Adverse Reactions to Contrast Agents: Dispelling the Myths

1.50 Contact Hours

Author: Charmaine Robinson

Outcomes

≥ 92% of participants will know how to recognize adverse reactions to contrast agents.

Objectives

After completing this continuing education course, the participant will be able to:

1. Associate diagnostic studies with respective contrast agents.
2. Identify strategies for preventing adverse reactions and complications from contrast use.
3. Recognize factors that place a patient at greater risk of experiencing a contrast adverse reaction or complication.
4. List examples of allergic and physiological reactions to contrast agents.
5. Characterize acute kidney injury.
6. Summarize the length of time contrast reactions can occur after administration.
7. Analyze the pharmacodynamics of contrast agents.

Introduction

CT Scan

Pin it

How many times have you heard the phrase "CT with and without contrast?" While it is important to know whether your patient needs a diagnostic test with contrast versus without, how much do you know about the effect of contrast agents on the body? Sure, you may have been taught that contrast agents can negatively affect the kidneys. However, if you are honest, you might agree that a knowledge gap exists among many nurses about the pharmacology of these specialized, diagnostic agents. Contrast agents are not only pertinent to radiology technicians or nurses working in radiology. All nurses should be aware of the contrast agents administered to their patients, as they can cause reactions well beyond the time spent in the radiology department.

Imagine your patient, who recently returned from the radiology department after a computed tomography (CT) scan with contrast, suddenly develops high blood pressure. How likely would you attribute their condition to the contrast agent? How many times have you heard "Push fluids to flush out the contrast!" in reference to intravenous (IV) contrast, but does this also apply to oral contrast? Does a shellfish allergy automatically mean an iodine allergy? Let us learn about contrast agents and their potential for adverse effects and complications while dispelling some myths that can negatively impact our patients.

Historical Overview of Early Imaging and Contrast Agents

Contrast agents, also called contrast media or opacification agents, are a fairly new discovery introduced in the late 19th century. Radiographic tests were introduced in the late 1800s and became increasingly popular during World War I (Bonnemain, 2021). Contrast agents were soon to follow, primarily in oral form, to help diagnose gastrointestinal conditions (American College of Radiology [ACR], 2025). In the early 1920s, two physicians, Jean-Athanase Sicard and Jacques

Forestier, introduced a contrast that was injectable in the subarachnoid space. This exploration sparked a journey of new discoveries and improvements over the following 30 years, including contrast for X-rays and ultrasounds, IV injections of sodium iodine, and other agents to opacify certain parts of the body, such as the bile duct.

However, with new discoveries come new challenges. By the 1970s, it was becoming clear that contrast agents were causing unpleasant side effects such as heat sensation and pain during certain radiographic tests with IV contrast (i.e., peripheral arteriography) – so much so that general anesthesia was required due to pain in some cases (Bonnemain, 2021). Despite these challenges, contrast agents remained favored, particularly IV iodinated contrast used in CT scans. This contrast was applauded for its quick diffusion, leading to the identification of brain lesions and tumors in less than 20 minutes after injection.

Over time, new radiographic tests emerged, such as the magnetic resonance imaging (MRI) machine, which was initially used to diagnose brain abnormalities. Some researchers had hoped this new advancement would limit the need for contrast agents. However, as nature would have it, other researchers wanted to test the machine's potential by developing a contrast to accompany its use. Today, the MRI with contrast is a highly dependable test to diagnose pathologies of multiple body systems. From oral bariums to synthetic oils to contrast for MRIs, contrast agents have historically been revered for their purposeful use in diagnostic testing.

Purpose of Contrast Agents

Today, contrast agents are used for all imaging modalities, including ultrasonography (US), fluoroscopy, CT, and MRI. Contrast media are chemicals used primarily to delineate borders between tissues to obtain diagnostic information (Mafraji, 2025b; Rogers & Tadi, 2023). However, administering contrast agents is not a benign endeavor. The administration of contrast agents comes with inherent risks that need to be mitigated, and when contrast reactions occur, they need to be appropriately managed. Therefore, providers must understand and consider the potential risks associated with each respective contrast agent.

There is a plethora of information regarding adverse reactions to contrast agents. However, the etiology of these contrast reactions is not completely understood and is likely multifactorial. As such, it is important to understand each contrast agent's pharmacology and the associated adverse reactions. This course will discuss in detail the contrast agents used for radiography and fluoroscopy, CT, and MRI. We will then discuss risk factors for adverse reactions to contrast reactions, each type of reaction, and how to manage them.

Types of Contrast Agents

Contrast agents can be administered by mouth, intravenously, per rectum, intrathecally (into the epidural space), intravesically (bladder), or into joint spaces (arthrograms). The ability to administer these contrast agents in many ways and via many routes, including ostomies, allows radiologists and other clinicians to enhance the differences between tissues that would normally be very close in attenuation. In the world of imaging today, the use of contrast is ubiquitous for most imaging modalities, especially CT imaging.

The primary routes of delivery for CT contrast are intravenous and enteric (oral and rectal). Intravascularly-administered agents are iodinated material that moves quickly into the extracellular fluid. No significant metabolism or transformation occurs. Excretion is primarily through the kidneys.

Intravenous Iodine Agents

IV iodinated contrasts are primarily used for CT scans and are the most popular of all contrast agents (Rogers & Tadi, 2023). Usually, water-soluble contrast agents are used IV in CT imaging for better visualization of vascular structures and hypervascular tissues.

IV contrasts were once used routinely for X-rays. This is no longer in practice. While iodine is a natural element found in humans, it can be toxic in contrast if not changed to a larger molecular structure by a binding agent. In the past, binding agents had very high osmolality (five to eight times that of blood) (Rogers & Tadi, 2023). Over time, due to adverse reactions such as severe pain, lower osmolality binding agents began to be favored (only three times the osmolality of blood). Lowering the osmolality, ion levels, and viscosity of IV contrast agents makes them less likely to cause complications (ACR, 2025; Rogers & Tadi, 2023). Iodinated IV contrast has a plasma half-life of two hours. After 24 hours, the contrast should have cleared from the bloodstream in patients without renal impairment, as the contrast is excreted primarily through the kidneys (Rogers & Tadi, 2023).

The risk of adverse reactions from iodinated contrast agents used in imaging is well-established (ACR, 2025). However, the exact etiology of contrast reactions after intravascular iodinated contrast agents is not well known (ACR, 2025). The average incidence of allergic reactions for nonionic formulations is approximately 3% or less. The assumption is that the incidence of ionic contrast agents is higher than that of nonionic contrast agents. Low-osmolality nonionic compounds are associated with fewer adverse reactions when administered via IV. Nonionic iso-osmolar agents are hydrophilic. These hydrophilic agents are better for use in patients at increased risk for contrast-induced acute kidney injury (CI-AKI) (will be discussed later).

Gastrointestinal Agents

Gastrointestinal contrast agents primarily include oral iodine-based agents and oral bariums (Patel et al., 2024). Rectal agents are an option as well. Unlike iodine-based agents, which are absorbed systemically, bariums are less likely to be absorbed in the bloodstream, making them ideal for preventing iodine-related adverse reactions (Patel et al., 2024). However, iodine-based agents are less favored due to taste and expense. This course will focus on bariums.

Barium sulfate mixtures are used to opacify the bowel during fluoroscopies, CT, and MRIs of the gastrointestinal system (ACR, 2025). Barium sulfate comes in a powder form and may need to be reconstituted with water. Administration volume may vary depending on the study performed and the patient's anatomy. The contrast agent is administered orally about 1.5-2 hours prior to imaging to allow for appropriate transit within the bowel. High-osmolality iodinated contrast agents should be avoided in patients who are at risk for aspiration (ACR, 2025; U.S. Food and Drug Administration [FDA], 2020). Aspirated high-osmolality contrast agents can cause chemical pneumonitis with associated pulmonary edema. Aspiration of large volumes of both barium-based and iodinated oral contrast agents has rarely been reported as fatal.

A main complication of oral contrast is leakage into the mediastinum or peritoneal cavity, which can lead to mediastinitis and peritonitis (ACR, 2025). Leakage can occur in conditions including gastrointestinal fistulas, ulcers, lesions, inflammatory bowel disease, diverticulitis, or appendicitis (FDA, 2020). Contraindications to barium contrast include allergy, known bowel obstruction, and known or suspected bowel perforation. Clinicians should encourage increased

fluid intake after barium administration as this type of contrast is not water-soluble and can cause constipation, obstruction, or impaction (ACR, 2025; FDA, 2020).

Intravenous Gadolinium-Based Agents

Gadolinium-based contrast agents (GBCAs) are used for MRIs and magnetic resonance angiography (MRAs). GBCAs are composed of gadolinium, a rare earth heavy metal toxic to humans in its raw form (Choi & Moon, 2019). For this reason, all gadolinium-based contrast agents are chelated (bonding of ions) to make them less toxic or non-toxic while also allowing for renal excretion. While GBCAs are deemed generally safe when administered in recommended doses, they do carry risks (Choi & Moon, 2019). Mild reactions from the composition of gadolinium-based agents typically occur in about 1% of all patients (ACR, 2025). The most common are headache, nausea, vomiting, itching, rash, distorted taste, and cold sensation at the injection site (Ibrahim et al., 2023; Mafraji, 2025a). Severe and anaphylactic reactions are extremely rare.

In 2018, the FDA reported that gadolinium can remain in patients' bodies, including the brain, for months and even years after receiving the agent (FDA, 2018). Patients at risk for GBCA retention include those who require multiple lifetime doses, pregnant people, children, and patients with inflammatory conditions. While GBCA retention is not necessarily problematic in patients with normal kidney function, gadolinium is excreted in the kidneys, and patients with kidney failure are at an increased risk for developing nephrogenic systemic fibrosis (will be discussed later) (FDA, 2018).

Despite these risks, clinicians are discouraged from avoiding diagnostic tests requiring contrast agents for patients who need them. Rather, they should minimize repeated studies if possible and ensure patients are aware of all risks.

Intravenous Ultrasound Agents

Unlike CT and MRI contrasts, ultrasound IV contrast consists of injected microbubbles within solutions/fats/crystals (Frinking et al., 2020). The use of ultrasound contrast agents in the U.S. is not yet ubiquitous but continues to gain considerable ground for certain applications, particularly cardiac imaging. Microbubble compounds contrast ultrasound imaging by altering the acoustic impedance between the blood and the injected gas/air. For example, when evaluating for cardiac shunts (blood flow deviations within the heart due to holes in the chamber walls), a patient may undergo an echocardiogram with "agitated saline." This exam is performed by an ultrasound technician and a nurse. The tech takes images of the heart while the nurse agitates a saline flush syringe and injects the tiny air bubbles within the saline into the patient's bloodstream through an IV. As the saline quickly flows through the vascular system, the tech observes for movement of the bubbles from one chamber to another through the heart wall, indicating that a tiny hole exists in the wall.

Other off-label uses of ultrasound agents in practice (or under investigation) include (ACR, 2025):

- Assessment of blood flow dynamics in tumors.
- Differentiation of benign kidney cysts from solid kidney masses.
- Detection of solid organ injury (in trauma cases).
- Detection of bowel wall inflammation in Crohn's disease.
- Detection of endoleaks after abdominal aortic aneurysm repair.

Although ultrasound contrast bubbles are very small, they are too large to move through the extracellular space like CT and MRI contrast. Instead, the bubbles stay in the vascular system for about ten minutes before they rupture and dissolve on their own (the gas is eliminated through the lungs) (ACR, 2025). Ultrasound contrasts are generally safe and do not carry the risk of nephrotoxicity when administered in approved doses.

The first ultrasound agent was introduced in the late 1960s, and more solutions and encapsulations were used over time, including lipids and human albumin (Frinking et al., 2020). Although ultrasound contrast agents are a progressive development, one challenge is bubble size as some are not the appropriate size for optimal imaging of certain body regions. Broad clinical acceptance of ultrasound contrasts beyond cardiology requires further research and development.

Risk Factors for Adverse Reactions

Providers and other clinical team members are encouraged to review each patient's risk factors as they pertain to contrast reactions prior to the administration of these contrast agents (ACR, 2025). Nurses and radiology technicians play a critical role in identifying that the patient's risk factors have been reviewed comprehensively. Although it is the ordering provider's responsibility to ensure that the patient's history is thoroughly reviewed, each member of the clinical team should be aware of these factors and must be encouraged to speak up if they feel something is being overlooked by other team members.

As is the case with any diagnostic exam or procedure, the ordering provider and the radiologist must carefully consider the risk to the patient versus the benefits of the diagnostic exam. For example, a patient who reports an "allergic" reaction of nausea and vomiting with the administration of iodinated contrast presents with symptoms concerning acute pulmonary embolism. The ordering provider must first understand that while contrast agents may elicit nonideal physiological responses in a patient, the risk of this possible reaction may outweigh the risk of delaying the diagnosis of a potentially life-threatening condition.

In addition to evaluating the risk/benefit ratio for each diagnostic or therapeutic test prior to administering the contrast agent, alternatives to the test currently ordered must also be considered. The radiologists will provide insight into whether these alternatives can answer the clinical question. For example, an indication of chest pain would not warrant ordering a transvaginal ultrasound or MRI of the pelvis.

The need for signed consent for the administration of contrast agents depends on the state law, department policy, and institutional policy. Most facilities do not require signed consent to administer contrast materials. However, special circumstances may warrant a consent.

Risk factors for contrast reactions include history of prior reaction, asthma, cardiovascular disease, anxiety, age, and renal disease (ACR, 2025). Each will be discussed in this section.

History of Prior Allergic Reactions

It is common knowledge that any history of allergic reactions predisposes individuals to future allergic reactions to other substances. A history of allergic reactions is sometimes challenging to evaluate in clinical practice because the definition of allergic reactions is not as clear to a patient reporting them as it is to providers, nurses, and other healthcare team members. For example, seasonal rhinitis is a very common allergy, but this would not be a symptom that would be documented as an allergic reaction.

A prior allergy-like reaction to contrast media increases the risk of a subsequent reaction by up to five-fold (the risk is two- to three-fold for those without prior allergic reactions) (ACR, 2025). If the patient reports a history of allergies, the providers and other clinical staff should focus specifically on the type of reaction, the specific contrast agent involved in the reaction (not just the agent class), the type of symptoms experienced, and the duration of the symptoms. The goal here is to establish the severity of the "allergy reaction" in order to clearly identify patients who may be atopic.

Past Medical History

Pin it

Atopy is defined as a genetically determined propensity to produce specific immunoglobulin E (IgE) following exposure to an allergen (Justiz Vaillant et al., 2024). Once this occurs, the patient is sensitized, but it is important to note that sensitization does not imply that the host exposed is allergic to that specific allergen. Individuals sometimes produce IgE to allergens in a given substance but never go on to develop symptoms upon subsequent exposure to that substance. It is not fully understood why certain individuals develop active allergic disease while others are only sensitized. The main concern is that patients who are atopic could experience more severe reactions with each exposure, potentially leading to a future anaphylactic reaction.

Asthma

A history of asthma may confer an increased risk of developing an allergic reaction to contrast agents (particularly bronchospasm). Because the risk is so low, clinicians are advised against withholding contrast (or pre-medicating) for patients with asthma.

Cardiovascular Disease

Patients with cardiovascular disease issues such as angina, congestive heart failure, severe aortic stenosis, primary pulmonary hypertension, or cardiomyopathy are at risk for adverse reactions to contrast agents, particularly cardiac-related reactions. In this group of patients, the volume of contrast and the osmolality of the contrast agents administered are critical because these two factors affect the cardiovascular status significantly. As with asthma, clinicians are advised against withholding contrast due to the low risk.

Anxiety

There are a few studies that have shown that the patient's emotional state can affect the occurrence of adverse effects to contrast agents. In a patient with a known history of anxiety, pre-medication with anti-anxiety medications or reassurance prior to the test can be helpful.

Age

Infants and neonates are at increased risk for adverse effects of contrast agents. Contrast volume is an important consideration because of the low blood volume of patients in this age group. Low blood volume makes them at increased risk for hyperosmolality with its associated cardiotoxic effects.

Renal Insufficiency

Renal insufficiency prior to the administration of iodinated contrast increases the risk of CI-AKI and nephrogenic systemic fibrosis, which will be discussed later in this course. Patients with acute renal failure, as well as those with end-stage renal disease (ESRD), are at increased risk.

Beta-Blockers

Some reports have suggested that the use of beta-blockers lowers the systemic threshold for contrast reactions and could potentially limit the effectiveness of epinephrine administered if a reaction occurs. However, the evidence for this is not significant enough to warrant pre-medication based solely on the use of beta-blockers. In fact, patients on beta-blockers do not need to discontinue their medications prior to the administration of contrast agents (ACR, 2025).

Hyperthyroidism

Patients with thyroid disease are at risk for adverse thyroid hormone-related reactions to contrast agents. For example, iodinated contrast is not recommended in patients with hyperthyroidism, particularly those in acute thyroid storm, as it can lead to thyrotoxicosis, although rare. For patients without thyroid disease, iodinated contrast does not affect thyroid function. Another example is bariums: certain bariums, such as iodinated water-soluble biliary agents, can alter thyroid function tests in patients with thyroid disease (FDA, 2020).

Food Intolerances

Patients with certain food intolerances may experience adverse reactions from contrast agents that contain certain food elements/nutrients. For example, although rare, patients with fructose intolerance may experience complications with bariums that contain sorbitol, including vomiting, hypoglycemia, jaundice, liver enlargement, and kidney failure (FDA, 2020).

Types of Contrast Reactions

Contrast reactions are plentiful in name, but many are rare in frequency. As with medications, contrast can affect multiple body systems and illicit various responses within the body. Adverse reactions also range in intensity. Types of contrast reactions include allergic-type, non-allergic, physiological, acute, mild, moderate, severe, and delayed (ACR, 2025). Each will be discussed in this section.

Allergic-Type Reactions

These reactions can either occur acutely or can be delayed for up to one week after the administration of contrast agents. Allergic-type reactions have an unclear etiology and occur above an unknown threshold. They are not dose- nor concentration-related. Allergic-type contrast reactions are likely independent of dose and concentration above a certain unknown threshold. For example, allergic reactions to barium sulfate are rare and most likely associated with additives within the preparation rather than the contrast itself (ACR, 2025; FDA, 2020).

Physiological Reactions

These are typically related to chemical attributes related to the specific molecules within contrast agents, such as hyperosmolality or chemotoxicity. Physiological reactions tend to be dose- and concentration-dependent. Examples related to bariums include nausea, vomiting, abdominal cramping, diarrhea, electrolyte imbalances (hypokalemia), and vasovagal reactions related to bowel distention (ACR, 2025; FDA, 2020). Examples related to IV contrasts include cardiac arrhythmias and seizures.

Acute Adverse Reactions

In general, acute adverse reactions can be considered either allergic or physiological, which can then be graded as mild, moderate, or severe. Note that this classification is used for both reactions to iodinated contrast media as well as gadolinium-based contrast agents.

Mild Reactions

Mild symptoms tend to be self-limited and require no further treatment. They tend to resolve without progressing to a more severe reaction. Mild reactions can further be characterized as allergic-type or physiological.

Table 1. Mild Contrast Reactions

Allergic-Type	Physiological
Sneezing	Nausea and vomiting (self-limited)
Conjunctivitis	Transient flushing
Runny nose	Warmth
Cutaneous edema	Chills
Itchy or scratchy throat	Headache

Allergic-Type	Physiological
Itchy skin	Dizziness
Limited hives	Mild hypertension
Nasal congestion	Vasovagal reactions that resolve spontaneously

(ACR, 2025; Mafraji, 2025b)

Moderate Reactions

These reactions typically require medical treatment and can become severe if not well-treated. As such, clinical team members must remain vigilant when these reactions occur. Like mild reactions, moderate reactions can be characterized as allergic-type or physiological.

Table 2. Moderate Contrast Reactions

Allergic-Type	Physiological
Wheezing	Vasovagal reactions (require treatment and are responsive to treatment)
Bronchospasm (typically associated with mild or absent hypoxia)	Isolated chest pain
Hives (diffuse)	Protracted nausea and vomiting
Itchy skin (diffuse)	Hypertensive urgency (blood pressure > 180/120 millimeters of mercury [mmHg] without evidence of end-organ damage, which differentiates it from a hypertensive emergency)

(ACR, 2025; Mafraji, 2025b)

Severe Reactions

Symptoms associated with severe reactions can be life-threatening and carry a significant risk for morbidity or death if they are not addressed promptly and appropriately. Unfortunately, both allergic-like and physiological reactions can result in cardiopulmonary arrest. GBCAs, for example, can cause severe reactions (although rare), including anaphylactic shock, respiratory distress, laryngeal edema, cardiac/respiratory arrest, shock, and nephrogenic systemic fibrosis (Ibrahim et al., 2023). Sometimes it is unclear what type of reaction caused the cardiopulmonary arrest.

Pulmonary edema is a rare, severe reaction that can occur regardless of cardiac reserves. Patients with low cardiac reserves get cardiogenic pulmonary edema, while patients with normal cardiac reserves get noncardiogenic pulmonary edema. Pulmonary embolisms, coagulation problems, and blood infections can occur with certain contrasts, such as barium when entering the vascular system (FDA, 2020).

Table 3. Severe Contrast Reactions

Allergic-Type	Physiological
Diffuse edema with shortness of breath	Vasovagal reactions (which are resistant to treatment)
Laryngeal edema with stridor	Arrhythmias
Wheezing	Seizures/convulsions
Bronchospasm with significant hypoxia	Hypertensive emergency (blood pressure > 180/120 mmHg with evidence of end-organ damage)

(ACR, 2025; Mafraji, 2025b)

Severe Reaction

Pin it

Delayed Reactions

Delayed adverse reactions typically occur 30 minutes to one week or more after the administration of the contrast agent, most commonly between three hours and two days. Delayed reactions are more likely following the administration of an ionic contrast agent than a nonionic contrast agent. The typical symptoms of delayed reactions involve itching and hives,

and they are treated with antihistamines or topical steroids. Other reactions may include nausea, vomiting, fever, drowsiness, headache, and hypotension, and may be treated with antipyretics, antiemetics, and fluid resuscitation.

Short- and Long-Term Complications

Acute reactions of contrast agents can be neurological, cardiovascular, gastrointestinal, and genitourinary, and can lead to long-term complications. Well-known complications are associated with IV administration and include contrast media extravasation, CI-AKI, and nephrogenic systemic fibrosis. These conditions can lead to extensive treatment and/or long-term disability.

Contrast Media Extravasation

Think about the last time you encountered an IV infiltration. Depending on the solution that was injected or infused at the time, the patient likely had an array of symptoms, most notably pain. Now imagine the difference between IV infiltration after infusion of normal saline versus a chemical agent like contrast. You can only imagine the potential complications that may ensue. Contrast media extravasation (CMEX) occurs when IV contrast leaks into the tissues after administration. This can happen if the extremity of the IV is ill-positioned during infusion, a distal IV site is accessed, or small-gauge needles are used (Rogers & Tadi, 2023). CMEX is characterized by progressive pain, sensation loss, and mobility impairment of the affected extremity.

Power injectors are often used to infuse IV contrast at a particular rate, time, and volume specific to the patient, indication, and type of equipment (Rogers & Tadi, 2023). Power injectors warrant the insertion of at least a 20-gauge IV, preferably in the antecubital area (ACR, 2025; Roditi et al., 2022). Additionally, the patient's arm should be positioned properly to avoid impedance of blood flow through the IV. CMEX usually goes away on its own with supportive care and monitoring, but if a larger volume of contrast is used, the patient may be at risk for compartment syndrome, vascular compromise, and skin ulcerations (Roditi et al., 2022; Rogers & Tadi, 2023). Treatment for CMEX includes raising the limb and applying cold compresses. Severe cases may require surgical intervention. Power injector use also increases the risk of air embolism, characterized by shortness of breath, chest pain, hypotension, tachycardia, and wheezing (ACR, 2025). Air embolisms are treated with 100% oxygen and assisting the patient to a left side-lying position.

Note: Careful consideration must be taken with children who receive IV contrasts, as any discomfort at the IV site can cause the child to move, complicating the exam or necessitating the need for repeated exams (ACR, 2025).

Contrast-Induced Acute Kidney Injury

CI-AKI – previously termed contrast-induced nephropathy – is a type of renal failure that occurs within 24-48 hours after the administration of contrast agents. While the pathophysiology is not entirely understood, evidence suggests contrast agents may affect renal vasoconstriction or have a direct toxic effect on the renal tubules (ACR, 2025). It is important to note that other causes of acute kidney injury must be excluded prior to diagnosing CI-AKI. Acute kidney injury is characterized by at least one of the following within 48 hours after contrast administration (ACR, 2025; Gameiro et al., 2020):

- Absolute increase in the serum creatinine of 0.3 milligrams per deciliter (mg/dl)

- Increase in creatinine of more than 1.5 times the patient's baseline
- Reduction in urine output of less than 0.6 milliliters per kilogram per hour (mL/kg/hr) for at least six hours

The risk of CI-AKI is very low in patients with normal renal function – that is, a glomerular filtration rate (GFR) greater than 60 ml/minute. In general, CI-AKI is self-limiting, and the renal function should return to baseline within seven to ten days, peaking by day four, without progressing to chronic renal failure. On the other hand, if a patient has an abnormal renal function at baseline – that is, a GFR less than 60 ml/minute – then the risk of CI-AKI is much higher. This is especially true in older adults with diabetes. Other risk factors for CI-AKI include hypertension, hemodynamic instability, dehydration, congestive heart failure, and receiving multiple doses of contrast within a 24-hour period (ACR, 2025).

It is also important to note that patients who take metformin are at risk for lactic acidosis if they develop CI-AKI from iodinated contrast (ACR, 2025; Mafraji, 2025b). Metformin is not only 90% excreted by the kidneys, but it also can cause increased lactic acid production; so, if the kidneys are damaged, the patient may develop lactic acidosis, which can be fatal (ACR, 2025). For this reason, metformin should be stopped at the time an iodinated contrast agent is administered and held for at least 48 hours until satisfactory renal function is ensured.

Interventions to prevent CI-AKI include pre- and post-hydration. Before the exam, IV fluids are administered starting one hour before and up to three to 12 hours after. Increased oral fluid intake has not been sufficiently studied in patients with underlying renal impairment. Prevention is key and involves performing patient-specific risk-benefit assessments, using a low osmolality contrast in patients with underlying renal disease, and administering contrasts at safe, recommended doses (ACR, 2025).

Nephrogenic Systemic Fibrosis

Nephrogenic systemic fibrosis is associated with GBCA use in MRIs; it is a fibrotic disease of the body, mostly involving the skin and tissues, that begins with skin thickening and itching and can progress rapidly to contractures and joint immobility (ACR, 2025). In some cases, the disease is fatal. Most patients who develop nephrogenic systemic fibrosis have underlying kidney disease (ESRD, AKI, or receiving dialysis) and have received large doses of GBCAs or multiple doses within a short period of time.

The pathophysiology of nephrogenic systemic fibrosis is not entirely understood, but a theory exists. As mentioned earlier, gadolinium is a naturally occurring heavy metal that is toxic to humans in its raw form and requires chelation (bonding of ions) to become safe for use. In patients with renal disease, it is hypothesized that gadolinium ions dissociate from the chelates within the GBCAs due to prolonged renal clearance times and other metabolic factors. The free gadolinium binds to anions in the body (like phosphate), creating a substance that stays in the tissues, resulting in tissue fibrosis over time (ACR, 2025).

There are very limited treatment options for nephrogenic systemic fibrosis. Therefore, prevention is key. Dose adjustments, avoidance of certain high-risk GBCAs, and/or an alternative diagnostic test should be considered.

Special Topics

We have discussed the history of contrast agents, types, adverse reactions, and risk factors, as well as complications. However, special situations may arise when managing the care of patients who receive contrast agents that need further consideration or clarification. This

section will address pre-medication to prevent allergic reactions, shellfish versus iodine allergies, and the safety of contrast use in pregnant and breastfeeding patients.

Pre-Medication to Prevent Contrast Reactions: To Medicate or Not to Medicate?

Think about a patient who will receive a blood transfusion under your care. If the patient reported they had a mild to moderate reaction to blood transfusions in the past, the provider may order an antihistamine to be administered prior to beginning the transfusions. Why? Because the patient may have a higher likelihood of having another transfusion reaction compared to a patient who has never had a reaction. While this case applies to patients who have had prior reactions, some clinicians may prefer to carry out these same actions in patients at risk for an allergic-like contrast reaction, even if the patient has not had a contract reaction in the past. This practice, however, is not always recommended and has its risks. Patients at risk for severe allergic contrast reactions include those with asthma, allergies/atopy, or a history of prior allergic-like reactions to contrast agents (Mafraji, 2025b; European Society of Urogenital Radiology [ESUR], 2022).

Antihistamines and corticosteroids are often the medications of choice for medicating before and after an allergic reaction. However, studies show pre-medication is not always effective in preventing reactions in those at risk and can cause problems such as corticosteroid-induced hyperglycemia (up to 80 to 150 mg/dL over baseline) and longer lengths of stay (ACR, 2025; Umakoshi et al., 2020). Other problems include infection risk, transient leukocytosis after 24 to 48 hours of corticosteroid administration, and drowsiness after diphenhydramine (ACR, 2025).

While many providers believe pre-medication to be beneficial, there is little evidence on the effectiveness of this practice. The ACR recommends against ***routine*** pre-medication but suggests this practice on a case-by-case basis. However, some experts (such as the ESUR) recommend against pre-medication due to its ineffectiveness, instead opting for an alternative test (ESUR, 2022; Umakoshi et al., 2020).

Clinicians should follow their facility's protocols surrounding pre-medication and be aware that breakthrough reactions can occur despite pre-medication. It is also important to note that pre-medication with antihistamines and corticosteroids does not prevent physiological reactions, such as hypertension, arrhythmias, nausea, or headache (ACR, 2025).

Shellfish Allergy and Allergy to Iodinated Agents: Fact or Fiction?

Clinical providers, including some radiologists have commonly believed that there is a link between an allergic reaction to shellfish and an increased risk of allergic reaction to iodinated contrast agents (ACR, 2025). This connection between an allergy to shellfish and iodinated contrast agents was first reported in the 1970s. The assumption is based on the fact that both shellfish and iodinated contrast contain significant amounts of iodine. This idea has led some providers to encourage pre-medication in patients who self-report a shellfish allergy. Providers have even gone as far as recommending against iodinated contrast media in patients with shellfish allergies.

Shellfish allergy remains one of the most common food allergies among adults and also remains a common cause of anaphylactic reactions related to food consumption. Shellfish are separated into two groups.

Shrimp

Table 4. Shellfish Types

Arthropods	Mollusks
Crab	Clams
Lobster	Mussels
Prawn	Oysters

(Giovanni et al., 2023)

Allergic Reaction

Pin it

Allergies to shellfish are true IgE-mediated allergic reactions due to tropomyosins in muscles, whereas the anaphylactoid reaction to iodinated contrast agents is secondary to the hyperosmolality of the contrast media compared to blood and is mediated by mast cells and basophils (ACR, 2025; Stewart, 2022). Neither is caused by iodine. Additionally, iodine plays a significant role in human survival because it is used by the thyroid gland for functions essential to human life.

Reactions to iodine contrast are not true allergic reactions in that IgE does not mediate them, but rather they occur by direct stimulation of mast cells and basophils. The stimulation of these cell types yields a pseudo-allergy-like reaction, also known as an anaphylactoid reaction, whereas a true allergic reaction would produce allergy-specific IgE following exposure, making

the patient sensitized to the allergen. Finally, the anaphylactoid reaction that occurs with iodinated contrast media does not occur due to iodine but rather occurs due to the hyperosmolality of the contrast media compared to blood (ACR, 2025; Stewart, 2022).

Even though a large number of providers continue to specifically inquire about shellfish allergy as a way to screen for allergies to iodinated contrast, there is no evidence to support the practice, and it is recommended that the practice be discontinued (ACR, 2025). Like most other allergic reactions, the treatment for shellfish allergies is antihistamines, corticosteroids, and epinephrine, if needed (ACR, 2025).

Contrast Agent Use in Pregnant and Breastfeeding Patients: Is It Really Safe?

As with any medication or treatment, clinicians should consider the effect that contract agents have on fetal health. Some agents are not absorbed systemically (like oral barium contrasts) and therefore do not impact fetal health in pregnant patients or those who breastfeed (FDA, 2020). However, for other contrast agents like those in IV form, there may a slight risk involved, especially for patients with preexisting medical conditions.

The half-life of IV-administered iodinated contrast agents is around two hours, by which time almost 100% of the agent is cleared from the bloodstream in patients with normal baseline renal function (provided it was last measured in the previous 24-hour period) (ACR, 2025).

Given that iodinated contrast agents have low lipid solubility, less than 1% of the agents administered are excreted into breast milk. Of the amount of contrast agents ingested by breastfeeding babies, less than 1% is absorbed from the infant's gastrointestinal tract. In effect, the dose presumably absorbed by a breastfeeding infant via the patient's milk is less than 0.01% of the dose administered by IV to the mother.

In comparison, this dose is less than 1% of the standard dose, which would be prescribed to a similar infant for the performance of an iodinated contrast-enhanced imaging study. The standard dose is usually 1.5 to 2 mL/kg for infants (ACR, 2025).

The risks to the infant are direct toxicity and allergic sensitization, or potentially an allergic reaction. It is important to note that these risks remain theoretical and have not been reported in the literature. There is also a risk that if the contrast agent is secreted in the breastfeeding patient's milk, it may alter the taste of the milk.

The ACR recognizes that an informed decision to stop breastfeeding temporarily is one that is made by the patient who is breastfeeding (ACR, 2025). However, they recommend that it is safe for the patient and the infant to continue breastfeeding during the administration of iodinated contrast agents, given that the available data support this position. If the patient still has concerns after reviewing the available data, they could defer breastfeeding for 24 to 48 hours after the administration of the iodinated contrast agent (ACR, 2025; Rogers & Tadi, 2023).

Treatment Guidelines for Acute Reactions

Clinicians should be prepared for potential acute reactions (both allergic and non-allergic) during and after contrast administration. Emergency equipment should be readily available, such as telemetry and vital sign monitoring equipment, defibrillators, suction equipment, oxygen, rescue medications, bag-valve masks, and IV start supplies (ACR, 2025). The patient should remain in a medical environment for at least 30 minutes after administration of the contrast (USUR, 2022). Acute reactions among adults and children will be discussed in this

section and include hives/itching, diffuse erythema, bronchospasm, laryngeal edema, hypo/hypertension, and pulmonary edema (ACR, 2025; Mafraji, 2025b). Other reactions, such as seizures, hypoglycemia, and panic attacks, may also occur and can be addressed per facility protocol.

Hives/Itching

If a patient presents with mild hives (scattered) after administration of a contrast agent, monitoring is typically the only recommendation. Treatment is generally not needed for mild hives unless the patient is symptomatic, which would prompt the need for antihistamines. If hives are moderate, bothersome, widespread, or progressive, vital signs should be monitored, and IV access and patency should be ensured. Depending on the severity level, clinicians might consider diphenhydramine (or fexofenadine, in adults only).

Diffuse Erythema

For diffuse erythema, clinicians should monitor vital signs and administer oxygen (six to ten liters is recommended, but clinicians should follow the provider's orders or facility protocol). If a patient is hypotensive, IV fluids (normal saline or lactated Ringer's) should be initiated. If the patient is not responsive to fluid resuscitation, epinephrine may be considered. Clinicians should call an in-house emergency response team (or 911 if in an outpatient setting).

Bronchospasm

If a patient develops bronchospasms, clinicians should monitor vital signs, administer oxygen, and call for emergency assistance. Depending on the severity of symptoms, clinicians should consider additional therapies. For milder symptoms, beta agonist inhalers are recommended; epinephrine is suggested for moderate symptoms, and both medications are suggested for severe symptoms.

Laryngeal Edema

Laryngeal edema, or throat swelling, is a life-threatening emergency that can occur after administration of contrast agents. Should a patient develop this reaction, clinicians should follow their facility's protocol, which may include calling for emergency assistance, administering epinephrine intramuscularly, ensuring IV access/patency, administering oxygen, and monitoring vital signs.

Hypo/Hypertension

If a patient develops hypotension after contrast administration, fluid resuscitation efforts and postural changes to restore hemodynamic stability should be initiated. As with the reactions above, clinicians should ensure IV access/patency, monitor vital signs, administer oxygen, and call for emergency assistance. Next, the patient's legs should be elevated at least 60 degrees, and IV fluids should be administered (normal saline or lactated Ringer's). If the hypotension is severe and accompanied by bradycardia, atropine may be considered. If the hypotension is severe with tachycardia, clinicians are advised to administer epinephrine. If an adult patient is experiencing a hypertensive crisis (systolic blood pressure > 200 mmHg or diastolic blood pressure > 120 mmHg) after contrast administration, labetalol or a combination of nitroglycerin and furosemide is recommended.

Pulmonary Edema

Although rare, pulmonary edema can occur after contrast administration (ACR, 2025). After ensuring optimal IV access, monitoring vital signs, and enlisting emergency assistance, clinicians are advised to raise the head of the bed and administer furosemide (as prescribed) to encourage diuresis and improvement of symptoms.

Case Scenario

Let us take a look at a real-life care scenario that you might encounter in your place of work. Pay attention to what the patient reports, and use the information you have learned in this course to come to the most appropriate solution.

Situation

You are providing care to a patient on the medical/surgical floor when you receive an order for a CT of the abdomen and pelvis with IV and oral contrast. The patient has a documented shellfish allergy with an allergic response of 'anaphylaxis'. In addition, the patient has a documented allergy to "iodine" with no specific reaction listed. As the clinician, the patient raises concerns to you about receiving iodinated contrast, stating, "I have a shellfish allergy, so that means I have a severe allergy to contrast." How should you address this dilemma?

Pin it

Intervention

The first step is to clarify the patient's allergy list, especially because there are allergies with undocumented allergic responses. In this case, the patient has an allergy to iodine with an undocumented response. Second, the patient has a knowledge deficit regarding shellfish, iodine, and iodinated contrast allergies that need addressing.

Discussion

The first thing to realize is that an iodine allergy is incompatible with life because the thyroid gland uses iodine to make thyroid hormone, which, again, is necessary for life. So, an allergy to iodine is just like saying you are allergic to calcium, which is an essential element for life. Because of this, the allergy to iodine should be deleted from the patient's record.

The patient may have an allergy to some iodine-containing substance, which should be clarified and documented accordingly. For example, a patient could be allergic to povidone-iodine due to sensitization, and this should be documented properly in the record, but an allergy to this substance does not necessarily imply an allergy to iodinated IV contrast agents. Most of the time, the allergy is to other substances in the iodine-rich materials and not to the iodine itself.

Finally, an allergy to shellfish does not confer a related allergy to iodinated contrast agents. This thought has been implied in medical literature and among the healthcare community, especially among the nursing community. Allergies to shellfish are true IgE-mediated allergic reactions due to tropomyosins, whereas the anaphylactoid reaction to iodinated contrast agents is secondary to the hyperosmolality of the contrast media compared to blood and is mediated by mast cells and basophils.

These issues should be discussed with the patient, and any additional questions that come up should be answered. These aforementioned issues are not contraindications to receiving the IV contrast for this CT.

Strengths/Weaknesses

Withholding contrast from the patient in this case is inappropriate. Obtaining a thorough medical history is most appropriate in determining patient-specific risks versus benefits. If the patient has had a reaction to iodinated contrast in the past or the provider determines the patient to have additional risk factors for contrast reactions, discussion with the radiologist may be appropriate to determine the safest dose for the patient, as well as pre-medication with antihistamines and corticosteroids (although pre-medication does not guarantee prevention).

Dispelling Myths

As we conclude, see if you can recognize (and debunk) these five myths about contrast agents. When educating patients about contrast agents, clinicians should dispel all myths to ensure patients make a well-informed decision about their care.

Myth 1: IV contrast agents are reserved for CT and MRI imaging studies only.

- IV contrast agents are used in CT, MRI, and some ultrasound studies. Ultrasound contrasts are used in cardiology imaging studies and involve the injection of microbubbles into the vascular system. Ultrasound contrasts are generally safe to use as they do not carry the risk of nephrotoxicity when administered in approved doses.

Myth 2: Patients at risk for allergic reactions to contrast agents must be pre-medicated with antihistamines and corticosteroids.

- Although recommended by some experts for patients at high risk of allergic reaction, there is little evidence on the effectiveness of pre-medication. Research suggests pre-medication is not always effective in preventing reactions in those at risk and can cause conditions such as hyperglycemia, infection risk, transient leukocytosis, and drowsiness. Patients can also have breakthrough reactions, and pre-medication with these particular

medications does not prevent physiological reactions such as headache, hypertension, or seizures.

Myth 3: Patients with shellfish allergies automatically have an allergy to both iodine and iodinated contrast.

- Neither shellfish nor iodinated contrast allergies are caused by iodine. An iodine allergy is not a true allergy, as iodine is a naturally occurring element that plays a significant role in human survival. Even though a large number of providers continue to specifically inquire about shellfish allergy as a way to screen for allergies to iodinated contrast, there is no evidence to support the practice. Allergies to shellfish are true IgE-mediated allergic reactions due to tropomyosins in muscle, whereas the anaphylactoid reaction to iodinated contrast agents is secondary to the hyperosmolality of the contrast media compared to blood and is mediated by mast cells and basophils.

Myth 4: Breastfeeding patients cannot receive contrast agents.

- Although contrast use in patients who are breastfeeding may carry a slight risk, these agents are deemed safe, as infant harm has not been documented. Additionally, clinicians are advised against withholding necessary diagnostic exams due to these risks. However, patients should be informed of the risks and educated on the option to defer breastfeeding until 24 to 48 hours after contrast administration.

Myth 5: Patients with a history of renal disease should avoid IV contrast.

- Renal disease is not a contraindication for IV contrast. Clinicians should perform patient-specific risk-benefit assessments, consider using low-osmolality contrast agents, and administer contrast at safe, recommended doses to prevent further renal complications. Even though risks exist, clinicians are discouraged from avoiding diagnostic tests requiring contrast agents for patients who need them.

Conclusion

Adverse reactions to contrast agents are an understandable cause for concern for both patients and clinical providers. A thorough understanding of true allergies to contrast agents and how to manage these reactions is necessary for clinicians in today's practice. With the increasingly ubiquitous use of electronic medical records, a history of an allergy to contrast agents, either real or perceived, could easily be propagated in the medical record. It is important for all clinicians to fully understand the typical adverse reactions to contrast agents, especially nurses who are often responsible for documenting allergies in the medical record. When documenting allergies in the medical record, it is imperative to clarify what the exact allergy is. The patient should be educated about the side effects of each contrast agent being administered, given that inaccurately documented allergies to contrast agents may limit the ability of providers to get appropriate diagnostic tests in the future.

Finally, it is imperative for clinical providers to understand that an allergy to a certain contrast agent does not imply automatic contraindication to that class of agents or the specific agent. Clinical decisions should be made on each patient's case, based on the risk-benefit ratio of the ordered test.

Implicit Bias Statement

CEUFast, Inc. is committed to furthering diversity, equity, and inclusion (DEI). While reflecting on this course content, CEUFast, Inc. would like you to consider your individual perspective and

question your own biases. Remember, implicit bias is a form of bias that impacts our practice as healthcare professionals. Implicit bias occurs when we have automatic prejudices, judgments, and/or a general attitude towards a person or a group of people based on associated stereotypes we have formed over time. These automatic thoughts occur without our conscious knowledge and without our intentional desire to discriminate. The concern with implicit bias is that this can impact our actions and decisions with our workplace leadership, colleagues, and even our patients. While it is our universal goal to treat everyone equally, our implicit biases can influence our interactions, assessments, communication, prioritization, and decision-making concerning patients, which can ultimately adversely impact health outcomes. It is important to keep this in mind in order to intentionally work to self-identify our own risk areas where our implicit biases might influence our behaviors. Together, we can cease perpetuating stereotypes and remind each other to remain mindful to help avoid reacting according to biases that are contrary to our conscious beliefs and values.

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