

## Artificial cardiac pacemakers

A special cluster of cells located in the right atrium (right upper chamber of the heart), called the sinus node, is the natural pacemaker that controls the heartbeat. To make sure that the heart beats regularly and at the right pace, the sinus node communicates with the atria and ventricles (the chambers of the heart), along nervous system pathways called the atrioventricular node and conducting system. If this system is damaged, it may send unreliable messages to the heart chambers.

Symptoms of problems with the natural pacemaker may include irregular heart rate, tiredness, dizziness and loss of consciousness.

An artificial pacemaker is an implantable device that mimics the actions of the nodes and conducting system, and helps to regulate the heart rate.

### How a healthy heart works

The heart is a double pump that circulates blood around the body. It has four chambers. The upper right chamber (right atrium) and lower right chamber (right ventricle) take in deoxygenated blood from the body and send it to the lungs. The upper left chamber (left atrium) and the lower left chamber (left ventricle) take in oxygenated blood from the lungs and send it around the body. The atria are responsible for collecting blood and filling the ventricles. The ventricles do all the pumping. Blood is supplied to the heart through the coronary arteries. The nervous system (nodes and conducting system) is responsible for the heart rate and coordinating the heart's contraction or pumping action.

### Sick sinus syndrome

'Sick sinus syndrome' happens when the sinus node cannot regulate a steady heart rate. This is caused by damage to the sinus node. The same damage may also affect the atria and result in atrial rhythm disturbances. Common symptoms include:

- A heart rate which is too fast or too slow
- Fatigue
- Breathlessness
- Dizziness
- Loss of consciousness.

### Heart block

'Heart block' is when the atrioventricular (AV) node, the conducting system or both fail to communicate with the ventricles. The most common symptom of this serious disorder is dizziness or loss of consciousness. Artificial pacemakers are successfully used to treat both sick sinus syndrome and heart block.

### The mechanics of an artificial cardiac pacemaker

An artificial cardiac pacemaker is a small battery-operated computer, called a pulse generator, which is connected to the heart by one or more pacing leads. These leads are made of a coiled metal conductor, insulated with plastic and anchored to the inner wall of the heart with either soft plastic hooks or a very short metal screw. The pulse generator sends an electrical signal down the lead to a bare metal electrode, which is fixed against the heart, and the heart chamber is prompted to contract. The system relies on feedback, which means the artificial pacemaker 'listens' to the heart and supplements the heart's natural rate. For example, the heart rate of a person with sick sinus syndrome may not increase during physical exertion. The artificial pacemaker recognises this and boosts the heart rate to an appropriate level. In order to do this, the pulse generator may have sensors to detect physical activity or changes in breathing.

The two major types of artificial cardiac pacemakers include:

- **Single chamber** - only one chamber is regulated, usually the ventricles.
- **Dual chamber** - two leads are used. Information from the atria regulates the contractions of the ventricles.

## Implantation procedure

The typical hospital stay for artificial cardiac pacemaker implantation is between one to two days. The procedure is usually done under local anaesthesia. The pulse generator, which is about the size and weight of three 50 cent coins, is generally implanted under the skin just below the collarbone on either the right or left side. The leads are inserted using x-ray control, via a vein found in this area, and positioned in the appropriate right-sided heart chamber. The leads are tested before the pulse generator is attached and the incision is closed.

There are other pacing systems, used in special circumstances, that require more than two leads and may involve pacing the left-sided chambers. Usual activities such as working, driving a car and light exercise can resume after one to two weeks recovery.

## Living with an artificial cardiac pacemaker

A person with an artificial cardiac pacemaker can live a normal life and can still perform moderate to strenuous activities, such as sex and (preferably) non-contact sports. Medications and household electrical appliances won't affect the pacemaker. Mobile phones, portable phones and microwave ovens are also safe to use. If there is concern about the effect of any electrical appliance, such as welders, then a pacemaker specialist should be consulted.

Certain body imaging tests, such as magnetic resonance imaging (MRI) scans, should not be performed in patients with an artificial cardiac pacemaker, unless the person has an MRI-safe device (these have recently become available).

Patients will require one or two pacemaker checks per year. These are generally conducted in specialised clinics. Adjustments to the pacemaker can be made non-invasively, using a specially designed radio frequency programmer, with a wand placed on the skin over the implanted device.

Most pacemakers last longer than five years. However, the life of the battery is dependent on how it is used. Most pacemakers can calculate the remaining life of the battery and this information is available at testing. Well before the pacemaker fails, a battery depletion indicator suggests that the pacemaker should be replaced. This is again performed under local anaesthesia.

## Implantable cardioverter defibrillator (ICD)

Some rapid and very dangerous heart rhythms, such as ventricular tachycardia and ventricular fibrillation, are potentially fatal. One treatment option includes an implantable cardioverter defibrillator (ICD). This is a complex device that can recognise a dangerous heart rhythm and send messages to regulate the heart. If this doesn't work, the ICD can send an electric shock to jolt the heart out of its fibrillation. Around 1,000 Australians are fitted with ICDs every year.

## Where to get help

- Local pacemaker clinic
- Cardiac (heart) specialist

## Things to remember

- The heart rate is regulated by a system made up of the sinus and atrioventricular nodes, and conducting system.
- Conditions such as 'sick sinus syndrome' or 'heart block' are characterised by the heart's inability to beat regularly and effectively.
- An artificial pacemaker works by supporting the heart's natural rhythm.

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