For recommendations on:
- Prevention and management of contrast-induced nephropathy (CIN) see pages 1 and 2.
- Holding metformin see page 2
- Prevention of contrast-induced reactions see page 3.
- 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.

## CIN Risk Factors

<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>Assess risk based on eGFR and the following CIN risk factors.</td>
<td>eGFR &gt; 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>
</tr>
<tr>
<td>• Critically ill patients with sepsis and/or hypotension</td>
<td>• Critically ill patients with sepsis and/or hypotension</td>
<td>• Critically ill patients with sepsis and/or hypotension</td>
<td>Note: Use alternative study if possible; otherwise, consider obtaining Nephrology Consult BEFORE procedure.</td>
</tr>
<tr>
<td>• Kidney transplant patients</td>
<td>• Kidney transplant patients</td>
<td>• Kidney transplant patients</td>
<td></td>
</tr>
<tr>
<td>• Congestive Heart Failure (CHF):</td>
<td>• Congestive Heart Failure (CHF):</td>
<td>• Congestive Heart Failure (CHF):</td>
<td>IV Volume Expansion</td>
</tr>
<tr>
<td>o NYHA Class III or IV</td>
<td>o LVEF &lt; 40%</td>
<td>o Large volume of IV contrast is &gt; 171 ml or 60 g of iodine within the past 24 hours (see page 2)</td>
<td>Normal saline (0.9% sodium chloride)</td>
</tr>
<tr>
<td>• Diabetes Mellitus (DM)</td>
<td>• Diabetes Mellitus (DM)</td>
<td>• Diabetes Mellitus (DM)</td>
<td>o Inpatient Protocol: 1–2 mL/kg/hr for 6–12 hrs before and after procedure.</td>
</tr>
<tr>
<td>• Age &gt; 60 years</td>
<td>• Age &gt; 60 years</td>
<td>• Age &gt; 60 years</td>
<td>o Outpatient Protocol: 3 mL/kg/hr for 1 hr. before procedure and 1.5 mL/kg/hr for 2–6 hrs after procedure.</td>
</tr>
<tr>
<td>• Hypertension</td>
<td>• Hypertension</td>
<td>• Hypertension</td>
<td>o Use caution in CHF patients. Rate of infusion at discretion of physician.</td>
</tr>
</tbody>
</table>

### 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.

### 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 1 hr. before procedure and 1.5 mL/kg/hr for 2–6 hrs after procedure.
  - Use caution in CHF patients. Rate of infusion at discretion of physician.

### 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.

### For the Patient Already on Dialysis

- No IV volume expansion. Schedule the examination prior to dialysis.

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**Note:**

- Use alternative study if possible; otherwise, consider obtaining Nephrology Consult BEFORE procedure.
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>

Note: Large volume of IV contrast is > 171 ml or 60g of iodine within the past 24 hours

For information about specific contrast media, see Pharmacy Intranet.

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 medications prior to the procedure are to be given within 1 hour of the procedure.

Non-emergent Pretreatment Protocol

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

Emergent Pretreatment Protocol

<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>
<tr>
<td>OR Hydrocortisone sodium succinate (Solu-Cortef®) PLUS Diphenhydramine (Benadryl®)</td>
<td>200 mg IV</td>
<td>Q4H until the procedure.</td>
</tr>
<tr>
<td>OR Dexamethasone sodium phosphate (Decadron®) PLUS Diphenhydramine (Benadryl®)</td>
<td>7.5 mg IV</td>
<td>Q4H until the procedure.</td>
</tr>
<tr>
<td>OR Omit steroids and give Diphenhydramine (Benadryl®)</td>
<td>50 mg IV</td>
<td>If emergent administration is needed, contact performing procedural attending prior to administration.</td>
</tr>
</tbody>
</table>

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 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.
**Delayed Hypersensitivity Reaction**

- 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 to 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).

**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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