

Cardiac (Heart) Screening

What is cardiac (heart) screening?

Screening examinations are tests performed to find disease before symptoms begin. The goal of screening is to detect disease at its earliest and most treatable stage. In order to be widely accepted and recommended by medical practitioners, a screening program must meet a number of criteria (http://www.radiologyinfo.org/en/info/safety-hiv_05), including reducing the number of deaths from the given disease.

Screening tests may include laboratory tests to check blood and other fluids, genetic tests that look for inherited genetic markers linked to disease, and imaging tests that produce pictures of the inside of the body. These tests are typically available to the general population; however, an individual's needs for a specific screening test are based on factors such as age, gender and family history.

In heart screening, individuals with no signs or symptoms of coronary artery disease — the most common form of heart disease — may be evaluated to measure:

- the amount of cholesterol carried in the blood known as low-density lipoproteins (LDL)—high levels of which can lead to a buildup in the arteries—and high-density lipoproteins (HDL), which absorb cholesterol and carry it back to the liver, where it is flushed from the body.
- blood glucose levels, the amount of sugar present in the blood.
- the amount of C-reactive protein in the blood with a test called high-sensitivity c-reactive protein (hs-crp) assay. C-reactive protein appears in higher amounts when there is inflammation or swelling somewhere in the body.
- blood pressure levels, the force of blood against the artery walls both when the heart beats and when it is at rest (systolic and diastolic, respectively).

Depending on the results of initial screening tests and the presence of risk factors for coronary artery disease, your doctor may recommend additional testing, including:

- Electrocardiography (ECG or EKG), which measures the electrical activity of the heart and reveals information on heart rate and rhythm.
- Exercise cardiac stress test (also called a cardiac stress test or exercise electrocardiogram) which involves walking on a treadmill or pedaling a stationary bike at increasing levels of difficulty, while heart rate and rhythm, blood pressure and the electrical activity of the heart (using electrocardiography) are monitored to determine if there is adequate blood flow to the heart when the heart is stressed. Patients who are unable to exercise instead receive a medication that makes the heart beat harder and faster.
- Echocardiography, which uses ultrasound to create moving pictures of the heart. In a stress echocardiography, an ultrasound of the heart is performed before and after the heart is stressed either through exercise or a medication that stimulates the heart.



- Cardiac CT for Calcium Scoring (http://www.radiologyinfo.org/en/info/ct_calscoring) (also called coronary artery calcium scoring), which examines the coronary arteries to measure the amount of calcium in the coronary arteries which is an indicator of the amount of plaque in the arteries. Importantly, calcium scoring only measures the presence of plaque. It cannot evaluate the severity of coronary artery narrowing (stenosis) due to the plaque.
- *Coronary CT angiography (CTA)* (<http://www.radiologyinfo.org/en/info/angiococt>) which uses computed tomography (CT) and a intravenous contrast material (dye) to create three-dimensional images of the coronary arteries to determine the exact location and extent of plaque buildup.
- Myocardial perfusion imaging (MPI) (also called a nuclear stress test) in which a small amount of radioactive material is injected into the patient and accumulates in the heart. A special camera takes pictures of the heart while the patient is at rest and following exercise to determine the effect of physical stress on the flow of blood through the coronary arteries and to the heart muscle.
- *Coronary catheter angiography* (<http://www.radiologyinfo.org/en/info/angiocath>) , which takes pictures of the blood flow through coronary arteries, allowing the doctor to see any blockage or narrowing of the coronary arteries (stenosis). In catheter angiography, a thin plastic tube, called a catheter, is inserted into an artery through a small incision in the skin. Once the catheter is guided to the heart, contrast material is injected through the tube and images are captured using X-rays.

Who should consider heart screening – and why?

About Coronary Heart Disease

According to the National Institutes of Health (<http://www.nlm.nih.gov/medlineplus/heartdiseases.html>) , heart disease is the leading cause of death in the United States and a major cause of disability. Of the many different forms of heart disease, coronary artery disease (CAD) is the most common and a major cause of myocardial infarction (heart attack).

CAD occurs when plaque (a build-up of fat, cholesterol and other substances) collects and forms along the walls of the heart's arteries, a condition called atherosclerosis. As the plaque builds up, the heart's (coronary) arteries narrow and blood clots (<http://www.radiologyinfo.org/en/info/bloodclot>) may form, limiting blood flow and creating a risk for the vessel to become completely obstructed resulting in a heart attack.

Risk Factors

Anything that increases an individual's chances of developing disease is called a risk factor. Risk factors for CAD include:

- age
- gender
- family history of the disease
- tobacco smoking
- high blood cholesterol
- high blood pressure
- physical inactivity
- obesity
- diabetes

Screening Recommendations

According to the American Heart Association (https://www.heart.org/HEARTORG/Conditions/Heart-Health-Screenings_UCM_428687_Article.jsp) , the following screening tests for coronary artery disease should begin at age 20, except for blood glucose screening which should begin at age 45. If you have been diagnosed with a heart condition or have risk factors for coronary artery disease, your physician may suggest that you undergo these screening tests more frequently than the

recommendations listed below.

Cholesterol

Every four to six years for people at normal risk for heart disease, or more often if you are at an increased risk for heart disease or stroke. Talk to your doctor.

Blood pressure

At least once every two years, if blood pressure is less than 120/80 mm Hg

Blood glucose

The United States Preventive Services Task Force (USPSTF) recommends that adults who are overweight or obese start screening for type 2 diabetes at age 40 and repeating the test every three years if the results are normal. The American Diabetes Association recommends that adults start annual screening at age 45. Patients who are at higher risk should talk to their doctor about when to start screening.

High-sensitivity c-reactive protein (hs-CRP) testing

The American Heart Association and the Centers for Disease Control and Prevention recommend hs-CRP testing not for screening the entire adult population, but instead to be used as an optional tool for evaluating patients. These groups say the test is most useful for people who have an intermediate risk (a 10 to 20 percent chance) of having a heart attack within the next 10 years. Your doctor can help determine whether you are at intermediate risk and should have this test performed.

If preliminary testing identifies signs of heart disease or if you have specific risk factors for coronary artery disease, such as an abnormal cholesterol, high blood pressure, diabetes, cigarette smoking or family members who developed the disease at a relatively young age, your physician may also recommend undergoing one or more of the following diagnostic tests:

- electrocardiography (ECG or EKG)
- exercise cardiac stress test
- echocardiography or stress echocardiography
- cardiac CT for calcium scoring
- coronary CT angiography (CTA)
- myocardial perfusion imaging (MPI), also called a nuclear stress test
- coronary catheter angiography

How are the procedures performed?

Cardiac CT for Calcium Scoring

The technologist will position you on the CT examination table lying flat on your back. Straps and pillows may be used to help you maintain the correct position and to help you remain still during the exam. You will be asked to raise your arms over your head. Electrodes (small, sticky discs) will be attached to your chest and to an electrocardiography (ECG) machine that records the electrical activity of the heart. You will then be instructed on how and when to hold your breath. The examination table will move multiple times as the CT scanner obtains the images.

Coronary CT angiography (CTA)

A nurse will insert an intravenous (IV) line into a vein in your arm. You may be given a medication, either by mouth or through the IV, to help slow your heart rate. You may also receive nitroglycerin (via spray or a tablet under your tongue) to enlarge your coronary arteries (which may improve the images). You will be positioned on an examination table and electrodes (small, sticky discs) will be attached to your chest and to an electrocardiography (ECG) machine that records the electrical activity of the heart. You will be asked to raise your arms over your head for the duration of the exam. You will then be instructed on how and when to hold your breath. The examination table will move multiple times as the CT scanner obtains the images. During the exam, contrast material (dye) will be given through your IV.

Myocardial perfusion imaging, also called a nuclear stress test

You will receive an injection of a small amount of radioactive material called a radiotracer and rest for approximately 20 to 40 minutes. Next you will be positioned on a moveable imaging table and a nurse or technologist will insert an intravenous (IV) line into a vein in your hand or arm. You may be asked to raise one or both arms over your head while the imaging is performed. Following imaging, you will be asked to walk on a treadmill or pedal on a stationary bicycle for a few minutes. While you exercise, your heart will be monitored and your blood pressure will be frequently measured. When blood flow to the heart has reached its peak, you will be given a second injection of radiotracer through your IV. Approximately 20 to 40 minutes later you will be placed on the imaging table again and a second series of images will be recorded. If you are unable to exercise, you will be given a medication that increases blood flow to the heart.

Coronary catheter angiography

A nurse or technologist will insert an intravenous (IV) line into a small vein in your hand or arm. The area of the groin or arm where the catheter will be inserted is shaved, cleaned, and numbed with local anesthetic. The doctor will make a small incision in the skin where the catheter can be inserted into an artery. The catheter is then guided through the coronary arteries. Multiple X-ray images are then taken of the coronary arteries as contrast material is injected through the catheter.

What are the benefits and risks of heart tests?

Cardiac CT for Calcium Scoring

Benefits

- Cardiac CT for calcium scoring is a convenient and noninvasive way of evaluating whether you may be at increased risk for a heart attack.
- The exam takes little time, causes no pain and does not require injection of contrast material.
- No radiation remains in a patient's body after a CT examination.
- X-rays used in standard CT scans have no immediate side effects.
- Cardiac CT for calcium scoring can document or exclude the presence of calcified plaque in the coronary arteries—a marker of coronary artery disease.
- The exam can guide medical treatment.

Risks

- Women should always inform their physician and x-ray or CT technologist if there is any possibility that they are pregnant. *See the Safety page (<http://www.radiologyinfo.org/en/info/safety-ct-pregnancy>) for more information about pregnancy and x-rays.*
- CT scanning is, in general, not recommended for pregnant women unless medically necessary because of potential risk to the baby.
- A high calcium score may sometimes be followed by other diagnostic tests for heart disease, which may or may not provide results with clinical value and can be associated with side effects.
- Radiation may slightly increase your life time risk of cancer. However, the benefit of an accurate diagnosis will generally outweigh the risk. The amount of radiation is minimized as much as possible.
- The amount of radiation for this procedure varies. *See the Safety page (<http://www.radiologyinfo.org/en/info/safety-xray>) for more information about radiation dose.*

Coronary CT angiography (CTA)

Benefits

- Coronary CTA is not invasive. An alternative test, cardiac catheterization with a coronary angiogram, is invasive, has more complications related to the placement of a long catheter into the arteries and the movement of the catheter in the blood vessels, and requires more time for the patient to recover.
- Coronary CTA can non-invasively detect or exclude coronary artery blockages and plaque build-up.
- A major advantage of CT is that it is able to view bone, soft tissue and blood vessels all at the same time. It is therefore suited to identify other reasons for your discomfort such as an injury to the aorta or a blood clot in the lungs.
- CT examinations are fast.
- CT has been shown to be cost-effective for a wide range of medical problems.
- CT is less sensitive to patient movement than MRI.
- CT can be performed if you have an implanted medical device of any kind, unlike MRI.
- No radiation remains in a patient's body after a CT examination.
- X-rays used in standard CT scans have no immediate side effects.

Risks

- In some people with abnormal kidney function, the contrast material used in CT scanning may worsen kidney function.
- If a large amount of contrast material leaks out from the vessel being injected and spreads under the skin where the IV is placed, skin damage or damage to blood vessels and nerves, though unlikely, can result. If you feel any pain in your arm at the location of the IV during contrast material injection, you should immediately inform the technologist.
- The amount of radiation for this procedure varies. *See the Safety page (<http://www.radiologyinfo.org/en/info/safety-xray>) for more information about radiation dose.*
- Women should always inform their physician and x-ray or CT technologist if there is any possibility that they are pregnant. *See the Safety page (<http://www.radiologyinfo.org/en/info/safety-ct-pregnancy>) for more information about pregnancy and x-rays.*
- CT scanning is, in general, not recommended for pregnant women unless medically necessary because of potential risk to the baby.
- Manufacturers of intravenous contrast indicate mothers should not breastfeed their babies for 24-48 hours after contrast medium is given. However, both the American College of Radiology (ACR) and the European Society of Urogenital Radiology note that the available data suggest that it is safe to continue breastfeeding after receiving intravenous contrast. For further information please consult the ACR Manual on Contrast Media and its references.
- The risk of serious allergic reaction to contrast materials for CT examinations is extremely rare, and radiology departments are well-equipped to deal with them. If you have a history of previous reaction to CT contrast, you may be required to take premedication with a steroid prior to the examination to limit risk of a second reaction occurring.
- Radiation may slightly increase your life time risk of cancer. However, the benefit of an accurate diagnosis will generally outweigh the risk. The amount of radiation is minimized as much as possible.

Myocardial perfusion imaging, also called a nuclear stress test

Benefits

- Nuclear medicine examinations offer information that is unique—including details on both function and structure of the heart muscle—and often unattainable using other imaging procedures.
- For many diseases, nuclear medicine scans yield the most useful information needed to make a diagnosis of ischemic heart disease or to determine appropriate treatment, if any.

Risks

- If you have coronary artery disease, it is possible that you could experience chest pain during the exercising or when a drug is given for the stress test. However, your heart will be monitored and if necessary, medication can be given for your chest

pain.

- The risks of the treatment are always weighed against the potential benefits for nuclear medicine therapeutic procedures. You will be informed of all significant risks prior to the treatment and have an opportunity to ask questions.
- Allergic reactions to radiopharmaceuticals may occur but are extremely rare and usually mild. Nevertheless, you should inform the nuclear medicine personnel of any allergies you may have or other problems that may have occurred during a previous nuclear medicine exam.
- Injection of the radiotracer may cause slight pain and redness which should rapidly resolve.
- Women should always inform their physician or radiology technologist if there is any possibility that they are pregnant or if they are breastfeeding. *See the Safety page (<http://www.radiologyinfo.org/en/info/safety-radiation>) for more information about pregnancy, breastfeeding and nuclear medicine exams.*
- Radiation may slightly increase your lifetime risk of cancer. However, the benefit of an accurate diagnosis will generally outweigh the risk. The amount of radiation is minimized as much as possible.

Coronary catheter angiography

Benefits

- Catheter angiography presents a very detailed, clear and accurate picture of the blood vessels. This is especially helpful when a surgical procedure or percutaneous intervention is being considered.
- Unlike computed tomography angiography (CTA), use of a catheter makes it possible to combine diagnosis and treatment in a single procedure. An example is finding an area of severe arterial narrowing, followed by angioplasty and placement of a stent. *See the Angioplasty and Vascular Stenting page (<http://www.radiologyinfo.org/en/info/angioplasty>) for more information.*
- The degree of detail displayed by catheter angiography may not be available with any other noninvasive procedures.
- No radiation remains in a patient's body after an x-ray examination.
- X-rays usually have no side effects in the typical diagnostic range for this exam.

Risks

- If you have a history of allergy to contrast material, your doctor may advise that you take special medication for 24 hours before catheter angiography to lessen the risk of allergic reaction. Another option is to undergo a different exam that does not call for contrast material injection.
- If a large amount of contrast material leaks out under the skin where the IV is placed, skin damage can result. If you feel any pain in this area during contrast material injection, you should immediately inform the physician or technologist.
- Women should always inform their physician or X-ray technologist if there is any possibility that they are pregnant. *See the Safety page (<http://www.radiologyinfo.org/en/info/safety-ct-pregnancy>) for more information about pregnancy and x-rays.*
- Manufacturers of intravenous contrast indicate mothers should not breastfeed their babies for 24-48 hours after contrast medium is given. However, both the American College of Radiology (ACR) and the European Society of Urogenital Radiology note that the available data suggest that it is safe to continue breastfeeding after receiving intravenous contrast. *For further information please consult the ACR Manual on Contrast Media (<https://www.acr.org/Clinical-Resources/Contrast-Manual>) and its references.*
- The risk of serious allergic reaction to contrast materials that contain iodine is extremely rare, and radiology departments are well-equipped to deal with them.
- There is a small risk that blood will form a clot around the tip of the catheter, blocking the artery and making it necessary to operate to reopen the vessel.
- If you have diabetes or kidney disease, the kidneys may be injured due to the contrast material. In most cases, the kidneys will regain their normal function within five to seven days.
- Rarely, the catheter punctures the artery, causing internal bleeding. It also is possible that the catheter tip will separate material from the inner lining of the artery, causing a blockage downstream in the blood vessel.

- Radiation may slightly increase your lifetime risk of cancer. However, the benefit of an accurate diagnosis will generally outweigh the risk. The amount of radiation is minimized as much as possible.

What happens if something is detected on my screening exam?

If screening tests reveal coronary artery disease, there are steps you can take to lower your risk for having a heart attack or worsening heart disease. Your doctor may recommend lifestyle changes such as a healthier diet, exercise and smoking cessation. Medications may also be necessary. Medicines can treat coronary artery disease (CAD) risk factors such as high cholesterol, high blood pressure, an irregular heartbeat and low blood flow. In some cases, more advanced treatments and surgical procedures can help restore blood flow to the heart.

A negative cardiac CT for calcium scoring means no calcification was found within your coronary arteries, suggesting that coronary artery disease is absent or so minimal it cannot be seen by this technique. Under these circumstances, your chance of having a heart attack over the next two to five years is very low.

A positive cardiac CT for calcium scoring means that CAD is present, regardless of whether or not you are experiencing any symptoms. The amount of calcification is expressed as the calcium score. A score of 1 to 10 indicates minimal evidence of CAD, 11 to 100 indicates mild evidence, 101 to 400 represents moderate evidence of disease and a score of over 500 indicates extensive evidence of disease.

Your calcium score helps predict the likelihood of a myocardial infarction (heart attack) in the coming years and helps your doctor decide whether you should take preventive medicine or undertake other measures such as diet and exercise to lower the risk for heart attack.

If coronary artery disease is present, steps to reduce the individual's risk of heart attack and to manage symptoms include lifestyle changes, medications and if necessary, medical or surgical procedures such as:

- *Angioplasty and stenting* (<http://www.radiologyinfo.org/en/info/angioplasty>) : In an angioplasty procedure, X-rays are used to guide a balloon-tipped catheter, a long, thin plastic tube, into a coronary artery and advance it to where the vessel is narrow or blocked. The balloon is then inflated to open the vessel, deflated and removed. During angioplasty, a small wire mesh tube called a stent may be permanently placed in the newly opened artery to help it remain open. There are two types of stents: bare stents (wire mesh) and drug-eluting stents.
- *Coronary artery bypass graft surgery (CABG)*: CABG is a surgical means of rerouting blood around diseased vessels. During this surgery, a healthy artery or vein from elsewhere in the body is connected, or grafted, to a coronary artery to bypass the blockage, creating a new path for oxygen-rich blood to flow to the heart muscle.

Which test, procedure or treatment is best for me?

- *Asymptomatic Patient at Risk for Coronary Artery Disease* (<http://www.radiologyinfo.org/en/info/article-appropriateness-criteria#b0eb2e813c19428b8493d0aca17f68bd>)

Where can I find more information about heart screening?

You can find more information on heart screening at:

- *American Heart Association* (<https://www.heart.org>)

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