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.

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) – 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 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 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 (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. 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 Kidney and Bladder Stones 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, is immunocompromised, or is not responding to treatment.

A CT of the abdomen and pelvis with or without intravenous (IV) contrast is usually the most appropriate test for adults. An MRI 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 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 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.

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 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 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.
Asymptomatic Patient at Risk for Coronary Artery Disease

There are many imaging tests that can detect the signs of early heart disease in people without any symptoms. Finding heart disease early can help doctors and patients treat it and may prevent future events. These imaging tests are usually not appropriate for patients if they have low risk scores on common heart risk assessment tests like the Framingham risk score or the Systematic Coronary Risk Evaluation.

For low-risk patients who don't have any symptoms but have strong family histories of heart disease, it may be helpful to use CT to determine the coronary artery calcium score (CACS). The CACS is a measure of the calcium buildup on the walls of the arteries around the heart and has been found to be a good indicator of future cardiac events such as heart attacks. For intermediate-risk patients without symptoms, measuring the CACS is usually appropriate because it helps find people who are at higher risk than suggested by their calculated heart risk assessment scores. For more information, see the Cardiac CT for Calcium Scoring page.

There are several imaging tests that may be appropriate for people at high risk who don't have any symptoms. This group includes people with type 2 diabetes, who have a higher risk for heart disease than people without diabetes. These tests include coronary CT angiography, a test that can detect blockages in the arteries around the heart, a heart stress test using MRI, myocardial perfusion imaging (a nuclear medicine test), and echocardiography, a type of ultrasound test of the heart. For more information, see the Cardiac (Heart) Screening page.

Breast Cancer Screening

Women with low lifetime risk of breast cancer (or digital breast 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 may be appropriate for women who have dense breast tissue but is associated with more false-positive findings. Screening using MRI 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 page for more information.

Breast Imaging of Pregnant and Lactating Women

Pregnant women under the age of 30 at high risk for 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 with lead shielding to minimize radiation exposure to the fetus. Alternatively, screening may be performed using digital breast tomosynthesis (DBT), a 3-D mammographic technology. Ultrasonography may be used as an additional screening tool for patients with 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 for more information.

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 that may occur a year after surgery. Patients with implants and without symptoms should continue routine breast screening.
A saline-implant rupture is often diagnosed with a physical examination. If imaging is needed, ultrasound (US) should be used for people under 30. For people 30 to 39 years old, a mammogram, digital breast tomosynthesis (DBT), or US may be used. A mammogram or DBT is the best test for people 40 and older.

MRI 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.

**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. 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 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 or MRI 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 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 tendonitis. Ultrasound 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
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. Some conditions need additional imaging tests for diagnosis or to plan for treatment. MRI 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, 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 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 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.

Colorectal Cancer Screening

Cancer in the bowel (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 (also known as virtual colonoscopy), double contrast barium enema, 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, 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.

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 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 is used in cases of chronic (ongoing) suspected traumatic brain injury. If blood vessel injury is suspected then CT angiography or MR angiography 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 page.

Δ 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.
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, either with or without contrast, is recommended. For more information, see the Headache page.

By Casey Quinlan. 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 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 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.

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 or MR angiography) 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 page.
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 without contrast or ultrasound may be appropriate.

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 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 (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 (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.

### 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, and MRI of the abdomen. 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, 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 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 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. 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 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) 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 or MR angiography 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 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, digital breast tomosynthesis (DBT), and breast ultrasound (US) 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 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 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 page.

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

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 and CT 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) or MR angiography (MRA) 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) 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 page.

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

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**Post-treatment Follow-up of Prostate Cancer**

Men who have been treated for 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 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 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 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 and CT of the abdomen and pelvis with intravenous contrast can be done in place of the specialized PET/CT scan.

See the Prostate Cancer Treatment page for more information.

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**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 shows the entire urinary tract (CT 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) 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, it is appropriate to get a chest CT with or without contrast.

A PET/CT scan 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.

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**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) 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 prostatemay 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 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.

High-risk prostate cancer should be monitored using CT of the abdomen and pelvis with intravenous contrast and a bone scan of the whole body.

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 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 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 page.

By Roberta Savo, Karin E. Dill, 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 is the most common concern. Imaging can be helpful to find the source of the pain.

Ultrasound (US) abdomen 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 with intravenous (IV) contrast, MRI abdomen without and with IV contrast with MR cholangiopancreatography (MRCP), MRI abdomen without IV contrast with MRCP, Tc-99m cholescintigraphy (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 cholescintigraphy is usually appropriate as the next imaging test.

In cases of gallbladder inflammation without evidence of gallstones or duct obstruction, Tc-99m cholescintigraphy 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 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 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. MRI of the brain 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, M.D. 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 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 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 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. MRI without and with IV contrast may be needed when meningitis, an infection that goes into the brain, is a probable diagnosis. 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, M.D. 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 (MDCT) with contrast and MRI 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 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 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 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) 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 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 and 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 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 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 (CT with contrast material injected into the spine) may also be appropriate.

If injury to arteries is suspected from cervical CT, CT angiography with contrast or MR angiography 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.

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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) 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) 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 page.

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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, with and without IV contrast, is also usually appropriate. 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 at 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.

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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