Which test, procedure or treatment is best for me?

The ACR Appropriateness Criteria (AC) are the largest body of evidence-based guidelines in medical imaging. For over 20 years, the AC have aided physicians and other providers with resources for appropriate utilization of medical imaging.

The Journal of the American College of Radiology (JACR), in collaboration with the ACR AC Patient Subcommittee, publishes patient-written summaries of the AC. By making the AC accessible to patients, we hope to improve communication between patients and their physicians about imaging exams.

Abdominal Aortic Aneurysm Follow-up (Without Repair)

The aorta is a main blood vessel in the chest and abdomen. An abdominal aortic aneurysm (AAA) ([https://www.radiologyinfo.org/en/info/abdoaneurysm](https://www.radiologyinfo.org/en/info/abdoaneurysm)) is an abnormal enlargement of the aorta in the abdomen; it is often asymptomatic, meaning that it causes no symptoms. Monitoring the size and growth of the aneurysm is important because it is often fatal if the aneurysm ruptures. This is more likely in individuals with AAA that grows more than 2 mm per year. Treatment should be considered when an individual without symptoms has an AAA larger than 5.4 cm in men and 4.9 cm in women.

There are three imaging examinations that are usually appropriate for people without symptoms with AAA: ultrasound ([https://www.radiologyinfo.org/en/info/abdominus](https://www.radiologyinfo.org/en/info/abdominus)) with aorta blood flow measurements (the most widely used test), CT angiography ([https://www.radiologyinfo.org/en/info/angioct](https://www.radiologyinfo.org/en/info/angioct)) of abdomen and pelvis with intravenous contrast, and MR angiography ([https://www.radiologyinfo.org/en/info/angiomr](https://www.radiologyinfo.org/en/info/angiomr)) of abdomen and pelvis with intravenous contrast. For people without symptoms in whom contrast should not be used, CT or MRI tests of the abdomen and pelvis may be appropriate.

For more information, see the Abdominal Aortic Aneurysm (AAA) page ([https://www.radiologyinfo.org/en/info/abdoaneurysm](https://www.radiologyinfo.org/en/info/abdoaneurysm)).

— By Celena Romero, PhD, MBA, RDN, CPHQ, CPASRM, and Frank J. Rybicki, MD, PhD. This information originally appeared in the Journal of the American College of Radiology.

Abdominal Aortic Aneurysm: Interventional Planning and Follow-up

An abdominal aortic aneurysm ([https://www.radiologyinfo.org/en/info/abdoaneurysm](https://www.radiologyinfo.org/en/info/abdoaneurysm)) is a balloon-like enlargement of the aorta, the largest artery in the abdomen and pelvis. The enlargement is often related to atherosclerosis (buildup of waxy plaque on the inside of blood vessels), which can cause the walls of the aorta to bulge out. Typically, treatment is necessary if the aneurysm diameter is bigger than 5.5 cm or if the diameter grows by 1 cm or more in a year.

There are two possible treatment options. In endovascular aneurysm repair (EVAR), a stent is inserted into the vessel using a catheter. The other option is open surgery to replace the damaged area of the aorta through an incision in the abdomen. The best option depends on the person’s anatomy and location of the aneurysm. Planning for treatment is done with imaging. Most commonly, computed tomographic angiogram (CTA) ([https://www.radiologyinfo.org/en/info/angioct](https://www.radiologyinfo.org/en/info/angioct)) or magnetic resonance angiogram (MRA) ([https://www.radiologyinfo.org/en/info/angiomr](https://www.radiologyinfo.org/en/info/angiomr)), in which contrast material is injected intravenously to highlight blood vessels and surrounding organs, is used. Other imaging tests may be appropriate to use for planning. These include CT with or without contrast and MRA without contrast. Aortography, an imaging procedure using x-rays with contrast inserted into an artery to view the aorta and smaller arteries, may also be appropriate.

After EVAR or open surgery, follow-up imaging examinations are needed to watch for any complications. Both CTA and MRA
are usually appropriate. Other imaging tests may be appropriate, including CT with and without contrast, CT and MRA without contrast, x-ray (https://www.radiologyinfo.org/en/info/abdominrad), ultrasound (https://www.radiologyinfo.org/en/info/abdominus), and aortography.

For more information, see the Abdominal Aortic Aneurysm (AAA) page (https://www.radiologyinfo.org/en/info/abdoaneurysm).

— By Lauren Yates and Ryan K. Lee, MD, MBA, MRMD. This information originally appeared in the Journal of the American College of Radiology.

**Acute Chest Pain (Suspected Pulmonary Embolism)**

Imaging tests are not necessary for many patients suspected of having a blood clot in the lungs known as a pulmonary embolism (PE). For medically stable patients, the risk of a PE should be assessed first by asking standard questions about the patient and his or her symptoms. If the answers to the questions result in a low risk score, no further testing is required.

If the answers indicate the possibility of PE, a blood test (d-dimer) to check for a substance released when a blood clot breaks up is recommended. If the test comes back negative, no further testing is required. The d-dimer test should not be used for anybody expected to have blood clots due to other things, such as recent surgery or trauma, or for pregnant women.

If the answers to the standard questions indicate a high risk of PE and the d-dimer test is positive, in most cases a pulmonary CT angiography (CTA) (https://www.radiologyinfo.org/en/info/angioct)—a CT scan to look at the blood vessels in the lungs—is the next step. For people with symptoms of a blood clot in the lower legs, especially for pregnant women, an ultrasound Doppler of the legs is often the first choice to reduce radiation exposure. Eighty percent of PEs are associated with blood clots in the lower legs. In addition, a chest x-ray (https://www.radiologyinfo.org/en/info/chestrad) may be performed to rule out other causes such as pneumonia or fluid in the lungs. Ventilation and perfusion nuclear medicine scans are sometimes used in place of CTA.

— By Andrea Borondy Kitts, MPH. This information originally appeared in the Journal of the American College of Radiology.

**Acute Hand and Wrist Trauma**

Injuries to the hand and wrist are common reasons for emergency room visits. X-rays are almost always the first imaging test used to evaluate the damage.

For blunt or penetrating types of injury, x-rays are usually enough to find any injury to tendons and bone. When injury is suspected but is not seen on the first x-ray, the next imaging tests that are usually appropriate include repeat x-ray in 14 days and CT or MRI without intravenous contrast (dye injected into the vein).

For wrist fractures seen on x-ray with suspected tendon or ligament damage, the next appropriate imaging can be MRI, ultrasound (US), MR, or CT arthrography (https://www.radiologyinfo.org/en/info/arthrog) (pictures taken after injection of contrast dye into joint). For hand fractures with suspected tendon or ligament damage, US and MRI without contrast are usually appropriate.

When an initial x-ray shows the wrist displaced from normal position without a fracture, CT and MRI of the wrist without contrast and MR arthrography are usually appropriate next imaging tests. CT arthrography may also be appropriate. When the hand is displaced from normal position, MRI without contrast or US is usually appropriate.

For penetrating injuries to the soft tissues of the hand or wrist not seen on x-ray, CT without contrast and US are usually appropriate next imaging tests. MRI without contrast may also be appropriate.


**Acute Hip Pain–Suspected Fracture**
Hip fractures after a fall or minor trauma are a common problem, especially among older patients. Imaging tests are needed to accurately diagnose hip fractures and decide on the best treatment option. Recommended imaging tests for high-velocity trauma differ from falls and minor trauma and are not part of this appropriateness criteria summary; they are covered under different appropriateness criteria.

Radiography, or x-ray (https://www.radiologyinfo.org/en/info/bonerad), of the hip and pelvis is the most appropriate first imaging test following fall or minor trauma and can be used to identify most hip fractures. When a hip fracture is not seen on x-ray but is suspected clinically, MRI (https://www.radiologyinfo.org/en/info/muscmr) of the pelvis and hips without intravenous (IV) contrast is the next best imaging test. Subtle findings of hip fractures that are not seen on x-ray and soft tissue injuries may be seen on MRI.

CT (https://www.radiologyinfo.org/en/info/abdominct) of the pelvis and hips without IV contrast is also generally appropriate as a second imaging test for suspected hip fracture not seen on x-ray. Though not as sensitive to subtle findings, CT is faster than MRI and is often used for people who have difficulties with the MRI procedure.

— By Shannon Rose, MPH, COTA/L, CPASRM, and Dianna M.E. Bardo, MD. This information originally appeared in the Journal of the American College of Radiology.

**Acute Mental Status Change, Delirium, and New Onset Psychosis**

Changes in mental status can be caused by a variety of factors, including intoxication, infection, stroke (https://www.radiologyinfo.org/en/info/stroke), bleeding, tumor (https://www.radiologyinfo.org/en/info/braintumor), fluid, trauma (https://www.radiologyinfo.org/en/info/headinjury) or brain injury, and inflammation. This can show up as changes in behavior, alertness, agitation, confusion, and seizures. When there is high suspicion of bleeding, stroke, infection, or tumor or if the individual has extremely high blood pressure, CT (https://www.radiologyinfo.org/en/info/headct) or MRI (https://www.radiologyinfo.org/en/info/headmr) without intravenous (IV) contrast may be the initial examination. If the examination without contrast does not show the cause, follow-up CT or MRI performed with IV contrast may help if a tumor or an infection is suspected. If an individual has a known infection, tumor, recent bleeding, or recent acute stroke and his or her condition is getting worse, it may be appropriate to have CT or MRI of the head without IV contrast or MRI of the head with and without contrast. When the reason for mental state change is known, for example, intoxication, and the cause is not thought to be due to trauma, it may be appropriate to have MRI of the head without and with IV contrast. For individuals whose mental state is getting worse even with treatment or is getting worse without a cause, MRI or CT of the head without IV contrast and MRI of the head without or with IV contrast are usually appropriate. For an individual with new delirium (disturbed state of mind), CT of the head without IV contrast is usually appropriate. For an individual with new psychosis (disconnection from reality), CT or MRI of the head without IV contrast or MRI of the head without and with IV contrast may be appropriate.

— By Susan Anemone and Tasneem Lalani, MD. This information originally appeared in the Journal of the American College of Radiology.

**Acute Nonlocalized Abdominal Pain**

Stomach pain occurs for various reasons. Imaging may help identify the source of pain. CT with contrast in the vein is the preferred examination for stomach pain with or without a fever. Contrast by mouth can be substituted in the event of poor kidney health or allergy to intravenous (IV) contrast materials. Pain with a fever may indicate infection or an abscess. CT is useful if an abscess is suspected because the doctor can drain the abscess at the same time. MRI may be helpful in distinguishing infected versus noninfected fluid. PET is useful if previous CT imaging did not find the source of the pain.

CT with contrast is the preferred scan for stomach pain after surgery. A complementary fluoroscopic study may be useful in evaluating postsurgical leaks. PET is not useful for stomach pain after surgery because it could lead to false-positive results.

CT is appropriate for stomach pain in people with weak immune systems. For patients unable to undergo CT, MRI may be helpful.
MR enterography (https://www.radiologyinfo.org/en/info/mrenterography) (special MRI with IV and swallowed contrast) can be used for stable patients with a history of inflammatory bowel disease. PET can also be useful if previous CT imaging did not find the source of pain.

Pregnant patients with stomach pain may receive an MRI or an ultrasound to diagnose urinary tract infection, bladder stones, ectopic pregnancy, ovarian torsion, adnexal masses, placental abnormalities, acute cholecystitis, pancreatitis, or inflammatory bowel disease.

— By Celena Romero, RD, MBA, CPHQ, and Ryan Lee, MD, MBA, MRMD. This information originally appeared in the Journal of the American College of Radiology.

**Acute Onset Flank Pain—Suspicion of Stone Disease (Urolithiasis)**

Kidney stones form from salts in urine and can travel through or block the ureter, the tube that carries urine from the kidney to the bladder. Stones can cause sharp pain on one or both side(s) of the body between the upper belly area and the back, often called flank pain. Flank pain can also be caused by other things such as appendicitis or diverticulitis (inflamed pouches of the bowel).

The best imaging test to identify a kidney stone and possible blockage in the ureter is a CT scan (https://www.radiologyinfo.org/en/info/abdominct). The CT scan can identify the size and location of the stone, which can predict the likelihood that a stone will pass on its own, with larger stones less likely to do so.

A CT scan with contrast fluid injected intravenously into the blood vessels may be needed to differentiate between a stone and a phlebolith, a calcification in a vein, or to determine other causes of flank or abdominal pain not seen on the initial CT scan.

Other imaging tests like ultrasound (US) and MRI do not use radiation, but both tests can miss smaller stones. For pregnant women, US is the best initial test. For patients with a history of kidney stones, younger patients, or follow-up imaging to see if a stone has moved or passed out of the body, an MRI or a combination of a US and x-ray test may be used to reduce radiation exposure. For more information, see the (https://www.radiologyinfo.org/en/info/stones-renal) Kidney and Bladder Stones (https://www.radiologyinfo.org/en/info/stones-renal) (https://www.radiologyinfo.org/en/info/stones-renal) page.

— By Søren Meibom, PhD. This information originally appeared in the Journal of the American College of Radiology.

**Acute Pyelonephritis**

An infection involving the kidney is known as acute pyelonephritis. This usually starts as a urinary tract infection that moves to the kidney. Acute pyelonephritis is commonly treated with antibiotics. Imaging studies are not usually required but may be needed if an individual has a history of diabetes or kidney stones (https://www.radiologyinfo.org/en/info/stones-renal), is immunocompromised, or is not responding to treatment.

A CT of the abdomen and pelvis (https://www.radiologyinfo.org/en/info/abdominct) with or without intravenous (IV) contrast is usually the most appropriate test for adults. An MRI (https://www.radiologyinfo.org/en/info/mri-abdomen-pelvis) with or without IV contrast of the abdomen and pelvis is also appropriate. One disadvantage of MRI compared with CT is that MRI does not find smaller stones. Use of IV contrast may provide important information about the kidney function. If a patient cannot tolerate contrast, diffusion-weighted imaging on MR can be used as an alternative, for example, in people with kidney function problems and pregnant or lactating women.

Ultrasound of the kidneys and bladder (https://www.radiologyinfo.org/en/info/abdominus) is sometimes appropriate. It can be done at the bedside and does not require use of contrast material. Color and power Doppler should be included to improve the sensitivity but may still miss problems with the kidneys.

Renal scintigraphy (https://www.radiologyinfo.org/en/info/renal) is a test that uses a camera and radioactive tracer (Tc-99m) to
look at how the kidneys work. It is sometimes appropriate for evaluating children with pyelonephritis. It may also help find reflux and birth defects that could cause repeated infections, scarring, and loss of kidney function.

— By Celena Romero, PhD, MBA, RD, CPHQ, Jennifer W. Uyeda, MD. This information originally appeared in the Journal of the American College of Radiology.

**Acute Respiratory Illness in Immunocompetent Patients**

Acute respiratory illness (ARI) is one of the most common reasons for individuals to seek medical treatment. A person with ARI will have one or more of the following symptoms: cough, phlegm production, chest pain, or trouble breathing. Most cases of ARI are caused by infection that will clear up without treatment. ARI cases caused by bacterial pneumonia ([https://www.radiologyinfo.org/en/info/pneumonia](https://www.radiologyinfo.org/en/info/pneumonia)) require treatment. Imaging is used to determine if there is pneumonia.

A chest x-ray ([https://www.radiologyinfo.org/en/info/chestrad](https://www.radiologyinfo.org/en/info/chestrad)) is usually the initial imaging test used for a person with a healthy immune system and no other risk factors.

In individuals with other risk factors, such as abnormal vital signs, a chest x-ray is usually appropriate. Chest ultrasound ([https://www.radiologyinfo.org/en/info/genus](https://www.radiologyinfo.org/en/info/genus)) may be appropriate. If the initial chest x-ray is negative or inconclusive, chest CT ([https://www.radiologyinfo.org/en/info/chestct](https://www.radiologyinfo.org/en/info/chestct)) without intravenous (IV) contrast is usually appropriate as the next imaging test. In a person with pneumonia and suspected abscess or fluid around the lung on the chest x-ray, chest CT either with or without IV contrast is usually appropriate.

In individuals with acute worsening asthma and no suspected pneumonia or pneumothorax (air around the lung), a chest x-ray may be appropriate. If pneumonia or pneumothorax is suspected, then a chest x-ray is usually appropriate.

In individuals with acute worsening of chronic obstructive pulmonary disease ([https://www.radiologyinfo.org/en/info/copd](https://www.radiologyinfo.org/en/info/copd)), a chest x-ray is usually appropriate for the initial imaging. Chest CT with or without IV contrast may be appropriate. In people who have symptoms such as chest pain or a history of heart disease, an ultrasound examination may be appropriate.

For more information, see the Pneumonia page ([https://www.radiologyinfo.org/en/info/pneumonia](https://www.radiologyinfo.org/en/info/pneumonia)).

— By Ryan Lockhart and Nina S. Vincoff, MD. This information originally appeared in the Journal of the American College of Radiology.

**Adnexal Cyst Follow-Up**

An adnexal cyst is a fluid-containing lump in the area of the pelvis around the uterus. This includes the ovaries, fallopian tubes, and surrounding tissues. Simple ovarian cysts frequently form during the normal menstrual cycle and are not considered to be a problem. In addition, ovarian cysts will form in approximately 20% of postmenopausal women.

Adnexal cysts can be categorized as simple or complex depending on their characteristics seen on the ultrasound. Most women with simple adnexal cysts do not need additional imaging tests after an initial transvaginal ultrasound. Ovarian cancer ([https://www.radiologyinfo.org/en/info/ovarian-cancer](https://www.radiologyinfo.org/en/info/ovarian-cancer)) is unlikely to arise from these benign-appearing cysts. However, women experiencing severe pain or worsening symptoms should be re-evaluated.

In women of reproductive age, simple cysts larger than 5 cm may require some form of additional imaging and annual ultrasound imaging ([https://www.radiologyinfo.org/en/info/pelvus](https://www.radiologyinfo.org/en/info/pelvus)) follow-up. In postmenopausal women, follow-up is recommended for simple cysts larger than 1 cm in greatest diameter. Additional imaging is also indicated for complex adnexal masses having both fluid and solid parts on ultrasound in both pre- and postmenopausal women. Depending on the size and location of the cyst, transabdominal ultrasound may be used in addition to transvaginal ultrasound for initial evaluation. Color Doppler
ultrasound imaging is used to evaluate the solid parts of a complex cyst and to look for blood vessel characteristics that may suggest a cancer is present.

An MRI or a CT scan is recommended when the ultrasound test does not provide enough information to tell whether cancer might be present.

— By Stacey Tinianov. This information originally appeared in the *Journal of the American College of Radiology*.

**Asymptomatic Patient at Risk for Coronary Artery Disease**

Coronary atherosclerotic disease (CAD) is caused by the buildup of cholesterol plaques in the walls of coronary arteries, which supply blood to the heart. CAD can lead to myocardial infarction (heart attack) and other cardiac events. A person with CAD may be asymptomatic (ie, not have any symptoms). An early diagnosis and treatment of CAD before a person has symptoms can reduce heart attacks and deaths.

Doctors can use a variety of factors to determine a person’s risk for CAD. These include family history, physical examination, blood tests, lifestyles, and risk calculators. These risk assessments are based on the average of a lot of people. Based on level of risk, imaging tests can look for coronary artery calcium. Coronary artery calcium is found in plaques in the walls of arteries. It is a strong indicator of CAD for an individual. It can be used to help develop a treatment plan to reduce the risk of a cardiac event.

For asymptomatic individuals with a low risk of CAD, imaging tests are usually not recommended.

For asymptomatic patients with intermediate risk for CAD, CT coronary calcium (https://www.radiologyinfo.org/en/info/ct_calscoring) (detects calcium deposits in the coronary arteries of the heart) is usually appropriate. CT angiography coronary arteries (https://www.radiologyinfo.org/en/info/angiocoroct) with intravenous (IV) contrast (CT scan of arteries using IV contrast) may be appropriate.

For asymptomatic individuals with high risk for CAD, CT coronary calcium and CT angiography of coronary arteries with IV contrast may be appropriate.

—By Emily Hahn and Khushboo Jhala, MD, MBA. This information originally appeared in the *Journal of the American College of Radiology*.

**Ataxia**

Ataxia is the loss of control of bodily movement due to impairment in the nervous system. The patient may have a wide-based, unsteady walk or poor coordination of the arms and legs. Ataxia may be caused by a problem in the cerebellum (the part of the brain that controls coordination), the spinal cord and nerves (which control body movement), or the inner ear vestibular system (which maintains balance). Ataxia can also be caused by a stroke (https://www.radiologyinfo.org/en/info/stroke). The appropriate imaging of ataxia depends on the suspected cause.

When ataxia occurs after head injury (https://www.radiologyinfo.org/en/info/headinjury), CT scan (https://www.radiologyinfo.org/en/info/headct) of the brain without intravenous (IV) contrast is usually an appropriate initial imaging test. If there is vertigo, CT of the inner ear (temporal bone) may be appropriate. If blood vessel damage is suspected, CT or MR of the arteries or veins may be appropriate. MRI of the brain (https://www.radiologyinfo.org/en/info/fmribrain) may be appropriate if injury to the lower part of the brain is suspected.

When ataxia occurs after injury to the spine, CT scan (https://www.radiologyinfo.org/en/info/spinect) or MRI of the spine (https://www.radiologyinfo.org/en/info/spinemr) without IV contrast or CT of the arteries of the neck with IV contrast is usually appropriate.
When ataxia occurs without a history of injury and a stroke is not suspected, the cause may be a brain tumor. MRI of the brain is usually appropriate. IV contrast may be helpful.

When ataxia occurs without a history of injury and a problem in the spine or spinal blood vessels is suspected, MRI of the spine is usually appropriate.

For more information, see the Movement Disorders page (https://www.radiologyinfo.org/en/info/movement-disorders)

— By Susan Anemone and Nina S. Vincoff, MD. This information originally appeared in the Journal of the American College of Radiology.

Breast Cancer Screening

Women with low lifetime risk of breast cancer (<15%) who have no family history of breast cancer and who have not had breast cancer themselves should be screened every year, starting at 40 years of age, with mammography (https://www.radiologyinfo.org/en/info/mammo) or digital breast tomosynthesis (https://www.radiologyinfo.org/en/info/tomosynthesis) (DBT). DBT is better at finding cancer than mammography and has fewer callbacks for false positives, which are findings that might look like but are not cancer. Screening using ultrasound (https://www.radiologyinfo.org/en/info/breastus) may be appropriate for women who have dense breast tissue (https://www.radiologyinfo.org/en/info/dense-breasts) but is associated with more false-positive findings. Screening using MRI (https://www.radiologyinfo.org/en/info/breastmr) is not appropriate for patients with low risk of breast cancer.

Patients with intermediate lifetime risk (15%-20%) who have a personal history of breast cancer or who have been diagnosed with benign changes in their breast tissue should be screened annually using mammography or DBT. Additional screening using MRI may be appropriate for intermediate-risk patients who have a history of breast cancer or lobular carcinoma in situ (abnormal cell growth). Ultrasound may be appropriate for patients with dense breast tissue.

Patients with high lifetime risk (>20%) who have a BRCA gene mutation themselves or in their immediate family, who have a strong family history of breast cancer, or who had radiation treatment of their chest when they were 10 to 30 years of age should be screened annually using mammography or DBT combined with MRI. Ultrasound is recommended when the patient cannot tolerate MRI.

Mammography and DBT expose patients to radiation.

See the Breast Cancer Screening (https://www.radiologyinfo.org/en/info/screening-breast) page for more information.

— By Casey Quinlan and Dianna M.E. Bardo, MD. This information originally appeared in the Journal of the American College of Radiology.

Breast Imaging of Pregnant and Lactating Women

Pregnant women under the age of 30 at high risk for breast cancer (https://www.radiologyinfo.org/en/info/breast-cancer), pregnant women age 30 to 39 at medium or high risk for breast cancer, and pregnant women 40 and older should receive screening mammography (https://www.radiologyinfo.org/en/info/mammo) with lead shielding to minimize radiation exposure to the fetus. Alternatively, screening may be performed using digital breast tomosynthesis (https://www.radiologyinfo.org/en/info/tomosynthesis) (DBT), a 3-D mammographic technology. Ultrasonography (https://www.radiologyinfo.org/en/info/breastus) may be used as an additional screening tool for patients with dense breasts (https://www.radiologyinfo.org/en/info/dense-breasts). Ultrasonography is particularly valuable when patients display a noticeable lump. However, ultrasonography may increase the rate of false alarms for cancer detection. When cancer is detected, mammography or DBT may improve visualization of the cancer and its location. Ultrasonography of the armpit region helps to determine the extent of disease.
Bloody nipple discharge may occur during pregnancy or early lactation. This usually goes away by itself. However, continuous bloody nipple discharge may be due to an infection, a noncancerous mass, or, less commonly, breast cancer. The affected breast should be initially evaluated by ultrasonography. Diagnostic mammograms with magnification views of the breast below the nipple and DBT may be useful.

Breast imaging during lactation is the same as for nonlactating women. However, breast tissue tends to be thicker during lactation; therefore, nursing or pumping before examination may improve accuracy of mammography or DBT screening. Ultrasonography may be used as an additional screening tool for medium- and high-risk patients and patients with dense breasts.

See the Breast Cancer Screening page (https://www.radiologyinfo.org/en/info/screening-breast) for more information.

— By Celena Romero, PhD, MBA, RD, CPHQ, and Nina S. Vincoff, MD. This information originally appeared in the Journal of the American College of Radiology.

Breast Implant Evaluation

Breast implants are made of saline, silicone, or both. Some complications that may occur with implants include the implant bursting (rupture), unexplained swollen lymph nodes in the armpits, or a rare blood cancer called anaplastic large-cell lymphoma (https://www.radiologyinfo.org/en/info/lymphoma) that may occur a year after surgery. Patients with implants and without symptoms should continue routine breast screening (https://www.radiologyinfo.org/en/info/screening-breast).

A saline-implant rupture is often diagnosed with a physical examination. If imaging is needed, ultrasound (https://www.radiologyinfo.org/en/info/breastus) (US) should be used for people under 30. For people 30 to 39 years old, a mammogram (https://www.radiologyinfo.org/en/info/mammogram), digital breast tomosynthesis (https://www.radiologyinfo.org/en/info/tomosynthesis) (DBT), or US may be used. A mammogram or DBT is the best test for people 40 and older.

MRI (https://www.radiologyinfo.org/en/info/breastmri) without contrast is the best test for diagnosing a silicone-implant rupture, especially when the silicone is still contained by the outer shell (majority of ruptures). Mammography and DBT are not recommended for contained ruptures.

For ruptures outside the shell, in addition to MRI without contrast, US may be used in people under the age of 30. Mammography, DBT, and US may be used for people over 30. For people with prior silicone implants, results may show leftover silicone, not a rupture of new implants, making it important to compare with prior tests.

For unexplained swollen lymph nodes in the armpits, US should be used for patients under the age of 30. For people over 30, mammography, DBT, or US should be used. If the person is suspected to have anaplastic large-cell lymphoma, US is recommended.

— By Celena Romero, RD, MBA, CPHQ, and Ryan K. Lee, MD, MBA, MRMD. This information originally appeared in the Journal of the American College of Radiology.

Cervical Neck Pain or Cervical Radiculopathy

Appropriate cervical spine (c-spine) imaging and use of intravenous contrast (venous dye) for neck pain varies depending on clinical scenario.

In individuals with new or increasing nontraumatic neck pain (no high-risk factors), x-rays (https://www.radiologyinfo.org/en/info/bonerad) are usually appropriate as first imaging test; MRI (https://www.radiologyinfo.org/en/info/headmr) or CT (https://www.radiologyinfo.org/en/info/heading) without contrast may be appropriate.
In cases with spinal nerve irritation (pinched nerve), MRI without contrast is usually appropriate, and x-rays or CT without contrast may be appropriate.

If there is history of prior c-spine surgery, x-rays or CT without contrast is usually appropriate; MRI with or without contrast (or both) or CT myelography [https://www.radiologyinfo.org/en/info/myelography] (contrast injection in space around spinal cord) may be appropriate.

If infection is suspected, MRI without and with contrast is usually appropriate; x-rays, CT, or MRI with or without contrast may be appropriate.

In individuals with cancerous tumors, MRI without and with or only without contrast is usually appropriate; x-rays, CT with or without contrast, or bone scan or CT may also be appropriate.

With headaches [https://www.radiologyinfo.org/en/info/headache] originating in the c-spine without weakened nerve function, MRI or CT without contrast may be appropriate, as well as x-rays or nerve block [https://www.radiologyinfo.org/en/info/nerveblock] injection.

In chronic neck pain, x-rays are usually appropriate as initial imaging. MRI without contrast may be appropriate.

If x-rays show degenerative changes, MRI without contrast is usually appropriate. CT without contrast or CT myelography may be appropriate.

If x-rays show hardening of the connecting fibers of the neck vertebrae, CT without contrast is usually appropriate; CT myelography or MRI without contrast may be appropriate.

— By Susan Anemone and Bruno Policeni, MD, MBA. This information originally appeared in the Journal of the American College of Radiology.

**Chest Pain-Possible Acute Coronary Syndrome**

Cardiovascular disease is the leading cause of death in the United States. Acute coronary syndrome (ACS) is most often caused by plaque rupture or clot formation in the heart’s arteries, which leads to sudden drop in blood flow to the heart. Symptoms may include chest pressure at rest or during light activities. Quick diagnosis and management are key to restore blood flow.

Chest x-ray [https://www.radiologyinfo.org/en/info/chestrad] may be used as the initial imaging test to help decide if further imaging tests are needed. Other imaging tests include coronary angiography [https://www.radiologyinfo.org/en/info/angiocoroct] and specialized CT, MRI [https://www.radiologyinfo.org/en/info/chestmr], and ultrasound [https://www.radiologyinfo.org/en/info/genus] (US) tests, some at rest and some with exercise. These look at the heart and how it functions. They are described next.

In individuals with chest pain who are at low to intermediate risk of ACS, CT angiography [https://www.radiologyinfo.org/en/info/angioct] (CTA) coronary arteries with intravenous (IV) contrast (CT of the heart specifically looking at the coronary arteries) is appropriate. A single-photon emission computed tomography (SPECT)/CT is also appropriate; this is a special type of CT performed at rest and during stress to look at how the heart is functioning. Ultrasound echocardiography transthoracic stress (echocardiogram after exercise) is also usually appropriate and allows direct visualization of the heart while it beats. An MRI with and without contrast looking at heart function may be appropriate.

For individuals who are high risk of ACS, coronary arteriography [https://www.radiologyinfo.org/en/info/angiocoroct] is usually appropriate. This is a test where a very thin tube catheter is put into an artery in the thigh, neck, or shoulder and threaded up to the heart. Dye is injected through the catheter to help see the arteries in the heart. US echocardiography transthoracic resting, CTA coronary arteries with IV contrast, MRI heart function and morphology without and with IV contrast, SPECT, or SPECT/CT MPI rest and stress may also be appropriate.
Chronic Ankle Pain

When ankle pain continues for 6 weeks or more, it is considered chronic. The most appropriate first imaging test is an x-ray (https://www.radiologyinfo.org/en/info/bonerad). X-rays provide general information about bone and tissue abnormalities. It is almost always the only imaging test of the ankle needed.

In people who have ankle arthritis (https://www.radiologyinfo.org/en/info/artthritis) and have pain that requires treatment, it may be appropriate to figure out which of the joints in the ankle is causing the pain. Either CT (https://www.radiologyinfo.org/en/info/bodyct) or MRI (https://www.radiologyinfo.org/en/info/musrcmr) without contrast is appropriate to locate the joint causing the pain. Using imaging to guide a needle to inject anesthetic in the area of the pain to help confirm the cause is usually appropriate, too.

Some chronic ankle conditions cannot be seen on x-ray. When these conditions are suspected, MRI without intravenous contrast is appropriate. CT or MR arthrography (https://www.radiologyinfo.org/en/info/arthrog) may also be appropriate, in which case an x-ray dye is injected before the test is performed. These conditions include:

- Osteochondral lesion: an injury affecting the talus bone (a supporting bone in the ankle) and the surrounding cartilage. CT or MRI may be appropriate.
- Tendon abnormality: inflammation of the tendon, commonly known as tendinitis. Ultrasound (https://www.radiologyinfo.org/en/info/musculous) or MRI may be appropriate.
- Ankle instability: residual wear and tear on the ligaments makes the ankle unstable. Ultrasound or MRI may be appropriate.
- Ankle impingement syndrome: overuse and microtears of the tendon causing pain and limiting ankle range of motion. MRI, CT or ultrasound may be appropriate.
- No obvious suspected disorder: MRI, CT, ultrasound, or image-guided local anesthetic injections may be appropriate.

Chronic Cough

Chronic cough is a cough that has lasted for at least 8 weeks. Chronic cough can come from smoking-related lung diseases (eg, chronic obstructive pulmonary disease (https://www.radiologyinfo.org/en/info/copd), emphysema, lung cancer (https://www.radiologyinfo.org/en/info/lung-cancer)), upper airway cough syndrome, asthma, gastroesophageal reflux disease, bronchitis, immunodeficiencies, or repeated exposure to inflammation in the body. Initial imaging is done to determine the cause of this persistent cough and provide the correct treatment.

For an individual with chronic cough and no known risk of lung cancer, chest x-ray (https://www.radiologyinfo.org/en/info/chestrad) is usually appropriate. CT of the chest (https://www.radiologyinfo.org/en/info/chestct) with or without intravenous (IV) contrast may be appropriate especially if the results of an initial chest x-ray are inconclusive. These same recommendations hold for individuals who have a chronic cough with an increased risk for lung cancer.

In individuals with a chronic cough that continues after the initial treatment, it is likely the initial clinical evaluation did not determine the right cause. In these cases, a chest x-ray or a chest CT scan with or without IV contrast is usually appropriate. In addition, a CT maxillofacial (CT of the face, head, sinus (https://www.radiologyinfo.org/en/info/sinusct)) without IV contrast may be appropriate if there is inflammation in the upper airways to better visualize the sinuses.
For more information, see the Chronic Obstructive Pulmonary Disease (COPD) (https://www.radiologyinfo.org/en/info/copd) page.

— By Emily Chu and Ryan Lee, MD, MBA. This information originally appeared in the Journal of the American College of Radiology.

**Chronic Dyspnea-Noncardiovascular Origin**

Dyspnea is the experience of breathing discomfort or shortness of breath and has many possible causes. When it is not caused by a heart problem, dyspnea is called “noncardiovascular.” When dyspnea lasts for more than 1 month, it is considered chronic.

For chronic dyspnea with no known cause, chest x-ray is an appropriate first imaging test. Chest CT (https://www.radiologyinfo.org/en/info/chestct) with or without intravenous contrast may be appropriate when chest x-ray (https://www.radiologyinfo.org/en/info/chestrad) is normal or does not provide an answer.

Chest x-ray is appropriate for individuals suspected to have chronic obstructive pulmonary disease, including chronic bronchitis and emphysema. Chest CT may be helpful to detect early chronic obstructive pulmonary disease (https://www.radiologyinfo.org/en/info/copd) or to show progression.

To evaluate disease of the large central airways (trachea and primary bronchi), chest x-ray or chest CT without intravenous contrast is appropriate, but chest x-ray can be normal in some cases. CT can show airway tumors and narrowing or collapse of airways. It may helpful to perform the CT while the individual exhales.

Interstitial lung disease causes lung tissue scarring. Chest x-ray or chest CT is an appropriate first test, but chest x-ray can be normal in some cases. It may be helpful to perform the CT while the individual lies on his or her stomach or exhales.

Chest x-ray is appropriate to diagnose pleural effusion (fluid around the lungs), but chest CT is better for evaluating the lining of the lung (pleura) and the chest wall.

Chest x-ray or fluoroscopy (video x-ray technique) is appropriate when abnormal motion of the diaphragm is suspected.

— By Emmanuel Budis and Nina S. Vincoff, MD. This information originally appeared in the Journal of the American College of Radiology.

**Chronic Liver Disease**

Chronic liver disease can be caused by a variety of conditions but is most commonly caused by nonalcoholic fatty liver disease (https://www.radiologyinfo.org/en/info/fatty-liver-disease), hepatitis C, hepatitis B, and alcohol-related liver disease. Over time, these conditions can lead to fibrosis (thickening, scarring of tissue) and to cirrhosis, in which the damage is so extensive that the liver does not function normally. These diseases can also result in liver cancer (hepatocellular carcinoma [HCC]).

In individuals with chronic liver disease, imaging tests are useful to confirm the presence and severity of fibrosis. MR elastography abdomen finds stiffening of the liver, and ultrasound shear wave elastography abdomen is usually appropriate for diagnosing and staging of fibrosis.

Individuals who have chronic viral hepatitis and cirrhosis are at high risk for developing HCC and should undergo screening with imaging. Ultrasound abdomen (https://www.radiologyinfo.org/en/info/abdominus), MRI abdomen (https://www.radiologyinfo.org/en/info/mri-abdomen-pelvis) without and with intravenous (IV) contrast, and MRI abdomen without and with hepatobiliary contrast are usually appropriate imaging tests to diagnose HCC. MRI abdomen without IV contrast may also be appropriate.

For individuals with HCC, surveillance after treatment with imaging tests is recommended to detect a possible return of cancer.
MRI abdomen without and with IV contrast, CT abdomen with IV contrast multiphase, CT abdomen without and with IV contrast, and MRI abdomen without and with hepatobiliary contrast are usually appropriate tests. The current guidelines recommend a CT or MRI scan every 3 to 6 months for 2 years and then every 6 to 12 months after the cancer is removed.

— By Emmanuel Budis and Jennifer W. Uyeda, MD. This information originally appeared in the Journal of the American College of Radiology.

**Chronic Wrist Pain**

Arthritis is usually diagnosed by a doctor or with laboratory tests. Imaging tests are used to figure out the amount of breakdown of cartilage in the joint.

The most appropriate initial imaging test for chronic wrist pain is an x-ray (https://www.radiologyinfo.org/en/info/bonerad). Some conditions need additional imaging tests for diagnosis or to plan for treatment. MRI (https://www.radiologyinfo.org/en/info/muscmr) without intravenous contrast is often the first follow-up examination, but other tests may also be appropriate, including MRI with intravenous contrast injection.

When infection is suspected, aspiration of the wrist with laboratory examination is indicated. Pain on the pinky side of the hand may represent an injury to cartilage near the small finger. MR or CT arthrography (https://www.radiologyinfo.org/en/info/arthrog), in which contrast material is injected into the wrist joints, is recommended. However, when the patient feels pain on the thumb side of the hand, the most likely diagnosis is a torn ligament. MR or CT arthrography or ultrasound (https://www.radiologyinfo.org/en/info/musculous) of the wrist may demonstrate the abnormality.

Other diagnoses with similar symptoms include:

- Kienböck's disease, a condition in which one of the wrist bones, the lunate, loses its blood supply and eventually dies. When Kienböck's disease is suspected, MRI or CT (https://www.radiologyinfo.org/en/info/bodyct) without contrast may be necessary to see the amount of bone that has collapsed.
- Pain associated with a mass, or if the physician suspects the presence of a ganglion cyst, suggests the need for MRI with intravenous contrast or ultrasonography of the wrist.
- A stress fracture or other break to the bone that is clinically suspected but not seen on x-ray may require CT without intravenous contrast material for diagnosis.
- Pain that is suggestive of carpal tunnel syndrome is best evaluated by ultrasonography of the wrist.

— By Frank J. Rybicki Jr. and Bruno Policeni, MBA, MD. This information originally appeared in the Journal of the American College of Radiology.

** Clinically Suspected Adnexal Mass, No Acute Symptoms**

When a woman has an ovarian mass, accurate imaging of it is important so that the correct diagnosis is made. Ultrasound (US) (https://www.radiologyinfo.org/en/info/pelvus) and MRI can be used to find a growth in or around the uterus, ovaries, or fallopian tubes (adnexal mass) and to determine whether or not it is cancerous (malignant) or not (benign).

If an adnexal mass is clinically suspected in a woman with no acute symptoms, initial imaging using US duplex Doppler pelvis, US pelvis through the vagina (transvaginal), and US pelvis through the abdomen (transabdominal) are done together.

If a likely benign mass is found, US duplex Doppler of pelvis, US pelvis transvaginal, and US pelvis transabdominal are done together as initial follow-up. MRI pelvis without and with intravenous (IV) contrast or MRI pelvis without IV contrast may be appropriate.

If it is unclear if the mass is benign, US pelvis transvaginal, US duplex Doppler pelvis, US pelvis transabdominal, and MRI pelvis...
without and with IV contrast are done together as initial follow-up. In postmenopausal women, CT pelvis without and with IV contrast may be appropriate.

If cancer is suspected, CT abdomen and pelvis (https://www.radiologyinfo.org/en/info/abdomen) with IV contrast and MRI pelvis (https://www.radiologyinfo.org/en/info/mri-abdomen-pelvis) without and with IV contrast are done together as initial follow-up. US pelvis transabdominal or US pelvis transvaginal may be appropriate.

In pregnant women, US duplex Doppler pelvis, US pelvis transabdominal, and US pelvis transvaginal are done together for initial imaging and follow-up. MRI pelvis without IV contrast may be appropriate.

For more information, see the Ovarian Cancer page (https://www.radiologyinfo.org/en/info/ovarian-cancer).

— By Susan Anemone and Karin E. Dill, MD. This information originally appeared in the Journal of the American College of Radiology.

Colorectal Cancer Screening

Cancer in the bowel (https://www.radiologyinfo.org/en/info/colocarcinoma) (colon) can be deadly. It is recommended that everyone over the age of 50 have a screening test to identify early-stage colon cancer and precancerous lumps called polyps. Over time, some polyps can develop into cancer. Available screening tests include colonoscopy, CT colonography (https://www.radiologyinfo.org/en/info/ct-colon) (also known as virtual colonoscopy), double contrast barium enema (https://www.radiologyinfo.org/en/info/lowergi), and stool-based tests like the fecal occult blood test, which looks for blood in the stool. Colonoscopy, CT colonography, and double contrast barium enema screen for both polyps and cancer, but stool-based tests screen only for cancer. CT colonography and barium enema expose the patient to ionizing radiation but do not require sedation and carry less risk of accidentally piercing the colon wall compared with colonoscopy. During colonoscopy, the physician can remove polyps and get biopsies of suspicious areas. All of the tests that visualize the colon require pretest bowel cleansing to remove stool from the colon.

People may be at average risk, moderate risk, or high risk for colon cancer based on family history and pre-existing conditions such as ulcerative colitis, Crohn's colitis (https://www.radiologyinfo.org/en/info/crohns-disease), or Lynch syndrome. For average- and moderate-risk adults, the appropriate imaging screening test is CT colonography every 5 years. Double contrast barium enema is less commonly used. If suspicious polyps are seen on a CT colonography, a colonoscopy is recommended to get a biopsy. For high-risk adults, imaging screening tests are not recommended because often there is the need to do a biopsy. In these individuals, colonoscopy is the recommended test. The CT colonography test is appropriate after a positive fecal occult blood test or an incomplete colonoscopy.

For more information, see the Colorectal Cancer Screening page (https://www.radiologyinfo.org/en/info/screening-colorectal).

— By Celena Romero, RD, MBA, CPHQ, and Ryan K. Lee, MD, MBA, MRMD. This information originally appeared in the Journal of the American College of Radiology.

CT for Adult Minor Head Trauma

A closed head injury results from hitting your head on something. Even a small minor blow to the head can be dangerous and should be evaluated by a doctor for a possible concussion, bleeding on the brain, or skull fracture. Most minor head injuries do not require imaging tests.

A test called the Glasgow Coma Scale helps assess a person's level of consciousness after a minor or mild closed head injury. If the test result is equal to or more than 13, additional guidelines are used to see if an imaging test is recommended. A CT scan (https://www.radiologyinfo.org/en/info/headct) without contrast is used if the guidelines say a test is needed to find out the seriousness of the head injury. People with moderate or severe closed head injuries are also recommended to have a CT scan.
without contrast.

The results of a noncontrast head CT may read as normal despite an existing brain injury. Follow-up imaging tests are recommended for people whose brain injury symptoms are not getting better or are getting worse. CT without contrast is usually the best test for follow-up. MRI (https://www.radiologyinfo.org/en/info/headmr) is used in cases of chronic (ongoing) suspected traumatic brain injury. If blood vessel injury is suspected then CT angiography (https://www.radiologyinfo.org/en/info/angioct) or MR angiography (https://www.radiologyinfo.org/en/info/angiomr) is used for arterial injury and CTV or MRV for vein injuries.

CT scans expose people to radiation. MRI tests do not. For more information, see the Head Injury (https://www.radiologyinfo.org/en/info/headinjury) page.

— By Celena Romero, RD, MBA, and Ryan Lee, MD, MBA, MRMD. This information originally appeared in the Journal of the American College of Radiology.

**Crohn's Disease**

Crohn disease (https://www.radiologyinfo.org/en/info/crohns-disease) (CD) is a chronic condition caused by inflammation of the bowel. The small bowel, the colon, or both can be involved. Individuals may have periods with frequent flare-ups and periods of remission. CD is usually diagnosed by colonoscopy along with clinical symptoms, laboratory tests, and imaging. Imaging is helpful to evaluate the extent of involvement on initial diagnosis, to evaluate for residual inflammation, or to monitor response to treatment.

For individuals without a prior diagnosis of CD or individuals with known CD with a suspected flare-up, CT abdomen and pelvis (https://www.radiologyinfo.org/en/info/abdomenct) with intravenous (IV) contrast, CT enterography (https://www.radiologyinfo.org/en/info/ctenterography), or MR enterography (https://www.radiologyinfo.org/en/info/mrenterography) is usually appropriate. For enterography, whether done under CT or MR, the individual has to consume approximately 1 to 1.5 L of a special liquid to help fill the small bowel. For individuals with known CD under surveillance or monitoring for treatment, MR enterography is preferred because of its lack of radiation dose.

Other imaging tests may be appropriate including MRI abdomen and pelvis (https://www.radiologyinfo.org/en/info/mri-abdomen-pelvis) without and with IV contrast when an individual is acutely ill and cannot tolerate a large volume of liquid to drink. CT abdomen and pelvis without IV contrast, fluoroscopy small-bowel follow-through (https://www.radiologyinfo.org/en/info/small-bowel-follow-thru), and MRI abdomen and pelvis without IV contrast can be performed in different situations but yield less information than CT enterography or MR enterography.

For more information, see the Crohn’s Disease page (https://www.radiologyinfo.org/en/info/crohns-disease).

— By Kristin Jordan Moore and Tasneem Lalani, MD. This information originally appeared in the Journal of the American College of Radiology.

**Dementia**

Dementia (https://www.radiologyinfo.org/en/info/dementia) refers to a group of symptoms that affect memory, thinking, and social abilities and interfere with daily life. Dementia is a common medical diagnosis and includes different subtypes. These include Alzheimer’s disease, frontotemporal dementia (when nerve cells in the frontal and temporal lobes of the brain are lost), Lewy body disease (progressive dementia from protein deposits in brain nerve cells), vascular dementia (caused by lack of blood flow to a part of the brain), and mixed dementias. Different imaging tests are used in these subcategories. All are first evaluated by a neurologist followed by CT of the head (https://www.radiologyinfo.org/en/info/headct) or MRI of the brain (https://www.radiologyinfo.org/en/info/fmribrain) without intravenous contrast.
If Alzheimer’s disease is suspected, an amyloid PET/CT scan (https://www.radiologyinfo.org/en/info/pet) brain (in which a chemical tracer or substance is injected into the brain that can show beta-amyloid plaques, a buildup of toxic proteins) or a fluorine-18-2-fluoro-2-deoxy-d glucose (FDG)-PET/CT brain (in which a radioactive glucose tracer is injected that shows metabolic activity in the brain) is usually appropriate as the next test.

For suspected frontotemporal dementia, FDG-PET/CT brain may also be appropriate. For suspected Lewy body disease, ioflupane single-photon emission CT (SPECT) (a special type of CT scan with radioactive isotope injected into the brain) or SPECT/CT brain (SPECT combined with CT) and FDG-PET/CT brain may be appropriate. For dementia due to idiopathic normal-pressure hydrocephalus (in which cerebrospinal fluid builds up in ventricles or interconnected fluid-filled chambers in the brain and compresses brain tissue), diethylenetriamine pentaacetate cisternography or hexamethylpropyleneamine oxime SPECT (imaging tests to visualize fluid flow in the brain) or SPECT/CT brain scan may also be appropriate.

For more information, see the Dementia (https://www.radiologyinfo.org/en/info/dementia) page.

— By Raquel Weinberg and Kemi Babagbemi, MD. This information originally appeared in the Journal of the American College of Radiology.

Developmental Dysplasia of the Hip—Child

Developmental dysplasia of the hip (DDH) is a condition in which the hip joint does not develop normally during pregnancy, but it can also be present at birth. Finding DDH early can reduce long-term complications, but most of the time the condition goes away by itself. Early screening for DDH includes hip examinations at every well-baby visit with a doctor or pediatrician. The American Academy of Pediatrics recommends screening of children with risk factors or those whose physical examinations show abnormalities. Recommendations for imaging tests depend on a child’s age. In infants who are younger than 4 weeks, imaging examinations are not recommended. For children between 4 weeks and 4 months, ultrasound of the hips (https://www.radiologyinfo.org/en/info/us-hip) is usually appropriate if (1) it is unclear from physical examination if DDH is present or (2) there are risk factors for DDH. For children younger than 4 months with a physical examination that shows signs of DHH, ultrasound of the hips is usually appropriate. For children older than 4 months with a concern for DDH, x-ray (https://www.radiologyinfo.org/en/info/bonerad) of the pelvis is usually appropriate. Ultrasound of the hips is usually appropriate to monitor progress in children younger than 6 months with a known diagnosis of DDH who are being treated for their dysplasia by being in a special harness.

— By Anastasia Sumpaopol, BA, and Ryan K. Lee, MD, MBA. This information originally appeared in the Journal of the American College of Radiology.

First Trimester Vaginal Bleeding

First trimester vaginal bleeding (https://www.radiologyinfo.org/en/info/vaginalbleeding) occurs in 7% to 27% of pregnancies, with many causes that range from a normal pregnancy to an ectopic pregnancy (pregnancy outside the uterus). The main imaging test recommended is transvaginal ultrasound (US) (https://www.radiologyinfo.org/en/info/pelvus), which when combined with blood tests and the mother’s signs and symptoms can identify the cause of bleeding.

Transabdominal US may be appropriate, usually in conjunction with transvaginal US, later in the first trimester rather than early in the first trimester. For the large majority of cases, transabdominal US and transvaginal US are the best imaging studies to guide management in individuals with vaginal bleeding in the first trimester.

Transvaginal US shows the gestation sac (the area of fluid around the embryo) at around 4.5 to 5 weeks of pregnancy and is the first feature that can show that the pregnancy is happening in the womb (intrauterine pregnancy). However, confirming a viable intrauterine pregnancy may require waiting until later in the first trimester when the yolk sac and/or embryo can be seen and embryonic cardiac activity can be checked. When there are symptoms that are suspicious for an ectopic pregnancy, both transvaginal and transabdominal US may be used. MR and CT are not usually used in the evaluation for first trimester vaginal
bleeding but are used in certain clinical settings.

*For more information, see the Abnormal Vaginal Bleeding page ([https://www.radiologyinfo.org/en/info/vaginalbleeding](https://www.radiologyinfo.org/en/info/vaginalbleeding)).*

— By Lauren Yates and Jennifer W. Uyeda, MD. This information originally appeared in the *Journal of the American College of Radiology.*

### Headache

Identifying the type and cause of most headaches can be done with a medical history and a physical examination, without the need for imaging tests. Unnecessary imaging tests can lead to incidental findings—things that are not associated with the reason for the test. This can lead to patients' getting unnecessary treatments and exposure to radiation.

If someone has a new headache with the following complications, he or she might benefit from imaging studies:

- Recent head or neck injury
- A sudden or suddenly worsening headache
- "Thunderclap" headache—a headache that takes seconds or minutes to go from nothing to maximum pain intensity
- Headache due to the trigeminal nerve (which runs from the face to the brain)—often cluster headaches
- Positional headache—severe headache on one side of the head that gets worse with certain head positions
- Headache located on one side, especially in young patients
- Headache that starts, or gets worse, with coughing, exercise, or sexual activity
- Headache that may be due to sinus or dental complications
- Suspected meningitis (infection of the brain lining) or encephalitis (inflammation of the brain)
- New headache with pain in the temples in older patients
- Pregnancy
- Compromised immune systems (e.g., HIV positive)
- Treatment for cancer
- Conditions affecting blood clotting
- Chronic headaches with new symptoms

In most cases, the recommended initial imaging test is MRI with and without intravenous contrast. For some conditions, CT or CT with angiography ([http://www.radiologyinfo.org/en/info.cfm?pg=angioct](http://www.radiologyinfo.org/en/info.cfm?pg=angioct)), either with or without contrast, is recommended. *For more information, see the Headache ([https://www.radiologyinfo.org/en/info/headache](https://www.radiologyinfo.org/en/info/headache)) page.*

— By Casey Quinlan. This information originally appeared in the *Journal of the American College of Radiology.*

### Headache—Child

Although headache ([https://www.radiologyinfo.org/en/info/headache](https://www.radiologyinfo.org/en/info/headache)) is common in children of all ages, imaging tests are rarely needed and most often do not reveal an underlying cause. Primary headache, a headache not due to an underlying condition, can happen at any age and is typically caused by tension or migraine. Imaging tests are not needed in children with primary headache. Secondary headache, a headache due to an underlying condition, is more common in younger children. The decision to have a brain imaging test to find the cause of secondary headache should be decided by the pediatrician after reviewing the child’s medical history and a physical examination.

When the child’s pediatrician decides imaging is needed, MRI ([https://www.radiologyinfo.org/en/info/headmr](https://www.radiologyinfo.org/en/info/headmr)) of the brain, and possibly the neck, without contrast is the most appropriate initial test. MRI is the best imaging test to look at the brain tissue for...
structural abnormalities or when the child had a prior incident of head trauma. CT (https://www.radiologyinfo.org/en/info/headct) of the brain may be the best initial imaging for sudden severe (thunderclap) headache, if bleeding in the brain is suspected, in headache due to acute trauma, or in an emergency setting when MRI is not available. Both MRI and CT may be used to look at the arteries (angiography) or veins (venography) in the brain and neck; intravenous contrast may need to be used. Intravenous contrast is used when there is infection or tumor and may be needed when other abnormalities are found.

For more information, see the Headache page. (https://www.radiologyinfo.org/en/info/headache)

— By Frank Rybicki Jr. and Dianna M.E. Bardo, MD. This information originally appeared in the Journal of the American College of Radiology.

**Hearing Loss and/or Vertigo**

The auditory system is responsible for hearing and balance. It translates sound waves into signals received and processed by the brain. Hearing loss and vertigo (the sensation of a spinning environment) are symptoms that can point to diseases of these auditory structures.

Conductive hearing loss (CHL) occurs when sound waves do not properly reach the brain because of lesions in the ear that stop the waves before they reach the nerves that conduct the auditory signals. CT (https://www.radiologyinfo.org/en/info/headct) of the temporal bone without contrast is appropriate when CHL is suspected. CT also shows the tiny bones in the middle ear cavity that vibrate to pass and amplify sound waves.

Sensory hearing loss (SHL) occurs when auditory signals do not properly reach the brain because of lesions in the structures responsible for transmitting and receiving the auditory signals. MRI (https://www.radiologyinfo.org/en/info/headmr) with and/or without contrast appropriate to diagnose hearing loss due to problems with SHL. CT and MRI, sometimes used together, are appropriate when a mix of CHL and SHL are suspected.

MRI is appropriate for vertigo that does not stop (persistent). For vertigo that comes and goes (episodic), CT is appropriate.

CT and MRI are often used together to provide a complete view of the entire ear canal and associated nerve cells for presurgical planning and for diagnosing complicated cases of hearing loss. These include cases of total deafness, surgical planning for a mass in the inner ear, and planning to surgically implant hearing devices (cochlear implant).

— By Frank Rybicki Jr., Bruno Policeni, MBA, MD. This information originally appeared in the Journal of the American College of Radiology.

**Hematuria**

“Hematuria (https://www.radiologyinfo.org/en/info/hematuria)” is the word used for describing blood in the urine. In small amounts, blood in the urine is considered normal.

Hematuria is divided into two categories. Gross hematuria is when a person can see blood in the urine. Microhematuria is when the blood can only be seen by a microscope. The blood can come from anywhere along the urinary tract. The causes are divided into nephrogenic (from the kidneys) and urogenic (from the bladder).

For microhematuria, individuals with no risk factors and with a known cause for the blood may not require an imaging test. Examples of known causes of microhematuria include strenuous exercise, current or recent menstruation, or infection or viral illness. In some cases, a CT of abdomen and pelvis (https://www.radiologyinfo.org/en/info/abdominct) without intravenous (IV) contrast may be appropriate.

For individuals with risk factors and without a known cause of microhematuria, a CT urography (https://www.radiologyinfo.org/en/info/urography) (also known as CTU, a special CT to see the urinary tract) without
and with IV contrast is usually appropriate. Other types of imaging may be appropriate and include MRU (MRI urography) without and with contrast, CT of the abdomen and pelvis without and with contrast, CT of the abdomen and pelvis without contrast, and ultrasound (US) (https://www.radiologyinfo.org/en/info/abdominus) of the kidneys and bladder.

For pregnant women with microhematuria, US of the kidneys and bladder is usually appropriate. MRU without contrast may be appropriate.

For individuals with gross hematuria, blood that is directly visible in the urine, a CTU without and with contrast and MRU without and with contrast are usually appropriate. Other CT, MRI, and US imaging examinations may be appropriate.

— By Kristin Jordan Moore and Khushboo Jhala, MD, MBA. This information originally appeared in the Journal of the American College of Radiology.

Hematuria–Child

Hematuria (https://www.radiologyinfo.org/en/info/hematuria) is blood in urine. The urine may be red or pink, which is called macroscopic hematuria, or the urine may be normal in color but show blood cells when examined under a microscope, which is called microscopic hematuria. When a child with hematuria is examined, the doctor will usually test the urine for both blood and protein. Protein in the urine is called proteinuria.

If the child has microscopic hematuria without pain and no protein in the urine, then imaging is not recommended.

Ultrasound (US) (https://www.radiologyinfo.org/en/info/abdominus) of the kidneys and bladder is appropriate for microscopic hematuria without pain and when protein is found in the urine to check for kidney disease. US can also be used to plan for a kidney biopsy, if needed.

US of the kidneys and bladder is appropriate for macroscopic hematuria without pain to look for tumors in the kidneys or bladder.

CT (https://www.radiologyinfo.org/en/info/abdominct) is useful for painful hematuria to look for stones in the urinary tract (urolithiasis). US and x-ray may also be appropriate but may not see the kidney stones (https://www.radiologyinfo.org/en/info/stones-renal).

If microscopic or macroscopic hematuria occurs after injury (traumatic hematuria), the recommendation is CT of the abdomen and pelvis to look for kidney or bladder injury and pelvic bone fractures. Retrograde urethrography or CT of the pelvis with bladder contrast may be appropriate when injury to the urethra or bladder is suspected. US is usually not recommended for macroscopic hematuria after an injury but may be helpful when the hematuria is microscopic.

For more information, see the Hematuria page (https://www.radiologyinfo.org/en/info/hematuria).

— By Celena Romero, PhD, MBA, RDN, CPHQ, CPASRM and Ryan K. Lee, MD, MBA. This information originally appeared in the Journal of the American College of Radiology.

Iliac Artery Occlusive Disease

Iliac artery occlusive disease is blockage of the large arteries supplying blood to the pelvis and legs. Risk factors include diabetes, high blood pressure, and smoking. This blockage is treated differently depending on whether it developed slowly (progressive) or suddenly (acute). The typical symptoms of progressive disease are pain, numbness, and tiredness in the legs when walking and standing, which worsens with time and improves with rest. Typical symptoms of acute disease are sudden leg pain and weak pulse in the groin. The leg may turn cold or blue.

For patients with worsening symptoms, diagnosis is made by physical examination, including blood pressure difference between the leg and arm, blood test to measure fat (lipid) content, and an ultrasound scan of the leg. If the tests show decreased blood flow...
to the legs, a CT or MRI with intravenous contrast material designed to show blood vessels (CT angiography [https://www.radiologyinfo.org/en/info/angioct] or MR angiography [https://www.radiologyinfo.org/en/info/angiomr]) is used to find the blood vessel that is blocked and to figure out the size of the blockage.

Acute patients should be imaged with CT angiography. For patients that are allergic to the contrast material, results of the blood pressure testing and ultrasound are used for diagnosis.

Acute patients should be treated immediately with blood thinners. For both acute and progressive patients, CT angiography and MR angiography are used to decide between placing a catheter inside the artery near the blockage and dissolving it or surgically removing or bypassing it. Treatment may include medications that interfere with clot formation to prevent blockage from coming back. For more information, see the Peripheral Artery Disease ([https://www.radiologyinfo.org/en/info/pad](https://www.radiologyinfo.org/en/info/pad)) page.

— By Søren Meibom, PhD, and Bruno Policeni, MD, MBA. This information originally appeared in the Journal of the American College of Radiology.

**Imaging After Total Knee Arthroplasty**

Knee replacement, or total knee arthroplasty, is the most common joint replacement procedure in the United States. Most patients do not require any imaging after discharge other than the x-rays at the first postoperative follow-up appointment.

Symptoms of pain after surgery can be due to infection, loosening of the components of the joint replacement, reaction to the liner of the replacement, or fracture, among other causes. The optimal examination in this setting is an x-ray to help identify loosening or fluid.

If there is fluid in or around the joint on x-ray or swelling on physical examination, fluid removal (aspiration) can be performed under local anesthetic to check for infection. If the joint fluid is infected, no further imaging is required.

If the joint fluid does not give a clear answer and if infection is still suspected, repeating the aspiration or doing a bone scan may be appropriate.

If there is no fluid and infection is unlikely, then loosening can be evaluated in two ways. Real-time video x-ray or fluoroscopy can help identify the abnormal motion of the knee joint. CT without contrast can also assess for loosening, inflammation, bone loss, or small fracture around the prosthesis. Additionally, CT can also help evaluate whether the parts of the joint replacement have rotated from the initial placement.

If a soft tissue abnormality is suspected (such as tendon or muscle injury or nerve impingement), an MRI ([https://www.radiologyinfo.org/en/info/kneemr](https://www.radiologyinfo.org/en/info/kneemr)) without contrast or ultrasound may be appropriate.

— By Casey Quinlan, Tasneem Lalani, MD. This information originally appeared in the Journal of the American College of Radiology.

**Imaging of Deep Inferior Epigastric Arteries for Surgical Planning (Breast Reconstruction Surgery)**

Breast cancer is the most common cancer in women in the United States. Breast reconstruction surgery is commonly part of breast cancer treatment ([https://www.radiologyinfo.org/en/info/breast-cancer-therapy](https://www.radiologyinfo.org/en/info/breast-cancer-therapy)) when a woman has a mastectomy.

One possible approach to breast reconstruction surgery is to use the skin and the tissue just beneath it from the woman's own abdominal wall to reconstruct her breast. This procedure is called deep inferior epigastric perforator (DIEP) flap breast reconstruction. To prepare for reconstruction surgery, the surgeon orders imaging tests to identify the location, size, and position of the arterial branches that supply the DIEP flap with blood. The blood supply is essential to map before surgery because that
blood supply must also be moved to the chest to keep the reconstructed tissue alive. The main artery is called the deep inferior epigastric artery; the size and location of this artery normally varies between women.

The preferred imaging test to map the blood supply is CT angiography (https://www.radiologyinfo.org/en/info/angioct) (CTA; a scan that shows the blood vessels), with intravenous (IV) contrast, of the abdomen and pelvis. The excellent detail improves outcomes and reduces complications by contributing to the best surgical planning. MR angiography (https://www.radiologyinfo.org/en/info/angiomr) (MRA), with and without IV contrast, of the abdomen and pelvis is an alternative to CTA. MRA of the abdomen and pelvis without IV contrast may also be appropriate. CTA exposes patients to radiation; MRA does not.

— By Casey Quinlan and Frank J. Rybicki, MD, PhD. This information originally appeared in the Journal of the American College of Radiology.

**Indeterminate Renal Mass**

Kidney (renal) masses are sometimes unexpectedly found when imaging is done on the abdomen. Although some of these masses may be harmful, many are not problematic. Imaging tests can help figure out which masses are concerning and need follow-up. The most common imaging tests for a kidney mass include abdominal ultrasound (US) (https://www.radiologyinfo.org/en/info/abdominus) with contrast, a CT scan of the abdomen (https://www.radiologyinfo.org/en/info/abdominct) with and without intravenous (IV) contrast, or an MRI abdomen (https://www.radiologyinfo.org/en/info/mri-abdomen-pelvis) test with and without IV contrast. US uses gas-filled microbubbles for contrast. CT uses an iodinated contrast agent. MRI uses gadolinium contrast. These tests are equivalent to each other, so only one test would usually be done.

For people in whom gadolinium contrast should not be used, US with contrast, CT scan with and without iodinated IV contrast, or MRI without contrast is usually appropriate. For people in whom iodinated CT contrast agent should not be used, either MRI with and without gadolinium contrast or US with contrast is usually appropriate.

For people in whom neither gadolinium or iodinated IV contrast should be used, an ultrasound of the kidneys from the back (retroperitoneal kidney US), US abdomen with contrast, or MRI abdomen without contrast is usually appropriate. CT abdomen without contrast may also be appropriate.

*For more information, see the Renal Cysts page (https://www.radiologyinfo.org/en/info/renal-cyst).*

— By Raquel Weinberg, MS, and Karin Evelyn Dill, MD. This information originally appeared in the Journal of the American College of Radiology.

**Inflammatory Back Pain - Known or Expected Axial Spondyloarthritis**

Axial spondyloarthritis or spondyloarthropathy (axSpA) is an inflammatory condition that can affect the back, pelvis, neck, and some other larger joints causing chronic back pain and stiffness. The stiffness associated with axSpA generally gets better with exercise. Initially, the inflammation is in the area of the lower back between the pelvis and spine (called the sacroiliac joints) and may spread to other joints along the spine.

An x-ray (https://www.radiologyinfo.org/en/info/bonerad) of the sacroiliac joints and spine is usually the initial imaging test. Follow-up imaging with MRI (https://www.radiologyinfo.org/en/info/spinemr) of the sacroiliac joints and spine with and without or without contrast is usually appropriate as the next test. CT (https://www.radiologyinfo.org/en/info/spinect) sacroiliac joints and spine without contrast or with contrast is sometimes appropriate. If these initial tests do not show a problem with the sacroiliac joints, the next imaging tests will be focused in the area of concern in the spine. Usually appropriate tests are x-ray, MRI, and CT of the spine. After axSpA is diagnosed, treatment focuses on controlling the disease and improving quality of life. Follow-up imaging may be needed to see if your disease is getting worse. X-ray sacroiliac joint and spine is usually appropriate. MRI
sacroiliac joints and spine may be appropriate.

Ankylosis can lead to bone loss (osteooporosis (https://www.radiologyinfo.org/en/info/osteoporosis) ) and increase the risk of breaking a bone. If a broken bone is suspected, x-ray, MRI without contrast, or CT without contrast of the spine is usually appropriate.

For more information, see the Osteoporosis (https://www.radiologyinfo.org/en/info/osteoporosis) page.

— By Natalie Skopicki and Bruno Policeni, MD, MBA. This information originally appeared in the Journal of the American College of Radiology.

Jaundice

Jaundice is a medical condition that causes yellowing of the skin or the whites of the eyes because of extra amounts of the pigment bilirubin. The most common causes are hepatitis, alcoholic liver disease, blockage of the common bile duct by a gallstone (https://www.radiologyinfo.org/en/info/gallstones) or tumor, or toxic reaction to a drug or medicinal herb.

Imaging examinations may be used to help diagnose jaundice, in addition to physical examination and laboratory tests.

In cases in which there are no known causes for jaundice, the usually appropriate initial imaging test is ultrasound (US) abdomen (https://www.radiologyinfo.org/en/info/abdominus), CT abdomen (https://www.radiologyinfo.org/en/info/abdominct) with intravenous (IV) contrast, or an MRI abdomen (https://www.radiologyinfo.org/en/info/mri-abdomen-pelvis) without and with IV contrast with magnetic resonance cholangiopancreatography (https://www.radiologyinfo.org/en/info/mrcp) (MRCP; a special type of MRI that shows the liver, pancreas, bile ducts, and gallbladder). MRI abdomen without IV contrast with MRCP may be appropriate.

In cases in which a blockage of the bile duct is thought to be the cause, CT abdomen with IV contrast, MRI abdomen without and with IV contrast with MRCP, MRI abdomen without IV contrast with MRCP, or US abdomen is usually appropriate. Endoscopic retrograde cholangiopancreatography (ERCP; an invasive test using an endoscope to take x-rays) and US abdomen endoscopic (an invasive US done with an endoscope under general anesthesia) may be appropriate.

In cases in which the cause is thought to be a medical condition and not a blockage, MRI abdomen without and with IV contrast with MRCP, CT abdomen with IV contrast, or US abdomen is usually appropriate.

For more information, see the Biliary Interventions page (https://www.radiologyinfo.org/en/info/biliary).

— By Patti Brossard, RT(R) ARRT, and Nina S. Vincoff, MD. This information originally appeared in the Journal of the American College of Radiology.

Left Lower Quadrant Pain-Suspected Diverticulitis

The most common cause of left lower abdominal pain in adults is diverticulitis, an inflammation of outpouchings that can develop in the colon. It is usually appropriate to get a CT with intravenous (IV) contrast of the lower abdomen and pelvis to confirm the diagnosis. Other imaging tests that may be appropriate include CT without IV contrast, ultrasound of the abdomen (https://www.radiologyinfo.org/en/info/abdominus), and MRI of the abdomen (https://www.radiologyinfo.org/en/info/mri-abdomen-pelvis). Unless complications are suspected, barium enema, abdominal X-ray, and ultrasound of the pelvis are usually not appropriate as the first imaging test.

Some possible complications of diverticulitis are blockage of the colon (obstruction), a hole in the colon (perforation), an abscess (an infected fluid collection in the abdomen), or a fistula (an abnormal connection from the colon to other structures). If the health care team suspects complications, CT with IV contrast is usually the most appropriate imaging test.
For people with suspected complications, CT without IV contrast, CT with bladder contrast, barium enema (https://www.radiologyinfo.org/en/info/lowergi), or cystography (x-ray images with bladder contrast) may also be appropriate.

Some individuals may not need a CT if their health care team has determined that the symptoms are typical of diverticulitis without complications or if the person has a history of diverticulitis and is having a recurrence. These individuals may be treated without any imaging. For more information, see the Diverticulitis (https://www.radiologyinfo.org/en/info/diverticulitis) page.

— By Susan Anemone, Nina S. Vincoff, MD. This information originally appeared in the Journal of the American College of Radiology.

Low Back Pain

Most people who go to the doctor with recent low back pain do not need to have x-rays or MRIs or other types of imaging tests. If the pain persists for more than 6 weeks despite physical therapy, exercise, and medication (conservative treatment), then some form of imaging test may be needed.

Imaging tests should also be considered for patients who have symptoms (red flags) that may mean there is a serious condition causing the pain. These may include a fracture, cancer, compressed nerves, or infection. Many different ways of imaging the spine are available to physicians to request on behalf of their patients. The one to use depends on what is suspected to be the cause of the pain, the urgency of the problem, and other patient medical conditions. If a fracture of the lower part of the spine (lumbar spine) is suspected, a CT scan (https://www.radiologyinfo.org/en/info/spinect) is recommended. Patients that continue to have pain after 6 weeks of conservative treatment and have persisting issues with nerves not working properly resulting in pain, weakness, numbness, or difficulty controlling specific muscles may want to have an MRI (https://www.radiologyinfo.org/en/info/spinemr). Patients that have severe or worsening problems with their nerves not working properly should be evaluated with MRI.

— By Andrea Borondy Kitts, MS, MPH. This information originally appeared in the Journal of the American College of Radiology.

Lower Extremity Arterial Revascularization - Post-Therapy Imaging

The goal of endovascular angioplasty (https://www.radiologyinfo.org/en/info/angioplasty) and of surgical bypass is to restore normal blood flow to the diseased arteries in the legs for individuals with peripheral artery disease. Both procedures need imaging follow-up to check for lesions, typically narrowing of arteries that may come back and cause symptoms. Often, noninvasive testing is done first to help choose the appropriate imaging test. The first test is usually measurement of the ankle-bronchial index (ABI), a noninvasive test in which blood pressure cuffs are placed on the legs to measure local pressures. Other noninvasive tests can also be used.

For individuals without symptoms after their procedure, it is appropriate to use a baseline ultrasound (US) (https://www.radiologyinfo.org/en/info/vascularus) examination in addition to ABI and other noninvasive tests. For patients with symptoms such as severe leg cramps during exercise, pain at rest, and wounds that do not heal properly after the procedure, imaging can include CT (https://www.radiologyinfo.org/en/info/angioct) or MR angiography (https://www.radiologyinfo.org/en/info/angiomr) in addition to US. If the symptoms are more severe, including cold and discolored limbs with a very low pulse, the primary object is to save the leg from amputation. In extremely severe cases, it is appropriate to skip imaging and go directly to surgery. In nonthreatening but severe cases, arteriography (x-rays after a dye is injected into blood vessels through a catheter) is the most appropriate follow-up. Arteriography can provide images of lesions that limit flow and cause drops in leg blood pressure. In less severe cases, both US and CT angiography are appropriate imaging tests. For more information, see the Peripheral Artery Disease (https://www.radiologyinfo.org/en/info/pad) page.

— By Frank Rybicki Jr., Karin E. Dill, MD. This information originally appeared in the Journal of the American College of Radiology.
Monitoring Response to Neoadjuvant Systemic Therapy for Breast Cancer

When a patient has a confirmed diagnosis of invasive breast cancer, the patient may receive chemotherapy ahead of surgery. This is called neoadjuvant therapy and is used to shrink tumors before they are removed surgically. It also treats cancer that has spread (metastasized). Imaging tests before and during neoadjuvant treatment can help guide treatment decisions.

- Mammography (https://www.radiologyinfo.org/en/info/mammo), digital breast tomosynthesis (DBT) (https://www.radiologyinfo.org/en/info/tomosynthesis), and breast ultrasound (US) (https://www.radiologyinfo.org/en/info/breastus) are used together to determine tumor size at the beginning of neoadjuvant treatment, changes in tumor size during treatment, and at the end of treatment. US is more accurate than mammography and DBT at determining tumor size after treatment, especially if the remaining tumor is larger than 7 mm. US is also used to determine if cancer cells have spread to the lymph nodes near the breast (the axilla). During and after neoadjuvant treatment, US can be used to see if cancer in the lymph nodes is responding to chemotherapy.

- MRI (https://www.radiologyinfo.org/en/info/breastmr) without and with intravenous contrast media is used before treatment to evaluate for multiple tumors in dense breast tissue and to evaluate response to neoadjuvant chemotherapy. MRI can also assess for tumor-containing lymph nodes in the chest.

- Fluorodeoxyglucose PET with CT (https://www.radiologyinfo.org/en/info/pet) or CT of the chest, abdomen, and pelvis with intravenous contrast and a bone scan are used when there is suspicion that cancer has spread outside the chest.

For more information, see the Breast Cancer Treatment (https://www.radiologyinfo.org/en/info/breast-cancer-therapy) page.

— By Casey Quinlan and Jennifer W. Uyeda, MD. This information originally appeared in the Journal of the American College of Radiology.

Nonatherosclerotic Peripheral Artery Disease


If a pinched artery around the knee is suspected or if narrowing of artery leading to legs is suspected, then CTA, MRA of the lower extremities without and with IV contrast, and ultrasound are usually appropriate as initial imaging tests. MRA without contrast and arteriography may be appropriate.

For those with suspected or known inflammation of the blood vessels of the lower extremities, arteriography or CTA is usually appropriate, as is MRA without and with IV contrast. An MRA without IV contrast or ultrasound may be appropriate.

In cases of a suspected or known tear in a blood vessel or in an individual with connective tissue lower extremity vascular disease, CTA or MRA without and with IV contrast is usually appropriate. MRA without IV contrast or arteriography may be appropriate.

With suspected or known other noninflammatory lower extremity vascular diseases (such as fibromuscular dysplasia or segmental arterial mediolysis), a CTA, MRA without and with IV contrast, or arteriography is usually appropriate. An MRA without IV contrast, an ultrasound, or intravascular ultrasound may be appropriate.

In individuals with trauma to the lower extremity blood vessels, a CTA is usually appropriate. An arteriography or ultrasound may be appropriate.

For more information, see the Peripheral Artery Disease (PAD) page (https://www.radiologyinfo.org/en/info/pad).
Orbits, Vision, and Visual Loss

Seeing (vision) is a complicated system that converts light coming in through the eyes into various signals that are received by different parts of the brain. MRI (https://www.radiologyinfo.org/en/info/headmr) and CT (https://www.radiologyinfo.org/en/info/headct) are used to diagnose diseases of the eye and eye cavity in the skull (orbits). MRI is good for examining soft tissues, and CT is useful to examine orbits, muscles, fat, foreign bodies, accumulation of calcium salts in tissues (calcifications), and bones. When vascular (blood vessel) disease is suspected, CT angiography (CTA) (https://www.radiologyinfo.org/en/info/angioct) or MR angiography (MRA) (https://www.radiologyinfo.org/en/info/angiomr) can be added to initial CT or MRI tests. MRA is preferred in the nontrauma setting. Common vision problems and the appropriate imaging follow-ups include:

- CT head and orbits without contrast is the most appropriate imaging evaluation for a traumatic loss of vision. CTA is appropriate for suspected vascular injury. MRI is an appropriate follow-up to an inconclusive CT scan or suspected damage of the optic nerve.
- Bulging out or caving in of the eyeball, infections, abnormal tissue growths (such as a tumor), and loss of control of eye movement are best assessed with MRI of the orbits without and with contrast and CT of the orbits with contrast. Both scans are complementary and appropriate.
- A mass on or inflammation of the optic nerve is best assessed on an MRI head and orbits without and with contrast.

When the correct orbital disease is identified in a clinical examination performed by a doctor or on a laboratory result, more imaging tests are usually not appropriate.

— By Frank Rybicki Jr., Bruno Policeni, MBA, MD. This information originally appeared in the Journal of the American College of Radiology.

Ovarian Cancer Screening

Ovarian cancer is usually found at a late stage because there are no current screening tests that have been able to find the cancer at an earlier stage or to reduce the number of ovarian cancer deaths. Women at a high risk of ovarian cancer due to certain risks factors may benefit from screening.

Pre- and postmenopausal women are considered to have a high risk of ovarian cancer if they have a personal or family history of ovarian cancer, have or are suspected to have BRCA1 or BRCA2 genetic mutations, or have an elevated CA-125 level (antigen 125—a protein elevated in cancer tumor cells) as measured by a blood test. These women may decide to get screened.

The recommended imaging test to screen for ovarian cancer is ultrasound (US) (https://www.radiologyinfo.org/en/info/pelvus) to visualize the ovaries. These tests include transvaginal US (preferred), transabdominal US (in women who are not good candidates for transvaginal US), and US color Doppler (allows for visualization of blood flow). US does not use any radiation.

Pre- and postmenopausal women with no personal or family history of ovarian cancer, who do not have BRCA1 or BRCA2 genetic mutations, and who do not have an elevated CA-125 level are considered to have an average risk of ovarian cancer. It is not recommended that these women have imaging tests to screen them for ovarian cancer.

CT and MRI are usually not appropriate for women with either average or high risk of ovarian cancer. For more information, see the Ovarian Cancer (https://www.radiologyinfo.org/en/info/ovarian-cancer) page.

— By Casey Quinlan and Phyllis Glanc, MD. This information originally appeared in the Journal of the American College of Radiology.
Pneumonia in the Immunocompetent Child

Pneumonia (https://www.radiologyinfo.org/en/info/pneumonia) is an infection of one or both lungs. Pneumonia may come from the community or from a health care environment; both are common in children. Imaging is not required for otherwise healthy children, 3 months of age or older, with pneumonia.

Chest x-ray (https://www.radiologyinfo.org/en/info/chestrad) is usually appropriate as the initial imaging test if community-acquired pneumonia does not respond to treatment, if the child is hospitalized, or if hospital-acquired pneumonia is suspected. Ultrasound (https://www.radiologyinfo.org/en/info/genus) (US) chest may also be appropriate.

Pneumonia can be complicated by pleural effusion, a fluid buildup between the lungs and the chest cavity; US is usually appropriate to determine the size and features of fluid buildup and may help guide drainage. Chest x-ray taken lying down may be used to distinguish flows or fluid collection.

Pneumonia can be complicated by suspected bronchopleural fistula, an abnormal communication between the lungs and the chest cavity; CT chest (https://www.radiologyinfo.org/en/info/chestct) with intravenous (IV) contrast is usually appropriate. CT chest without IV contrast may also be appropriate.

For pneumonia complicated by suspected lung abscess, or an infected mass, CT chest with IV contrast is usually appropriate. US chest and MRI chest (https://www.radiologyinfo.org/en/info/chestmr) without and with contrast may be appropriate.

CT chest without IV contrast is usually appropriate to evaluate for underlying lung disease for children with recurrent nonlocalized pneumonia. For children with recurrent localized pneumonia, CT angiography (https://www.radiologyinfo.org/en/info/angioct) chest focused on the heart with IV contrast or CT chest with IV contrast is usually appropriate.

For more information, see the Pneumonia page (https://www.radiologyinfo.org/en/info/pneumonia).

— By Celena Romero, PhD, MBA and Diana Bardo, MD. This information originally appeared in the Journal of the American College of Radiology.

Post-treatment Follow-up of Prostate Cancer

Men who have been treated for prostate cancer (https://www.radiologyinfo.org/en/info/prostate-cancer) need regular prostate-specific antigen (PSA) blood tests to check if the cancer has come back. High PSA is a strong sign the cancer may be back but does not indicate if it is local or has spread outside of the prostate area. The recommended imaging test depends on the initial cancer treatment:

- Surgery to remove the prostate (radical prostatectomy)
- Radiation to the prostate and pelvic area
- Hormone therapy, chemotherapy, or immunotherapy (systematic therapies)

Specialized PET/CT (https://www.radiologyinfo.org/en/info/pet) scanning is appropriate for all three scenarios. In addition, each case has differences in follow-up tests.

Radical prostatectomy removes the prostate and some surrounding tissue. Because prostate cancer spreads slowly, if the cancer comes back, it will likely be in nearby tissue. MRI (https://www.radiologyinfo.org/en/info/mr_prostate) with intravenous contrast is usually the right test to find the cancer.

Radiation kills tumor cells to stop them from growing. If the cancer comes back, it will likely come back to the prostate. In
addition to the PET/CT, a diagnostic MRI and MRI or transrectal ultrasound-guided biopsy of the prostate ([https://www.radiologyinfo.org/en/info/prostate-biopsy](https://www.radiologyinfo.org/en/info/prostate-biopsy)) is appropriate.

Systematic therapies are typically used in more advanced cases, often to shrink the cancer so that it can be surgically removed. If the cancer comes back, it is likely to have spread to the bones and lymph nodes. A whole-body bone scan ([https://www.radiologyinfo.org/en/info/bone-scan](https://www.radiologyinfo.org/en/info/bone-scan)) and CT of the abdomen and pelvis ([https://www.radiologyinfo.org/en/info/abdominect](https://www.radiologyinfo.org/en/info/abdominect)) with intravenous contrast can be done in place of the specialized PET/CT scan.


— By Frank J. Rybicki Jr. and Jennifer W. Uyeda, MD. This information originally appeared in the Journal of the American College of Radiology.

### Pretreatment Staging of Muscle-Invasive Bladder Cancer

Bladder cancer is considered muscle invasive (MIBC) when the tumor extends into the muscles in the wall of the bladder. MIBC may spread to the lymph nodes, bones, lungs, liver, and peritoneum (the lining of the abdomen). Standard treatment is surgery to completely remove the bladder (radical cystectomy) and the surrounding lymph nodes (pelvic lymphadenectomy). Chemotherapy may also be used. CT of the pelvis and abdomen ([https://www.radiologyinfo.org/en/info/abdominect](https://www.radiologyinfo.org/en/info/abdominect)) shows the entire urinary tract (CT urography ([https://www.radiologyinfo.org/en/info/urography](https://www.radiologyinfo.org/en/info/urography))) and is used to stage MIBC, look for cancer outside of the bladder, and figure out if surgery is possible.

CT urography with and without contrast is the most appropriate initial imaging test for MIBC. CT can detect the primary tumor and most other tumors except for extremely small tumors.

MRI urography (MRI of the pelvis and abdomen) ([https://www.radiologyinfo.org/en/info/mri-abdomen-pelvis](https://www.radiologyinfo.org/en/info/mri-abdomen-pelvis)) with and without contrast, although more time-consuming, is more sensitive and is good at imaging soft tissues and finding small tumors. It is also appropriate for staging MIBC. When cancer in the lymph nodes is suspected, fine-needle aspiration should be considered to biopsy any suspicious tumors.

All patients with MIBC should get a chest x-ray to look for tumors in the lungs. If any suspicious mass is found on the chest x-ray ([https://www.radiologyinfo.org/en/info/chestrad](https://www.radiologyinfo.org/en/info/chestrad)), it is appropriate to get a chest CT ([https://www.radiologyinfo.org/en/info/chestct](https://www.radiologyinfo.org/en/info/chestct)) with or without contrast.

A PET/CT scan ([https://www.radiologyinfo.org/en/info/pet](https://www.radiologyinfo.org/en/info/pet)) using fluorine-18-2-fluoro-2-deoxy-D-glucose may also be appropriate to look for spread of the cancer outside of the bladder (metastasis).

These tests are all useful and more than one may be performed.

— By Frank Rybicki Jr., Phyllis Glanc, MD. This information originally appeared in the Journal of the American College of Radiology.

### Prostate Cancer—Pretreatment Detection, Surveillance, and Staging

Regular screening is recommended for men beginning about age 55. The first sign of cancer comes from either a blood test for a protein specific to prostate cancer (PSA) or by a digital examination of the prostate through the rectum to assess enlargement or firmness. Neither of these is perfectly accurate. Suspicion of cancer warrants additional testing.

The recommended first test is transrectal ultrasound (TRUS) ([https://www.radiologyinfo.org/en/info/us-prostate](https://www.radiologyinfo.org/en/info/us-prostate)) with biopsy, in which small samples of prostate tissue are collected and examined for evidence of cancer. This can be negative even if there is tumor.
If the biopsy shows no cancer but the PSA levels are still high, an MRI of the prostate (https://www.radiologyinfo.org/en/info/mr_prostate) may be appropriate.

For low-risk prostate cancers (based on the microscopic appearance of the cancer—Gleason score), MRI followed by TRUS- or MRI-guided biopsy (https://www.radiologyinfo.org/en/info/prostate-biopsy) is recommended if the MRI reveals a suspicious lesion.

Patients with "favorable type" intermediate risk may elect to watch and wait. MRI can be used to monitor the cancer. TRUS- or MRI-guided biopsy may be used if there is a change.

Patients with "unfavorable type" intermediate risk should chose to treat their cancer and then undergo further evaluation with CT and nuclear medicine bone scans.


Once the presence, extent, and severity of prostate cancer have been determined, identification of risk can help direct treatment planning.

See the Prostate Cancer page (https://www.radiologyinfo.org/en/info/prostate-cancer) for more information.

— By David B. Andrews, PhD, and Tasneem Lalani, MD. This information originally appeared in the Journal of the American College of Radiology.

**Radiologic Management of Central Venous Access**

Venous access is a procedure in which a catheter is placed into a vein for medical diagnosis or therapy. The type of device used depends on the patient and the type of illness being treated. There are two main types of venous access devices: peripheral and central catheters. A peripheral catheter is usually placed into a small vein, often in the arm, and is usually used for up to 96 hours. A central catheter can be placed into a small or large vein in the body, with the tip located in a large vein close to the heart in the chest, and is used for a longer time.

There are different types of central venous catheters. These include peripherally inserted central catheters, temporary for short-term use, and tunneled for long-term use. Other devices, like a chest port, may also be put in the body. It is important to use proper hygiene and to monitor for bloodstream infections. If there is an infection, the device may need to be taken out and a new one placed in a different location, and antibiotics may be needed. Monitoring for a blood clot (https://www.radiologyinfo.org/en/info/bloodclot) is also important, and anticoagulant medication may be needed if one forms.

Typical uses for central venous access include giving nutrition and blood products. Chest ports are used to administer chemotherapy in people with cancer, to treat people having a sickle-cell crisis, or to treat patients with intravenous antibiotics for a blood infection. For more information, see the Vascular Access Procedures (https://www.radiologyinfo.org/en/info/vasc_access) page.

— By Roberta Savo, Karin E. Dill, MD. This information originally appeared in the Journal of the American College of Radiology.

**Radiologic Management of Uterine Leiomyomas**

Leiomyomas (fibroids) in the uterus are benign tumors and are common in women of reproductive age. They are treated when they cause abnormal bleeding, pain, pressure, or bloating.
The usually appropriate treatments are (1) oral medication; (2) uterine artery embolization (UAE) (https://www.radiologyinfo.org/en/info/ufe), or blocking the arteries that feed the fibroids; (3) myomectomy, or the surgical removal of the fibroids; and (4) hysterectomy, or surgical removal of the entire uterus. High-frequency focused ultrasound (HIFU) ablation surgery, in which sound waves are used to break down the fibroid, can also be used.

In middle-aged woman with multiple fibroids, excessive menstrual bleeding, urinary frequency, and bloating who are not pregnant and do not want a future pregnancy, UAE or hysterectomy is usually appropriate. If there is uterine wall fibroid and growth of uterine lining tissue into the uterine wall, surgical removal of uterine lining may be appropriate.

In middle-aged woman with pelvic discomfort and uterine lining fibroid, UAE, myomectomy, or hysterectomy is usually appropriate. Oral medication may also be appropriate. If there is fibroid compressing the rectum, UAE, myomectomy, or hysterectomy is usually appropriate.

In childbearing-age woman who do not want a future pregnancy but are concerned about losing femininity after hysterectomy, UAE is usually appropriate. Hysterectomy may be appropriate but would result in complete loss of fertility.

In childbearing-age women with multiple fibroids in the uterine wall who may want a future pregnancy, UAE or myomectomy is usually appropriate. Ultrasound ablation (HIFU) may also be appropriate.

— By Susan Anemone and MacArinze Ojiaku, MD. This information originally appeared in the Journal of the American College of Radiology.

Radiologic Management of Venous Thromboembolism-Inferior Vena Cava Filters

Deep vein thrombosis is caused by blood clots in the veins in the legs. These can travel to the lungs, causing pulmonary embolism (PE) (https://www.radiologyinfo.org/en/info/pulmonary-embolism). These conditions are referred to as venous thromboembolism (VTE).

VTE is usually treated with anticoagulants (medicines that decrease blood clotting). It may also be appropriate to put a permanent or retrievable device within the inferior vena cava (IVC) to stop the clot from going into the lungs. A retrievable IVC is usually appropriate when the use of anticoagulants may cause too high a risk of bleeding.

A permanent IVC may be appropriate. In cases of acute VTE with a clot in calf veins below the knee (which has a lower risk for PE), observation with serial imaging tests is usually appropriate. Anticoagulation may also be appropriate if there is severe pain with the calf vein clot or if the patient is bedridden or has an underlying malignancy.

In individuals who have chronic VTE, anticoagulation is usually appropriate. In select patients who develop high pressures within the lung arteries due to chronic VTE and PE, an operation to remove the clots from the lungs or a procedure to open the artery in the lungs by inflating a balloon may be appropriate. A permanent or retrievable IVC may also be appropriate. For more information, see the IVC Filters page (https://www.radiologyinfo.org/en/info/venacavafilter).

In people at high risk for VTE (for example, those with major trauma), anticoagulation and using a device that automatically compresses the legs to keep blood flow moving is usually appropriate. Retrievable IVC or surveillance may also be appropriate.

— By Susan Anemone and Tasneem K. Lalani, MD. This information originally appeared in the Journal of the American College of Radiology.

Right Upper Quadrant Pain

Right upper quadrant pain is a common problem. Although it can be difficult to detect the cause, gallbladder inflammation (https://www.radiologyinfo.org/en/info/cholecystitis) is the most common concern. Imaging can be helpful to find
Ultrasound (US) abdomen (https://www.radiologyinfo.org/en/info/abdominus) is usually appropriate as the first imaging test for those with right upper quadrant abdominal pain. Other imaging tests may also be appropriate: CT abdomen (http://www.radiologyinfo.org/en/info.cfm?pg=abdominct) with intravenous (IV) contrast, MRI abdomen (https://www.radiologyinfo.org/en/info/mri-abdomen-pelvis) without and with IV contrast with MR cholangiopancreatography (MRCP) (https://www.radiologyinfo.org/en/info/mrcp), MRI abdomen without IV contrast with MRCP, Tc-99m cholecintigraphy (tracking a tracer given by IV from the liver into the gallbladder and small intestine), and CT abdomen without IV contrast.

With a negative or questionable US with no fever or elevated white blood cell count, MRI abdomen without and with IV contrast with MRCP, MRI without IV contrast with MRCP, or CT abdomen with IV contrast is usually appropriate as next imaging.

In someone who also has a fever and elevated white blood cell count, MRI without and with IV contrast with MRCP, CT with IV contrast, or Tc-99m cholecintigraphy is usually appropriate as the next imaging test.

In cases of gallbladder inflammation without evidence of gallstones (https://www.radiologyinfo.org/en/info/gallstones) or duct obstruction, Tc-99m cholecintigraphy is usually appropriate. CT with IV contrast, CT without IV contrast, MRI without and with IV contrast with MRCP, percutaneous cholecystostomy (placing catheter into the gallbladder), or MRI without IV contrast with MRCP may also be appropriate.

— By Susan Anemone and Jennifer W. Uyeda, MD. This information originally appeared in the Journal of the American College of Radiology.

**Routine Chest Radiography**

Getting a chest x-ray before going into the hospital for an operation or for something routine is not needed unless a patient has heart or lung disease or symptoms of a heart or lung condition. The x-ray does not add information that would change treatment after getting information about the patient's medical history and symptoms and performing the physical examination. Chest x-rays should not be used routinely for the evaluation of patients with high blood pressure unless some type of heart disease is suspected. Chest x-rays are not recommended for routine physical examinations or for lung cancer screening.

For patients older than 70 years, patients with heart or lung disease or who have had heart or lung disease in the past, or if the medical history is not available, having a chest x-ray before an operation or when admitted to the hospital may be appropriate. Also, if a patient is undergoing a high-risk operation, such as emergency surgery, it may be appropriate to have a chest x-ray. However, having a chest x-ray before an operation does not mean that after the operation, during the recovery process, the patient will not have issues with lung function.

Chest x-rays expose patients to radiation. They also can show things that are not associated with the reason for the x-ray, called incidental findings. Sometimes these findings can lead to more tests or treatments that are not really needed. For more information, see the Chest X-ray (https://www.radiologyinfo.org/en/info/chestrad) page.

— By Casey Quinlan. This information originally appeared in the Journal of the American College of Radiology.

**Seizures—Child**

Every year, approximately 120,000 children have a first seizure. To determine what type of imaging test should be performed after a seizure, physicians look at additional symptoms and use the results of an electroencephalogram, a test that measures brain electrical activity.

A simple seizure due to a fever (febrile seizure) typically lasts fewer than 15 minutes and does not recur within 24 hours. Patients
suffering a febrile seizure do not require imaging. A complex febrile seizure lasts longer than 15 minutes and reoccurs within 24 hours. MRI or CT is recommended for patients with complex febrile seizures or if infection or trauma is suspected.

Brain CT (https://www.radiologyinfo.org/en/info/headct) is recommended for a first-time seizure in a child without fever who is younger than 2 years to look for signs of injury resulting from child abuse.

Seizures in newborns (neonatal seizures) are usually due to brain damage due to lack of oxygen or bleeding in the brain. The recommended imaging test is an ultrasound of the head (https://www.radiologyinfo.org/en/info/ultrasound-cranial). MRI of the brain (https://www.radiologyinfo.org/en/info/headmr) without contrast may also be appropriate.

Brain CT without contrast is recommended when a seizure occurs after acute trauma. Follow-up brain MRI without contrast may be beneficial after traumatic brain injury.

In partial seizures (affecting one side of the brain), generalized seizures (affecting the whole brain), and seizures that, even with treatment, recur for more than 12 months (intractable seizure), an MRI without contrast is recommended to look for malformations of the brain.

— By Stacey Tinianov and Dianna M.E. Bardo, MD. This information originally appeared in the Journal of the American College of Radiology.

**Sinonasal Disease**

Most people who have rhinosinusitis, a runny nose, or a stuffed up feeling in their sinuses don't need imaging tests. The patient's symptoms are used to determine the type of rhinosinusitis. If the symptoms are acute and limited to the nose and last less than 4 weeks, no imaging is recommended.

If acute rhinosinusitis comes back more than four times a year, it is considered recurrent acute rhinosinusitis. If the symptoms persist for more than 12 weeks and include mucus draining, pain in the face, stuffy nose, congestion, and a diminished sense of smell, chronic rhinosinusitis is probable. There may also be polyps or a fungus in the nose. In these cases patients may benefit from surgery, and imaging with either CT (https://www.radiologyinfo.org/en/info/sinusct) or cone-beam CT without intravenous contrast is recommended.

If symptoms of acute rhinosinusitis include symptoms pointing to infection in the eye cavity or the brain, MRI (https://www.radiologyinfo.org/en/info/headmr) with and without intravenous contrast is recommended. If the patient can't undergo MRI, a CT scan with contrast is recommended.

If a blockage or mass is suspected because of persistent pain, blocked nasal passages, or bleeding from the nose, both MRI with and without contrast and CT without contrast are recommended.

If a fungal invasion is suspected in the mucus tissues, blood vessels, and/or bones, both CT without contrast and MRI with and without contrast of the sinuses, nearby brain tissues, and eye sockets are recommended.

— By Casey Quinlan. This information originally appeared in the Journal of the American College of Radiology.

**Sinusitis–Child**

Acute sinusitis, the uncomplicated inflammation or swelling of normally air-filled spaces of the skull surrounding the nose (paranasal sinuses), is common in children. Sinusitis may be caused by a virus, bacteria, or fungus. Imaging tests are not recommended for children with acute sinusitis because diagnosis and treatment are based on clinical findings.

If sinusitis does not improve, gets worse even with treatment, or happens when a child is very ill with acute disease, imaging may be needed. CT scan (https://www.radiologyinfo.org/en/info/sinusct) without intravenous (IV) contrast is the best way to examine...
paranasal sinus anatomy or complications of sinusitis. This test may be used to help plan for paranasal sinus surgery.

CT of the paranasal sinuses with IV contrast is recommended when complications of sinusitis are thought to extend to the eye sockets (orbits), skull, or brain. Sometimes paranasal sinus infections cause problems with the blood vessels of the base of the skull. CT or MR angiography and venography are helpful to diagnose involvement of these arteries and veins.

Children with compromised immune systems, especially those with cancers of the blood, are prone to acute and invasive fungal paranasal sinus infection. In these cases, CT and MRI of the head and paranasal sinuses without and with IV contrast are the most appropriate imaging examinations.

— By Celena Romero, PhD, MBA, RD, CPHQ, Dianna M.E. Bardo, MD. This information originally appeared in the Journal of the American College of Radiology.

Staging and Follow-up of Ovarian Cancer

Ovarian cancer is a cancer that begins in the ovary or the adjacent fallopian tube and can spread (metastasize) to the peritoneum (a thin membrane that lines the abdominopelvic cavity), liver, spleen, lymph nodes, and lungs. Imaging tests are used to diagnose and stage ovarian cancer both before and after initial treatment. Staging helps plan treatment. Treatment options include surgical removal of the cancer, chemotherapy, and radiation therapy. Chemotherapy and radiation may be used before surgery to hopefully shrink tumors enough for surgical removal. Monitoring for recurrence includes laboratory test (high CA-125 levels) or a clinical examination.

Contrast-enhanced CT of the pelvis, abdomen, and sometimes the chest is the most appropriate imaging technique for diagnosing and staging initial and recurrent ovarian cancer. CT detects local and metastatic tumors and can be used for guided biopsy to diagnose suspicious masses. CT may not find small tumors, especially in the intestines, peritoneum, and lymph nodes.

A PET/CT scan using fluorine-18-2-fluoro-2-deoxy-D-glucose is used for staging cancer that has metastasized or reoccurred. PET scans are not appropriate for initial diagnosis because they may give false-negative results. PET scans detect metabolic activity (tumors have high metabolism) and help locate microscopic tumors not found on routine CT.

Contrast-enhanced MRI is not used often in ovarian cancer imaging; MRI is a long procedure; if the individual moves the image is not accurate. MRI is appropriate for inconclusive CT scans (borderline tumor findings) and helps preserve fertility (no radiation exposure).

If kidney disease prevents contrast-enhanced imaging, both CT and MRI without contrast may be appropriate. For more information, see the Ovarian Cancer page.

— By Frank Rybicki Jr., Phyllis Glanc, MD. This information originally appeared in the Journal of the American College of Radiology.

Staging of Pancreatic Ductal Adenocarcinoma

Pancreatic ductal adenocarcinoma, cancer of the pancreas, usually causes only vague symptoms until the pancreatic duct is blocked. Surgery with complete removal of the tumor is curative. Thus, it is important to find out if the tumor has spread outside of the pancreas or whether it remains confined to the pancreas and can be...
completely resected (surgically removed).

Multidetector CT (https://www.radiologyinfo.org/en/info/bodyct) (MDCT) with contrast and MRI (https://www.radiologyinfo.org/en/info/bodymr) with and without contrast are both appropriate methods for detecting and staging of pancreatic cancer. MDCT is usually preferred. Pancreatic cancer can spread (metastasize) locally to the adjacent organs like the stomach and peritoneal lining (abdominal membrane surrounding the pancreas and other organs) or distantly via the blood or lymph system to the lymph nodes, liver, lungs, and bones.

An endoscopic ultrasound done with fine-needle aspiration may be appropriate to biopsy suspicious lesions, both in the pancreas and lymph nodes. PET (https://www.radiologyinfo.org/en/info/pet) using fluorine-18-2-fluoro-2-deoxy-D-glucose imaging/CT may also be an appropriate follow-up to see if the cancer has spread.

Depending on stage, pancreatic cancer can either be operated on right away or can require treatment to shrink the tumor in order to allow surgery. If, however, there is metastasis elsewhere, then it can render the patient inoperable.

There are limited data on the appropriate imaging follow-up after the initial treatment to shrink the tumor(s) before curative surgery, but MDCT with contrast and MRI with and without contrast are appropriate in re-evaluating the cancer before the patient undergoes surgery.

See the Pancreatic Cancer Treatment page (https://www.radiologyinfo.org/en/info/pancreatic-cancer-treatment) for more information.

— By Frank J. Rybicki Jr. and Tasneem Lalani, MD. This information originally appeared in the Journal of the American College of Radiology.

**Suspected Acute Aortic Syndrome**

Acute aortic syndrome (AAS) is caused by abnormalities affecting the wall of the aorta. The aorta is the main blood vessel that carries blood from the heart to the rest of the body. People with AAS typically have sudden severe pain in the front or back of their chest. Risk factors include high blood pressure and family history. Rapid diagnosis of AAS is important to guide medical or surgical treatment and to avoid serious harm, including death.

For diagnosis of AAS, transesophageal echocardiograph; specialized ultrasound (https://www.radiologyinfo.org/en/info/abdominus) of the aorta; chest x-ray (https://www.radiologyinfo.org/en/info/chestrad); MR angiography (https://www.radiologyinfo.org/en/info/angiomr) (MRA; MRI of arteries) chest or MRA chest, abdomen, and pelvis with and without intravenous (IV) contrast; CT chest or CT chest, abdomen, and pelvis without or without and with IV contrast; and CT angiography (https://www.radiologyinfo.org/en/info/angioct) (CTA; CT scan of arteries) chest or CTA chest, abdomen, and pelvis with IV contrast are usually appropriate.

Other imaging examinations, such as transthoracic echocardiography; aortography chest; MRA chest or chest, abdomen, and pelvis without IV contrast; MRI chest, abdomen, and pelvis without IV contrast; CT chest without IV contrast; and CTA chest or coronary arteries with IV contrast, may be appropriate.

For more information, see the Abdominal Aortic Aneurysm (AAA) page (https://www.radiologyinfo.org/en/info/abdoaneurysm).

— By Emily Hahn and Dianna M.E. Bardo, MD. This information originally appeared in the Journal of the American College of Radiology.

**Suspected Appendicitis—Child**

Suspected Appendicitis—Child
The appendix is a finger-shaped pouch off the first part of the colon. Appendicitis ([https://www.radiologyinfo.org/en/info/appendicitis](https://www.radiologyinfo.org/en/info/appendicitis)) is inflammation of the appendix. Symptoms of appendicitis include pain, appetite loss, nausea, and vomiting, but these symptoms also occur for other illness and disease conditions, sometimes making appendicitis hard to diagnose. Appendicitis is most common in adolescents, less common in infants and preschool children, and rare in newborns. The most common treatment is an appendectomy, the surgical removal of the appendix. Clinical diagnosis uses scoring systems to assess the level of risk and to help determine the best imaging test to confirm diagnosis.

Imaging tests are not recommended for children identified to be at low risk.

US abdomen ([https://www.radiologyinfo.org/en/info/abdomus-pdi](https://www.radiologyinfo.org/en/info/abdomus-pdi)) right lower quadrant (RLQ) or US abdomen is usually an appropriate imaging test for children identified to be at intermediate risk for appendicitis.

Children identified to be at high risk may have an appendectomy without imaging. When imaging is performed, CT abdomen and pelvis ([https://www.radiologyinfo.org/en/info/abdominet](https://www.radiologyinfo.org/en/info/abdominet)) with intravenous (IV) contrast, MRI abdomen and pelvis ([https://www.radiologyinfo.org/en/info/mri-abdomen-pelvis](https://www.radiologyinfo.org/en/info/mri-abdomen-pelvis)) without IV contrast, or ultrasound abdomen RLQ may be appropriate.

CT abdomen and pelvis with IV contrast, MRI abdomen and pelvis without IV contrast, or MRI abdomen and pelvis without and with IV contrast is usually appropriate following a nondiagnostic ultrasound abdomen RLQ in children with suspected acute appendicitis.

CT of the abdomen and pelvis with contrast is usually appropriate for assessment of complications of appendicitis either as initial imaging or as follow-up imaging after initial imaging shows complications such as an abscess or bowel obstruction.

— By Celena Romero, PhD, MBA, RDN, CPHQ, CPASRM, and Dianna M.E. Bardo, MD. This information originally appeared in the *Journal of the American College of Radiology*.

**Suspected Lower Extremity Deep Vein Thrombosis**

Lower extremity deep vein thrombosis (DVT), a blood clot in the lower leg, only happens to a small percentage of the general population. When DVT is clinically suspected, imaging is typically done to evaluate the thrombus (blood clot) in the leg because the clot can move toward the lung. This creates a life-threatening condition called pulmonary embolism. DVT typically starts in the leg close to the ankle but it can come from further up the leg, above the knee, and in the pelvis.

Locating the area of the DVT is important because there is a greater risk of a pulmonary embolism if the DVT is above the knee. Ultrasound (US) ([https://www.radiologyinfo.org/en/info/venousus](https://www.radiologyinfo.org/en/info/venousus)) duplex Doppler is used to find and diagnose suspected lower extremity DVT. Doppler imaging helps show blood flow and if the clot is totally blocking or partially blocking the blood vessel.

US is used because it is the most accurate test for diagnosing DVT close to the knee. It is not as accurate for diagnosing blood clots below the knee. In some patients, CT venography ([https://www.radiologyinfo.org/en/info/venography](https://www.radiologyinfo.org/en/info/venography)) with contrast or MR venography with and without contrast or MR venography without contrast of the lower extremities is also appropriate to make the diagnosis of the blood clot in the leg. For more information, see the Blood Clots ([https://www.radiologyinfo.org/en/info/bloodclot](https://www.radiologyinfo.org/en/info/bloodclot)) and Pulmonary Embolism ([https://www.radiologyinfo.org/en/info/pulmonary-embolism](https://www.radiologyinfo.org/en/info/pulmonary-embolism)) pages.

— By Lauren Yates, Frank J. Rybicki, MD, PhD. This information originally appeared in the *Journal of the American College of Radiology*.

**Suspected Spine Trauma**

Imaging of the cervical spine (neck) is usually not appropriate in individuals 16 to 65 years old who do not meet high-risk criteria for injury on clinical examination.
For individuals 16 years or older with suspected acute cervical spine blunt trauma who meet high-risk criteria on clinical 
examination, CT (https://www.radiologyinfo.org/en/info/spinect) without intravenous (IV) contrast is usually appropriate; x-rays 
may also be appropriate. CT without contrast is also appropriate if acute spinal injury is found on x-rays and in cases in which no 
unstable injury was found at first, but the individual had a neck collar for neck pain.

MRI (https://www.radiologyinfo.org/en/info/spinemri) without contrast may also be appropriate in these cases as well as when 
injury to the ligaments is seen on cervical CT or suspected from clinical examination or if there is reduced alertness even with a 
negative CT.

MRI without IV contrast is usually appropriate as the next imaging test if a cervical CT shows or suggests a spinal cord or nerve 
root injury with or without traumatic injury. A CT myelography (https://www.radiologyinfo.org/en/info/myelography) (CT with 
contrast material injected into the spine) may also be appropriate.

If injury to arteries is suspected from cervical CT, CT angiography (https://www.radiologyinfo.org/en/info/angioct) with contrast 
or MR angiography (https://www.radiologyinfo.org/en/info/angiomr) with and without contrast is usually appropriate.

In individuals meeting criteria for thoracic and lumbar spine imaging, a CT without IV contrast is usually appropriate. X-rays may 
be appropriate. If acute injury is detected, the next appropriate imaging test is MRI thoracic and lumbar spine without contrast. CT 
myelography thoracic and lumbar spine may be appropriate.

— By Susan Anemone and Bruno Policeni, MD, MBA. This information originally appeared in the Journal of the American 
College of Radiology.

Suspected Thoracic Aortic Aneurysm

Thoracic aortic aneurysm (TAA) is an increase in size of the aorta, a large main artery leading away from the heart in the chest. 
Patients with a TAA do not usually have symptoms, but some experience chest or back pain.

When TAA is suspected, both CT angiography (CTA) (https://www.radiologyinfo.org/en/info/angioct) and MR angiography 
(MRA) (https://www.radiologyinfo.org/en/info/angiomr) are appropriate to determine the size of the aorta and to assess other 
problems with the blood vessels in the chest. CTA always uses contrast; MRA is typically done with intravenous contrast but can 
also be done without contrast for people in whom contrast should not be used.

Several tests may be appropriate. These include a chest x-ray (https://www.radiologyinfo.org/en/info/chestrad), which is often 
done in the urgent care setting. Chest CT (https://www.radiologyinfo.org/en/info/chestct) without contrast can show the size of 
the blood vessels and any abnormal calcium deposits. It can also show that there is no aneurysm, but it does not give as much 
detail as a CTA.

Echocardiography is a specialized ultrasound test that can show parts of the thoracic aorta and may be appropriate when a TAA is 
suspected. The ultrasound probe can either be placed noninvasively on the chest (transthoracic) or be placed within the esophagus 
(transesophageal) on a specialized device to acquire the images.

— By Andrea Borondy Kitts, MS, MPH, and Frank J. Rybicki, MD, PhD. This information originally appeared in the Journal of 
the American College of Radiology.

Thoracic Aorta Interventional Planning and Follow-Up

Thoracic endovascular aortic repair (TEVAR) treats an aneurysm of the aorta with a procedure that is less invasive than open 
surgery. The aorta is the main artery from the heart, and an aneurysm refers to abnormal enlargement of an artery. In TEVAR, the 
physician uses a catheter-based system to treat the aneurysm by strengthening the wall and limiting growth of the weakened aorta 
wall.
Usually appropriate imaging before TEVAR includes CT angiography (CTA) ([https://www.radiologyinfo.org/en/info/angioct](https://www.radiologyinfo.org/en/info/angioct)) of the chest, abdomen, and pelvis to identify the extent and size of the aorta. These images allow physicians to decide on the best method to correct the aneurysm while minimizing complications.

MR angiography (MRA) ([https://www.radiologyinfo.org/en/info/angiomr](https://www.radiologyinfo.org/en/info/angiomr)) may be appropriate imaging as well, particularly MRA without contrast for individuals for whom contrast material should not be used. Ultrasound, echocardiography, radiography, and some nuclear medicine tests may also be appropriate to evaluate conditions related to the aneurysm.

After TEVAR, CTA is usually appropriate to make sure there are no complications. MRA may be appropriate, and in patients for whom contrast material should not be used, noncontrast imaging may be appropriate. *For more information, see the Abdominal Aortic Aneurysm ([https://www.radiologyinfo.org/en/info/abdoaneurysm](https://www.radiologyinfo.org/en/info/abdoaneurysm)) page.*

— By Celena Romero, PhD, MBA, RD, CPHQ, Frank Rybicki, MD, PhD. This information originally appeared in the *Journal of the American College of Radiology.*

**Thyroid Disease**

Imaging tests of the neck assist in the diagnosis and management of thyroid conditions ([https://www.radiologyinfo.org/en/info/thyroid-disease](https://www.radiologyinfo.org/en/info/thyroid-disease)) including thyroid cancer. Ultrasound (US) ([https://www.radiologyinfo.org/en/info/us-thyroid](https://www.radiologyinfo.org/en/info/us-thyroid)) is usually the first imaging test used. For nodules in the neck, US is usually appropriate to determine cancer risk. CT ([https://www.radiologyinfo.org/en/info/bodyct](https://www.radiologyinfo.org/en/info/bodyct)) with or without intravenous (IV) contrast may also be appropriate. For suspected enlarged thyroid (goiter), US or CT without IV contrast is usually appropriate. CT with IV contrast, MRI ([https://www.radiologyinfo.org/en/info/bodymr](https://www.radiologyinfo.org/en/info/bodymr)), or nuclear medicine scan ([https://www.radiologyinfo.org/en/info/thyroiduptake](https://www.radiologyinfo.org/en/info/thyroiduptake)) may also be appropriate. If overactive thyroid (hyperthyroidism) or excessive thyroid hormone (thyrotoxicosis) is suspected, US or nuclear medicine thyroid scan is usually appropriate. Imaging is not required for diagnosis of underactive thyroid (hypothyroidism).

US or CT of the neck with IV contrast is usually appropriate before thyroid cancer surgery. CT without IV contrast or MRI with and without contrast may also be appropriate. After treatment for thyroid cancer, US is appropriate to check for residual cancer. MRI of the neck with and without contrast or nuclear medicine full-body scan may also be appropriate. US or CT with IV contrast may be used periodically after treatment to check if cancer has returned (surveillance). If cancer is suspected to have returned, CT of the neck with IV contrast, MRI of the neck with and without contrast, or nuclear medicine full-body scan is usually appropriate. For monitoring medullary thyroid cancer, a type of cancer more likely to spread to other tissues and organs, US, CT with IV contrast, or MRI with and without contrast is usually appropriate.

*For more information, see the Thyroid Disease page ([https://www.radiologyinfo.org/en/info/thyroid-disease](https://www.radiologyinfo.org/en/info/thyroid-disease)).*

— By Shannon Rose, MPH, COTA/L, CPASRM and MacArinze Ojiaku, MD. This information originally appeared in the *Journal of the American College of Radiology.*

**Tinnitus**

Tinnitus is a perceived sound in a person's ears that only they can hear, without an identifiable external source. The noise can be intermittent or continuous. Tinnitus is common and occurs in 10% of people.

There are two types of tinnitus:

- **Pulsatile tinnitus:** sound occurring with the person's heartbeat; usually from a problem in the blood vessel system
- **Nonpulsatile tinnitus:** most common type, often described as ringing, buzzing, or clicking

If no findings are seen on a physical examination of a person's ears, then the doctor may order imaging tests.
If pulsatile tinnitus is suspected, a CT angiography (CTA) of the head, CTA of the head and neck, or CT of the temporal bone without intravenous (IV) contrast is usually appropriate. MRI or MR angiogram of the head without IV contrast, MR venography with and without IV contrast, arteriography of the head and neck, ultrasound of the carotid arteries, or CT of the temporal bone with IV contrast may be appropriate.

If nonpulsatile tinnitus is suspected, and only in one ear, MRI of the head and ear canals with and without IV contrast is usually appropriate. MRI of the head without IV contrast, or CT of the temporal bone with or without IV contrast, or CTA of the head with IV contrast may be appropriate.

If the individual has nonpulsatile tinnitus in both ears, imaging tests are not usually appropriate. If there is hearing loss or head trauma associated with the tinnitus, following Appropriateness Criteria for those conditions is recommended.

— By Casey Quinlan, Jennifer W. Uyeda, MD. This information originally appeared in the Journal of the American College of Radiology.

**Transcatheter Aortic Valve Replacement**

A common cause of heart disease is buildup of calcium in the aorta that causes narrowing and stiffness of the aortic heart valve (aortic stenosis). Transcatheter aortic valve replacement (TAVR) is a procedure to replace the aortic heart valve by going through an individual's larger blood vessels (for example, arteries located in the groin or neck or under the clavicle). It is an alternative for people that might do poorly if they have open heart surgery.

When planning for TAVR, precise measurements of the dimensions of the person's aorta, at the location of the heart valve, are important for picking the right size and shape of the artificial valve. Measurements of the aorta and connected arteries are also important to figure out if blood vessels are big enough for the artificial valve to go through and to select the path with lowest risk. CT angiography (CTA) with intravenous contrast is recommended to show blood vessels of the chest, abdomen, and pelvis. CTA data reduce the chance of complications with the procedure.

CTA without contrast is not good enough for planning TAVR. In people with CT contrast allergy, ultrasound (echocardiography) of the heart can measure the size of the aorta but is not good enough for planning the TAVR. For these individuals, MR angiography (MRA) with contrast is a better alternative. MRA is limited in showing the amount of calcium and cannot be used in people with some implants, claustrophobia, or irregular heart rhythms.

— By Søren Meibom, PhD, and Bruno Policeni, MD, MBA. This information originally appeared in the Journal of the American College of Radiology.

**Trauma Head Child**

Head injuries in children can be dangerous and should be evaluated by a doctor. The Glasgow Coma Scale test helps determine if imaging tests are needed. In children with Glasgow scores less than 13 or with Glasgow scores greater than or equal to 13 with no symptoms of an injury, imaging is often not needed. If the test is equal to or more than 13 and the child has symptoms of a possible injury or if the score is less than 13, a CT scan without contrast is recommended. A CT scan helps identify bleeding, brain tissue damage, fluid in the brain, or skull fractures. The main risk to a child having a CT scan is exposure to radiation.

MRI does not use radiation and is better at finding areas of traumatic damage in the brain than a CT test. MRIs need the child to stay still for a long time, so the doctor may give the child calming medication. MRI is often used to follow up if the symptoms do not go away or if there are new symptoms.
A CT scan of the head is the preferred test when child abuse is suspected. An MRI can be done if the CT scan does not show anything. MRI is better than a CT scan at evaluating areas of brain injury that are more likely in child abuse. An MRI of the top of the spine should also be considered in these cases because there is often damage in this area as well.

For more information, see the Head Injury page [https://www.radiologyinfo.org/en/info/headinjury](https://www.radiologyinfo.org/en/info/headinjury).

— By Celena Romero, RD, MBA, CPHQ, and Ryan K. Lee, MD, MBA, MRMD. This information originally appeared in the Journal of the American College of Radiology.

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