

Atherosclerosis

Introduction

The arteries

The circulation system is made up of arteries and veins. The blood is pumped from the heart and through the aorta (the main artery leading from the heart) before travelling through increasingly small arteries that branch off from each other.

The blood passes into tiny blood vessels, known as capillaries, where the oxygen in the blood is transferred into the cells of your body's tissues and organs. The blood then returns to the heart through the veins.

Two particularly important arteries are:

coronary arteries – which provide blood to the heart

carotid arteries – which supply blood to the brain

If a blood clot occurs in the coronary artery it can trigger a heart attack. Similarly a blood clot in the carotid artery can trigger a stroke.

Atherosclerosis is a potentially serious condition where arteries become clogged up by fatty substances, such as cholesterol. These substances are called plaques or atheromas.

The plaques cause affected arteries to harden and narrow which is potentially dangerous for two reasons:

restricted blood flow can damage organs and stop them functioning properly

if a plaque ruptures, it can cause a blood clot that blocks the blood supply to the heart – triggering a heart attack, or the brain – triggering a stroke

Cardiovascular disease (CVD)

Atherosclerosis is a major risk factor for many conditions involving the flow of blood.

Collectively, these conditions are known as cardiovascular disease (CVD). Examples of CVD include:

peripheral arterial disease: where the blood supply to your legs is blocked, causing muscle pain

coronary heart disease: the coronary arteries (the main arteries that supply your heart) become clogged with plaques

stroke: where blood supply to your brain is interrupted

heart attack: where blood supply to your heart is blocked

What causes atherosclerosis?

Exactly how arteries become clogged is still unclear, though there are certain things that increase your risk of atherosclerosis. These include:

smoking

a high-fat diet

a lack of exercise

being overweight or obese

having either type 1 or type 2 diabetes

having high blood pressure (hypertension)

having high cholesterol

Read more about causes and risk factors for atherosclerosis.

Treating atherosclerosis

Treatment for atherosclerosis aims to prevent the condition from worsening to the point that it can trigger a serious CVD, such as a heart attack.

This can be achieved by making lifestyle changes, such as eating a healthier diet and increasing exercise, and also using certain medications, such as statins, to help lower cholesterol levels

In some cases, surgery may be required to widen or bypass a section of a blocked or narrowed artery.

Who is affected

It is hard to estimate how common atherosclerosis is, although it is suspected almost all adults have some degree of the condition.

A person's arteries naturally get harder as they grow older. Therefore, atherosclerosis tends to be more common in people over 40 years of age.

Atherosclerosis is more common in men than women. It is thought this is because sex hormones used in the female reproductive cycle, such as oestrogen, provide some protection against the effects of atherosclerosis.

The public health impact of atherosclerosis

Atherosclerosis (and the resulting cardiovascular diseases) is the single biggest cause of death in the developed world, accounting for one in three of all deaths. CVD causes two non-fatal, but serious, complications, such as a stroke or heart attack.

It is expected that atherosclerosis will continue to be a major health problem in this country due to the on-going obesity epidemic.

Symptoms of atherosclerosis

Atherosclerosis does not usually produce symptoms until your blood circulation becomes restricted or blocked, leading to cardiovascular disease (CVD).

The type of CVD and its associated symptoms will depend on where the blockage occurs.

Conditions caused by atherosclerosis include:

peripheral arterial disease

angina

aneurysm

heart attack

stroke

The conditions and their symptoms are described below.

Peripheral arterial disease

Peripheral arterial disease, also known as peripheral vascular disease, is a condition that occurs when there is a blockage in the arteries of your limbs (in most cases, your legs).

The most common symptom of peripheral arterial disease is pain in your legs. This is usually in one or both of your thighs, hips, or calves.

The pain can feel like a cramp, or a sensation of dullness or heaviness in the muscles of your legs. The pain usually comes and goes and is worse when doing exercise that uses your legs, such as walking or climbing stairs.

Other symptoms of peripheral arterial disease include:

weakness or numbness in your legs

having sores on your feet or legs that never heal

a change in the colour of the skin on your legs

hair loss on your legs or feet

thickening of your toenails

erectile dysfunction, also known as impotence

Angina

Angina is caused by a reduced blood supply to the heart.

The most common symptom of angina is a feeling of pain or discomfort, in your chest. The pain can feel tight, dull, or heavy, and usually passes within a few minutes.

The pain can spread from your chest to your left arm, neck, jaw and back. It usually follows a period of physical activity or emotional stress. In some cases, the pain can develop during cold weather or after eating a meal.

Some people with angina may also experience:

breathlessness

feeling sick

fatigue (feeling tired all the time)

dizziness

belching (burping)

restlessness

Angina symptoms are sometimes referred to as an angina attack.

Aneurysm

If atherosclerosis weakens the walls of your blood vessels, it can lead to the formation of an aneurysm (a bulge in a blood vessel). If the aneurysm grows too large, there is a danger that it will rupture, which can cause potentially fatal internal bleeding and organ damage.

An aneurysm can develop anywhere in the body, but the two most common types of aneurysm are:

a brain aneurysm (also known as a cerebral aneurysm), which develops inside the brain

an aortic aneurysm, which develops inside the aorta (a large blood vessel that runs down the abdomen and transports blood away from your heart)

If an aortic aneurysm ruptures, you will experience a sudden and severe pain in the middle or side of your abdomen. In men, the pain can spread down into the scrotum (the sac containing the testicles).

Symptoms of a ruptured brain aneurysm usually begin with a sudden and severe headache, which has been described as like being hit on the head.

You should request an ambulance if you suspect a ruptured aneurysm.

Heart attack

If one of the plaques in your coronary arteries ruptures it could create a blood clot. If the blood clot blocks the supply of blood to your heart, it will cause you to have a heart attack.

Symptoms of a heart attack include:

chest pain – usually located in the centre of your chest and giving the sensation of pressure, tightness, or squeezing

pain in other parts of the body which can feel as though it is travelling from your chest to your arms (usually the left arm is affected, although it can affect both arms), jaw, neck, back, and abdomen

an overwhelming sense of anxiety (similar to a panic attack)

shortness of breath

feeling sick

lightheadedness

coughing

vomiting

wheezing

Stroke

Blood clots can also block the supply of blood to your brain, causing a stroke.

The main symptoms of a stroke can be remembered by using the acronym FAST, which stands for:

Face: the face may have fallen on one side, the person may be unable to smile, or their mouth or eye may have drooped

Arms: due to a weakness or numbness of the arms, the person with a suspected stroke may not be able to raise both their arms and keep them raised

Speech: the person's speech may be slurred

Time: it is time to dial 999 immediately if you see any of these signs or symptoms

Symptoms in the FAST test are successful in identifying about 90% of all strokes.

You should dial 999 immediately to request an ambulance if you suspect a stroke.

Other signs and symptoms may include:

dizziness

communication problems (difficulty talking and understanding what others are saying)

problems with balance and coordination

difficulty swallowing

severe headaches

numbness or weakness resulting in complete paralysis (lack of sensation) in one side of the body

loss of consciousness (in severe cases)

A transient ischaemic attack (TIA) is where the blood supply to the brain is temporarily interrupted, causing a 'mini-stroke'.

The symptoms of a TIA are the same as those of a stroke, but they only last for between a few minutes and a few hours before disappearing completely.

However, a TIA should never be ignored as it is a serious warning sign that there is a problem with the blood supply to your brain.

Causes of atherosclerosis

As you get older it is thought your arteries naturally begin to harden and narrow, leading to atherosclerosis.

However, there are a number of things that accelerate this process. These are described below.

High-fat diets and cholesterol

Cholesterol is a type of fat that is essential for the functioning of the body. Cholesterol helps to produce hormones, make up cell membranes (the walls that protect individual cells) and protect nerve endings.

There are two main types of cholesterol:

Low-density lipoprotein (LDL) is mostly made up of fat, plus a small amount of protein. This type of cholesterol can block your arteries, so it is often referred to as 'bad cholesterol'.

High-density lipoprotein (HDL) is mostly made up of protein, plus a small amount of fat. This type of cholesterol can help to reduce any blockage in your arteries, so it is often referred to as 'good cholesterol'.

Most of the cholesterol your body needs is manufactured by your liver. However, if you eat foods high in saturated fat, the fat is broken down into LDL ('bad cholesterol').

Foods high in saturated fat include:

biscuits

cakes

bacon

sausages

processed meat

butter

cream

The LDL cholesterol sticks to your artery walls in the form of fatty deposits which, over time, gradually build up and reduce, or completely block, your blood supply. The fatty deposits are also known as plaques or atheroma.

As well as a high-fat diet, a lack of regular exercise, being obese and drinking excessive amounts of alcohol can also increase the levels of LDL cholesterol in your body. The medical term for having high cholesterol is hyperlipidemia.

Smoking

Smoking can damage the walls of your arteries. If your arteries are damaged by smoking then blood cells, known as platelets, will clump together at the site of the damage to try to repair it. This can cause your arteries to narrow.

Smoking also decreases the blood's ability to carry oxygen around your body, which increases the chances of a blood clot occurring.

High blood pressure

If you have high blood pressure (hypertension) it will damage your arteries in the same way as cigarette smoke. Your arteries are designed to pump blood at a certain pressure. If that pressure is exceeded, the walls of the arteries will be damaged. High blood pressure can be caused by:

being overweight

drinking excessive amounts of alcohol

stress

smoking

a lack of exercise

Diabetes

If you have poorly controlled type 1 or type 2 diabetes, the excess glucose in your blood can damage the walls of your arteries.

Obesity

Being overweight or obese does not directly increase your risk of developing atherosclerosis and cardiovascular disease (CVD), but it does lead to related risk factors that do. In particular, overweight or obese people:
have an increased risk of developing high blood pressure
tend to have higher levels of cholesterol as a result of eating a high-fat diet
have an increased risk of developing type 2 diabetes

Alcohol

Drinking an excessive amount of alcohol can cause high blood pressure (hypertension) and raised blood cholesterol levels, increasing your risk of developing atherosclerosis and CVD.

Family history

If you have a first-degree relative (a parent, or a brother or sister) with atherosclerosis and CVD, you are twice as likely to develop similar problems compared with the population at large.

Ethnicity

Rates of high blood pressure and diabetes are higher among people of African and African-Caribbean descent. This means that people in this group also have an increased risk of developing atherosclerosis and CVD.

People of South Asian descent (those from India, Bangladesh, Pakistan and Sri Lanka) are five times more likely to develop diabetes than the population at large. Again, this increases the risk of this group developing atherosclerosis and CVD.

Air pollution

Recent research suggested that air pollution, in particular traffic pollution, can cause a slight increase in levels of atherosclerosis.

Researchers found that people living within 50 metres of a major road had higher levels of atherosclerosis than would otherwise be expected.

Diagnosing atherosclerosis

As atherosclerosis does not cause symptoms until cardiovascular disease occurs, those at risk of developing the condition should be tested.

Screening allows treatment to be given to reduce the risk of CVD developing.

Your DOCTOR may recommend you are screened if you:

are over 40 years of age

are overweight or obese

are a smoker, or have a history of heavy smoking

eat a high-fat diet

have high blood pressure (hypertension)

have type 1 or type 2 diabetes

have a family history of heart disease, high blood pressure or diabetes

There are several tests that assess your level of existing atherosclerosis and your risk of developing CVD, these include:

blood tests – to measure the amount of cholesterol in your blood and the amount of glucose, if you are diabetic

blood pressure tests

a measurement of your weight and waist size

Your DOCTOR may also carry out an ankle-brachial index test. This compares the blood pressure in your ankle to the blood pressure in your arm. A difference between the two readings may suggest that atherosclerosis is restricting the blood supply to your legs and that you have peripheral arterial disease.

Further tests

If your risk of developing CVD is high, or if you are experiencing symptoms associated with CVD, further tests may be needed to confirm the level of atherosclerosis and locate any potential blockages in your arteries. These tests are explained below.

Electrocardiogram

An electrocardiogram (ECG) measures the electrical activity of your heart. This test can measure how well your heart is functioning and can often detect the presence of heart disease.

Ultrasound

An ultrasound scanner uses sound waves to build up a picture of the inside of your body. This can be used to measure your blood pressure at different points in your body. Any variation in pressure could point to the site of a blockage in your arteries. Ultrasound tests can also be used to study the larger arteries.

Angiography

During an angiography you are injected with a special dye that can be seen on X-rays. The test is used to see how the blood flows through your body.

Computerised tomography scan

A computerised tomography (CT) scan takes a series of X-ray images and uses a computer to assemble them into a more detailed three-dimensional image. It can often detect narrowing or hardening in the larger arteries.

Ophthalmoscopy

An ophthalmoscopy is a type of eye test where an instrument called an ophthalmoscope is used to examine the blood vessels in the back of your eye. The ophthalmoscope can sometimes detect hardening of the blood vessels in your retina (the retina is the light-sensitive layer at the back of the eye).

Treating atherosclerosis

Cholesterol lowering foods

Plant sterols and stanols are naturally occurring substances found in some types of food that are known to lower low-density lipoprotein (LDL or 'bad cholesterol').

Sources of sterols and stanols include:

fruits

vegetables

nuts

seeds

cereals

legumes (such as beans or peas)

olive oil

vegetable oil

Research suggests that eating 2,000mg of sterols and stanols a day reduces levels of LDL cholesterol by around 10% which, in turn, should reduce the risk of heart disease by around 25%.

The average intake of plant sterols and stanols is about 100-450mg.

There are now a number of commercial products, promoted for their alleged 'cholesterol-lowering' effects, which contain higher levels of sterols and stanols. These include special types of yoghurt, milk, margarine, and cheese.

The National Institute of Clinical Excellence (NICE) has stated that there may be a role for these types of products in the treatment of high cholesterol and atherosclerosis.

However, there is not currently enough evidence to confirm whether plant sterols and stanols are an effective method of preventing cardiovascular disease (CVD). Further research is required to clarify the issue.

If you are at risk of developing a cardiovascular disease (CVD) due to atherosclerosis, you will be advised to change your lifestyle to reduce this risk. Lifestyle changes include changing your diet and taking more exercise. Read more about preventing atherosclerosis-related CVD.

Medication

There are several medications available to treat many of the underlying causes of atherosclerosis, such as a high cholesterol level and high blood pressure (hypertension).

Depending on your individual circumstances, you may only need to take one medication, or you may need a combination of different medications.

High blood pressure (hypertension)

The most widely used medications for treating high blood pressure are outlined below.

Angiotensin-converting enzyme (ACE) inhibitors

Angiotensin-converting enzyme (ACE) inhibitors work by blocking the actions of some of the hormones that help to regulate blood pressure.

By stopping these hormones from working, ACE inhibitors reduce the amount of water in your blood, as well as widening your arteries, both of which will lower your blood pressure.

ACE inhibitors are not suitable for:

pregnant or breastfeeding women

people with conditions that affect the blood supply to their kidneys

those with a history of heart disease

The side effects of ACE inhibitors include dizziness, tiredness and headaches.

If the side effects of ACE inhibitors become troublesome, angiotensin-2 receptor antagonists may be recommended. They work in a similar way to ACE inhibitors.

Calcium channel blockers

Calcium channel blockers work by relaxing the muscles of your artery walls, which causes your arteries to widen and lowers your blood pressure.

Calcium channel blockers are not recommended for people with a history of heart disease, liver disease or circulation problems.

Side effects include a flushed face, headaches, swollen ankles and dizziness.

You should not drink grapefruit juice if you are taking calcium channel blockers because this can cause your blood pressure to fall.

Thiazide diuretics

Thiazide diuretics work by reducing the amount of water in your blood and widening the walls of your arteries. They are not recommended for pregnant women or people with gout (a type of arthritis where crystals develop inside the joints).

Thiazide diuretics have been known to reduce the level of potassium in your blood, which can interfere with your heart and kidney functions. They can also raise the level of sugar in your blood, which could lead to diabetes.

You will probably be advised to have blood and urine tests every six months so that your potassium and blood sugar levels can be monitored.

A few men reported they could not get or maintain an erection while taking thiazide diuretics, although this side effect resolved once the medication was withdrawn.

High cholesterol levels

Statins

Statins are a type of medication used to lower blood cholesterol levels. Statins block the effects of an enzyme in your liver called HMG-CoA reductase, which is used to make cholesterol.

Statins sometimes have mild side effects including constipation, diarrhoea and headaches.

Occasionally, statins can also cause muscle pain, weakness and tenderness. You should contact your DOCTOR if you experience these symptoms because your dosage may need to be adjusted.

If you have high blood cholesterol, you may need to take statins indefinitely.

Preventing blood clots

As many of the serious complications that arise from atherosclerosis, such as a heart attack or stroke, are associated with blood clots, you may be given medication to help reduce the risk of a blood clot.

Antiplatelets

Medications used to prevent blood clots developing are known as antiplatelets. Platelets are tiny particles in the blood that help it to clot. Antiplatelets work by reducing the 'stickiness' of platelets.

You may be advised to take low-dose aspirin which, as well as being a painkiller, has blood-thinning properties.

If testing shows you have a higher than average risk of developing a blood clot, you may be given an additional antiplatelet medication called clopidogrel. Clopidogrel can also be used if you are allergic to aspirin.

Surgery

Surgery may be required if certain important blood vessels become narrowed. These are the:

coronary arteries, which supply blood to your heart (narrowing of your coronary arteries can trigger a heart attack)

carotid arteries, which supply blood to your brain (narrowing of your carotid arteries can trigger a stroke)

Coronary angioplasty

Coronary angioplasty is a type of surgery used to widen your coronary arteries. A long, flexible plastic tube called a catheter is inserted into a blood vessel and a balloon attached to the catheter is inflated to widen the artery. A small metal tube called a stent is often used to help keep the artery open.

Coronary artery bypass graft

A coronary artery bypass graft (CABG) can be used to treat narrowing of the coronary arteries. During a CABG, healthy blood vessel segments (grafts) are taken from other parts of the body in order to bypass the blocked artery.

Segments of vein taken from your legs, arms and chest are used to create a new channel through which blood can be directed around the blocked part of the artery. This enables more blood to get through to the heart muscle.

Carotid arteries

Surgery is usually only recommended to widen the carotid arteries if you have experienced previous symptoms related to a blocked blood supply, such as a stroke or transient ischaemic attack (TIA).

Unlike the coronary arteries, preventative surgery on the carotid arteries is not usually recommended, except in cases where testing shows high levels of narrowing. This is because studies have found that the benefits achieved in reducing the risks of a stroke in most people without any symptoms are outweighed by the risks associated with surgery.

Carotid endarterectomy

A carotid endarterectomy is the most commonly used method of widening the carotid artery (the main artery in your neck). During the procedure a cut is made into the narrowed part of the artery and the inner lining of the artery is removed, along with any plaque inside it.

Most surgeons sew a patch into the opening to widen this section of the artery. The patch may be taken from a vein in your thigh or it might be synthetic (man-made). Using a patch can reduce your risk of having a stroke after the operation, as well as reducing the likelihood of restenosis (the artery becoming narrowed again).

Carotid angioplasty

A carotid angioplasty uses a balloon catheter (a thin plastic tube with an inflatable balloon at one end). The catheter is inserted into your femoral artery (the body's main blood vessel) in your groin.

Under the guidance of X-ray, the catheter is threaded up into your femoral artery until it reaches your carotid artery. The balloon is then inflated to around 5mm in diameter. This expands the artery, clearing the narrowing so blood is able to flow through it again.

Carotid angioplasty is a less invasive type of surgery than carotid endarterectomy, so you will experience less post-operative pain and have a faster recovery time.

However, research carried out in 2009 found people who had a carotid angioplasty were more likely to have re-narrowing of the carotid artery compared with those who had a carotid endarterectomy. You should discuss the advantages and disadvantages of both types of surgery with your surgeon.

Extracranial to intracranial bypass

A new type of surgery used to treat blockage of the carotid artery is known as an extracranial to intracranial bypass.

In this type of surgery a section of blood vessel found outside of the skull is diverted and used to bypass the site of the blockage so the blood supply to the brain can be restored.

Extracranial to intracranial bypass is still an evolving field of treatment and it is unclear how effective or safe it may be in the long-term.

Preventing atherosclerosis

Making lifestyle changes is a very effective way of preventing or reversing the process of atherosclerosis, as well as reducing your risk of developing a cardiovascular disease (CVD), such as coronary heart disease, heart attack, or stroke. There are five ways you can help reduce your risk of developing further coronary heart disease:

eat a healthy diet

stop smoking (if you smoke)
take regular exercise
lose weight (if you are overweight or obese)
moderate your consumption of alcohol
These lifestyle changes are discussed in more detail below.

Diet

Eating an unhealthy diet high in fat will make your atherosclerosis worse and increase your risk of developing a heart attack or stroke.

There are also two types of fat – saturated and unsaturated. Avoid foods that contain saturated fats because they will increase the levels of bad cholesterol in your blood. Foods high in saturated fat include:

- meat
- sausages and fatty cuts of meat
- butter
- ghee (a type of butter often used in Indian cooking)
- lard
- cream
- hard cheese
- cakes and biscuits
- food that contains coconut or palm oil

Eating a small amount of unsaturated fat will increase the level of good cholesterol and help reduce any blockage in your arteries. Foods high in unsaturated fat include:

- oily fish
- avocados
- nuts and seeds
- sunflower, rapeseed and olive oil

Smoking

Smoking is a major risk factor for both heart attacks and strokes because it causes atherosclerosis and raises your blood pressure.

If you decide to stop smoking, your DOCTOR will be able to refer you to an NHS Stop Smoking Service, which will offer dedicated help and advice about the best ways to quit. You can also call the NHS Smoking Helpline on 0300 123 1044 (7am to 11pm). The specially trained helpline staff offer free expert advice and encouragement.

If you are committed to giving up smoking but do not want to be referred to a stop smoking service, your DOCTOR should be able to prescribe treatment to ease your withdrawal symptoms.

For more information about giving up smoking, see treatment for quitting smoking and stop smoking.

High blood pressure

Persistent high blood pressure can put both your arteries and heart under extra strain, increasing your risk of developing a heart attack or stroke.

High blood pressure can often be reduced by eating a healthy diet, moderating your consumption of alcohol, maintaining a healthy weight and taking regular exercise.

Diet

The dietary advice above also applies if you have high blood pressure. In addition, you should cut the amount of salt in your food and eat plenty of fruit and vegetables.

Salt raises your blood pressure. The more salt you eat, the higher your blood pressure. You should aim to eat less than 6g (0.2oz) of salt a day, which is about a teaspoonful. Find out more about how to cut down on salt.

Eating a low-fat diet that includes lots of fibre, such as wholegrain rice, bread and pasta, and plenty of fruit and vegetables, has been proven to help lower blood pressure. Fruit and vegetables are full of vitamins, minerals and fibre and help keep your body in good condition. You should aim to eat five 80g portions of fruit and vegetables every day. Find out more about getting your 5 A Day.

Alcohol

Regularly drinking alcohol above the limits recommended by the NHS will raise your blood pressure. Therefore, staying within the recommended levels is the best way to reduce your risk of developing high blood pressure. The recommended limits for alcohol consumption are:

three to four units a day for men

two to three units a day for women

Find out how many units are in your favourite tittle, track your drinking over time and get tips on cutting down.

Alcohol is also high in calories, so you will gain weight if you drink regularly. Being overweight will also increase your blood pressure. Find out how many calories are in popular drinks.

Weight

Being overweight forces your heart to work harder to pump blood around your body which can raise your blood pressure. Find out if you need to lose weight with the BMI healthy weight calculator.

If you do need to shed some weight, it is worth remembering that just losing a few pounds will make a big difference to your blood pressure and overall health. Get tips on losing weight safely.

Exercise

Being active and taking regular exercise will lower your blood pressure by keeping your heart and blood vessels in good condition. Regular exercise can also help you to lose weight, which will help lower your blood pressure.

If you have a history of CVDs then low-impact activities, such as walking, swimming and cycling are recommended. More strenuous activities, such as playing football and squash, may not be recommended. Check with your DOCTOR for advice.