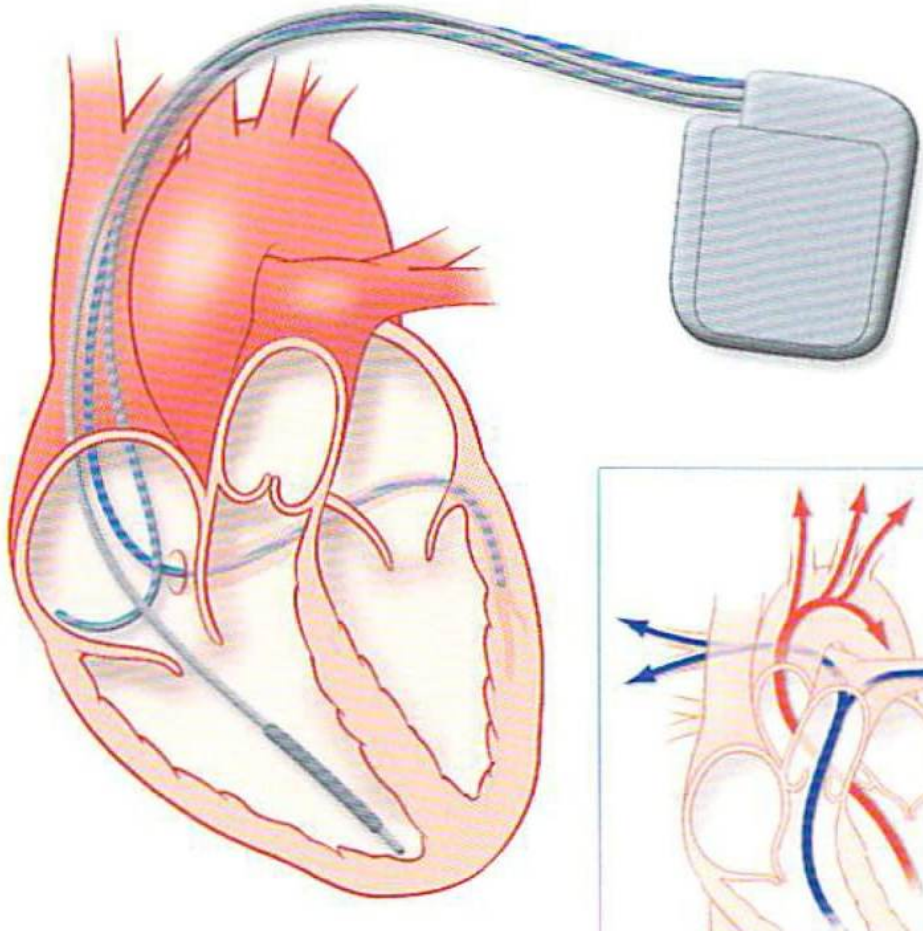
Cardiac Resynchronization Therapy (CRT)



A Patient's Guide

This booklet is not intended to replace professional medical care. Only your doctor can diagnose and treat medical problems.

Your doctor may have told you that you need cardiac resynchronization therapy, or CRT, to treat heart failure. Now, you probably have some questions and concerns about this treatment. This booklet can help answer many of your questions.

What Is CRT?

When you have heart failure, your heart is weakened and is unable to pump enough blood to meet your body's needs. Common symptoms include shortness of breath, swelling of the feet and legs, and fatigue.

Your doctor may prescribe medications to help your heart. In some cases, he or she may also recommend a CRT device. This is a small electronic device that is inserted into your body. It delivers small electrical impulses to the heart chambers to make them beat in a coordinated way, or "in sync" with one another. This helps your heart beat more efficiently.

How Can CRT Help?

If you have been having symptoms of heart failure, a CRT device may help reduce your symptoms. You may breathe more easily, have less swelling in your legs, and have more energy.

CRT is not a cure for heart failure, however. Even if you feel better, you must also follow with the other parts of your treatment plan. This may include taking medications, eating less salt, monitoring your body weight, and getting enough rest.

When Is CRT Needed?

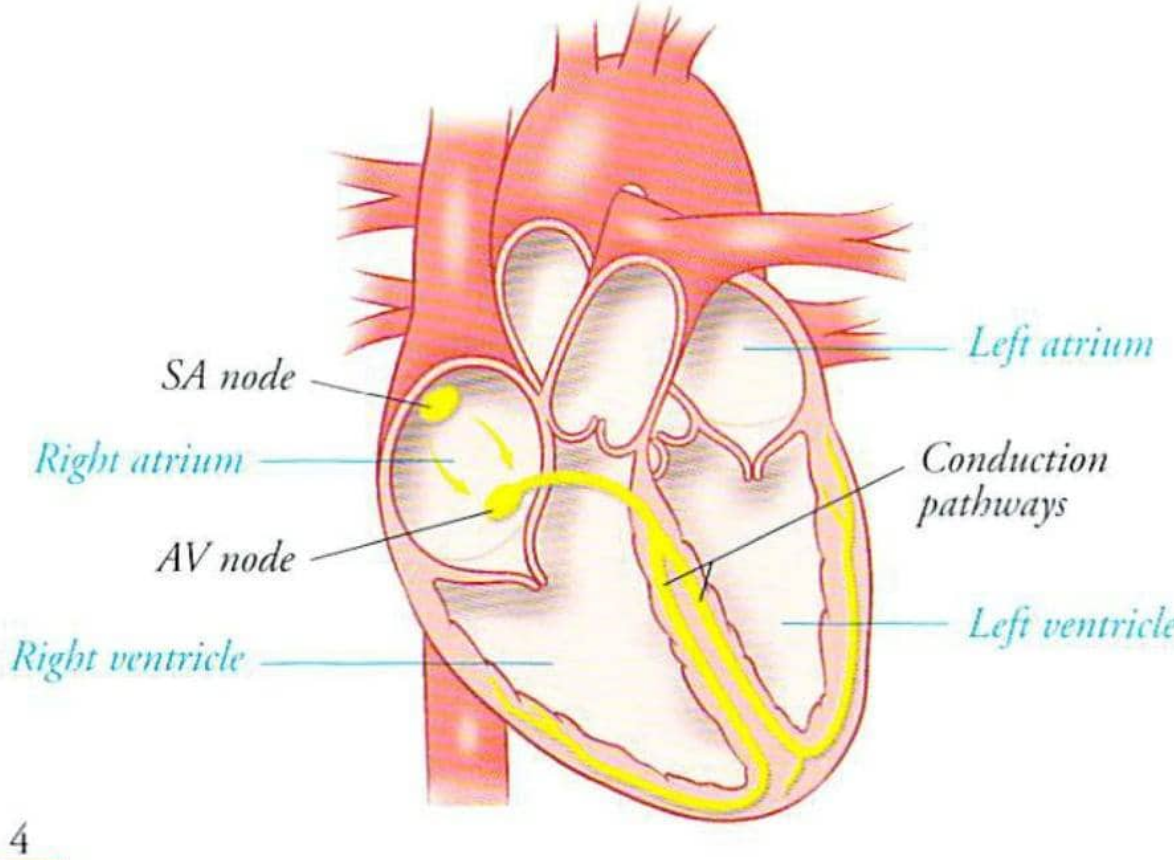
Before you learn about the details of CRT, it helps to understand how the heart works and what happens when you have heart failure.

The Heart as a Pump

The heart is a hollow organ that constantly pumps blood throughout your body. It is made up of strong muscle tissue, called **heart muscle**.

The heart has four chambers: two chambers on the left side and two on the right. The upper chamber on each side, called an **atrium**, receives and collects blood. The lower chamber on each side, called a **ventricle**, pumps blood out of the heart.

The four heart chambers work together to **contract** (squeeze) and pump blood. As it circulates, blood delivers oxygen and nutrients throughout the body.



The Heart's Electrical System

The heart has an electrical system that produces tiny electrical impulses. These impulses travel from the upper to the lower chambers and tell the chambers to contract and pump blood.

The heart's electrical impulses normally begin at the sinoatrial node, or **SA node**. This cluster of special cells, also known as the heart's natural pacemaker, is located at the top of the right atrium. It produces electrical impulses at regular intervals and sets the proper rhythm for the heartbeat.

Each electrical impulse spreads throughout the two atria (plural of atrium), causing them to contract and pump blood into the ventricles.

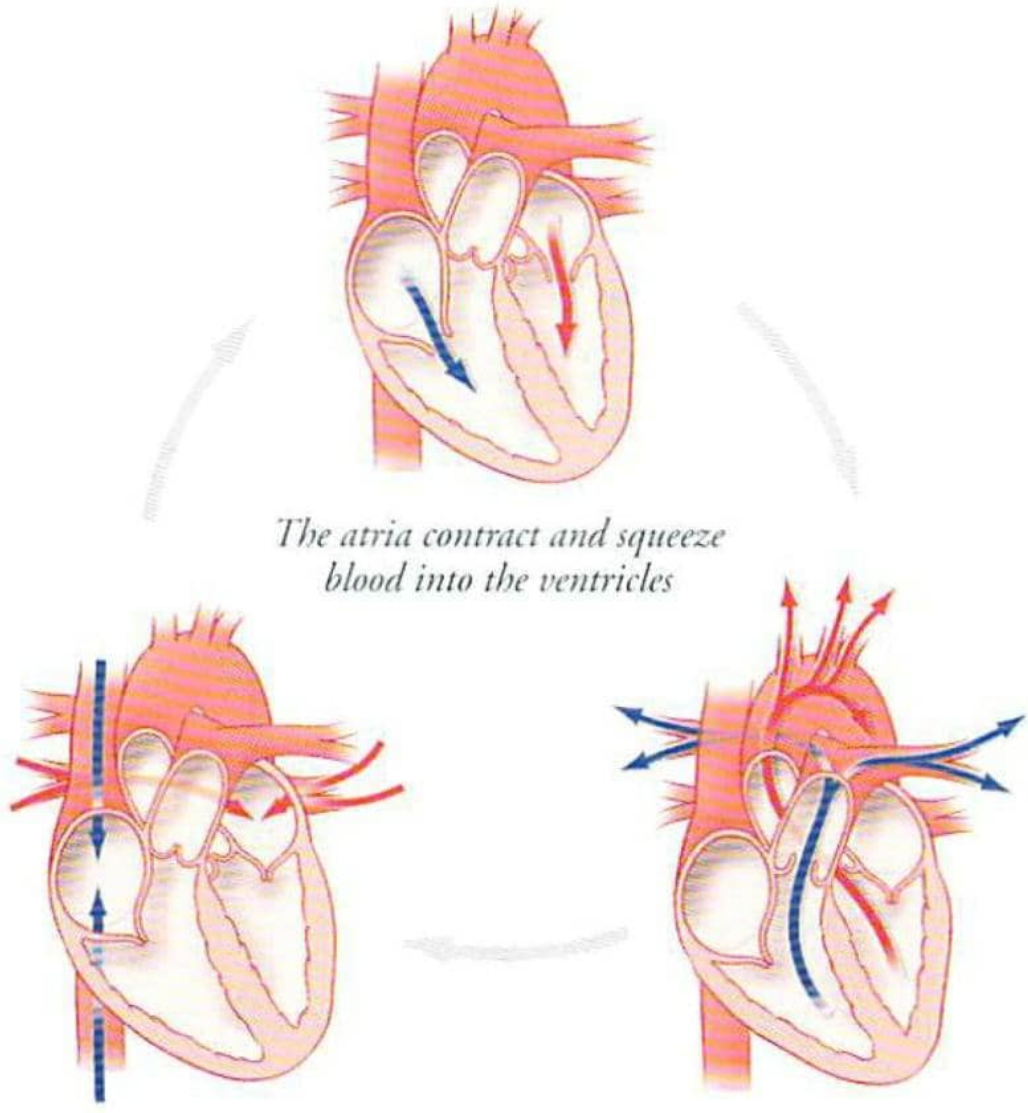
From the atria, the electrical impulse reaches the atrioventricular node, or **AV node**, which is located between the atria and the ventricles. The AV node slows down each electrical impulse before it passes through to the ventricles.

After a fraction of a second, the impulse continues to the ventricles through **conduction pathways**, also known as the **left and right bundle branches**. The bundle branches fan out to the ventricles and enable the electrical impulse to stimulate both ventricles at the same time. This causes the ventricles to contract and pump blood.

How the Heart Pumps Blood

The heart chambers work together, or in "sync," to contract and pump blood.

The two atria contract first and squeeze blood into the ventricles. A fraction of a second later, the two ventricles contract and pump blood out of the heart. This sequence ensures that the contractions of the heart chambers are timed correctly, or **synchronized**, and helps the heart beat more efficiently.



The atria contract and squeeze blood into the ventricles

The atria fill up with blood while the ventricles rest

The ventricles contract and pump blood out of the heart

What Happens in Heart Failure?

In heart failure, the heart is weakened and is unable to pump enough blood to meet the body's needs.

Heart failure can be caused by any medical condition that injures the heart or makes the heart work too hard for a long time. Common causes include a past heart attack, high blood pressure, heart muscle disease, and heart valve disease.

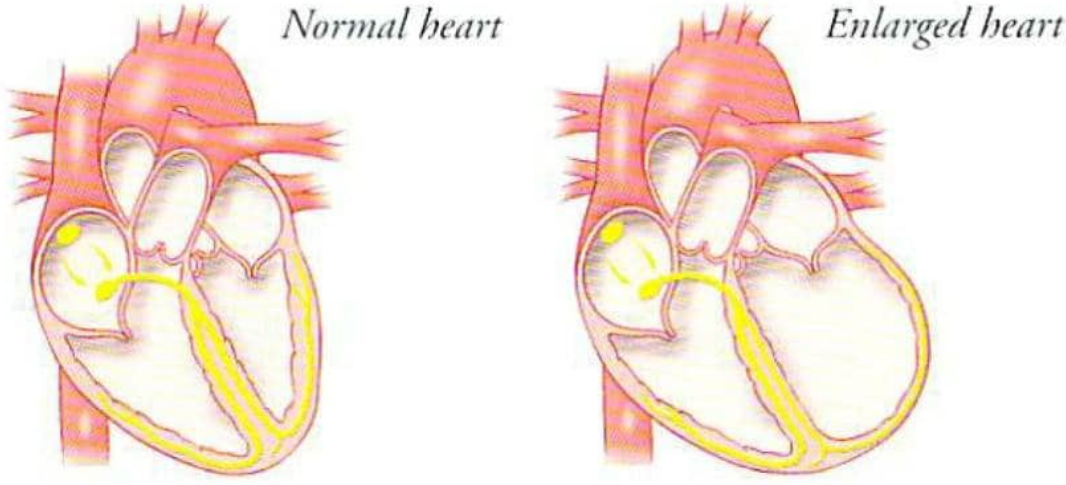
When the heart does not pump blood as well as it should, fluid tends to build up in the lungs and other parts of the body. In addition, organs such as the kidneys and the brain receive less blood. As a result, you may be short of breath, have swelling of your feet and legs, and feel tired.

Over time, the heart often enlarges and the muscle weakens. Your doctor will most likely order tests (such as an echocardiogram or a heart scan) to study the size and strength of your heart.

The **ejection fraction** is the percentage of blood that is pumped out of the left ventricle (main pumping chamber) with each heartbeat. It is a measure of the heart's pumping strength. A normal ejection fraction is greater than 50 percent. Patients with moderate or severe heart failure often have an ejection fraction of less than 35 percent.

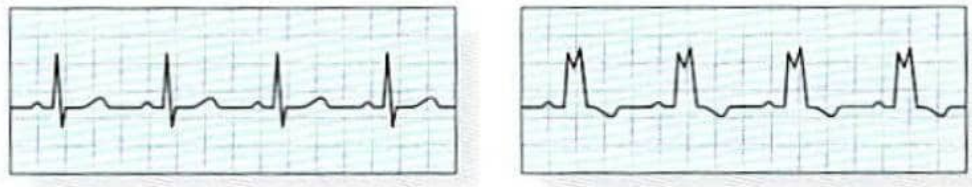
Knowing the ejection fraction will help your doctor decide if you are a candidate for CRT (see page 9).

When the heart enlarges, the electrical impulses may travel more slowly through the conduction pathways (see page 5). This is known as a **conduction delay** or a **bundle branch block**. About one third of people with heart failure have a conduction delay.



When you have a conduction delay, the left and right ventricles do not contract at the same time. In other words, their contractions are not synchronized. As a result, less blood is pumped out of the heart, which can make the symptoms of heart failure worse.

To diagnose a conduction delay, your doctor will do an electrocardiogram, or **ECG**. The conduction delay shows on the tracing as a widening of the main 'wave.' The ECG helps to identify patients who may benefit from CRT (see next page).



Normal tracing *Conduction delay*

People who have heart failure are also more likely to have abnormal heart rhythms, or **arrhythmias.** During an arrhythmia, the heart may beat too fast, too slowly, or irregularly.

Tachycardia occurs when the heart beats too fast. The heart may beat so fast that the ventricles do not have time to fill with blood. As a result, the heart cannot pump as much blood as the body needs. This can make heart failure worse.

Some types of tachycardia can lead to cardiac arrest if not treated right away. During cardiac arrest, no blood is being pumped out of the heart. Emergency treatment must be given right away to get the heart pumping again, or death will occur within minutes.

Who Is a Candidate for CRT?

In general, CRT may be recommended for patients with the following:

- moderate or severe symptoms of heart failure despite medical treatment
- a weak, enlarged heart with an ejection fraction of less than 35 percent (see page 7)
- a conduction delay that causes the ventricles to contract in an uncoordinated fashion

If you are a candidate for CRT and are also at risk of having life-threatening tachycardias, your doctor will most likely recommend a special CRT device that can stop dangerous rapid rhythms by delivering an electric shock to the heart (see page 14).

Understanding CRT

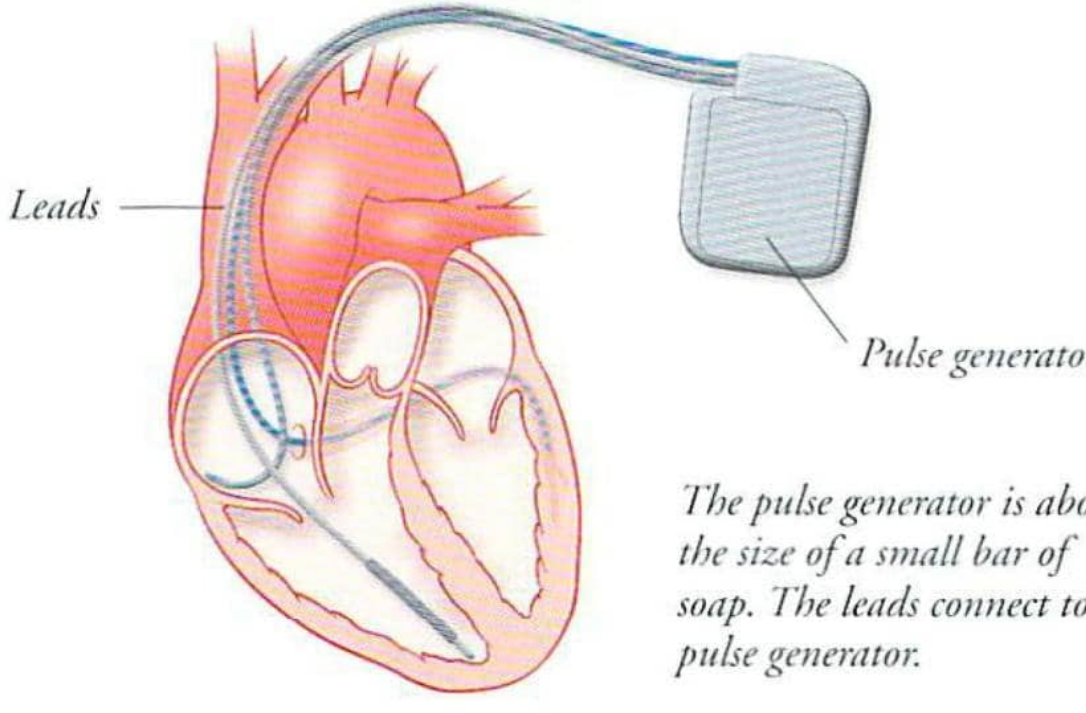
CRT (cardiac resynchronization therapy) is a kind of treatment prescribed for some heart failure patients. The CRT device delivers small electrical impulses that help correctly time, or "**resynchronize**" the heart's contractions. This in turn can help a weakened heart pump more efficiently.

The Parts of a CRT Device

A CRT device has two main parts: a pulse generator and several leads.

■ *Pulse Generator*

The pulse generator is a small, lightweight metal case that contains a battery and circuitry. The battery supplies the electrical energy. The **circuitry** is like a tiny computer inside the device. It produces electrical impulses and controls the timing at which these are delivered to the heart.



The pulse generator is about the size of a small bar of soap. The leads connect to the pulse generator.

Leads

A lead is an insulated, flexible wire that is placed in the heart. The lead carries electrical energy from the pulse generator to the heart. The lead also relays information about the heart's electrical activity back to the pulse generator. CRT devices generally have three leads.

How CRT Works

When you have heart failure and a conduction delay (see page 8), the contractions of the left and right ventricles are no longer synchronized. This can make symptoms of heart failure worse.

The CRT device delivers small, well-timed electrical impulses to the heart chambers. It stimulates the left and right ventricles at the same time, and restores a coordinated pumping action. When the contractions of the ventricles are timed correctly, the heart pumps more efficiently.

CRT is also called **biventricular pacing** because both ventricles are paced (stimulated) at the same time.

[Although a CRT device resembles a pacemaker, it does not work the same way. A standard pacemaker is designed to treat slow heart rhythms; it delivers electrical impulses to stimulate the heart *only* when the rhythm is slow. A CRT device delivers impulses around the clock, *whether or not* the rhythm is slow.]

The Benefits of CRT

If you have symptoms of heart failure, a CRT device can help reduce your symptoms. Once you have the device, you may notice one or more of the following improvements:

- breathing more easily when you lie flat and/or when you are active
- having less swelling in your feet and legs
- having more energy
- being able to return to your daily activities (such as walking, shopping, climbing stairs)
- making fewer visits to the hospital because of heart failure symptoms

Many patients notice these improvements right away. For others, it may take weeks or months before they feel better. Unfortunately, a small number of heart failure patients do not benefit from CRT at all. More studies are needed to identify those who are most likely to benefit.

Despite these possible benefits, CRT is *not a cure* for heart failure. It does not replace other heart failure treatments. Even if you feel better, you must continue with the other parts of your treatment plan. This may include taking your medications, eating less salt, exercising in moderation, monitoring your weight, and getting enough rest.

Types of CRT Devices

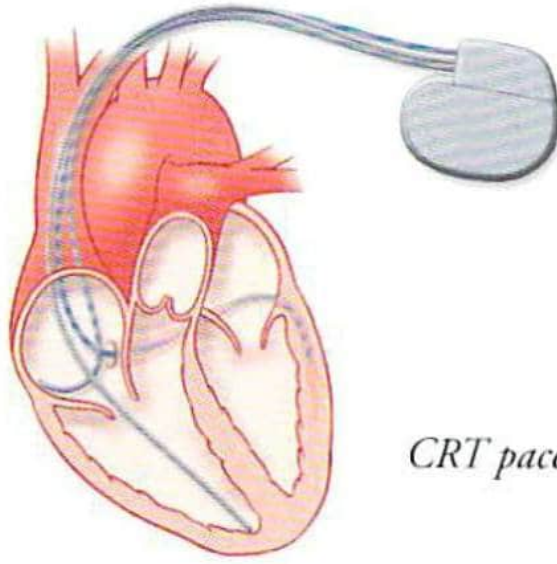
All CRT devices perform the same basic function that we've just described (see pages 10-11). They help "resynchronize" the heart's contractions. In addition, many CRT devices have extra features, such as the ability to treat dangerous rapid heart rhythms.

■ *CRT Pacemaker*

This is the basic type of CRT device. It is also called a **biventricular pacemaker**.

A CRT pacemaker has three leads. One lead is placed in the right atrium, another lead is placed in the right ventricle. The third lead is placed in a vein on the back surface of the left ventricle.

The atria are stimulated first (either by your natural heartbeat, or by the CRT device if your heartbeat is too slow). A fraction of a second later, the left and right ventricles are stimulated at the same time. This timing sequence ensures that the heart chambers contract in a coordinated way, or "in sync."



CRT pacemaker

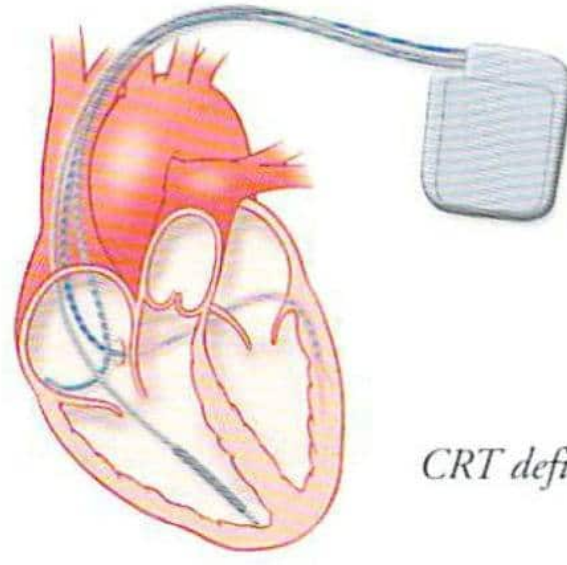
CRT Defibrillator

If you have heart failure and also are at risk of having life-threatening rapid heart rhythms (see page 9), your doctor may recommend a CRT defibrillator, also called a **biventricular ICD**.

Like a CRT pacemaker, this device can send electrical impulses to help make the heart chambers beat "in sync" with one another. In addition, it has an **ICD** (implantable cardioverter defibrillator).

The ICD's main function is to treat life-threatening rapid heart rhythms. The ICD monitors the heart rhythm at all times. If it senses a very rapid rhythm, the device delivers an electrical treatment, called a **therapy**, to restore a normal rhythm.

A therapy can be a fast series of pacing impulses that "override" the rapid rhythm, or it can be a stronger electrical shock that "resets" the heart's electrical activity and restores a normal rhythm.



CRT defibrillator

The ICD can deliver one or more of these therapies. Mild therapies are generally given first.

- **Anti-tachycardia pacing**. If the ICD detects a fast, regular rhythm, it delivers a series of rapid pacing impulses to override the fast rhythm and bring it back to normal.

The impulses may feel like fluttering in your chest, or you may not feel them at all.

- **Defibrillation**. If pacing impulses do not stop the rapid rhythm, or if the tachycardia is very fast, the ICD will deliver an electrical shock. The shock stops the arrhythmia and helps restore a normal rhythm.

When the rhythm is extremely fast, many people pass out, so they are not aware of receiving a shock. People who are conscious often describe the shock as a "kick in the chest." The shock is over quickly.

. . . . .

The ICD has a memory that can store information about your heart rhythm. The memory recalls the number and types of therapies you received, whether the therapies worked, and what your heart was doing during the "events." The stored information can be retrieved during follow-up visits (see page 22).

Implanting the CRT Device

The CRT device is inserted into your body during a procedure called **implantation**. Implanting a CRT device is generally a minor surgical procedure. It is usually done in an electrophysiology (EP) lab or an operating room.

Preparing for Implantation

Unless you already are in the hospital, most likely you will be asked to arrive in the morning on the day of the procedure, or perhaps the night before.

You may have several routine tests, such as an ECG, x-rays, and blood tests. (These tests may be done a few days before the procedure.)

The doctor will review your medical history and examine you. (You may see the doctor at the office several days before the procedure.)

The doctor or nurse will talk with you about the procedure and its purpose, benefits, and risks. This is a good time to ask questions and, most important, to share any concerns you may have. You will then be asked to sign a consent form.

An intravenous (IV) line will be inserted into a vein in your arm. This line allows drugs to be injected directly into the vein. To help you relax, you will be given a sedative.

Before the Procedure

- Generally, **you'll be asked not to eat or drink anything** for 6 to 8 hours before the procedure. This helps prevent nausea. You may have small sips of water with your medications.
- Check with your doctor a few days before the procedure. **You may be asked to stop some medications** (such as aspirin) for a few days before the procedure.
- **Bring a list of the names and dosages of all the medications** you are taking.
- **Make arrangements** with a friend or family member to drive you to and from the hospital. You will not be allowed to drive home after the procedure, since you may be sedated.
- **Pack a small bag for your hospital stay.** You may want to include a robe, slippers, pajamas or nightgown, and toiletries.
- **Tell the doctor or nurse** if you have had any allergic reactions to medications or if you have a history of bleeding problems.
- **Be sure to empty your bladder** before the procedure starts. (There will also be a bedpan or a urinal, in case you need it.)

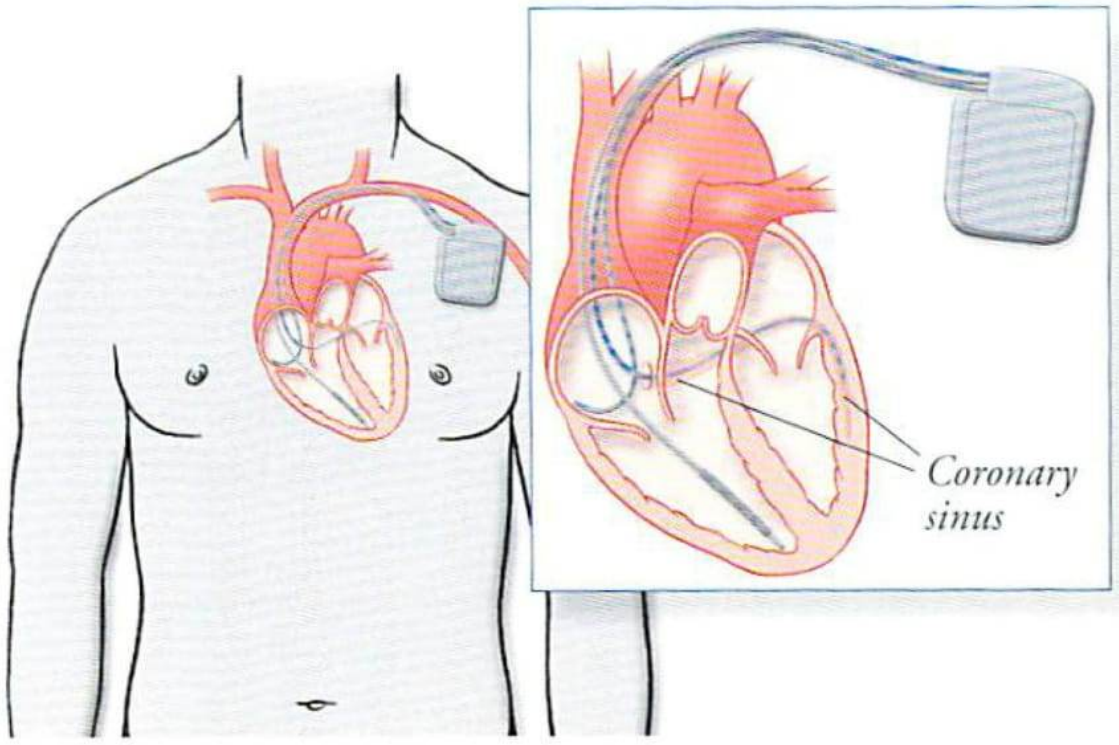
During the Procedure

Most often, a CRT device is implanted in the upper chest, usually near the left shoulder.

A local anesthetic is injected to numb the area where the device will be inserted. An incision is made below the collarbone and a "pocket" is created under the skin, where the pulse generator will be placed.

A lead is inserted through the incision and into a vein in the upper chest. With the help of x-ray monitors, the lead is passed into the right ventricle. In the same way, a second lead is inserted into the right atrium.

A third lead is guided into the **coronary sinus**, a vein on the back surface of the left ventricle. Doctors may inject contrast "dye" into the coronary sinus to make the pictures on the monitors clearer.



After the leads are in place, they are tested to make sure they sense the heart signals correctly. Each of the leads is then connected to the pulse generator.

The pulse generator is placed in the "pocket" in your chest. The device is then tested to make sure it is working properly. Finally, the incision is closed and covered with a sterile dressing.

You will be given medication to help you relax and make you drowsy. You may be awake, or you may sleep through part or all of the procedure. Be sure to let the staff know if you feel any pain or discomfort. The procedure usually takes 2 to 4 hours.

[In rare cases, the lead cannot be inserted through the coronary sinus. If this happens, doctors may suggest another procedure. The chest is opened so that the lead can be attached to the *outside* of the heart. Your doctor will tell you more if you need this procedure.]

Is Implanting a CRT Device Safe?

Implanting a CRT device is a simple procedure with little risk. However, as with any surgery, problems or complications can occur.

Some patients may develop bleeding at the incision or pocket site. Blood may collect under the skin, causing local swelling and/or a bruise.

In rare cases, the procedure may lead to more serious complications, including damage to the heart and blood vessels, a punctured lung, infection, and blood clots. Death is very rare.

After the Procedure

After your CRT device is implanted, you will be taken to the recovery area or to your room. A nurse will take your pulse and blood pressure and will check the incision for bleeding or swelling.

During your hospital stay, your heart rhythm will be monitored at all times. Your doctor may also test the device to make sure it is working properly. This is done from outside your body, so it is painless.

It is normal to have some pain and stiffness around the incision site for a few days. Your doctor will most likely prescribe pain medication to help make you more comfortable. Do not raise the arm on the side of the incision above shoulder level.

Most patients stay in the hospital for one day. Some will stay an extra day or two. Before you go home, you will be instructed about caring for the incision, physical activity, and medications. When it is time to leave, have a friend or family member drive you.

Recovering at Home

A few days after you leave the hospital, you will most likely be able to go back to your usual daily activities. However, it may take a few weeks before the incision is completely healed.

For a few weeks, you may feel numbness or fullness in the area around the implant site. This is normal. You may also be aware of the pulse generator under the skin, but gradually you will adjust to it.

The First Few Weeks

- **Follow your doctor's instructions** regarding activity, exercise, and returning to work.
- **Keep the incision site completely dry** for a week or so, to help prevent infection.
- **Do not lift** anything heavier than 10 to 15 pounds. Also, avoid too much pushing, pulling, or twisting.
- For a few weeks, **do not raise the arm** on the side of the implant above shoulder level.
- **Call your doctor** if the incision site shows signs of infection (pain, redness, swelling), there is drainage from the incision, or you develop a temperature over 100°F.
- **Call your doctor** if you have twitching chest muscles, hiccups that will not stop, or a swollen arm on the side of the incision.
- **Call your doctor** if the symptoms you had before come back, or if you have dizziness, chest pain, or shortness of breath.
- Be sure to **check with your doctor or nurse about medications**—which ones to keep taking and which ones to stop.
- **Tell any doctors** and medical personnel you see that you have a CRT device.

Caring for Your CRT Device

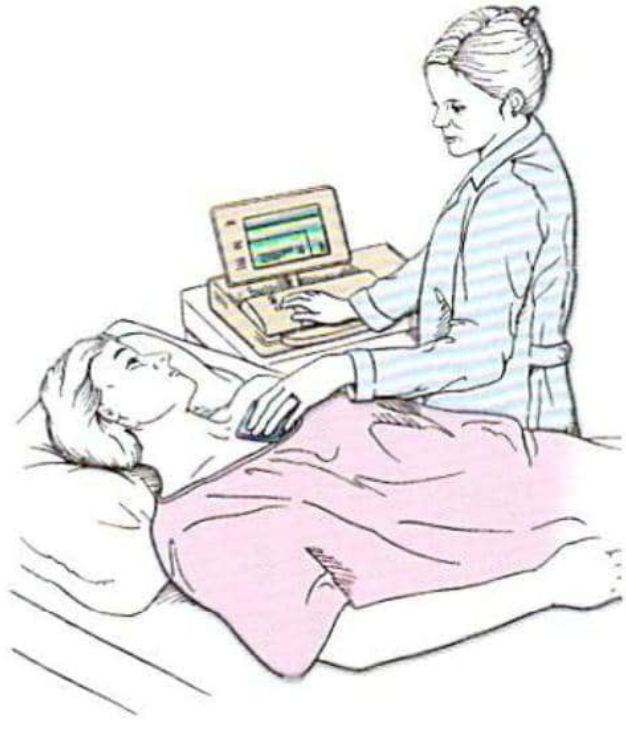
It is important that you have regular follow-up visits with your doctor or clinic.

Follow-Up Visits

Follow-up visits help ensure that your CRT device is working properly. Your visits may take place at the doctor's office, pacemaker/ICD clinic, or hospital. A typical visit takes about 30 minutes.

How often you have a follow-up visit depends on the type of CRT device you have and on your medical condition. It is common to have a first visit one month or so after the device was implanted. After that, you may have a visit every 3 to 6 months.

During follow-up visits, the doctor or nurse will use a **programmer**. This electronic instrument can "talk" to your CRT device to make sure it is working properly. It can also check the battery in the device.

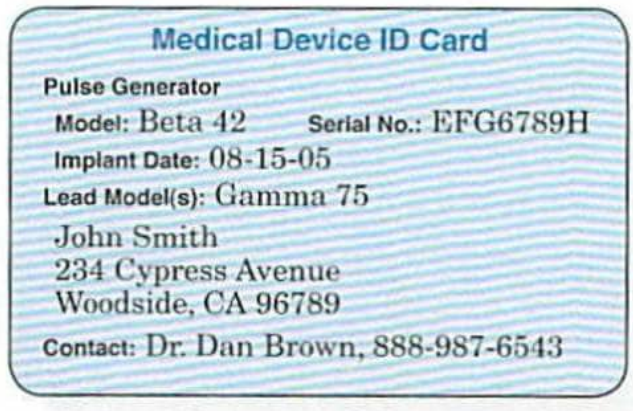


If you have a CRT defibrillator (with an ICD), the programmer retrieves the information stored in the device's memory. If you had one or more "events" since your last follow-up visit, the memory recalls the number and the types of therapies you received, whether the therapies worked, and what your heart was doing during the events.

If your medical condition changes, the programmer can be used to "**reprogram**" (adjust) the settings on your CRT device. This is done from outside your body, so it is painless. It works like a remote control for programming a VCR.

Identification Card

You will be given a wallet card that gives information about your CRT device. It tells others what to do in case of an emergency, and it gives your doctor's name and telephone number. Carry your identification card with you at all times! Show it to any health care provider you visit.



In addition, consider getting a medical alert bracelet or necklace that shows you have a heart condition and a CRT device.

If You Have a CRT Defibrillator (with an ICD)

If you have symptoms of a rapid heart rhythm, it is likely that your ICD will deliver a therapy soon. If the therapy is pacing impulses, you may not feel anything. But if the ICD delivers electrical shocks, you need to be ready. This is what you should do:

- Stay calm and find a place to sit or lie down.
- Have someone stay with you throughout the event, if possible.
- Ask a friend or family member to phone for an ambulance if you receive several shocks or are unconscious for more than a few moments.
- If you receive a shock and do not feel well afterwards, have someone call your doctor.
- Follow your doctor's or nurse's directions on when to call after receiving a shock. When you call, you may be asked:
  - What were you doing right before the shock?
  - What symptoms did you have?
  - How did you feel right after the shock?

It is possible you could feel symptoms of a rapid heart rhythm and not receive a shock. If your symptoms are severe or do not go away and you do not feel a shock, call your doctor (or 9-1-1) right away.

Anyone touching you while the ICD delivers a shock might feel the muscles of your chest and upper arms tighten. The shock will not harm the person touching you, but he or she may feel a tingle.

When To Call Your Doctor

If you have a CRT defibrillator, you'll be given instructions on when to call. Call your doctor or nurse as instructed or:

- Within 24 hours of receiving a shock
- If you receive 3 or more shocks in a row
- If your symptoms of a rapid heart rhythm last longer than a couple of minutes
- Before having medical or dental procedures, especially if they involve surgery
- When you have questions about your ICD, medications, or activities
- When you plan to travel or move

Replacing the Battery

CRT pacemakers and defibrillators are powered by long-lasting lithium batteries. How long the battery lasts depends on the way the device is programmed, and the number and types of therapies it delivers. In general, a battery lasts 4 to 7 years.

Since the battery is sealed inside the pulse generator, the entire pulse generator must be replaced when the battery wears out. In most cases, the original leads will not need to be replaced.

Living with a CRT Device

Your CRT device can help you feel better by relieving symptoms of heart failure. It may also give you more freedom to do the things you enjoy.

However, there are a few things you need to be aware of, so that your device works properly.

Resuming Daily Activities

Ask your doctor or nurse how soon you can go back to your normal daily activities. These may include walking, playing golf, gardening, driving, shopping, and returning to work.

Avoid activities where you could get hit or fall on the area around the device. Such activities may include football, basketball, baseball, racquetball, soccer, and skiing. Also, avoid hunting if a rifle butt is rested on or next to your chest implant.

If you have a CRT defibrillator, you may be asked to avoid activities where losing consciousness because of your rapid heart rhythm could be a danger to you or others. This may include driving, swimming or boating alone, and climbing a ladder.

Driving

Your doctor will tell you if and when you can safely resume driving. This will depend on your condition, the reason the device was implanted, and the laws in your state.

Travel

Once you have recovered from surgery, you will be free to travel with your CRT device. If you plan to be away for more than 3 months, you should arrange to have the device checked by a specialist or clinic in the area you will be visiting. Get a copy of your medical records to take with you.

Your Emotions

It is natural for patients and their families to feel anxious about the CRT device at first. Other feelings, such as fear, depression, and anger, are normal too.

These feelings rarely last for more than a few weeks. Most people gradually adjust to having the device and are able to resume their normal daily routine. If such feelings last for more than a few months, talk to your doctor.

Avoiding Interference

Things that use magnets or electricity have magnetic fields around them. These fields are usually weak and will not affect your CRT device. Strong magnetic fields, however, can interfere with the device and may affect the way it works.

- ***Items that are safe***

You can safely operate most household and office appliances that are properly grounded and in good working order. These include:

- Kitchen appliances such as microwave ovens, toasters, blenders, and electric can openers
- Radios, televisions, CD/DVD players, pagers, remote controls, garage door openers
- Hand-held appliances such as hair dryers and shavers (avoid holding against the implant site)
- Major appliances such as refrigerators, washers, dryers, and electric stoves
- Electric blankets and heating pads
- Personal computers, printers, fax machines, and copy machines

- ***Items that can be used but should remain at least 12 inches away from the implant site***

- Battery-powered, cordless power tools such as screwdrivers and drills
- Shop tools, such as corded drills and table saws
- Lawn mowers, leaf blowers
- Slot machines, stereo speakers

■ *Things to avoid*

To make sure your CRT device works properly, you should avoid the following:

- Large generators, electric motors, arc welders, and other large industrial equipment
- Radio transmitters, high-voltage power lines
- Magnetic therapy products, such as mattress pads, pillows, and massagers
- Maintaining or repairing any electrical or gasoline-powered appliances
- Leaning over the open hood of a running car

Important: If you have questions about the safety of a particular appliance, tool, or activity, check with your doctor or nurse or call the company that makes the CRT device.

■ *Medical procedures*

Most medical procedures are not likely to interfere with your CRT device. Some procedures, however, produce strong magnetic fields and should usually be avoided (talk to your doctor first). These include: magnetic resonance imaging (MRI), electrocautery, lithotripsy, diathermy, transcutaneous electrical nerve stimulation (TENS), and radiation therapy.

Important: Always tell any doctors or other medical personnel that you have a CRT device.

- ***Security systems***

It is OK to walk through security gates, such as those at airports and stores. The system will not harm your device, but it may detect the metal case around the pulse generator and set off the alarm. If this happens, show your wallet card to security personnel.

However, hand-held security wands, such as those used at airports, may interfere with your device. Show your wallet card to security and ask to be hand searched in place of the hand-held wand.

At the entrance to stores and libraries, you may walk normally through anti-theft security gates. However, do not stand near the theft detection equipment.

- ***Cellular phones***

A cellular phone can affect your CRT device if the phone is held too close to it. This effect is temporary. Simply move the phone away, and the device will work normally again.

When using a cellular phone, hold the phone to the ear farthest from your CRT device. Do not carry the phone in a breast pocket or within 6 inches of where the device is implanted.

(These precautions apply only to *cellular* phones, not to indoor cordless phones.)

Your CRT Device and You

Here are a few simple rules that will help you live safely with your CRT device:

- Keep your appointments with your doctor or pacemaker/ICD clinic.
- Carry your medical device ID card with you at all times.
- Tell your doctor or clinic if you change your address or plan to take a trip.
- Do not fiddle or play with your device. This could damage or dislodge the lead(s).
- If a piece of equipment causes you to have symptoms of dizziness or palpitations, simply move away from it. The device will go right back to working normally.
- If you find it hard to adjust to your device, talk about your feelings with your doctor, nurse, or another CRT patient. Find out if there is a patient support group near you.
- **Important**: CRT is one treatment for heart failure. Even if you are feeling better, you must continue with the other parts of your treatment plan. This may include taking medications, eating less salt, monitoring your body weight, and getting enough rest.