For recommendations on:
  o Prevention and management of contrast-induced nephropathy (CIN) see pages 1 and 2.
  o Holding metformin see page 2
  o Prevention of contrast-induced reactions see page 3.
  o Management of acute reactions related to contrast including tissue damage from extravasation see page 4.

This guideline was developed for both emergent and non-emergent studies. Due to the urgent need for clinical insight from imaging, further communication between the requesting clinician and procedural attending physician may be required. For emergent cases, consider post-procedure fluid resuscitation.

<table>
<thead>
<tr>
<th>CIN Risk Factors</th>
<th>Low Risk</th>
<th>Moderate Risk</th>
<th>High Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>eGFR ≥ 40 mL/min/1.73 m² and no CIN risk factors.</td>
<td>eGFR 31-40 mL/min/1.73 m² or eGFR &gt; 40 mL/min/1.73 m² and any CIN risk factors</td>
<td>eGFR ≤ 30 mL/min/1.73 m²</td>
<td></td>
</tr>
</tbody>
</table>
| Critically ill patients with sepsis and/or hypotension | Oral Volume Expansion  
Prior to procedure, liberal water intake up to 2 hours before procedure with goal of passing very light-colored urine.  
Use caution in CHF patients. | Oral Volume Expansion  
Prior to procedure, liberal water intake up to 2 hours before procedure with goal of passing very light-colored urine.  
Use caution in CHF patients.  
Note: Use alternative study if possible; otherwise, consider obtaining Nephrology Consult BEFORE procedure. |
| Kidney transplant patients | IV Volume Expansion or Fluid Bolus  
Normal saline (0.9% sodium chloride)  
Inpatient Protocol: 1−2 mL/kg/hr for 6−12 hrs before and after procedure.  
Outpatient Protocol: 3 mL/kg/hr for 2−6 hrs after procedure.  
Use caution in CHF patients and in setting of eGFR < 15 mL/min/1.73 m².  
Rate of infusion at discretion of physician. | |
| Congestive Heart Failure (CHF):  
NYHA Class III or IV  
LVEF < 40% | Staging  
If feasible, perform diagnostic and interventional procedures sequentially; if intervention is delayed, then recheck SCr for contrast media-induced acute kidney impairment before intervention. | |
| Large volume of IV contrast is > 171 ml or 60 g of iodine within the past 24 hours (see page 2) | Follow-Up  
Serum creatinine (SCr) to be drawn and followed up at 48−72 hrs post-procedure by ordering physician.  
If post-procedure SCr is increased ≥ 50% or 0.3 mg/dL from baseline, obtain repeat SCr and/or consider obtaining Nephrology Consult. | Follow-Up  
SCr to be drawn and followed up at 48−72 hrs. post-procedure by ordering physician.  
If post-procedure SCr is increased ≥ 50% or 0.3 mg/dL from baseline, obtain repeat SCr and/or consider obtaining Nephrology consult. |
| Diabetes Mellitus (DM) | For the Patient Already on Dialysis  
No IV volume expansion. Schedule the examination prior to dialysis. | |
| Age > 60 years | | |
| Hypertension | | |
Contrast-Induced Nephropathy (CIN)

- Nephropathy is used to describe damage to the units of the kidneys that clean the blood and/or the supplying small blood vessels.
- CIN is a specific form of acute renal insufficiency following exposure to intravascular iodinated contrast media that is not attributable to other causes.
  - The definition of CIN varies considerably, but in general reflects a 50% increase in serum creatinine from a normal baseline value, or an absolute increase of at least 0.3mg/dL, which appears within 48 hours after the administration of contrast media and is maintained for 2–5 days.
- The prevalence of CIN varies depending on the definition used. The clinical course of CIN is related to factors including baseline renal function, coexisting risk factors, and degree of hydration.
- When chronic renal failure develops, it is associated with lifelong morbidity.
  - It is unusual for patients with CIN to develop permanent renal failure, and this usually occurs in the setting of multiple risk factors.

**Note:** This definition will be used for quality measures: 50% increase or 0.3mg/dL increase in serum creatinine 48 hours after iodinated contrast media injection.

- All patients with suspected renal dysfunction or at risk for CIN should have a serum creatinine drawn.
  - Outpatients– Must be drawn within 30 days
  - Inpatients– Must be drawn within 48 hours.
  - Emergency patients– Must be drawn during Emergency Department visit (excluding trauma/stroke/ruptured aorta alert, or at ED Attending discretion).
- If eGFR is not available in IHIS, GFR should be calculated using the 4-variable MDRD equation (age, sex, race, and SCr).
- Modification of the care plan for patients with renal insufficiency may be necessary.
  - See table on page 1 for appropriate use of iodinated-contrast agents in the setting of renal insufficiency.
- Medications that potentially increase the risk of CIN include chronic- or high-dose non-steroidal anti-inflammatory drugs (NSAIDS), regular use of aminoglycoside, and vancomycin. When contrast media is administered, consider increased monitoring or holding the offending agents if possible.
- For any patient requiring follow-up imaging within 24 hours of large-dose iodinated contrast media, a non-iodinated- requiring study is recommended.
- Consider identifying an amount of contrast (e.g. every 100 mL) when the provider administering the contrast is notified of the amount of iodinated contrast given.

**Volume Based on 60 Grams of Iodine**

<table>
<thead>
<tr>
<th>Concentration (mg/mL)</th>
<th>60 grams of Iodinated Volume (mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>140</td>
<td>429</td>
</tr>
<tr>
<td>180</td>
<td>333</td>
</tr>
<tr>
<td>240</td>
<td>250</td>
</tr>
<tr>
<td>300</td>
<td>200</td>
</tr>
<tr>
<td>350</td>
<td>171</td>
</tr>
</tbody>
</table>

**Metformin**

- Metformin should not be held before the administration of contrast medication in patients with normal renal function.

<table>
<thead>
<tr>
<th>eGFR (mL/min/1.73m²)</th>
<th>Metformin</th>
<th>Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;60 (WITHOUT history of liver disease, alcoholism, heart failure, or intra-arterial administration of contrast)</td>
<td>DO NOT HOLD</td>
<td>--</td>
</tr>
<tr>
<td>30-60 (WITH history of liver disease, alcoholism, heart failure, or intra-arterial administration of contrast)</td>
<td>HOLD</td>
<td>Consider re-evaluating eGFR 48 hours after the procedure and restart metformin if renal function is stable. Follow up with the prescriber about continuation if eGFR 30 - 45 mL/minute/1.73m²</td>
</tr>
<tr>
<td>&lt;30</td>
<td>HOLD</td>
<td>Do not restart metformin and follow up with the prescriber</td>
</tr>
</tbody>
</table>

**Iodinated Contrast Anaphylactoid Reactions**

- Nearly all life-threatening reactions occur within the first 20 minutes post-contrast media injection.
- Anaphylactoid reactions can occur with the use of radiographic contrast media. Those at increased risk include:
  - Patients with prior reactions to contrast media (16-33% incidence of recurrence).
  - Patients with a history of asthma or allergies to skin allergens or other drugs (2 to 5 times increased risk).
    - A patient history of allergy to shellfish is NOT predictive of an allergy to contrast media; that theory has been disproved.
  - Patients receiving beta-blockers.
    - There is some evidence the use of beta-blocking agents lower the threshold for and increase the severity of contrast reactions, and reduce the responsiveness of treatment of anaphylactoid reactions with epinephrine.
- Mild reactions do not require treatment but, they may predict or evolve into a more severe reaction.
  - Therefore, any patient with any reaction should be observed for 20 to 30 minutes, or as necessary, to ensure clinical stability and recovery.
- Urticarial reactions are more common in patients with history of active allergies.
- Bronchospasm is more common in patients with active asthma.
Description of Adverse Reactions
(In patients with no previous history of contrast allergy)

**Mild**
Signs and symptoms appear self-limited without evidence of progression (e.g., limited urticaria with mild pruritus, transient nausea, one episode of emesis), and include:
- Nausea, vomiting
- Cough
- Warmth
- Headache
- Altered taste
- Shaking
- Dizziness
- Anxiety
- Itching
- Pallor
- Flushing
- Chills, sweats
- Altered taste
- Rash, hives, nasal stuffiness

**Moderate/Severe**
Signs and symptoms are more pronounced. Moderate degree of clinically evident focal or systemic signs or symptoms that could be life-threatening, including:
- Tachycardia / bradycardia
- Hypertension
- Vasovagal reactions
- Generalized or diffuse erythema
- Dyspnea
- Swelling: eyes, face
- Bronchospasm, wheezing
- Laryngeal edema
- Mild hypotension

**Pretreatment for Previous Adverse Reactions to Iodinated Contrast Agents**

- Prior reaction to contrast is the best indicator of a recurrent adverse event.
  - It is important to assess allergies and medications (by technologist/nurse).
  - Definition of previous known allergy-like symptoms as mild, moderate, or severe and the type of agent implicated is important.
- Pre-medication is recommended in all patients with a prior history of immediate (within an hour of exposure) moderate to severe allergy to iodinated contrast.
- Note: The American College of Radiology states that IV corticosteroids have not been shown to be effective when administered less than 4 to 6 hours prior to contrast injection.

<table>
<thead>
<tr>
<th>Medication</th>
<th>Dose</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predisone</td>
<td>50 mg PO</td>
<td>13, 7, and 1 hour before the procedure.</td>
</tr>
</tbody>
</table>
| OR
| Methyprednisolone (Medrol®) | 32 mg PO | 12 and 2 hours before the procedure. |
| OR
| Hydrocortisone sodium succinate (Solu-Cortef®) | 200 mg IV | 13, 7, and 1 hour before the procedure. |
| PLUS
| Diphenhydramine (Benadryl®) | 50 mg IM/IV/PO | 1 hour before procedure. |

**Emergent Pretreatment Protocol**
(in decreasing order of desirability)

<table>
<thead>
<tr>
<th>Medication</th>
<th>Dose</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methylprednisolone sodium succinate (Solu-Medrol®) PLUS Diphenhydramine (Benadryl®)</td>
<td>40 mg IV</td>
<td>Q4H until the procedure.</td>
</tr>
</tbody>
</table>
| OR
| Hydrocortisone sodium succinate (Solu-Cortef®) PLUS Diphenhydramine (Benadryl®) | 200 mg IV | Q4H until the procedure. |
| OR
| (known allergy to methylprednisolone, aspirin, or NSAIDs, especially if asthmatic): Dexamethasone sodium sulfate (Decadron®) PLUS Diphenhydramine (Benadryl®) | 7.5 mg IV | Q4H until the procedure. |
| OR
| Omit steroids and give Diphenhydramine (Benadryl®) | 50 mg IV | If emergent administration is needed, contact performing procedural attending prior to administration. |

**Treatment of Adverse Reactions**

Contact the physician/licensed independent practitioner in the event of an adverse reaction to contrast; a provider should be contacted immediately to assess the patient.

**Mild**
Observe for 60 minutes to confirm resolution and/or lack of progression. For urticaria, usually no treatment is required or at most low-dose diphenhydramine (Benadryl®).

**Moderate/Severe**
If a life-threatening reaction is suspected (persistent hypotension or oxygen desaturation < 88% or any concern for cardiopulmonary arrest), call a Code Blue in Ambulatory Imaging Imaging sites call 911.

Use the Imaging Emergency Response Kit if indicated. Prompt recognition and aggressive treatment is needed, and treatment frequently requires hospitalization.

**Management of Acute Reactions**

- **Urticaria** - No treatment is usually indicated, although diphenhydramine (Benadryl®) 25–50 mg PO/IM/IV/SQ can be used to alleviate patient discomfort.
  - In severe cases, 0.3 mg IM epinephrine (EpiPen®) may be used.
- **Facial or laryngeal edema** - Administer 6–10 L/min O₂ and administer 0.3 mg IM (EpiPen®) OR 0.1 mg IV epinephrine; may repeat up to 1 mg.
  - Consider diphenhydramine (Benadryl®) 25–50 mg IM/IV.
- **Bronchospasm** - Administer 6–10 L/min O₂ and administer 2-3 puffs of an albuterol inhaler.
  - Consider 0.3 mg IM (EpiPen®) OR 0.1 mg IV epinephrine; may repeat up to 1 mg.
  - Monitor the patient for changes on EKG, oxygen desaturation, and blood pressure.
• **Hypotension with tachycardia** - Elevate the patient's legs by ≥ 60 degrees, administer 6-10 L/min O₂, and administer boluses of normal saline or lactated Ringer's solution.
  - Monitor the patient for changes on EKG, oxygen desaturation, and blood pressure.
  - Administer epinephrine 0.1 mg IV OR 0.3 mg IM (EpiPen®) if unresponsive to fluid boluses; may repeat to maximum of 1 mg. IV is preferred over IM for adequate absorption.

• **Hypotension with bradycardia** - Elevate the patient's legs by ≥ 60 degrees, administer 6-10 L/min O₂, and administer boluses of normal saline or lactated Ringer's solution.
  - Monitor the patient for changes on EKG, oxygen desaturation, and blood pressure.
  - If unresponsive to fluid and oxygen, administer atropine 0.6-1 mg IV.
    - May repeat atropine administration to a total of 0.04 mg/kg (~3 mg).

• **Severe hypertension (>180 mmHg systolic)** - Administer 6-10 L/min O₂.
  - Monitor the patient for changes on EKG, oxygen desaturation, and blood pressure.
  - Give nitroglycerin 0.4 mg sublingual; may repeat up to three times.
  - If no response or inadequate response, administer labetalol 20 mg IV.
    - Repeat labetalol as needed every 10 minutes, and transfer the patient to an ICU (inpatient) or ED (outpatient).

• **Seizures or convulsions** - Administer 6-10 L/min O₂ and administer lorazepam 2 – 4 mg IV.
  - Monitor vitals carefully, especially pO₂.
  - Call Emergency Response Team or Code Blue if unresponsive to lorazepam.

• **Pulmonary edema** - Administer 6-10 L/min O₂, elevate the torso, and administer furosemide 20-40 mg IV.
  - Transfer the patient to an ICU (inpatient) or ED (outpatient).

**Delayed Hypersensitivity Reaction**

- Onset occurs within 3 hours to 7 days of contrast study and tends to recur if iodinated contrast media are administered again.
- Treatment is symptomatic but should be followed closely and documented.

**Tissue Damage from Extravasation**

- Although the incidence of extravasation is low (0.1–0.9%) in patients receiving contrast, it is important to assess these situations and determine what treatment is necessary to avoid the potential for tissue damage.
- Most commonly, extravasations extend only to localized soft tissue.
  - Acute local inflammation occurs 24-48 hours after injection.
  - Blisters and skin ulcerations can occur.
- Rarely, compartment syndrome and tissue ulceration and/or necrosis can occur, requiring surgical consultation.
- See Suggested Treatment for Extravasation of IV Medications Excluding Cancer Chemotherapy Agents, Section D, under “Response to Extravasation.”

**Risk Factors**

- Patients at risk for extravasation damage include those who:
  - Have circulatory disorders.
  - Are severely ill or debilitated.
  - Have barriers to adequate communication.
  - Have more distal sites of contrast injection.
- Additionally, peripheral intravenous lines that have been in place for > 24 hours or are in a vein with multiple recent venous punctures may put a patient at increased risk of extravasation.

**Treatment**

- See Suggested Treatment for Extravasation of IV Medications Excluding Cancer Chemotherapy Agents.

**Order Sets**

**OSU GEN: Contrast Induced Nephropathy (CIN) Prevention**

**Pre-Procedure**

- Outpatient Radiology
- Interventional Radiology US/CT
- Pre-Intra-Procedure Interventional Radiology

**Post-Procedure**

- Interventional Radiology:
  - US/CT
  - Radiology orders
  - Arterial closure
  - Venous access
  - Intravascular lysis
  - Percutaneous drain insertion
  - Peripheral intervention
  - Tube biopsy
  - US/CT biopsy

**References**

**Quality Measures**

- Frequency of documentation of patients CIN risk prior to contrast
- Percentage of patients properly risk stratified
- Frequency of appropriate IV hydration in moderate and high-risk patients or documentation of why hydration was not administered
- Percentage of patients with contrast-induced nephropathy

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**Guideline Approved**


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