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About this booklet

This booklet describes the special tests that are commonly used to help diagnose heart diseases. Some of the tests are also used to assess the current condition of people who have already been diagnosed with heart disease.

The information in this booklet is a general guide. The arrangements for each test, and the way tests are carried out, may vary between different hospitals.

This booklet does not replace the advice that your doctors and other healthcare professionals involved in your tests may give you, but it should help you to understand what they tell you.
Having tests

You may be reading this booklet because your doctor has just advised you to have some tests to find out if you have heart disease. Or you may already know that you have heart disease and need tests to find out more about your condition.

It can be worrying to be referred for tests, and it’s natural to feel a bit anxious. All sorts of fears may be running through your mind. If you feel anxious, ask if your partner, or a relative or friend, can go with you. For some tests they can sit with you. For others they may be able to sit outside or wait in the hospital, so that they’re close at hand when the test is over. If you have the chance to talk to the doctor straight after the test, your partner, relative or friend may be able to see the doctor with you.

Some of the tests involve high-tech equipment with lots of machines, wires and computer screens, which may feel very impersonal. This booklet explains what the tests are for and how they are done.

A healthcare professional, such as a cardiac physiologist, can explain the tests to you as well. If you feel uneasy, remember that it often helps to get fears out into the open, so tell the people doing the test how you feel.
They can then explain things to you again, which can be reassuring.
The electrocardiogram (ECG)

An electrocardiogram, or ECG, records the electrical activity of your heart. Most GP surgeries can do an ECG for you if you need one, and some can also give you the result while you are there. Sometimes people have an ECG before having a routine operation. People who go to the accident and emergency department of a hospital with chest pain or an abnormal heart rate will have an ECG. Or you might have one as part of a private health check-up, even if there is no suspicion of heart disease.

What happens?
Small sticky patches called ‘electrodes’ are put on your arms, legs and chest. These are connected, by wires, to an ECG recording machine. The recording machine picks up the electrical activity in your heart and interprets it into wavy lines which are printed onto paper.

The whole test takes about five minutes. The ECG machine will only record electrical signals from your heart. It does not give electric shocks and does not damage your heart. It isn’t painful or uncomfortable. However, you will need to be able to lie still, because body movements can affect the result.
What can the test show?
An ECG can detect problems called arrhythmias. These are abnormally slow, fast or irregular heart rates or heart rhythms. If someone gets sudden symptoms such as chest pain, an ECG can help doctors to diagnose if that person is having a heart attack. An ECG can often show if a person has had a heart attack days, weeks or even years ago. It can also indicate if the heart might be enlarged, or if the heart wall might have become thicker due to too much strain on it.

The ECG is a simple and useful test, but it has some limitations. An abnormal reading does not necessarily mean that there is something wrong with the heart. On the other hand, some people may have a normal ECG recording even though they do have a heart disease. This is why you may need to have one or more other tests as well as the ECG.

Signal-averaged ECG
This is an ECG that adds together the electrical readings from at least 250 heartbeats so that any very subtle variations can be seen – for example, if the electrical impulses in the heart are being conducted more slowly. It is useful for diagnosing certain types of arrhythmias.
Exercise ECG

Also known as an exercise electrocardiogram, exercise stress testing or an exercise tolerance test.

An exercise ECG is an electrocardiogram that is recorded while you are walking on a treadmill or cycling on an exercise bike. The idea of this test is to see how your heart works when you are moving about and when your heart has to work harder – which is what happens in everyday life. The heart needs more blood and oxygen when you are active. An exercise ECG test can show if your heart muscle is not receiving enough blood (which is supplied to the heart muscle by coronary arteries).

The test can be used in several ways.

- It helps doctors find out if you have coronary heart disease. If, during the test, the exercise ECG recording shows certain changes in the ECG pattern, or you develop symptoms of chest pain, or if there are abnormal changes in your blood pressure or heart rate, this may show that there is narrowing of the coronary arteries and that you have coronary heart disease.
- If you already know you have coronary heart disease, an exercise ECG gives information about how severe your condition might be. For example, it can give some idea of how much strain your narrowed coronary arteries are under when you exercise. This can help
doctors to assess if your condition has got worse, and help them plan the best treatment for you.

- An exercise ECG is also helpful for looking at how well your heart is working if you have recently had heart surgery or a coronary angioplasty, or had a heart attack. And it can help doctors decide what level of exercise you should do as part of your cardiac rehabilitation programme.

- Exercise ECGs are also sometimes used to find out if someone is fit to drive, including people who drive an LGV (large goods vehicle) or public transport for their job.

- They are also used to investigate people who have been collapsing or having blackouts, particularly if this happens while they are being active or exercising.

**Getting ready for the test**

Wear light, comfortable clothes and shoes. Don’t have a heavy meal before you have your exercise ECG.

Exercise raises your pulse rate. However, this effect shows up less in people who are taking a type of medicine called beta-blockers. So, if you take beta-blockers, the cardiac department may advise you to stop taking them for one or two days before the test.
What happens?
Several small sticky patches (electrodes) are put on your chest. These are connected, by wires, to an ECG recording machine to record all the electrical activity of your heart, in the same way as for the ECG described on page 7. You will then be asked to exercise, either on a treadmill or on an exercise bike.

The test starts off at a very easy rate and is gradually made harder, either by increasing the speed and slope of the treadmill or by applying a brake to the bike. A doctor or specially trained physiologist will carefully check your ECG reading, blood pressure and pulse at regular intervals throughout the test. The exercise you have to do is not as intensive as an exercise workout. If you have an exercise ECG shortly after a heart attack, the exercise test may be less intensive.

The tester will tell you when to stop – usually when they have the measurements they need. They may also tell you to stop if you start getting chest pains, if your blood pressure either rises too much, or drops too low, if you develop an abnormal heart rate, or if you get tired or very short of breath. Let them know if you get any of these symptoms. You can also tell the tester if you can’t carry on with the test. After you have stopped exercising, they will take more ECG readings.
The exercise test usually lasts between a few minutes and 15 minutes. It can be hard work, but should not be too much for you. Many people are pleasantly surprised by how much they can achieve. The value of the test is much greater if you try to work as hard as you can.

If you can’t do the exercise test because you have another physical condition, such as severe arthritis or lung disease, your doctor may recommend a radionuclide test (see page 39) or a stress echocardiogram (see page 24) instead.

**What can the test show?**

If you have coronary heart disease, an exercise ECG can show ‘ischaemic changes’ during exercise. (Ischaemic changes happen when there is a reduced oxygen supply to the heart muscle.) If you experience chest pain and there are ischaemic changes on the ECG recording at the same time, this could mean that the chest pain is coming from your heart.

After the test, you may be told that you have had a ‘positive’ or a ‘negative’ exercise ECG.

- A positive exercise ECG is when abnormal changes in the electrical activity of the heart are seen on the ECG during exercise. This means that you may have coronary heart disease.
• A negative exercise ECG means that no abnormal or significant changes were seen on the ECG during the test.

An exercise ECG is a very useful test. It is widely available and it is a very safe test compared to many other medical tests. Most people find that the test in not unpleasant or distressing. Sometimes the exercise ECG test may show changes that suggest coronary heart disease, even though the person has very few symptoms.

However, the exercise ECG test is not 100% accurate. Occasionally the test may give a ‘false positive’ result. This means that someone with a normal heart may have an exercise ECG that shows changes that could indicate heart disease. This sometimes happens in young women, for example. On the other hand, people who do have coronary heart disease may occasionally have a negative exercise ECG – that is, a ‘false negative’ test.

If you have a negative exercise ECG after a heart attack, statistically you have only a low risk of having further heart problems in the recovery period. It is also reassuring for you to know that you can gradually build up your exercise safely.
24-hour ECG recording

Also known as Holter monitoring or ambulatory ECG monitoring.

This technique involves continuously recording an electrocardiogram (ECG), usually for 24 to 48 hours. It is frequently done as an outpatient. The test is safe and painless. It can help to diagnose the cause of symptoms – such as palpitations – which don’t happen all the time and which rarely happen in the GP’s surgery!
What happens?
You may need to make two visits to the hospital – once to have the recorder fitted and once to return it. Some hospitals will let you post the recorder back to them.

The recording device comes in two different forms – either a small portable tape recorder (about the size of a small pack of cards), or a small digital device in the shape of a pager. You wear the device on a belt around your waist. Four or six ECG leads from the device are taped to your chest. The device records the electrical activity of your heart. While you’re wearing it, you can do everything you would normally do, except have a bath or shower.

The cardiac physiologist may ask you to keep a simple ‘diary’ while you are wearing the device, noting any times when you have symptoms. This can help them when they’re analysing the results later. When the test is finished, you will need to return the device to the hospital. You will get the results of the monitoring a few weeks later.

What can the test show?
A 24-hour ECG recording can give a lot of useful information. In particular it may show an abnormally fast or slow heart rhythm that may need treatment. Or, if you are having palpitations but the device records a normal
heart rhythm, this can be reassuring for you. In most cases, palpitations are not due to any heart abnormality.

**7-day ECG recording**

*Also known as a 7-day Holter monitor test.*

If your palpitations don’t happen every day, your doctor may suggest doing a continuous ECG recording for up to seven days. You will have a monitor like the one described on page 15, but they will show you where to put the electrodes and how to connect them to the monitor. This means that you can remove the monitor once a day so that you can have a shower or bath.
Cardiac event recorders

If you have symptoms that don’t happen frequently, your doctor may suggest using a cardiac event recorder to record your heart’s rate and rhythm over a longer period of time. These recorders are not available for everyone.

There are several different types of event recorders. Some are portable devices – cardiac event recorders – that you just hold to your chest at particular times. There is also a device called an implantable loop recorder which is placed under the skin.

Cardiac event recorder

If you do not have palpitations very often or you are not collapsing regularly, you may be given a small electrical recording device to keep with you. The advantage of this device is that there are no leads attached to it. When you experience your typical symptoms, you just need to hold it to your chest and activate it. You will be shown how to do this. It is not invasive or painful. You make the recording and then contact the hospital where you are being treated. They will tell you what they want you to do to get the recording to them. They will then analyse the information and tell you if they find any abnormality and if you need more treatment.
Implantable loop recorder
*Also known as an ILR.*

An implantable loop recorder (ILR) is a device for finding out what is causing symptoms that don’t happen very often, such as dizzy spells or blackouts. Doctors may use an ILR if other cardiac event recorders have failed to reveal an underlying problem with the heart’s electrical signals.

The ILR is a small, slim device, about the size of a packet of chewing gum or a computer memory stick. It has a battery that can last up to three years.

The ILR is implanted under the skin on your chest. Inserting the ILR is a very simple and quick procedure. You will have a local anaesthetic and a small cut of about 2 centimetres will be made, to allow the device to be implanted under the skin. It is usually placed in the upper left chest area.

When you experience symptoms, you place a hand-held activator over the ILR and press a button to start the recording. A friend or family member can help you with the activator. The ILR stores the information before, during and after you press the button. The ILR can also be programmed to automatically detect an abnormal rhythm without using the activator. However, it is
important to use the activator whenever you have symptoms, so that the medical staff can see what is happening to your heart rhythm when you feel unwell.

When your doctor is happy that enough heart activity has been recorded, the device will be removed. The procedure for removing the ILR is similar to when it was inserted and it is usually done as a day case.
Chest X-ray

Your doctor may ask you to have a chest X-ray. If you are pregnant or think you may be pregnant, make sure you tell your doctor or radiographer, as they may suggest that you avoid having a chest X-ray during your pregnancy.

What happens?
To have a chest X-ray, most people stand with their chest pressed to a photographic plate. The radiographer will ask you to stay still and to take a deep breath and hold it. While you are doing this, he or she will turn on the equipment which sends a beam of X-rays from the X-ray source to the photographic plate. (Holding your breath improves the quality of the X-ray image.) They may want to take X-rays from several different angles. The radiographer will ask you to wait until he or she checks the images and makes sure that there are pictures of the whole chest.

Having an X-ray is painless. The main discomfort may be from the photographic plate which is a bit cold and hard.

What can the test show?
A chest X-ray allows closer examination of the heart, lungs and chest wall. If you have symptoms such as
shortness of breath, a chest X-ray can help doctors find out whether it is caused by a heart or lung condition, or whether it might be caused by something else. If the doctor thinks you might have a heart condition, he or she will probably arrange for you to have other tests too.
Echocardiogram

An echocardiogram uses high-frequency sound waves that reflect against structures in your heart to build up a detailed picture of the heart. It is a similar sort of scan to the ultrasound scan used in pregnancy. An echocardiogram is a safe and easy test, and most people find it’s not uncomfortable at all.

What happens?
You will have the test in a private room, because you’ll need to take off your clothes from your top half. If you’re very nervous, a friend or relative may be allowed to go in with you. The room has to be dimly lit for the machine to work well. A recorder (probe) that gives off pulses of ultrasound wave is placed on your chest. Lubricating jelly is used to help make a good contact between your skin and the probe. The ultrasound waves pass through the skin of your chest and the probe then picks up the echoes reflected from various parts of the heart and shows them as an echocardiogram – a picture on a screen. You can see different parts of the heart as the probe is moved around on your chest. Recording these images is a skilful job and can take up to an hour. A specialist then needs to look at the results, so you may
not be told the results for a few weeks.

**What can the test show?**
The echocardiogram can give accurate information about the structure and pumping action of your heart. It is a useful test if you have recently had a heart attack or if you might have heart failure. It is also used routinely to assess people with heart valve disease and those who have congenital heart defects (defects they are born with). An echocardiogram is especially useful for diagnosing heart disease in newborn babies and infants, because it doesn’t hurt and it is easy to do. It usually avoids the need for the child to have more complicated, and possibly more traumatic, tests. Echocardiograms are also used to diagnose certain heart defects before a child is born (foetal echocardiograms).

**Other types of echocardiography**

**Transoesophageal echocardiography (TOE)**

With this procedure, detailed pictures of the heart are taken from the gullet (oesophagus) which lies behind the heart. You ‘swallow’ a small probe which is mounted at the end of a flexible tube. To help you, an anaesthetic will be sprayed onto the back of your throat. You may have a light sedative first, just to help you relax. While the probe
is in your oesophagus, it takes ‘pictures’ of your heart. The pictures are taken quite quickly and the tube and probe are then gently withdrawn.

This test is particularly useful when doctors need a closer and more defined image of the heart valves and the areas around them.

**Stress echocardiogram**

Sometimes an echocardiogram is done while the heart is put under stress by increasing its heart rate – either with exercise or with a certain type of medicine.

This test can help to diagnose coronary heart disease. It’s also used to diagnose heart failure and cardiomyopathy (a disease of the muscle of the heart). If parts of the heart are damaged, they will contract less effectively and this can show up on the echocardiogram. This test is useful if the results of other tests are not clear, and in some hospitals a stress echocardiogram is used instead of radionuclide tests (see page 39).
A Doppler test is a special ultrasound test that shows the movement of blood through your blood vessels.

What happens?
During the test, a technician trained in ultrasound imaging will press a small probe (a bit like a very thick, blunt pen) over the area of your body that is being examined. Lubricating jelly is put on your skin to improve the contact between the probe and your body. The scan is non-invasive and there is normally no discomfort. It takes about 15 to 45 minutes to do the test, depending on which part of the body is being examined.

What can the test show?
A Doppler test can be used to check the blood flow in the major arteries and veins in your abdomen, arms, legs and neck. It can help diagnose many conditions including:

- narrowing of an artery – for example, of an artery in your neck (carotid artery stenosis)
- a bulging artery (an aneurysm)
- poor blood circulation to your legs (peripheral arterial disease)
- poorly functioning valves in your leg veins, which can
cause blood or other fluids to pool in your legs, and
• blood clots.
A Doppler test is sometimes done as part of the
assessment that people have before having surgery.
Blood tests

This section includes information on the blood tests you may have, including:

- **cardiac enzyme tests**, including **troponin tests** and tests for other enzymes, and
- other blood tests, such as a **full blood count, U and Es test, thyroid function test, cholesterol test, BNP tests, homocysteine test** and **CRP test**.

**Cardiac enzyme tests**

Cardiac enzyme tests can tell whether or not you have had damage to your heart muscle. The most common cause of this damage is a heart attack.

Enzymes are proteins that help with chemical reactions in the body. When the heart muscle is damaged after a heart attack, it releases certain enzymes into the blood. Some of these enzymes are normally found in the blood but at a low level. The more severely the heart is damaged during a heart attack, the more enzymes are released and the higher the levels of enzymes will be in the blood. The levels can be measured from a series of blood samples taken over a few days.
**Troponin test**

The main type of cardiac enzyme test used to find out if your heart muscle is damaged is a test to measure the level of troponins in the blood. Troponins are a type of protein normally found in the heart muscle but not in the blood. If the heart is damaged – for example, by a heart attack – troponins leak into the blood where they can be detected by a simple blood test. So, troponin tests can help to tell whether or not a heart attack is taking place. If you are admitted to hospital with chest pains, a troponin test can help doctors to decide whether you have had a heart attack. If you have a raised troponin level but your ECG does not show a clear pattern of a heart attack, this means that you have probably had a heart attack and that you may be at risk of having another one.

**Other cardiac enzyme tests**

Other cardiac enzymes tested apart from troponin include CK, LDH and AST. The levels of these enzymes peak at different times, so this can help doctors diagnose when a heart attack took place if there is any uncertainty. They are sometimes measured along with troponin. However, one problem with these tests is that these enzymes can also be released by damage in other types of muscle such as muscles in your arms or legs.
Other blood tests

Abnormal heart rhythms can sometimes happen in people with other conditions such as thyroid dysfunction or anaemia. So the following blood tests may also be done.

Full blood count

A full blood count (FBC) test can show the level of haemoglobin in your blood, and also if there is an infection in your bloodstream.

- A low haemoglobin level might mean that you have anaemia, which can cause the heart to have to beat faster.
- A full blood count can show if there is an infection in the body. Infection can cause an increase in heart rate.

U and Es test

‘U and Es’ stands for ‘urea and electrolytes’. This test can tell, for example, if there is too much or too little sodium or potassium in your blood. If the level is extremely high or low, this can cause abnormal heart rhythms (arrhythmias).

Thyroid function test

If you are having palpitations, or have a very slow or fast
heart rate, you may need to have a thyroid function test. Treating hypothyroidism (underactive thyroid) or hyperthyroidism (overactive thyroid) may improve the heart rate and symptoms.

**Cholesterol test**

Cholesterol is a fatty substance which is mainly made in the body. The liver makes some of the cholesterol from the saturated fats in the food you eat, and the body also takes in some cholesterol from certain foods. Too much cholesterol in your blood can increase your risk of having a cardiovascular event, such as a heart attack or stroke. Finding out your cholesterol level helps your doctor to decide whether you should start taking a cholesterol-lowering medicine. If you’re already taking tablets to lower your cholesterol, a cholesterol test will tell whether that treatment is working well or whether you need a stronger treatment.

**BNP tests**

BNP stands for ‘B-type natriuretic peptides’. BNP and NT-proBNP tests are used to help diagnose heart failure. They are hormones that are produced by the cells of the heart muscle. Having a high level of these hormones can be a sign of heart failure. If someone has symptoms that could suggest heart failure, doctors might use a BNP test,
along with an echocardiogram, to rule out the possibility of heart failure. Doctors do not base a diagnosis of heart failure on the results of the BNP tests alone, because it is possible to have normal levels of BNP and have stable heart failure. Also, although high levels of BNP are usually seen in people with heart failure, a high BNP level can also be caused by other heart conditions.

**Homocysteine test**

Homocysteine is a chemical that is found in the blood. People with very high levels of homocysteine have a higher risk of having a cardiovascular event such as a heart attack or stroke. However, only a very small number of people have extremely high levels of homocysteine, and most people with heart disease don’t have a very high level. So this test is not used very widely.

**CRP test**

CRP stands for C-reactive protein, which is a protein in the blood. A high level of this protein indicates the presence of infection or inflammation in the body. Research is currently being done to find out more about the possible links between inflammation and coronary heart disease.
24-hour blood pressure recording

Also known as **ambulatory blood pressure monitoring**.

Your doctor may want to record your blood pressure at regular intervals over a 24-hour period. This can be done by using a special recording device.

**What happens?**

On a belt around your waist, you wear a portable recorder for a full 24 hours. The recorder is about the same size as a pack of cards. This is attached, through tubes under your clothes, to a cuff which is wrapped around your arm. You can carry on with your usual daily activities except for having baths or showers. For a continuous 24-hour period, including through the night, every hour or so, the cuff automatically inflates and measures your blood pressure. The recorder keeps a record of each blood pressure measurement and the time that it was taken. The next day, when you go back to the hospital, the device is taken off. The recorder will be analysed and the results will be sent to your GP.

**What can the test show?**

This test can give an overview of all the blood pressure readings throughout the 24 hours. It confirms whether
you have high blood pressure or not. It is particularly useful if your doctor thinks that your blood pressure is unusually high when you have it measured in the doctor’s surgery or at hospital appointments. If you’re already taking tablets for high blood pressure, it can tell how well or how poorly your high blood pressure is controlled.
Coronary angiogram

Also known as cardiac catheterisation.

Sometimes doctors cannot make a definite diagnosis of coronary heart disease unless a test called a coronary angiogram is done. This test is also essential for deciding what sort of treatment a person with coronary heart disease should have. For example, it can help your doctors decide if you need to have a coronary angioplasty or coronary bypass surgery.

What can the test show?

One of the problems with many tests on the heart is that the heart lies behind the ribcage, which means that it is difficult to see the heart well. A coronary angiogram has the advantage that it can look inside the arteries. So it can show exactly where any narrowings in the coronary arteries are and how severe they are. And, if an angiogram of the left ventricle is also done, it can give some idea of how well the heart is pumping blood.

What happens?

The test takes place in a ‘cath lab’ (also called a catheterisation lab, catheter lab or angio lab). It usually takes about half an hour, but don’t be alarmed if it takes
longer than this.

A team of specialist health professionals – including at least one cardiologist (a doctor specialising in the heart), a nurse, a cardiac physiologist and a radiographer – carry out this test. It is usually done as a day case, which means that you don’t have to stay overnight in hospital. Or, you may have an angiogram if you have been admitted to hospital with chest pain that has been diagnosed as acute coronary syndrome (heart attack or unstable angina).

A catheter is a long, flexible, hollow plastic tube, about the width of the lead in a pencil. It is passed into the artery in the groin, or much less commonly, into the arm. You will have a local anaesthetic to numb the area where the catheter is put in, so it should not be painful.

The operator then uses X-ray screening to help direct the catheter through the blood vessels and into the correct position in the heart. (See the diagram on the next page.) You won’t feel the catheter moving around inside your chest, but you may be aware of the occasional palpitation. You can see your heart on the video screen if you want to.

While you are having the angiogram, you will be continually linked to a heart monitor which records your heart rate and rhythm.
A special dye (called a contrast medium) is then injected and a series of X-ray pictures is taken. The dye sometimes gives you a hot, flushing sensation which lasts a few seconds. The dye shows up all the coronary arteries on the X-rays, so doctors can see if there are any narrowings or blockages there. Sometimes doctors may look at the left heart chamber (the left ventricle) in more detail.
People sometimes feel some angina during the test. You need to tell one of the catheter lab team if you are having any pain or discomfort.

When the test is over, the catheter is removed from the artery. If the catheter was inserted in your groin, a nurse or doctor will either press on your groin for a period of time, or put in a plug called an angioseal, to stop any bleeding. If the catheter was put into your arm, a tight dressing will be applied there for a few hours. A nurse will examine your groin or arm several times after the test, to check for any possible bleeding. Some people feel a bit tired for a few hours after the test.

The place where the catheter was inserted may be tender for a few days. You may feel rather bruised. Most people feel OK after a day or two, but this varies from one person to another.

**Is there any risk?**

It is rare for anyone to have a reaction to the dye, apart from the brief hot, flushing sensation it can cause, as described on page 36. However, a very small proportion of people are highly allergic to the dye. If you know you are allergic to iodine or contrast agents, tell the doctor before you have the test.

Sometimes there may be a small amount of bleeding
when the catheter is removed, and a swelling or small lump may form around the area. This should go down after a few days, but if you have any concerns, contact your doctor.

A common after-effect is for a bruise to form in the groin or arm. This is not serious, but it may look quite obvious for a week or so.

Serious complications are very rare, but it would be wrong to give the impression that investigations such as this can be carried out on patients without any risk at all. A coronary angiogram is a relatively safe test. The risk of having a serious complication during the test – such as a heart attack, stroke or death – is estimated at about 1 or 2 in every 1,000 people. However, the level of risk varies depending on your overall health and your individual heart condition. So, your doctor will not recommend that you have a coronary angiogram unless he or she feels that the benefits outweigh this small risk. You will be asked to sign a consent form before having the angiogram. Before you sign the form, you should discuss with your doctor the benefits and possible risks of having this test, and any other worries.

Having a coronary angiogram does mean that you are exposed to some radiation. For more on this, see page 56.
Radionuclide tests

Radionuclide tests are used for investigating coronary heart disease. They are less common than electrocardiograms (ECGs) or echocardiograms, because the specialised equipment and staff are only available at some hospitals in the UK. This section includes information on the following types of radionuclide tests:

- myocardial perfusion scans, and
- CT scans. In this booklet we just describe two types of CT scans – the CT coronary angiogram and the coronary calcium scoring test.

Radionuclide tests give more detailed information than the exercise ECG test.

Myocardial perfusion scans

Also known as thallium scan, MIBI scan, MPS or technetium scan.

What happens?

There are two parts to this test – rest and stress.

- Rest – A doctor, nurse or radiographer will inject a small amount of radioactive substance (isotope) into the blood. A large ‘camera’ will then be positioned close to
the chest, to pick up the gamma rays sent out by the isotope as it passes through the heart while you are resting. It takes pictures of different parts of the heart.

- **Stress** – You will then be given another injection of an isotope, and will be asked to exercise on an exercise bike or treadmill. (Or you may be given a medicine which stimulates your heart to beat faster and harder. This is particularly useful if you cannot do much exercise.) The camera will then take the same sort of pictures as before.

The staff will monitor your heart rate throughout the test and will also check your blood pressure.

Various isotopes are used in different hospitals. These can include technetium and thallium.

There can be a lot of waiting around during myocardial perfusion scans. This is because there needs to be a certain amount of time in between the parts of the scan. Sometimes the two parts are done on different days. Sometimes only the stress part of the test is done.

**What can the test show?**

The camera can take pictures to:

- help diagnose coronary heart disease
- look at how well your heart pumps, or
- look at the flow of blood to the walls of the heart muscle.

Is there any risk?
Having a myocardial perfusion scan does mean that you are exposed to some radiation. For more on this, see page 56.

**CT scans**

*Also called a *CAT scan*.*

CT stands for ‘computerised tomography’. A CT scan is a sophisticated type of X-ray. It is useful for looking at the internal organs in your body, such as your heart or lungs. Below we just describe two tests for the heart which use CT scanning.

**CT coronary angiogram**

**What can the test show?**

A CT coronary angiogram shows the blood flow through the coronary arteries. If a CT coronary angiogram shows that you have narrowing of the coronary arteries, which may mean that you need angioplasty and stenting, you will need to go on to have a standard coronary angiogram (see page 34).
What happens?
For this test, you lie on a bed which passes through a doughnut-shaped opening in a scanner. At the start of the scan, a special dye (called a contrast medium) will be injected into a vein in your arm to help to show up the blood vessels on the surface of the heart. You may be given a medicine called a beta-blocker to slow your heart rate down during the test.

What can the test show?
A CT coronary angiogram looks for narrowings in the coronary arteries. It also provides a calcium score. (We explain more about calcium scores on the next page.) However, a CT coronary angiogram is generally not as able to detect narrowings in small coronary arteries or in small branches as a standard coronary angiogram. So, for now, the standard coronary angiogram is still the ‘gold standard’ for diagnosing coronary heart disease.

Is there any risk?
Having a CT coronary angiogram does mean that you are exposed to some radiation. We explain more about this on page 56.
Coronary calcium scoring test

What can the test show?

This test is done using a high-resolution CT scanner. It is a way of measuring how much calcium deposit there is in the coronary arteries. Normal, healthy arteries don’t contain calcium. If the test detects calcium, it is because there is atheroma in the arteries. Atheroma is the name for the calcium-containing fatty deposits that can build up and cause a narrowing in the coronary arteries.

For certain people, a CT coronary calcium scoring test has been recommended as the first test for diagnosing coronary heart disease.

The test gives you a calcium score. If your score is zero, it means that no atheroma has been found and you are unlikely to have coronary heart disease. If your score is very high, you may be advised to have further tests or medicines.

Is there any risk?

Having a coronary calcium scoring test does mean that you will be exposed to a very small amount of radiation. We explain more about this on page 56.
Magnetic Resonance Imaging (MRI)

Also known as an MRI scan.

Magnetic Resonance Imaging (MRI) is a technique which produces extremely detailed pictures of your internal organs. MRI is available in an increasing number of specialised units in the UK.

What happens?

An MRI is not painful or uncomfortable. You lie in a short ‘tunnel’, around which there is a large magnet. Short bursts of magnetic fields and radio waves from the MRI scanner allow images to be created. These images are then processed and analysed. You must lie still while the scan is done. The whole test takes up to an hour. Some people with claustrophobia (fear of enclosed spaces) may find they cannot cope with having this type of scan. One of the advantages of an MRI scan is that it does not expose you to radiation as it uses a magnetic field rather than radiation to create the images.

What can the test show?

MRI is very good at showing the structure of your heart and blood vessels. It can also measure the flow of blood through the heart and some of the major arteries. Your
cardiologist may ask you to have an MRI if he or she suspects that you were born with an abnormality in the structure of your heart and the vessels around it. An MRI scan can also show where the heart is working abnormally in disorders such as cardiomyopathy (a disease of the muscle of the heart) and coronary heart disease. And it can identify defects in the structure of the heart. MRI scans are not routinely used to diagnose coronary heart disease.

In the past, people who had a pacemaker or an ICD were not usually able to have an MRI scan, because the scan interfered with the way that these devices worked. Recently, an MRI-safe pacemaker has been approved for use. People who have this new device will be able to have MRI scans without any complications.
Electrophysiological studies

*Also called an EP study, EPS or electrophysiological testing.*

Electrophysiological testing has revolutionised the way we understand and treat abnormally fast heart rhythms. However, at the moment it is only available at some hospitals in the UK. This is because specialist equipment is needed and the test has to be performed by an electrophysiologist (an EP specialist). This is a cardiologist who specialises in electrical problems in the heart.

**What happens?**

This test – often called an ‘EP study’ – is sometimes done as a day case, but some people may need to stay in hospital overnight after the test. If you also have catheter ablation treatment during the EP study, you will need to stay overnight. (We explain more about catheter ablation treatment on page 48.)

The hospital will ask you not to eat or drink anything for a few hours before the procedure. They will tell you for exactly how long.

Most people need only a local anaesthetic and sedation before having this test. The local anaesthetic involves
having an injection which numbs the area where the catheters are put in. The sedation is given through a cannula (tube) in a vein in your arm or hand. This helps to relax you during the procedure.

The EP cardiologist will place flexible tubes, called catheters, into a large vein in the groin and sometimes also into a vein in the neck area. The catheters are gently moved into position in the heart. Special electrodes at the tip of the catheters then stimulate the heart and pick up recordings of the electrical activity in the heart. This can make you have palpitations, and it can make some people feel dizzy. As the tubes are inserted, you may feel a sensation in your chest, but this should not be painful. The team of staff will be monitoring you and reassuring you. The test can take about two to three hours.

Afterwards, the catheters are taken out and the nurse or doctor will press on the vein where the catheters have been removed. You will be asked to stay in bed for a while, first lying down and then sitting up. After that you will be able to walk around, as long as the puncture site is OK. You may need to have more pressure applied to the place where the catheter was put in, to stop any bleeding. You can get back to your normal activities in a week or so.
What can the test show?
An EP study can diagnose abnormal heart rhythms and identify which areas of your heart are affected.

If the cardiologist can pinpoint the exact area of your heart where special electrical cells are causing your abnormal heart rhythm, they may treat the problem at the same time as they do the test. This involves using radio-frequency electrical energy to destroy the areas inside the heart which are causing the abnormal rhythm. This treatment is called **catheter ablation**.

Is there any risk?
Having an EP study does involve some risks. These will all be explained to you before you sign the consent form for having the test.

One of the risks is that there may be bleeding from the place where the catheter was put in, leaving a haematoma (where blood collects under the skin). This can feel uncomfortable and can cause bruising.

Abnormal heart rhythms often happen during the test. These can help with the results of the test but occasionally may need to be treated during the EP study.

Also, having an EP study does mean that you are exposed to some radiation. For more on this, see page 56.
Tilt table test

This test is used to investigate people who have had frequent episodes of syncope (fainting, collapsing or passing out) which are not thought to be caused by abnormal heart rhythms or structures.

It is used for people who have collapsed several times and where the cause is suspected to be an abnormal change in blood pressure and heart rate related to changes in body position, but where the person has no structural problems with their heart and where no abnormal heart rhythm has been found on ECG recordings. Sometimes a tilt table test is used for people who collapse and look like they are having an epileptic fit, to find out if they are epileptic or not.

During the test, the doctors and staff will try to make you have an episode of syncope, but in a safe environment. This helps them to diagnose why you have the problem, and to plan the most effective treatment.

What happens?
The tilt table test is often done as an outpatient test. It is a safe, low-risk procedure, but an experienced nurse, cardiac physiologist or doctor will be there, because the heart can have abnormally slow heart rhythms during the test.
You will be told not to eat or drink for some time before the procedure. The hospital can tell you more about this.

You will have a cannula (tube) put in your hand or arm, in case you need to have any medicines or fluids during the test. You will be asked to lie down on the tilt table, and the staff will measure your pulse rate and heart rhythm using an ECG (see page 7), and measure your blood pressure. The head of the table is then raised up so that you are gradually tilted upwards to a standing position. This can make your blood pressure and heart rate drop. How quickly the symptoms you experience disappear, and how quickly your blood pressure and heart rate improve, will help the doctors to make a diagnosis and work out the best treatment for you.

The test doesn’t hurt, but sometimes people can feel light-headed or feel faint either during or after the test. Some people feel nervous about being made to faint or about having a collapse brought on, but for many people the test offers the chance of a diagnosis and possible treatment. As you are strapped to the special tilt table, you won’t suffer any injuries if you do faint.
For more information on syncope, contact:

**Stars (Syncope Trust and Reflex Anoxic Seizures)**
PO Box 175
Stratford upon Avon
CV37 8YD.
Phone: 01789 450564.
Email: info@stars.org.uk
Website: www.stars.org.uk
Genetic testing

The BHF continues to fund research into genes and heart disease. No specific gene directly causing coronary heart disease has ever been found. However, there are some other, rarer, types of heart disease that can be caused by alterations (mutations) to certain genes. We all inherit genes from both our parents, so it is possible for these diseases to be passed down from one family member to another.

The heart diseases that can be passed down in this way include some types of cardiomyopathies (diseases of the heart muscle) such as hypertrophic cardiomyopathy, and channelopathies (defects in cell proteins called ion channels) such as long QT syndrome and Brugada syndrome. Some of these conditions can occasionally cause sudden death in people of all ages, including children. (These conditions are not the same as coronary heart disease, which causes heart attacks and angina.)

Who might have genetic testing?

If a person has been diagnosed with a condition that can be passed on through the genes – such as hypertrophic cardiomyopathy – it is important to consider whether other members of the person’s family (for example, their
sister or brother, or their own children) could be at risk. This is done in two main ways.

- The first would be to look for signs of the disease in the person’s family members, using some of the tests described in this booklet. So if, for example, your sister has cardiomyopathy, your doctor might arrange for you to have an electrocardiogram and an echocardiogram to check for signs of cardiomyopathy.
- If no signs of cardiomyopathy are found, DNA tests may be done to find out if you have certain altered genes that make it more likely that you may, one day, develop the same disease yourself. If those altered genes are found, this is an early warning sign. But carrying an altered gene does not mean that you will definitely develop the disease. Also, the DNA test might reveal that you are carrying altered genes, but they might not be the genes that have been linked to hypertrophic cardiomyopathy. They may be linked to a different disease, or they may be genes that have not yet been linked with any particular disease.

Testing for DNA in seemingly healthy people can raise complicated medical and ethical issues for families, so before you have genetic testing it is very important to have genetic counselling. For more information, contact one of the organisations on the next page.
Research continues to try to identify other genes that may be responsible for certain conditions.

**Cardiomyopathy Association**  
Unit 10  
Chiltern Court  
Asheridge Road  
Chesham  
Bucks HP5 2PX  
Phone: 0800 018 1024  
Email: info@cardiomyopathy.org  
Website: www.cardiomyopathy.org

**CRY (Cardiac Risk in the Young)**  
Unit 7  
Epsom Downs Metro Centre  
Waterfield  
Tadworth  
Surrey KT20 5LR  
Phone: 01737 363 222  
Email: cry@c-r-y.org.uk  
Website: www.c-r-y.org.uk
SADS UK (Sudden Arrhythmic Death Syndrome)
Suite 6
Churchill House
Horndon Park
Station Road
West Horndon
Essex CM13 3XD
Helpline: 01277 811215
Email: info@sadsuk.org
Website: www.sadsuk.org
Is there any radiation in these tests?

Some of the tests described on pages 20 to 48 – such as chest X-rays and CT scans – involve being exposed to radiation.

Every day we are exposed to small amounts of radiation which occurs naturally in the environment. This comes from the ground and building materials around us, the air we breathe, and even outer space (cosmic rays). In most of the UK the largest contribution (which is still only a very small amount) is from radon gas which seeps out of the ground and builds up in our homes. Our risk of cancer can increase if we are exposed to lots of radiation. That’s why it is important only to have tests that are really necessary. Having an X-ray of any type increases your exposure to radiation. For example, a chest X-ray will give you the equivalent of 3 days of natural background radiation.

Cancers caused by radiation take many years or even decades to develop. So, the younger you are, the greater the risk of developing a cancer caused by radiation. Women who are pregnant will be advised to avoid radiation where possible but, if the mother’s health is at serious risk, she may be advised to have a test involving radiation, because the unborn baby depends on her health for survival.
The basic principle is that, when having a medical test, the benefits of knowing the results of the test need to far outweigh the risks of having the test. The amount of radiation used in most medical tests is quite small. So, if you have been told that it is likely that you have heart disease and you need, for example, a coronary angiogram, the risks involved in not having the test may well be far greater than the risks from radiation.

On the next page we explain which tests involve radiation and how much radiation is involved.
How much radiation is involved?

The following tests do not involve any radiation: ECG, echocardiogram, Doppler test, blood tests, 24-hour blood pressure recording, MRI scan, tilt table test, cardiac event recorder and genetic testing.

The tests shown in the table below do involve some radiation.

<table>
<thead>
<tr>
<th>Test</th>
<th>Approximate equivalent period of natural background radiation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chest X-ray</td>
<td>3 days</td>
</tr>
<tr>
<td>Conventional coronary angiogram</td>
<td>Around 1½ years</td>
</tr>
<tr>
<td>Radionuclide tests</td>
<td></td>
</tr>
<tr>
<td>Myocardial perfusion scans</td>
<td>At least 2 years</td>
</tr>
<tr>
<td>CT coronary angiogram</td>
<td>At least 3 years</td>
</tr>
<tr>
<td>Approximate extra lifetime risk of cancer for each test (We explain this on page 62.)</td>
<td>Notes</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Negligible risk</td>
<td></td>
</tr>
<tr>
<td>Low risk</td>
<td>The amount of radiation will increase if angioplasty with stenting is needed during the procedure.</td>
</tr>
<tr>
<td>Low risk</td>
<td>The amount of radiation can vary considerably – for example, depending on which isotope is used.</td>
</tr>
<tr>
<td>Low risk</td>
<td>The amount of radiation involved depends on the type of scanner used.</td>
</tr>
<tr>
<td>Test</td>
<td>Approximate equivalent period of natural background radiation</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>-------------------------------------------------------------</td>
</tr>
<tr>
<td>Coronary calcium scoring test</td>
<td>At least 3 years</td>
</tr>
<tr>
<td>Electrophysiological studies (EPS)</td>
<td>8 months</td>
</tr>
<tr>
<td>Approximate extra lifetime risk of cancer for each test (We explain this on page 62.)</td>
<td>Notes</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td><strong>Very low risk</strong></td>
<td>Some scanners give out more radiation than others. For example, a 64-slice CT scanner may give a clearer image but may expose you to more radiation than a scanner with fewer slices. And, if you get a high calcium score, you will probably need further tests which may also contain radiation. The risk may also increase if other types of CT scans are done at the same time.</td>
</tr>
<tr>
<td><strong>Very low risk</strong></td>
<td>If catheter ablation is done at the same time as the EPS, it is very likely that this will increase the risk from ‘very low’ to ‘low’.</td>
</tr>
</tbody>
</table>
What do the ‘risk’ figures mean?
The ‘risk’ figures on pages 58 and 61 tell you the extra risk of getting cancer in your lifetime, due to the radiation from the test.

**Negligible risk:** Less than 1 in 1,000,000 for each test.

**Minimal risk:** 1 in 1,000,000 to 1 in 100,000 for each test.

**Very low risk:** 1 in 100,000 to 1 in 10,000 for each test.

**Low risk:** 1 in 10,000 to 1 in 1,000 for each test.

These risk levels represent very small additions to the nearly 1 in 3 chance we all have of getting cancer even if we never have an X-ray.
What next?

Depending on the results of your tests, you may be advised to take medicines, or have treatment such as coronary angioplasty. If this is the first time you have been diagnosed with coronary heart disease or heart failure, it may come as a shock to you. Or, you might suddenly be faced with the prospect of major heart surgery. Sometimes it takes a long time for the news to sink in. At times you may feel afraid, angry or depressed. It is natural to feel anxious about what the news means for you, your family life and your work.

Information can be a great help. Ask questions and make sure you get explanations in language you understand. When you go to see your GP, cardiologist or the nurse, you may find it helpful to take in a list of the questions you want to ask. It may help if someone goes with you so that they can also remember what your doctor tells you. If an answer isn’t clear, it’s OK to say: “I don’t understand that. Could you explain it again please?” Before you leave, try and make sure that you know the answers to all your questions, if there is an answer. And ask what you can do if you think of any more questions afterwards – for example, if there is someone you could contact.
How your support can help

Over recent decades, research funded by the BHF has contributed to a substantial reduction in the number of people dying from heart attacks and strokes. And we have played a crucial role in developing a test to help spot some of the gene alterations that cause hypertrophic cardiomyopathy (HCM) – an inherited heart condition that affects the heart muscle, and can cause sudden death.

With the development of these techniques and medicines we are now seeing more and more people surviving to live with the often debilitating consequences of their disease, in particular heart failure. Fortunately, we can treat heart failure, but we can’t cure it because the heart can’t repair itself. The next big challenge is to discover how to help the heart repair itself, so that heart failure can be cured rather than treated. Visit the Research pages on our website bhf.org.uk to see how your support can make a difference.
For more information

British Heart Foundation website
bhf.org.uk
For up-to-date information on heart disease, the BHF and its services.

Heart Helpline
0300 330 3311 (a similar cost to 01 and 02 numbers)
For information and support on anything heart-related.

Genetic Information Service
0300 456 8383 (a similar cost to 01 and 02 numbers)
For information and support on inherited heart conditions.

Booklets and DVDs
To order our booklets or DVDs:
• call the BHF Orderline on 0870 600 6566, or
• email orderline@bhf.org.uk or
• visit bhf.org.uk/publications

You can also download many of our publications from our website. For a list of resources available from the BHF, ask for a copy of Our heart health catalogue. Our booklets are free of charge, but we would welcome a donation. (See page 2 for how to make a donation.)
Heart Information Series

This booklet is one of the booklets in the *Heart Information Series*. The other titles in the series are as follows.

- Angina
- Atrial fibrillation
- Blood pressure
- Cardiac rehabilitation
- Caring for someone with a heart condition
- Coronary angioplasty
- Diabetes and your heart
- Having heart surgery
- Heart attack
- Heart rhythms
- Heart transplantation
- Heart valve disease
- Implantable cardioverter defibrillators (ICDs)
- Keep your heart healthy
- Living with heart failure
- Medicines for your heart
- Pacemakers
- Peripheral arterial disease
- Physical activity and your heart
- Primary angioplasty for a heart attack
- Reducing your blood cholesterol
- Returning to work with a heart condition
- Tests for heart conditions
Heart Matters

Heart Matters is the BHF’s free, personalised service to help you live with a healthy heart. Join today and enjoy the benefits, including heart matters magazine, a Heart Helpline and an online members’ area with articles, recipes and lifestyle tips. You can join online at bhf.org.uk/heartmatters or call 0300 330 3300 (a similar cost to 01 and 02 numbers).

Emergency life-support skills

Heartstart

For information about a free, two-hour course in emergency life-support skills, contact Heartstart at the British Heart Foundation. The course teaches you to:

• recognise the warning signs and symptoms of a heart attack
• help someone who is choking or seriously bleeding
• deal with someone who is unconscious
• know what to do if someone collapses, and
• perform cardiopulmonary resuscitation (CPR) if someone has stopped breathing and his or her heart has stopped pumping.
Heart support groups

Many people with heart conditions can benefit from meeting other people who have had similar experiences. Heart support group activities vary from group to group, and may include:

- sessions where you can talk about your own experience with other heart patients and their carers
- exercise classes
- talks by guest speakers.

The BHF has resources and holds networking events to help new and existing heart support groups. For more details, or to find out about your local support group, contact the Heart Helpline on 0300 330 3311.
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Have your say

We would welcome your comments to help us produce the best information for you. Why not let us know what you think? Contact us through our website b hf.org.uk/contact. Or, write to us at the address on the back cover.

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The British Heart Foundation would like to thank all the GPs, cardiologists, nurses and other health professionals who helped to develop the booklets in the Heart Information Series, and all the patients who commented on the text and design.

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- Dr Barron Sin, Cardiology Registrar, Whipps Cross University Hospital, London, and
- Dr Simon Woldman, Consultant Cardiologist, The Heart Hospital, London.
Coronary heart disease is the UK’s single biggest killer.

For over 50 years we’ve pioneered research that’s transformed the lives of people living with heart and circulatory conditions. Our work has been central to the discoveries of vital treatments that are changing the fight against heart disease.

But so many people still need our help.

From babies born with life-threatening heart problems to the many Mums, Dads and Grandparents who survive a heart attack and endure the daily battles of heart failure.

Join our fight for every heartbeat in the UK. Every pound raised, minute of your time and donation to our shops will help make a difference to people’s lives.

FIGHT FOR EVERY HEARTBEAT
bhf.org.uk

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