



### ELECTRICAL CONDUCTION SYSTEM OF THE HEART

#### Patient Information

The heart is a muscle pump that depends on a synchronized electrical system to function normally. The electrical signals that stimulate the heart muscle to contract and pump the blood are called *heartbeats*, a series of these signals is called the *heart rhythm*.

#### How the conduction system works

A normal heart is divided into right and left sides with an upper and lower chamber on each side. The upper chambers (*atria*) are the filling chambers; the bottom chambers (*ventricles*) are the pumping chambers. There are four heart valves that open and close with special timing to allow the flow of blood through the heart.

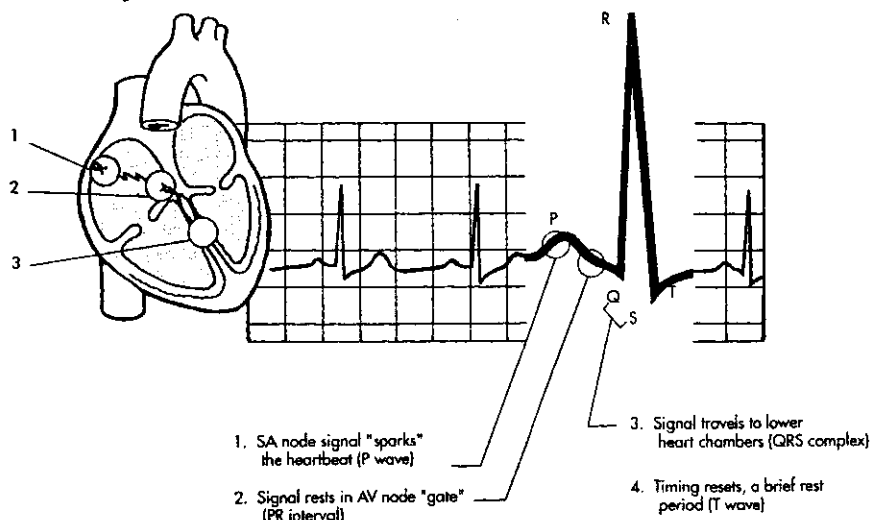
The heart tissue has special cells that can create an electrical signal and “spark” the heartbeat. The normal heartbeat begins in the SA node, or sinus node, located in the top of the right upper chamber (right atrium). The SA node works like a spark plug, which starts an engine. The SA node is often called the “pacemaker of the heart”. Once the heartbeat is triggered, it spreads across the top chambers like waves and then slows briefly at the AV node, or junction. The AV node acts like the gatekeeper and allows the signals to pass through to the ventricle one at a time with a slight delay. The signal spreads along special pathways through the lower chambers of the heart and stimulates them to squeeze and pump the blood out of the heart. Then the heart beat is finished. The heart muscle resets itself. After a brief delay, the sinus node starts another cycle.

#### What is a normal heart rhythm?

The special timing mechanism of the heart’s conduction system is sensitive to changes in activity. A normal heart rhythm speeds up and slows down all the time. When the body needs more blood and oxygen, the heart rhythm speeds up. During rest and during sleep, the heart rhythm slows down. The heart rhythm often changes during normal breathing; it speeds up as a person inhales and slows down as a person exhales.

The pulse felt at the wrist or on the neck is the result of the heartbeat stimulating the heart muscle to pump the blood out into the blood vessels. An adult’s normal pulse, or heart rate, while at rest is between 60 and 100 beats per minute. Lower resting rates are common for people who exercise regularly. During sleep, rates of 40 - 50 beats per minute are common. Infants and children normally have much higher resting heart rates. The heart rate decreases gradually with age.

An **electrocardiogram (EKG or ECG)** is a recording of the heart’s electrical signals on paper. The heart’s electrical signals are recorded by a machine from electrodes that attach to the skin over the chest. The ECG picture below represents one heartbeat followed by another. The heartbeats come on schedule at a regular pace.



## ABNORMAL HEART RHYTHMS

Heartbeats originating from locations other than the sinus node are called **arrhythmias**. They can be thought of in three categories - fast, slow, and seriously disorganized rhythms. Some arrhythmias cause no major problems or symptoms; others may cause palpitations, shortness of breath, dizziness, chest pain, or loss of consciousness. A few rhythms are extremely serious and may require emergency treatment. Your doctor will tell you which type you have and whether it needs to be watched over time or whether treatment is necessary.

### **Causes of abnormal heart rhythms**

Most arrhythmias occur in people who have a history of heart disease. People born with congenital heart disease may develop arrhythmias as they get older. Such a problem is often related to the original surgical repair. Damage from a heart attack can also cause arrhythmias. The most common chemicals that can cause arrhythmias include caffeine, alcohol, tobacco/nicotine, diet pills, cough and cold medicines and illegal drugs. Stress may trigger arrhythmias. Sodium, potassium, calcium, and magnesium also affect the heart rhythm and need to stay in proper balance. Age affects the heart rhythm also. Arrhythmias are common in the elderly.

### **Fast arrhythmias which involve the atria**

Fast rhythms, called **tachycardias**, are often caused by the SA node, the pacemaker of the heart, becoming overly excited and thereby triggering the heart to beat faster. Sometimes a fever, anxiety, stress, and imbalances in the body can cause the SA node to receive extra stimulation. Fast rhythms are also caused by irritable atrial cells that take over as the pacemaker of the heart and push the heart to beat faster. Sometimes fast heartbeats take a different route through the heart on an accessory pathway, and they end up bypassing the AV node, or gatekeeper/junction. The accessory pathway allows the heartbeats to travel very quickly in a circuit which includes both atria and ventricles. In one direction, the heartbeat travels over the accessory pathway, while in the other direction, the heartbeat follows along the AV node. This circuit can enable the heart to beat rapidly and can be uncomfortable. Atrial flutter and atrial fibrillation are two other common fast arrhythmias.

### **Extra or skipped heartbeats**

Occasionally you may feel your heart beat prematurely or the doctor may tell you there were a few early beats on your electrocardiogram (ECG). These beats are not dangerous.

The more common arrhythmias in this group are premature atrial contractions (PAC's) and premature ventricular contractions (PVC's).

### **Slow arrhythmias**

Slow rhythms are usually caused by depression or damage to the SA node or AV node. Also, blocked signals at the AV node that never reach the lower heart chambers can cause seriously slow heart rhythms. Irritation or swelling of the heart tissue as a result of infection, surgery, or a heart attack can cause damage to the areas of the heart that stimulate and regulate the heartbeat. This causes a slow rhythm. Some names for slow rhythms are sinus bradycardia; first, second, and third degree heart blocks; and complete heart block.

### **Seriously disorganized arrhythmias**

Disorganized rhythms can be life threatening and require emergency medical attention. Your doctor or nurse will advise you if you are at risk for one of these arrhythmias. Know your emergency phone numbers and know where the paramedics respond from (i.e. fire station, hospital). Many of these disorganized rhythms require shock from a defibrillator machine as quickly as possible and intravenous medications. Until the emergency team arrives, it is important for CPR to be given. Disorganized rhythms include ventricular tachycardia (Vtach) and ventricular fibrillation (Vfib).

### **Medication for arrhythmias**

Numerous medications are now on the market for the treatment of arrhythmias. Many medications have side effects, especially gastrointestinal side effects. You should also be aware of the signs and symptoms that indicate too much of the medication is in your body. Many of the medications require careful monitoring of blood levels to make sure you have the right amount in your system.

All of this should be reviewed with your doctor. Never start or stop taking one of these medications or skip or double your doses without discussing it with your doctor first. Other medications, especially over-the-counter cough and cold or allergy preparations, may interfere with your heart rhythm medication. Never take a new medication without talking with your doctor first. Avoid smoking, alcohol, and caffeine, which affect your heart rate and medication effects. The nurse may teach you to take your pulse and keep a diary of your average daily heart rates, especially when starting to take a new heart medication or when changing a dose.