), I (inhibited), D (dual, triggered or inhibited), or O (none)
- Fourth letter: indicates the programmability of the pacemaker—P (basic function programmability), M (multiprogrammable), C (communicating functions such as telemetry), R (rate responsiveness or modulation), or O (none)
- Fifth letter: designates special tachyarrhythmia functions and how the pacemaker will respond to a tachyarrhythmia—P (pacing ability), S (shock), D (dual, can shock and pace), or O (none)

(Mininni, 2012)

Implantable Cardioverter Defibrillators

An implantable cardioverter defibrillator (ICD) is an electrical impulse generator that continuously monitors the heart rhythm and can deliver pacing and/or shocks to restore normal rhythm. ICDs have been shown to prolong survival in patients who are receiving the device for treatment of ventricular arrhythmias, or for prevention of sudden cardiac death. Patients who have heart failure and decreased left ventricular function can benefit from an ICD (Ghislandi, Torbica, & Boriani, 2013).

ICD Indications

Indications that a patient may benefit from an ICD, in conjunction with other treatment options, include:

- Patients with a history of sustained ventricular fibrillation
- Patients with a history of sustained ventricular tachycardia
- Patients at least 40 days post myocardial infarction, with an ejection fraction of 30-40%
- Patients who have survived a sudden cardiac death
- Patients with prolonged QT syndrome or long QT intervals and previous myocardial infarction

(Ghislandi et al., 2013).

ICD Shock

This rhythm strip shows a patient in Torsades de Pointe. The ICD sends a shock, and the rhythm

converts out of the arrhythmia.

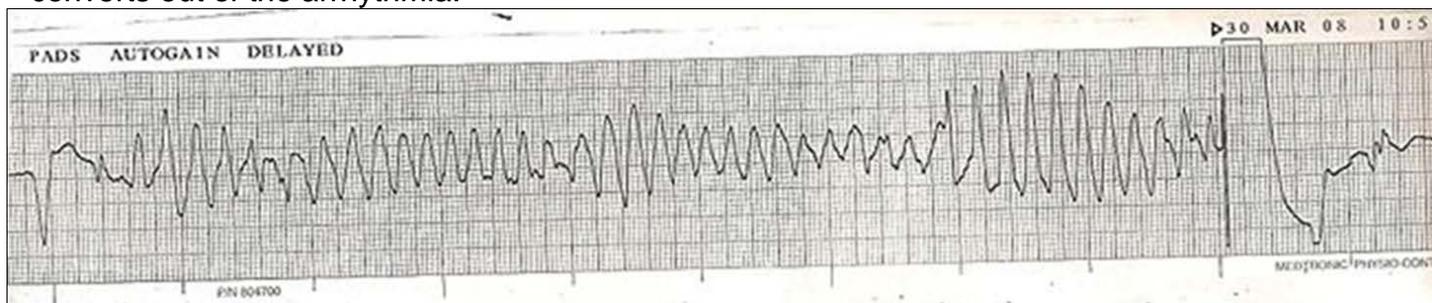


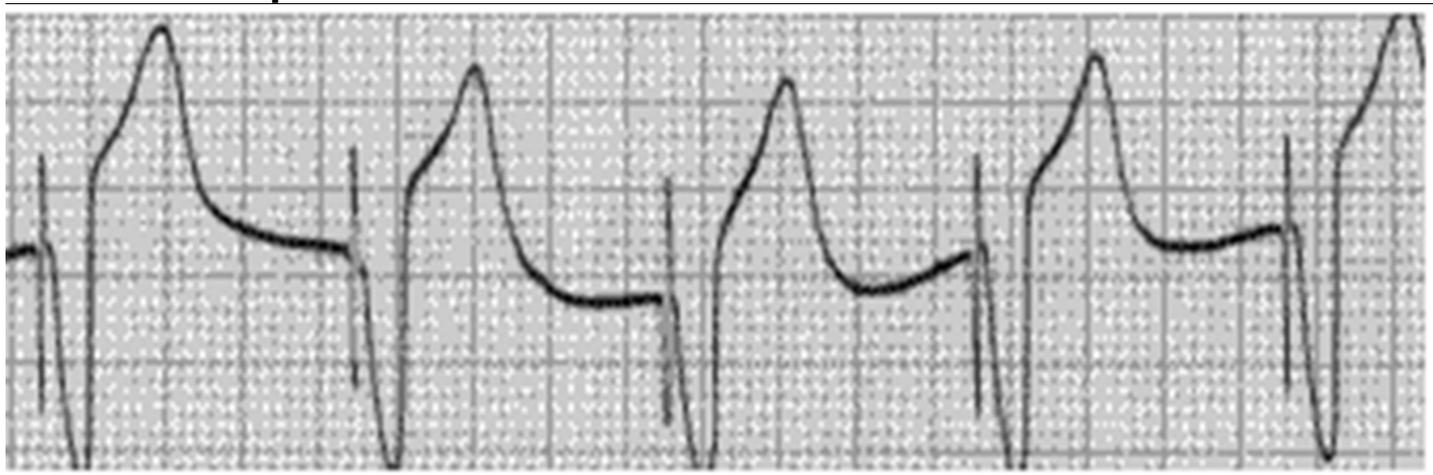
Image retrieved from http://en.wikipedia.org/wiki/Torsades_de_pointes

Image released into Public Domain

Pacemakers Rhythm Interpretation

When interpreting a rhythm strip for a patient who has a pacemaker, evaluation of the P wave, QRS complex, and T wave is done. In addition, atrial and/or ventricular spikes should be located, depending on the type of pacemaker used. The impulse that travels from the pacemaker to the heart is what creates the spikes on the electrocardiogram (ECG). These spikes appear above or below the isoelectric line, and can be either large or small.

Pacemaker Spikes



Zorkun, C. (2008). Image provided by Wikipedia, under the Creative Commons Attribution License.
Image retrieved from <http://www.wikidoc.org/index.php/File:Paced2.gif>

Capture

A capture is what occurs when the heart responds to the electrical stimuli from the pacemaker and depolarizes. Depending on the site of the leads, this can be an atrial capture, a ventricular capture, or both.

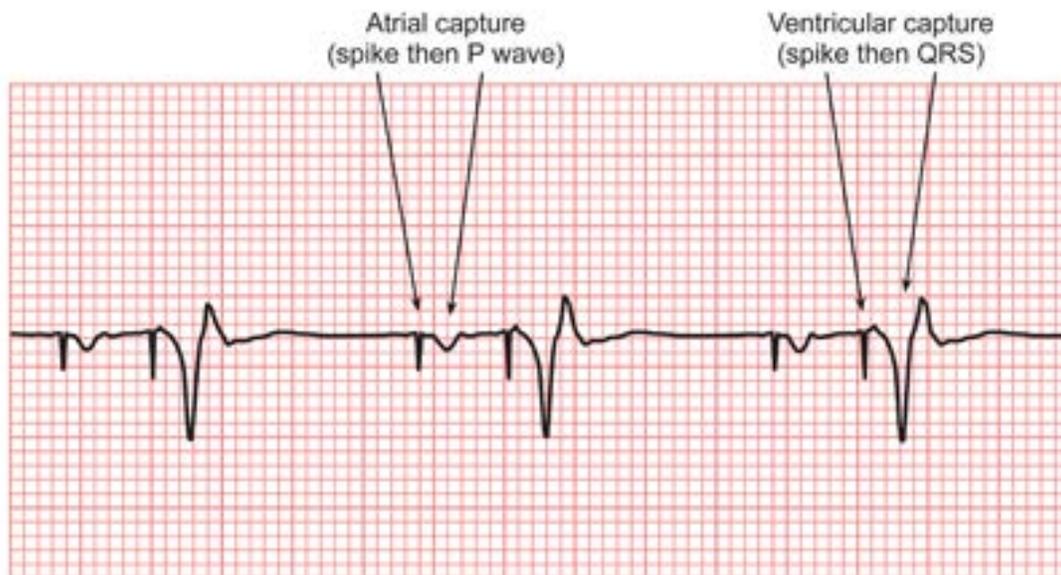
Material Protected by Copyright

When the pacemaker lead is located in the atria, the spike is followed by a P wave, QRS complex, and T wave. This indicates successful capture of the myocardium. The P wave may appear different from the patient's normal P wave.

When the pacemaker lead is located in the ventricle, the spike is followed by a QRS complex and T wave. This demonstrates effective pacing of the myocardium. The QRS complex appears wider than the patient's own QRS complex because of the way the pacemaker depolarizes the ventricles.

When both the atria and ventricle are stimulated by the pacemaker, one spike is followed by a P wave, and then another spike occurs, followed by a QRS complex. This pattern represents successful capture of the myocardium. This is called atrioventricular (AV) sequential pacing, dual pacing, or DDD pacing (Minnini, 2012).

Atrial and Ventricular Capture



Atrial & Ventricular Capture

When both the atria and ventricle are stimulated by the pacemaker, one spike is followed by a P wave, and then another spike occurs, followed by a QRS complex.

© 2013 Amicus Visual Solutions

(Havranek, 2014)

Test Yourself

While interpreting a rhythm, you note a P wave, then a pacemaker spike followed by a QRS complex.

Material Protected by Copyright

This indicates:

- A. Atrial capture
- B. Ventricular capture**
- C. AV sequential pacing

Rationale:

- When the pacemaker lead is located in the atria, the spike is followed by a P wave, QRS complex, and T wave. This indicates successful capture of the myocardium. The P wave may appear different from the patient's normal P wave.
- When the pacemaker lead is located in the ventricle, the spike is followed by a QRS complex and T wave. This demonstrates effective pacing of the myocardium. The QRS complex appears wider than the patient's own QRS complex because of the way the pacemaker depolarizes the ventricles.
- When both the atria and ventricle are stimulated by the pacemaker, one spike is followed by a P wave, and then another spike occurs, followed by a QRS complex. This pattern represents successful capture of the myocardium. This is called atrioventricular (AV) sequential pacing, dual pacing, or DDD pacing

Assessing Pacemaker Function

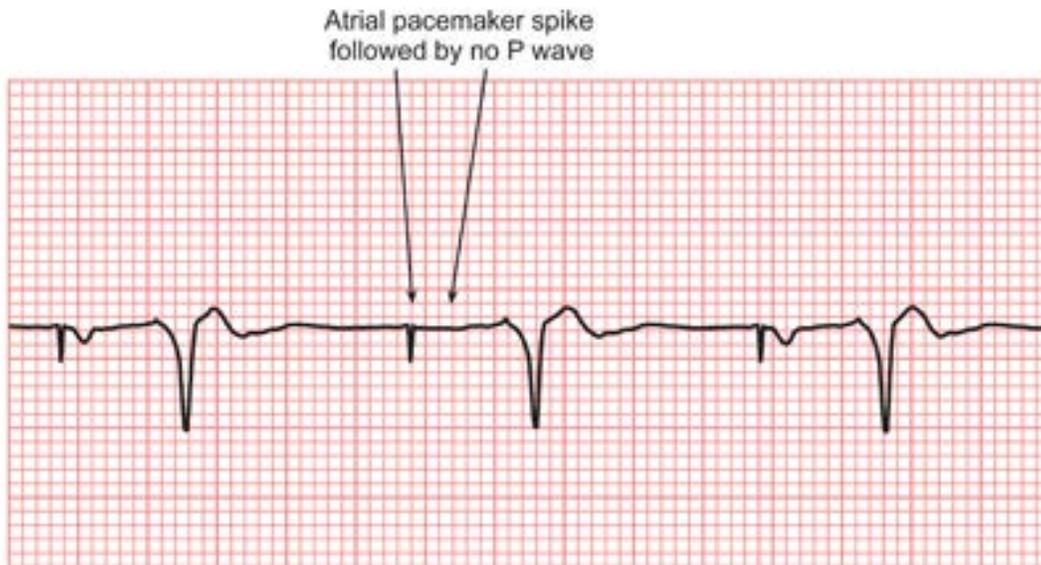
To assess the function of a pacemaker, the following should be performed:

- Determine the pacemaker's mode and settings
- Review the patient's 12-lead electrocardiogram (ECG)
- Select a monitoring lead that clearly shows the pacemaker spikes
- Determine the heart rate
- Assess the patient for any symptoms of decreased cardiac output
- Look for information that tells you which chamber is paced, and review the strip:
 - Is there capture?
 - Is there a P wave or QRS complex after each atrial or ventricular spike?
 - Are P waves and QRS complexes coming from intrinsic activity?
 - If intrinsic activity is present, does the pacemaker respond appropriately?

Failure to Capture

A failure to capture occurs when the pacemaker sends an electrical pulse that is not successful in triggering a response from the heart. In these cases, a pacemaker spike is seen without a P wave for atrial pacing or a QRS complex for ventricular pacing. Failure to capture may be caused by loose connections with the pacemaker, problems with the pacemaker leads, a weak pacemaker battery, or an increased threshold for pacing. An increased pacing threshold results from changes in the patient's body, such as metabolic or electrical imbalances (Minnini, 2012).

Failure to Capture: Atrial



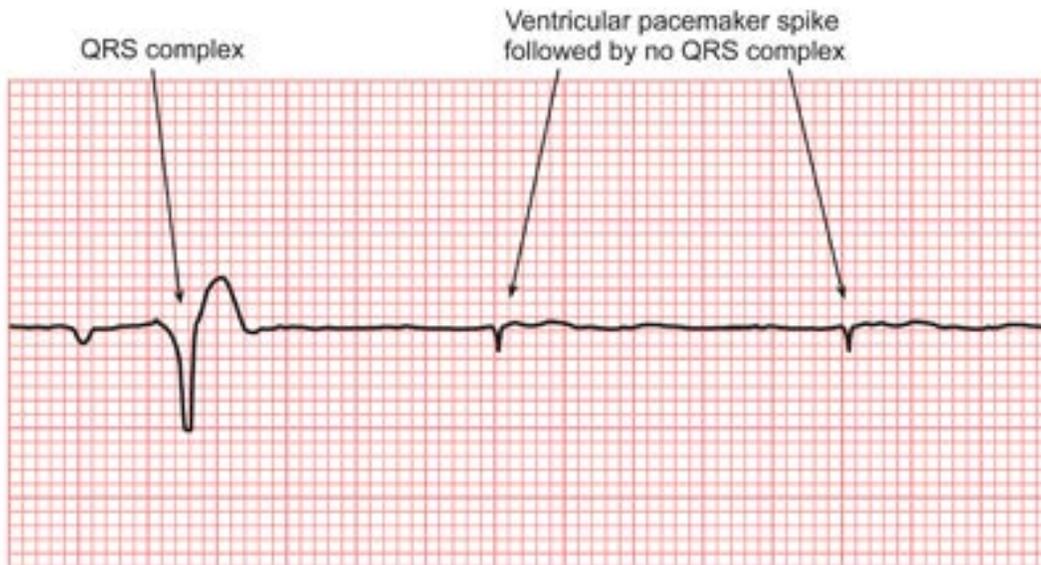
Failure to Capture: Atrial

A failure to capture occurs when the pacemaker sends an electrical pulse that is not successful in triggering a response from the heart. In these cases, a pacemaker spike is seen without a P wave for atrial pacing or a QRS complex for ventricular pacing.

© 2013 Amicus Visual Solutions

(Havranek, 2014)

Failure to Capture: Ventricular



Failure to Capture: Ventricular

A pacemaker spike is seen without a QRS complex for ventricular pacing.

© 2013 Amicus Visual Solutions

(Havranek, 2014)

Troubleshooting Failure to Capture

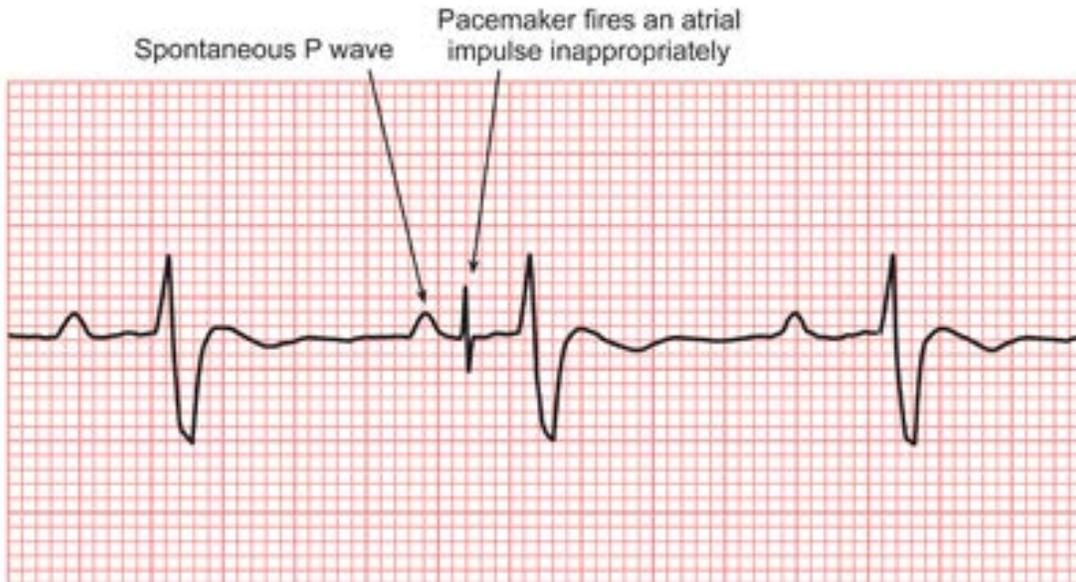
If failure to capture is identified with a patient, it is important to find what the cause is and correct it. The steps to follow are:

- Notify the physician
- Assess the patient for a myocardial infarction, acidosis, hypoxia, electrolyte imbalance
- Assess for mechanical issues, including low battery, disconnection or damage of leads (may be from pacemaker or heart), machine malfunction
- Provide external pacing with temporary transcutaneous pacemaker
- Prepare for CPR

Failure to Sense

Failure to sense occurs when the pacemaker does not sense a naturally occurring electrical stimulation and response from the heart, and fires inappropriately. This can happen if the sensitivity on the pacemaker is not set appropriately, if there is a mechanical failure with the pacemaker, or if there is electrical interference. In these situations, a pacemaker spike can be seen after a spontaneous P wave or QRS wave (Minnini, 2012).

Failure to Sense: Atrial



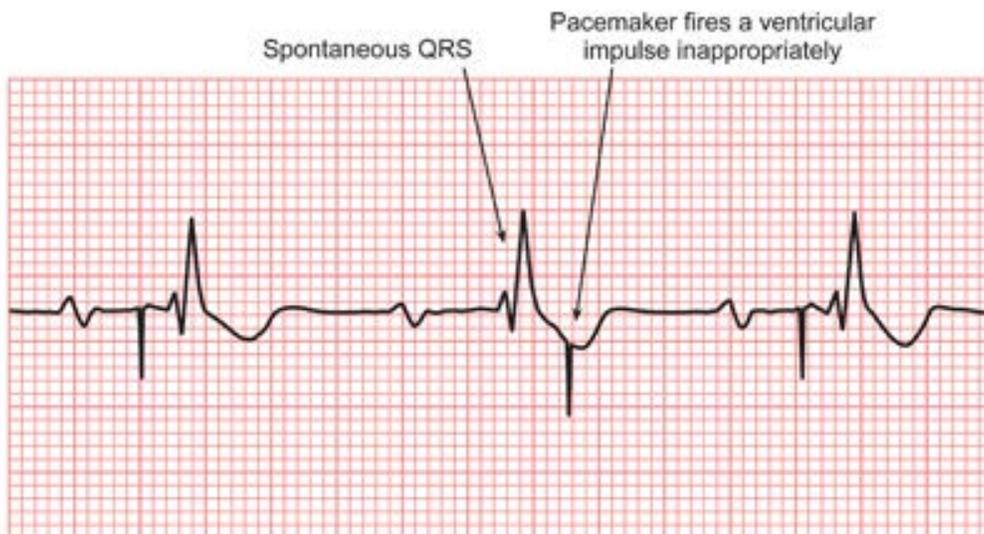
Failure to Sense: Atrial

Failure to sense occurs when the pacemaker does not sense a naturally occurring electrical stimulation and response from the heart, and fires inappropriately. In this situation, a pacemaker spike can be seen after a spontaneous P wave.

© 2013 Amicus Visual Solutions

(Havranek, 2014)

Failure to Sense: Ventricular



Failure to Sense: Ventricular

Failure to sense occurs when the pacemaker does not sense a naturally occurring electrical stimulation and response from the heart, and fires inappropriately. In this situation, a pacemaker spike can be seen after a spontaneous QRS wave.

© 2013 Amicus Visual Solutions

(Havranek, 2014)

Troubleshooting Failure to Sense

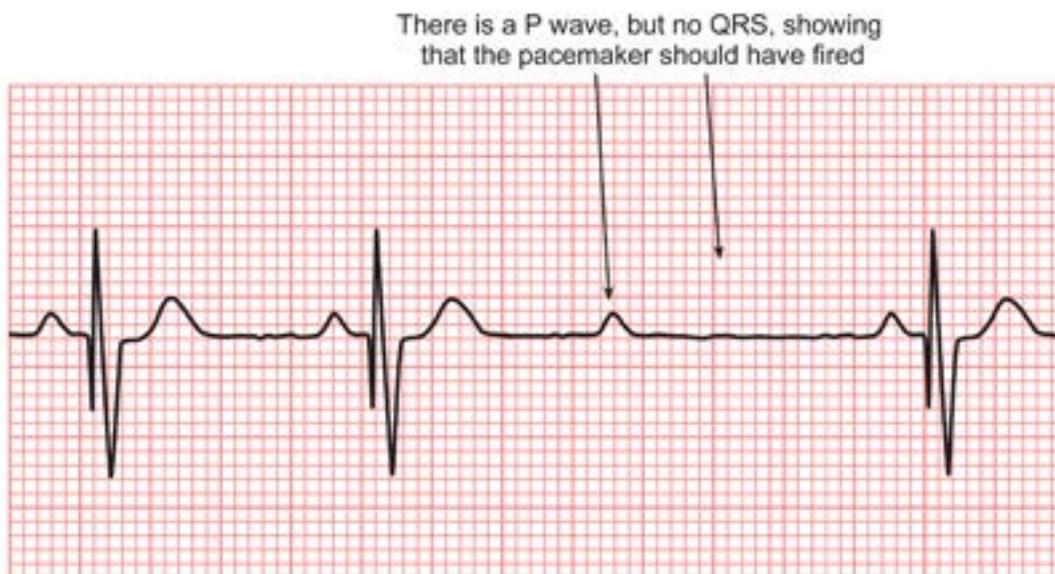
If failure to sense is identified with a patient, it is important to find what the cause is and correct it. If a pacemaker cannot sense an intrinsic rhythm and fires while the ventricle is repolarizing, a lethal ventricular arrhythmia may occur.

- Notify the physician
- Assess the pacemaker sensitivity
- Check for sources of electrical interference
- Assess for mechanical issues, including low battery, disconnection or damage of leads (may be from pacemaker or heart), machine malfunction
- Provide external pacing with temporary transcutaneous pacemaker
- Prepare for CPR

Failure to Pace

A failure to pace occurs when the pacemaker does not provide the electrical stimulus when it should. On a rhythm strip, there are no pacemaker spikes where there should be. This is caused by a weak battery or a mechanical problem (Minnini, 2012).

Failure to Pace Rhythm



Failure to Pace Rhythm

A failure to pace occurs when the pacemaker does not provide the electrical stimulus when it should. On a rhythm strip, there are no pacemaker spikes where there should be.

© 2013 Amicus Visual Solutions

(Havranek, 2014)

Troubleshooting Failure to Pace

If failure to pace is identified with a patient, it is important to find what the cause is and correct it. If a pacemaker cannot sense an intrinsic rhythm and fires while the ventricle is repolarizing, a lethal

Material Protected by Copyright

ventricular arrhythmia may occur.

- Call for help and prepare for CPR
- Notify the physician
- Provide external pacing with temporary transcutaneous pacemaker
- Assess for mechanical issues, including low battery, disconnection or damage of leads (may be from pacemaker or heart), machine malfunction

Test Yourself

While interpreting a rhythm, you note a P wave followed by a QRS complex and T wave, then a pacemaker spike. This indicates:

- A. Failure to capture
- B. Failure to sense**
- C. Failure to pace

Rationale: Failure to sense occurs when the pacemaker does not sense a naturally occurring electrical stimulation and response from the heart, and fires inappropriately. This can happen if the sensitivity on the pacemaker is not set appropriately, if there is a mechanical failure with the pacemaker, or if there is electrical interference. In these situations, a pacemaker spike can be seen after a spontaneous P wave or QRS wave

Nursing Considerations

- Maintain continuous cardiac monitoring, and monitor for arrhythmias
- Administer medications as ordered
- Document the type of pacemaker inserted, lead system, pacemaker mode, and pacing guidelines
- After the first 24 hours of permanent pacemaker insertion, begin passive range-of-motion exercises on the affected arm if ordered
- Monitor vital signs
- Monitor intake and output
- Assess for complications, such as abnormal bleeding and infection
- Assess the surgical wound and dressing
- Monitor drainage
- Assess pacemaker function

Patient Teaching

After a patient has a pacemaker implanted, points to include with patient and family teaching are:

- Possible complications and when to notify the physician (e.g. signs and symptoms of infection)
- Any diet or activity restrictions (including driving and return to work) as ordered by the physician
- How to monitor the heart rate and rhythm
- The patient should avoid placing excessive pressure over the insertion site, pushing or pulling objects, lifting objects greater than 10 pounds, or extending his/her arms over his/her head for four to six weeks after discharge
- Ensure there is a follow up appointment with the physician

- The physician should be notified if the patient experiences signs of pacemaker failure, such as palpitations, a fast heart rate, a slow heart rate (5 to 10 beats less than the pacemaker's setting), dizziness, fainting, shortness of breath, swollen ankles or feet, anxiety, forgetfulness, or confusion
- Medical personnel need to be informed of the implanted pacemaker before undergoing certain diagnostic tests
- Provide the patient with an identification card that includes:
 - The pacemaker type and manufacturer
 - Serial number
 - Pacemaker rate setting
 - Date implanted
 - Physician's name

Case Scenario:

Mrs. Jones is found down at home by her husband, who immediately calls 911 and starts CPR. When the medics arrive, he tells them she suffers from uncontrolled atrial fibrillation. When the monitor is placed, the waveform shows a heart rate of 24, multiple p waves without a ventricular response. You anticipate that the medics next step would be:

1. Continue CPR and transport Mrs. Jones to the emergency department
2. Stop CPR and allow Mrs. Jones' heart to do its job
3. Continue CPR until the transcutaneous pacing pads can be applied and Mrs. Jones can be paced
4. Stop CPR and place the transcutaneous pads for pacing

If you picked "3" you are correct. Atrial fibrillation with a slow ventricular response is one of the most common dysrhythmias requiring pacing. Mrs. Jones is unresponsive so the medics must continue CPR until they can establish a paced rhythm for Mrs. Jones.

Once Mrs. Jones is paced at a rate of 80, she begins to wake up and cry out. Mr. Jones is frightened by the jerky motions his wife is making and worries that she is in pain. You would anticipate the medics would educate Mr. Jones by:

1. Letting him know the jerky movements are in response to the electrical stimulation of the pacing pads.
2. Telling him his wife is now having a seizure
3. Calling the base-station to see if a dose of sedation and or pain medication is advisable

If you chose 1 & 3 you are correct. The muscles in the body respond to the impulses delivered to the electrodes and cause seizure like motions and can be painful. If Mrs. Jones' vital signs are stable enough for sedation and pain medications, and if the team carries those medications; Mrs. Jones should receive them whenever possible.

The medics transport Mrs. Jones to the nearest facility, where the providers are unable to provide monitoring and placement of a permanent pacemaker. However, they are able to provide a different method of temporary pacing in order to stabilize Mrs. Jones so she can be transported to the nearest cardiac intensive care unit. You anticipate that they will place:

1. Transvenous pacemaker wires
2. Epicardial pacemaker wires

3. Transcutaneous pacer pads

If you chose number 1, you are correct. Mrs. Jones already has transcutaneous pacer pads in place, there is no cardiac surgery determined to be necessary so epicardial pacer wires cannot be placed. However, this facility has a very experienced radiologist who will use fluoroscopy to place transvenous wires.

While recovering from her procedure and awaiting the transport team, Mrs. Jones continues to stabilize. She is given sedation to help her maintain a comfortable and safe position so she does not dislodge her temporary pacing wires.

Mr. Jones inquires as to whether his wife will need a permanent pacemaker and the intensivist replies:

1. No, this is just a once-in-a-life time occurrence
2. Unable to discern now, would like to monitor Mrs. Jones for a few days to see if her rhythm improves
3. Would like to monitor Mrs. Jones for a few days and send her home with the temporary pacemaker if needed
4. Would like to place a permanent pacemaker to ensure that Mrs. Jones will have an adequate heart rate in the future

Watching Mrs. Jones for a few days to monitor her rhythm and discern how much, if any pacing assistance she may need is a prudent answer; however, placing a permanent pacemaker is also prudent to ensure a stable heart rate.

The cardiologist examines Mrs. Jones and her rhythm strips over the past several days. He interprets the rhythm to be 100% ventricularly paced with an underlying intrinsic rhythm of 30. He consults with Mr. & Mrs. Jones, explains his findings and suggests that Mrs. Jones receives a permanent ventricular pacemaker.

After the surgery, Mr. Jones receives a card with the following information on it:

DDD

Rate: 80

He asks what this means. You tell him:

Dual chamber pacing

Dual chamber sensing

Dual chamber inhibiting

To maintain a heart rate of 80 beats per minute

You are correct, this mode of pacing is capable of pacing, sensing, and inhibiting one or both chamber responses as needed. This type of pacing will also maintain atrioventricular synchrony with variable atrial and ventricular rates.

After another couple of days in the hospital to determine the best settings for Mrs. Jones pacemaker, she is ready for discharge. What will you teach her to be sure she recognizes pacemaker dysfunction?

If you teach her the signs of pacemaker syndrome:

- Shortness of breath
- Dizziness
- Fatigue

- Palpitations
- Headache
- Pulsations in the neck
- Syncope
- Chest pain
- Vertigo
- Near syncope
- Confusion

You will have provided her and Mr. Jones with the information they will need to monitor her condition.

Conclusion

Pacemakers have evolved, improving morbidity and mortality of patients suffering from a variety of conditions. Pacing can be done through temporary or permanent devices, preventing potentially lethal arrhythmias. It is important for nurses to have a basic understanding of indications and functions of pacemakers. In addition, interpretation of rhythm strips can help evaluate pacemaker function.

Resources

- American College of Cardiology: www.acc.org
- American Heart Association: www.heart.org

References

- American Heart Association. (2016). Advanced cardiovascular life support. ISBN: 978-1-61669-400-5
- Aquilina, C. (2006). A brief history of cardiac pacing. *Images in Paediatric Cardiology*, 8(2), 17–81.
- Brignole, M., Auricchio, A., Baron-Esquivias, G., Bordachar, P., Boriani, G.... & Vardas, P. (2013). 2013 ESC guidelines on cardiac pacing and cardiac resynchronization therapy. *European Heart Journal*, 34, 2281–2329.
- Ghislandi, S., Torbica, A., & Boriani, G. (2013). Assessing the outcomes of implantable cardioverter defibrillator treatment in a real world setting: results from hospital record data. *BMC Health Services Research*, 13(1), 1-9.
- Maryniak, K. (2012). *Interpreting AV (heart) blocks: Breaking down the mystery*. Retrieved from www.rn.com
- Mininni, N. (2012). The beat goes on: A pacemaker primer. *American Nurse Today*, 7(3), 26-31.
- Vardas, P., Simantirakis, E., & Kanoupakis, E. (2012). New developments in cardiac pacemakers. *Circulation*, 127, 2343-2350.

Disclaimer

This publication is intended solely for the educational use of healthcare professionals taking this course, for credit, from RN.com, in accordance with RN.com terms of use. It is designed to assist healthcare professionals, including nurses, in addressing many issues associated with healthcare. The guidance provided in this publication is general in nature, and is not designed to address any specific situation. As always, in assessing and responding to specific patient care situations, healthcare professionals must use their judgment, as well as follow the policies of their organization and any applicable law. This publication in no way absolves facilities of their responsibility for the appropriate orientation of healthcare professionals. Healthcare organizations using this publication as a part of their own orientation processes should review the contents of this publication to ensure accuracy and compliance before using this publication. Healthcare providers, hospitals and facilities that use this publication agree to defend and indemnify, and shall hold RN.com, including its parent(s), subsidiaries, affiliates, officers/directors, and employees from liability resulting from the use of this publication. The contents of this publication may not be reproduced without written permission from RN.com.

Participants are advised that the accredited status of RN.com does not imply endorsement by the provider or ANCC of any products/therapeutics mentioned in this course. The information in the course is for educational purposes only. There is no “off label” usage of drugs or products discussed in this course.

You may find that both generic and trade names are used in courses produced by RN.com. The use of trade names does not indicate any preference of one trade named agent or company over another. Trade names are provided to enhance recognition of agents described in the course.

Note: All dosages given are for adults unless otherwise stated. The information on medications contained in this course is not meant to be prescriptive or all-encompassing. You are encouraged to consult with physicians and pharmacists about all medication issues for your patients