

## Arrhythmias and cardiomyopathy

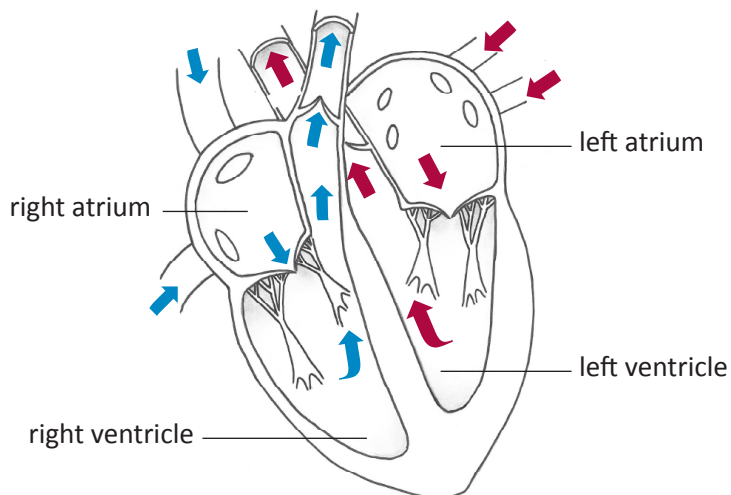
### An introduction to heart rhythm disturbances

- The heart normally beats in 'sinus rhythm', controlled by electrical signals from within the heart.
- When electrical signals are disrupted this can cause 'arrhythmias' – when the heart beats too fast, too slow or erratically.
- Some arrhythmias are harmless. Others require treatment with medication, surgery or devices.

#### The structure of the heart

The heart is made up of four chambers, two on the right and two on the left. The upper chambers are the atria, which collect blood coming into the heart. The lower chambers are the ventricles, which receive blood from the atria above. The ventricles are separated by a muscular wall called the septum.

#### The structure of the heart and how blood flows



*In these illustrations deoxygenated blood is shown in blue, oxygenated blood is shown in red.*

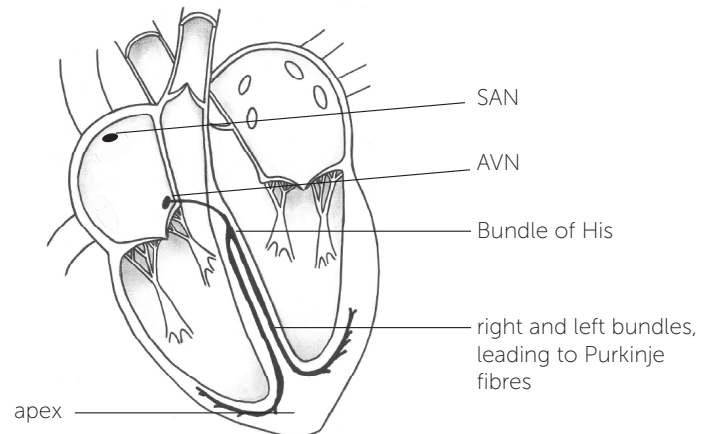
#### The cardiac cycle

Blood flows around the body in 'double circulation': traveling through the heart twice on each complete cycle (from the heart to the lungs to pick up oxygen then from the heart to the rest of the body to deliver oxygen). The following is how this happens.

- Deoxygenated blood (carrying no oxygen) enters the right atrium and the chamber fills with blood.
- The atrium contracts, forcing the blood into the right ventricle.
- The ventricle relaxes and fills with blood.
- The ventricle contracts forcing the blood out of the heart through the pulmonary artery.
- Blood flows to the lungs where it picks up oxygen.
- From the lungs, blood flows into the left atrium.
- The atrium contracts, forcing blood into the ventricle.
- The ventricle relaxes and fills with blood.
- The ventricle contracts forcing the blood out through the aorta to the body to deliver oxygen.

#### How the heart beats

The heart beat is controlled from within the heart itself, from an area of specialised muscle cells called the sinoatrial node or 'SAN'.



The SAN spontaneously generates and conducts regular electrical impulses which make the chambers of the heart relax and fill, or contract and empty, in sequence to force blood through the heart and to the lungs and the body. As the SAN controls the rhythm and speed of the heartbeat, it is sometimes referred to as the 'pacemaker'. The following is how this happens.

- Electrical activity is spontaneously generated by the SAN.
- The electrical activity spreads through the muscle wall of both atria, making them contract.
- The electrical activity is stopped from spreading to the ventricles by a layer of connective tissue. Instead, the activity reaches a second group of specialised muscle cells called the atrioventricular node (or AVN), between the two atria and the top of the ventricles.
- The AVN passes the electrical activity down a group of muscle fibres called the Bundle of His, which sits in the septum – the muscular wall between the two ventricles.
- From the Bundle of His, the activity spreads into the left and right bundle branches and to the smaller muscle fibres (Purkinje fibres). This causes the ventricle walls to contract from the bottom point of the heart (the apex) upwards, pushing the blood out of the heart.

♥ *For more information about how the heart works see our factsheet 'About the heart'.*



## What is a normal rhythm?

The normal rhythm of the heart is called 'sinus rhythm'. This is when the electrical signals that control the heart beat are relayed through the heart, causing the heart's chambers to fill and empty effectively and in sequence.

The speed at which the heart beats (pumps blood out) will vary, and depends on what the person is doing. For example, the heart beats more quickly when someone is exercising, and their body needs more oxygen to get to the muscles, than when someone is resting. A normal 'resting' heartbeat is usually between 60 and 100 beats per minute in an adult.

## What are arrhythmias?

'Arrhythmia' is a general term for any abnormal heart rhythm, where the heart is not beating in sinus rhythm. Arrhythmias happen when the electrical signals that control the heartbeat are disrupted in some way.

Arrhythmias are changes in heartbeat that happen independently of the person's state (not caused by the person's activity or emotion). For example, the heart would normally beat faster during exercise, or in response to emotions such as fear or stress, but if the heart beats too fast out of context (where there is no other known cause), it may be an arrhythmia.

Some arrhythmias start in the atria (top chambers of the heart) and may be called 'supraventricular' as they start above (supra) the ventricles. Some start in the ventricles (the bottom chambers).

Arrhythmias can cause the heart to beat too fast (called 'tachycardia', usually more than 100 beats per minute in an adult) or too slow (called 'bradycardia', usually less than 60 beats per minute in an adult). Some cause 'fibrillation' where the electrical signals cause the heart to beat erratically (called 'fibrillation') and be uncoordinated.

Note: arrhythmias are sometimes referred to as 'dysrhythmia', and either term can be used.

## What is the affect of arrhythmias?

Arrhythmias can reduce how effective the heart is at beating, and pumping blood around the body. This is because the heart's chambers are uncoordinated or unable to pump properly.

Some arrhythmias are 'normal' and do not need treatment. For example, 'sinus arrhythmia' is normal and happens when you breath in. Some arrhythmias are short-lived, and may cause no lasting problem for the person. They may not even be aware of them happening.

However, some people may be aware of a change in how their heart is beating. It might feel like it is pounding or fluttering, which can be uncomfortable. This is referred to as a 'palpitation'. Arrhythmias can also cause feelings of dizziness, light-headedness or loss of consciousness, due to the reduced output of blood from the heart.

However, some arrhythmias are more persistent, or can have serious consequences. As they reduce how effective the heart is at pumping blood around the body, they can be life-threatening.

## How are arrhythmias treated?

Arrhythmias are often treated with medication ('anti-arrhythmic drugs'). However, some life-threatening arrhythmias are managed with an ICD (implantable cardioverter defibrillator). These devices constantly monitor the heart's rhythm, and detect and monitor any arrhythmias in the ventricles. Depending on the type of arrhythmia, the ICD will treat this.

## Types of arrhythmia

The following pages explain types of arrhythmia that may happen in people with cardiomyopathy. They are diagnosed with an ECG (electrocardiograph). This test records the electrical activity of the heart, and looks at the heart rate and rhythm, and how the electrical signals are conducted through the heart.

### Atrial fibrillation (AF)

Atrial fibrillation (AF) is a common arrhythmia, and can affect anyone of any age. In cardiomyopathy it can be caused by the changes in the heart's structure caused by the condition, for example where the muscle is enlarged in dilated cardiomyopathy. It affects the top chamber of the heart (the atrium).

In AF the normal electrical messages that cause the heart muscle to contract are interrupted by *abnormal* electrical impulses from the atria walls. This means that unlike the normal rhythm of contraction, the atria contracts fast, randomly and is uncoordinated (called 'fibrillation'). The blood flow around the atria becomes 'turbulent'. Some of the electrical impulses are passed on to the ventricles below, causing a characteristic fast and erratic heart beat.

AF can be paroxysmal (happening for a short time) or persistent (happening all the time). It can reduce the effectiveness of the heart's pumping, and so cause palpitations, breathlessness and dizziness. Although AF is not life-threatening, the turbulent flow of blood in the atria can increase the risk of blood clots forming. This can increase the risk of stroke if a blood clot blocked blood flow in the brain.



AF is treated with anticoagulants (such as warfarin or apixaban) to reduce the chance of blood clots forming. Anti-arrhythmia drugs are often used to control the heart rate and rhythm. In some cases electrical cardioversion is used. This is where, under general anaesthetic, an electrical charge is given to the heart to shock it back into a normal rhythm. Some people may have surgery that stops the electrical impulses from the atria travelling to the ventricles, such as an 'AV node ablation'. After this surgery, the electrical signalling in the ventricles needs to be taken over by an implanted pacemaker.

### Atrial flutter

Atrial flutter is common, and can develop into atrial fibrillation. It is when the atrium beats (contracts and relaxes) in a regular rhythm but faster than normal. This means that it beats more frequently, and out of synchrony, with the ventricle below (which beats regularly but more slowly).

Atrial flutter is caused by a problem with the normal electrical signalling of the heart that ensures that the chambers of the heart beat in a synchronous rhythm. It is caused by small electrical circuits that form within the atria, so the electrical messages go around these circuits rather than being transmitted from the SAN to the AVN (see page 1).

Atrial flutter can reduce the effectiveness of the heart's pumping, and cause palpitations, dizziness and breathlessness. Although it is not life-threatening, it can increase the risk of blood clots forming. This can increase the risk of a stroke if they block blood flow in the brain.

Atrial flutter is treated with anticoagulants (such as warfarin or apixaban) to reduce the chance of blood clots forming, and anti-arrhythmia drugs are often used to control the heart rhythm. Surgery, called 'catheter ablation', is often used to treat atrial flutter and involves a catheter (thin tube) being tunnelled through a vein or artery in the groin into the heart. Radio waves are then transmitted to destroy areas of the heart muscle and stop the transmission of the electrical signals that cause the arrhythmia.

### Bundle branch block (BBB)

Bundle branch block (BBB) is when the transmission of electrical messages down the bundle branches in the ventricle walls are slowed down or blocked. These electrical messages usually cause the ventricles to contract, and so when they are slowed or blocked, the ventricles contract more slowly than usual.

BBB can affect the left and the right side of the heart.

When the blockage is in the left bundle (called LBBB), the electrical messages travel down the right bundle (to contract the right ventricle), and then have to spread from the right ventricle to the left ventricle, in order for the left ventricle to contract. This means that the ventricles, which normally contract together, become uncoordinated.

The slow and uncoordinated contraction of the ventricles reduced the amount of blood that leaves the heart and circulates to the body.

BBB may not need treatment, depending on how often it happens and how it affects the individual. However, it is important to try and identify the cause. BBB in the left ventricle can happen in both dilated and hypertrophic cardiomyopathy, and can affect how effectively the heart pumps. In some cases a biventricular pacemaker may be needed. This type of pacemaker is used in cardiac resynchronisation therapy (CRT), as it helps both sides of the heart to beat together. This aims to improve how effectively the heart pumps, increase the output of blood, and reduce any symptoms.

### Heart block

Heart block happens when the normal spread of electrical activity from the SAN to the AVN, which controls the contracting of the atria and ventricles in sequence, is slowed or stopped. The messages from the SAN may be partially blocked and so delayed in reaching the AVN, or they may be completely blocked. This results in the heart beating too slowly (bradycardia) or interruptions in the heart beat.

Heart block is sometimes called atrioventricular node (or AV node) heart block, if the electrical signals between the SAN and AVN (between the atrium and ventricle) are affected. In tachybrady syndrome, the SAN itself is affected, which affects the electrical signals it sends to the AVN.

Heart block can be caused by many conditions, such as coronary heart disease or a heart attack, high blood pressure, and also cardiomyopathy. It is usually diagnosed by an ECG, which looks at the electrical activity through the heart. It can also happen naturally as part of the aging process.

Heart block can be classified as either first-, second- or third- degree, depending on the symptoms.

- **First degree heart block** - the transmission of the impulse to the ventricles is slightly delayed. The person will probably have no obvious symptoms, and may not be aware that they have it. It may be found during tests for other conditions. If they have no symptoms, they may not need treatment.



- **Second degree heart block** - some of the impulses from the atria are not conducted to the ventricles. The person may have symptoms that need to be treated, such as feeling light-headed or dizzy, and fainting (loss of consciousness). They might also have chest pain and feel short of breath. Treatment includes having a pacemaker implanted, which takes over the electrical signalling in the heart to coordinate the contraction of the heart's chambers.
- **Third degree heart block** - none of the impulses from the atria are conducted to the ventricles. The symptoms are the same as second degree heart block, but worse, and the person is more likely to faint, and have palpitations. This type of heart block may require urgent treatment.

### Ventricular fibrillation (VF)

Ventricular fibrillation (VF) is a serious arrhythmia. The contraction of the ventricles is uncoordinated and ineffective, so blood is not pumped out of the heart. This condition is life-threatening and requires urgent treatment with a defibrillator.

VF happens when the electrical activity of the heart becomes disorganised and erratic, when abnormal impulses, coming from many parts of ventricle walls, interrupt the electrical signalling. This causes the ventricles to contract in a fast, uncoordinated way, and 'quiver' (or 'fibrillate') rather than contract normally. This means that the heart can't pump out blood effectively, so the heart output is greatly reduced. This means that blood supply to the vital organs such as the brain is affected. Early symptoms can include dizziness and shortness of breath, and the person will lose consciousness and collapse.

VF can be a cause of cardiac arrest. This is when the output of the heart stops suddenly and the person collapses, which can be fatal. However, a shock to the heart (from an AED\* or ICD\*) interrupts these abnormal 'chaotic' signals. This literally 'de-fibrillates' (stops the fibrillation), and restores sinus rhythm.

There can be many causes of VF, including a heart attack, or developing from ventricular tachycardia. It can also be caused by cardiomyopathy. The risk of VF caused by cardiomyopathy can be treated in several ways. Medication such as anti-arrhythmic drugs control the heart's rhythm and help to prevent arrhythmias happening.

ICDs can be used to monitor the heart's rhythm and, if a dangerous arrhythmia such as VF is detected, give a shock to the heart to interrupt the arrhythmia and restore the normal heart rhythm.

### Ventricular tachycardia (VT)

Ventricular tachycardia (VT) is an arrhythmia that starts due to abnormal electrical activity happening within the ventricle walls, which affects the normal electrical signalling in the heart. It causes the ventricles to beat too quickly (over 100 beats per minute), out of synchrony with the atria. This means that the ventricle doesn't have time to fill properly so blood cannot be pumped around the body effectively.

VT can be caused by different heart conditions, including a heart attack, and often happens in people with heart failure. However, cardiomyopathy is a common cause of VT.

VT can be brief and not cause any problems. However, it can be more prolonged it can cause dizziness and light-headedness, and sometimes collapse. The person may have palpitations and chest pain. In extreme cases, it can lead to VF (see above) and can cause the heart's function to be reduced so much that emergency resuscitation is needed.

VT may be treated with anti-arrhythmic drugs to control the heart's rhythm and so help to prevent arrhythmias happening. In some cases, surgery known as radio frequency ablation is used to destroy the area of heart muscle that is generating the abnormal electrical activity.

Some people will have an ICD, to monitor the heart's rhythm and detects arrhythmias. If it detects a too-fast rhythm which doesn't return to sinus rhythm, the it 'paces' the heart (takes over the electrical signals controlling the heart rate) by giving fast electrical impulses to interrupt the arrhythmia. This is called 'anti-tachycardia pacing'. If pacing the heart doesn't restore sinus rhythm the ICD will send an electrical shock to the heart to try stop the arrhythmia and convert the heart back into sinus rhythm.

An **AED** (automated external defibrillator) is a portable machine that detects and treats abnormal heart rhythms by giving an electric shock to return the heart to a normal rhythm. An **ICD** (implantable cardioverter defibrillator) is a device implanted into the chest, used to monitor the heart rhythm and give an electric shock to the heart if it detects a dangerous arrhythmia.

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**a:** Unit 10, Chiltern Court, Asheridge Road, Chesham, Bucks HP5 2PX  
**t:** 01494 791 224

**helpline:** 0800 018 1024

**live chat:** [www.cardiomyopathy.org](http://www.cardiomyopathy.org)

**w:** [cardiomyopathy.org](http://cardiomyopathy.org)

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