The Pediatric & Congenital Electrophysiology Society

Patient Resources: ICD/Pacemaker Overview

ICD/Pacemaker Overview

What is a pacemaker?

A pacemaker is a device that uses low energy electrical pulses to prompt the heart to beat whenever a pause in the rhythm is detected. They have the ability to speed up a slow heart rhythm, as well as sense when it is not needed to pace. They can help to coordinate electrical signals between the upper and lower chambers so they will beat in a coordinated fashion, which can sometimes help control abnormal fast rhythms from the upper chamber.

What is a pacemaker used for?

Pacemakers are used for patients that have an abnormally slow rhythm. Pacemakers may be indicated in patients with symptomatic bradycardia (slow heart rate), high grade AV block (where the top and bottom chambers are not communicating effectively), or sinus node dysfunction (the sinus node is the hearts natural pacemaker that sets the pace for how fast the heart should beat). Bradycardia, heart block, & sinus node dysfunction can produce the following symptoms: dizziness, near fainting or fainting (syncope), weakness, decrease energy or early tiring during physical activity, fatigue, shortness of breath, or chest pain. If untreated, severe bradycardia can rarely result in heart failure.

Different indications for pacemaker implantation are the following:

1. Patients who are symptomatic because they do not have the ability to increase their heart rates when attempting to exert themselves.
2. Patients who have sinus node dysfunction (SND) with documented symptomatic bradycardia (slow heart rates), including frequent sinus pauses that produce symptoms.
3. Patients that have symptomatic bradycardia with a heart rate less than 40 beats/minute while awake.
4. Infants that were born with congenital heart block with heart rates less than 55 beats/min or an infant that was born with a structurally abnormal heart and has heart rates less than 70 beats/min.
5. Patients that have persistent heart block that persists at least 7 days after cardiac surgery.
6. Patients with syncope (passing out) of unexplained origin when clinically significant abnormalities of sinus node function are discovered or provoked in electrophysiological studies.
7. Patients with heart block who are symptom-free have a documented period of no heart beat for greater than or equal to 3.0 seconds or if the beat is coming from outside the normal conduction system at rates less than 40 beats/minute.

What is an ICD?

An Implantable cardioverter defibrillator (ICD) is a special type of pacemaker that can recognize abnormal rhythms in the bottom part of the heart and deliver therapy to restore the heart to a normal rhythm. ICDs can function in a couple of ways: 1. ICD's analyze heart rates that are too fast and identify if this rhythm may be life threatening, such as ventricular tachycardia (VT) or ventricular fibrillation (VF). If the ICD identifies an abnormal rhythm (arrhythmia) it attempts to pace the heart into an organized normal rhythm. If unable to convert (normalize) the rhythm by pacing, the ICD will deliver energy by shocking the heart, to convert it into an organized normal rhythm. 2. If heart rate is too slow, it can function like a pacemaker.

What are ICD's used for?

Implantable cardioverter defibrillators (ICD) have become the treatment choice for primary and secondary prevention of patients who are at a high risk of sudden cardiac death.
Secondary prevention would be in a patient who has experienced a sudden cardiac arrest, whereas primary prevention is when a patient has been identified to be at high risk but has not yet experienced a sudden cardiac event. Indications for ICD implantation would include primary electrical diseases, structural congenital heart disease, hypertrophic cardiomyopathy (HCM), dilated cardiomyopathy (DCM), and severe left ventricular dysfunction in the presence of ventricular arrhythmias.

Guidelines for ICD implantation are the following:

1. ICD therapy is indicated in patients who are survivors of cardiac arrest due to ventricular fibrillation (VF) or hemodynamically unstable sustained VT (both are abnormally fast rhythms from the bottom part of the heart) after evaluation to define the cause of the event and to exclude any reversible causes.
2. ICD therapy is indicated in patients with structural heart disease and spontaneous sustained VT, whether hemodynamically stable or unstable.
3. ICD therapy is indicated in patients who have passed out where the cause is identified to be an abnormal heart rhythm.
4. ICD implantation is reasonable for patients who are high risk of sudden cardiac death related to an electrical abnormality of the heart who have experienced syncope.
5. ICD implantation is reasonable for the prevention of sudden cardiac death in patients with hypertrophic cardiomyopathy (HCM) where the muscle of the heart is abnormally thick or if there are other concerning risk factors. Your EP team will talk to you about this risk. These risk factors may include:

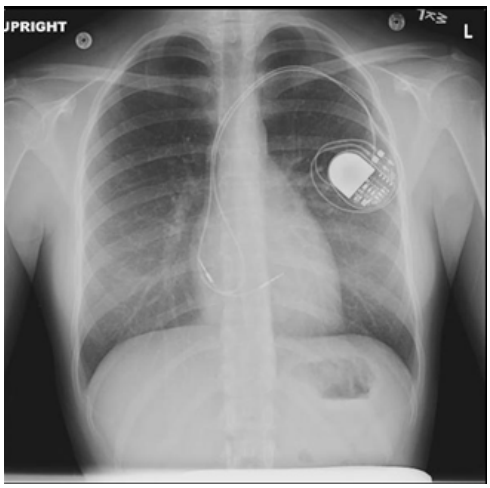
- A patient that survived an episode of sudden cardiac event.
- A family history of a first degree relative that had sudden cardiac death

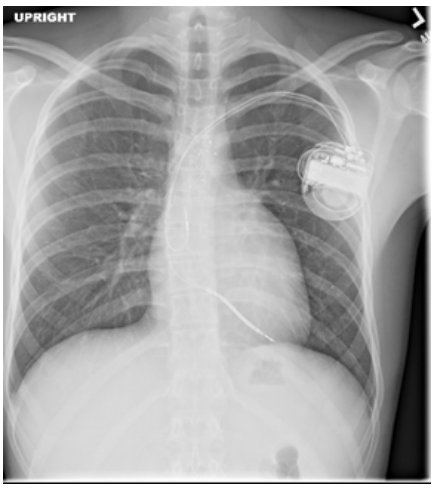
- Unexplained syncope
- Nonsustained episodes of ventricular tachycardia on a routine surveillance Holter
- Maximal wall thickness on echocardiogram of greater than or equal to 30mm
- Evidence of late gadolinium enhancement on MRI, which is scarring in the wall of the lower chamber
- Decreased blood pressure response on routine exercise stress test.

How are these devices implanted?

Pacemakers and implantable cardioverter defibrillator (ICDs) can be implanted in two basic ways in children and adolescents. The systems can be epicardial (leads outside the heart) or transvenous (leads inside the veins leading to the heart). The leads are wires which connect the heart to the pacemaker or defibrillator. Children can have a lead on the top chamber of the heart (atrium) or the bottom chamber of the heart (ventricle) or both. Sometimes leads are placed on both ventricles. All references in the following to “pacemakers” also apply to “defibrillators” except where noted.

Transvenous pacing system: This type of system is usually implanted in children older than 8-10 years of age who also have normal circulation between the upper body veins and the heart and no significant structural heart problems. The leads are inserted into the vein just below the clavicle (collar bone), threaded through the large vein leading into the heart (superior vena cava) and placed in the top chamber of the heart (atrium) or the bottom chamber of the heart (ventricle) or both. Transvenous leads generally last longer than epicardial but do have an incidence of long-term problems that will be explained to you by your physician.





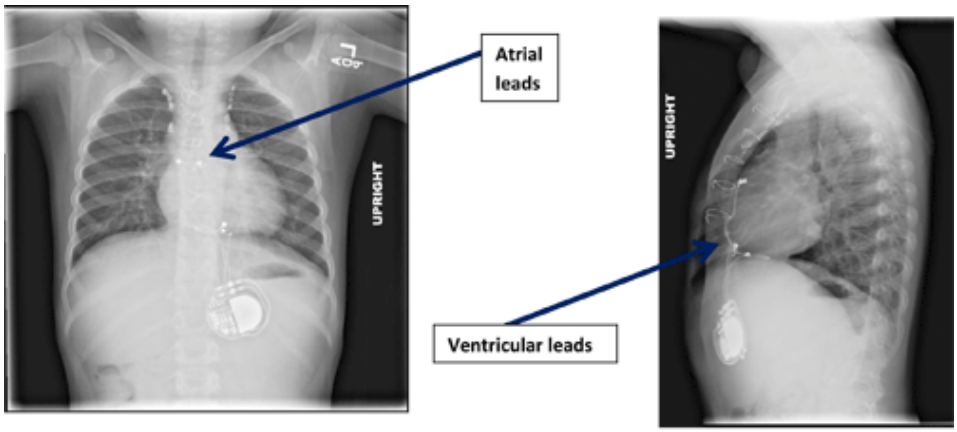
Transvenous pacing system **Transvenous ICD system**

Surgery for a transvenous pacing system is performed by an electrophysiologist (heart rhythm doctor) in the operating room or cardiac catheterization laboratory under anesthesia. The doctor makes a small incision (about 2 inches long) just below the collar bone. The leads are inserted into the veins as described above and connected to the pacemaker. The doctor makes a "pocket" below the clavicle (or sometimes in the armpit) for the pacemaker to fit into. The leads and pacemaker are tucked safely inside the body and the incision is closed. A small bandage is applied and the child usually spends one night in the hospital. The pacemaker may be visible as a "lump" under the skin in leaner children and young adults. Once surgical healing is complete the pacemaker does not cause any pain.

Epicardial pacing system: This type of system is usually implanted in children less than 8-10 years of age. The leads are attached to the outside of the heart (epicardial surface) because the young child's veins leading to the heart are too small for a lead to fit safely inside the vein. A lead inside the small child's vein can place the child at risk for a clot forming inside the vein. In many cases the epicardial pacing leads can last until the child is old enough for safe implantation of a transvenous pacing system.

Epicardial pacing lead

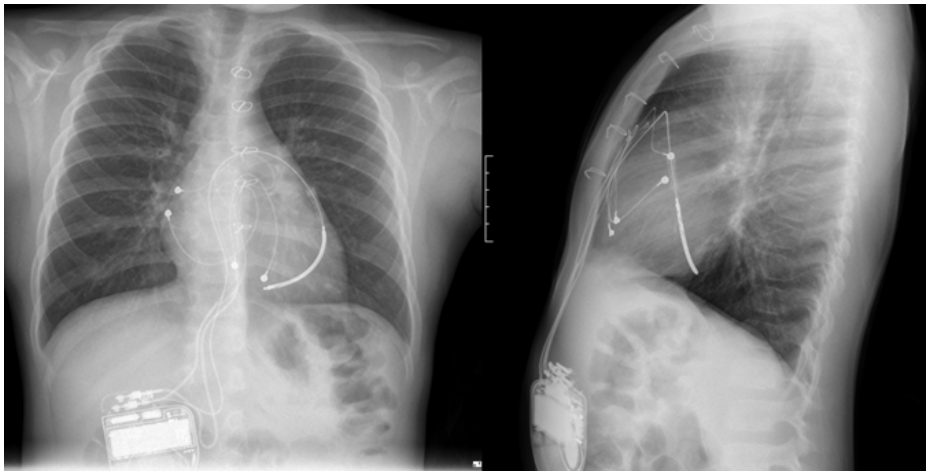
In some instances, a child's heart and vessel anatomy, or previous heart surgery does not allow access to the inside of the heart from the veins. In these situations the pacing leads need to be placed on the outside of the heart (epicardial leads).



Epicardial pacing system with leads on the atrium (top) and ventricle (bottom).

Surgery for an epicardial pacing system is an “open chest” procedure performed by a cardiothoracic (heart/chest) surgeon in the operating room under general anesthesia. This does not mean the same thing as “open heart” surgery. The surgeon enters the chest through a sternotomy incision (cut). This is an incision directly over the breast bone which the surgeon will use to access the heart surface. This surgery can also be performed through a smaller incision in the front of the chest between the ribs (thoracotomy). The surgeon sews the pacing leads to the heart surface without opening the heart. The pacing leads are then connected to the pacemaker which is placed in a surgically made “pocket” below the breast bone or in the upper abdomen. Typically a drain is placed in the chest cavity before the chest is closed (the drain is removed within a few days after the operation). The chest is closed and the leads and pacemaker are tucked safely inside the body in such a way to prevent them from being harmed by typical childhood play. The pacemaker may be visible as a “lump” under the skin in infants and lean small children. Once surgical healing is complete the pacemaker does not cause any pain.

A defibrillator is larger than a pacemaker and may be slightly more noticeable on the child’s body. The epicardial defibrillator also includes implantation of an additional lead which is necessary for shocking the heart out of a dangerous, fast arrhythmia (abnormal rhythm).



Epicardial ICD system

Recovery from implantation of a pacing system varies, depending on the child and whether or not other heart surgery was performed at the time. Typically, a child leaves the hospital two to three days after implantation of a pacing system if this is the only surgery performed at the time.

How long does the battery last?

This is the most commonly asked question about pacemakers and defibrillators. The answer is dependent on many factors such as how much they are used and how high the energy is programmed at to provide pacing. Pacemaker batteries come in a few different sizes so the battery size also affects longevity. Pacemakers with small batteries are used in smaller patients and typically last about five to seven years. The next size up lasts about seven to ten years. Pacemakers used in older children and adults are the largest and they can last up to 13 years. Defibrillators are generally larger and their life expectancy is also dependent on how frequently a shock is required to stop dangerous arrhythmias. They typically last about five to seven years. The pacemaker itself includes the pacemaker battery and circuitry (electrical portions). Referring to “changing the battery” actually means changing the entire pacemaker. Sometimes the pacemaker is also called a “generator”. Surgery to replace a pacemaker is typically performed as an outpatient procedure in most cases.

How long do the leads last?

Pacemaker or defibrillator leads only need to be changed if they stop functioning normally. If they need to be replaced the surgery will be similar to when the pacing system was first implanted.

Are there special precautions to take to prevent damage to the pacemaker?

Activity restrictions or precautions may be recommended depending on your child’s heart

disease and type of pacemaker. Your cardiologist will review these recommendations with you. What is the best way to make sure the pacemaker is working properly? Routine visits with the cardiologist and/or electrophysiologist and pacemaker specialist provide the best care for the pacemaker. At these appointments the pacemaker leads and battery are tested. Multiple settings on the pacemaker can be adjusted to provide the best function of the device and make it last as long as possible. Check with your doctor to discuss the frequency of your child's appointments. Most pacemakers should be checked two to four times per year.

Remote monitoring

Today's advanced technology provides a way to check a pacemaker at home or other places without having to come to the clinic or hospital. A monitor will be set up by your child's doctor or pacemaker clinic if it is part of their plan of care. The monitor will collect information from the pacemaker and send it securely over the phone system (land line or cell tower) and internet to the pacemaker clinic. The pacemaker clinic (or anyone else) cannot send information back to the pacemaker to program it. Your child's doctor will determine how often and when transmissions are to be sent using the monitor.