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.

<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 &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>
<td></td>
</tr>
<tr>
<td>Critically ill patients with sepsis and/or hypotension</td>
<td>Oral Volume Expansion</td>
<td>Oral Volume Expansion</td>
<td>Note: Use alternative study if possible; otherwise, consider obtaining Nephrology Consult BEFORE procedure.</td>
</tr>
<tr>
<td>Kidney transplant patients</td>
<td>Prior to procedure, liberal water intake up to 2 hours before procedure with goal of passing very light-colored urine.</td>
<td>Prior to procedure, liberal water intake up to 2 hours before procedure with goal of passing very light-colored urine.</td>
<td>IV Volume Expansion</td>
</tr>
<tr>
<td>Congestive Heart Failure (CHF):</td>
<td>- Use caution in CHF patients.</td>
<td>- Use caution in CHF patients.</td>
<td>Normal saline (0.9% sodium chloride)</td>
</tr>
<tr>
<td>- NYHA Class III or IV</td>
<td></td>
<td></td>
<td>- Inpatient Protocol: 1−2 mL/kg/hr. 6−12 hrs. before and after procedure.</td>
</tr>
<tr>
<td>- LVEF &lt; 40%</td>
<td></td>
<td></td>
<td>- Outpatient Protocol: 3 mL/kg/hr. 1 hr. before procedure and 1.5 mL/kg/hr. 2−6 hrs. after procedure.</td>
</tr>
<tr>
<td>Large volume of IV contrast is &gt; 171 ml or 60 g of iodine within the past 24 hours (see page 2)</td>
<td>Oral Volume Expansion</td>
<td>IV Volume Expansion or Fluid Bolus</td>
<td>- Use caution in CHF patients and in setting of eGFR &lt; 15 mL/min/1.73 m². Rate of infusion at discretion of physician.</td>
</tr>
<tr>
<td>Diabetes Mellitus (DM)</td>
<td>Oral Volume Expansion</td>
<td>Normal saline (0.9% sodium chloride).</td>
<td>Staging</td>
</tr>
<tr>
<td>Age &gt; 60 years</td>
<td>Prior to procedure, liberal water intake up to 2 hours before procedure with goal of passing very light-colored urine.</td>
<td>- Inpatient Protocol: 1−2 mL/kg/hr for 6−12 hrs before and after procedure.</td>
<td>- If feasible, perform diagnostic and interventional procedures sequentially; if intervention is delayed, then recheck Scr for contrast media-induced acute kidney impairment before intervention.</td>
</tr>
<tr>
<td>Hypertension</td>
<td>- Use caution in CHF patients.</td>
<td>- Outpatient Protocol: 3 mL/kg/hr 1 hr. before procedure and 1.5 mL/kg/hr for 2−6 hrs after procedure.</td>
<td>Follow-Up</td>
</tr>
</tbody>
</table>

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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**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.*

**Medications that potentially increase the risk of CIN**

- Anaphylactoid reactions can occur with the use of iodinated-contrast agents in the setting of drug-induced allergy.
- Nearly all life-threatening reactions occur within the first 20 minutes post-contrast media injection.

### 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 steroids 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>Prednisone</td>
<td>50 mg PO</td>
<td>13, 7, and 1 hour before the procedure.</td>
</tr>
<tr>
<td>OR Methyloprednisolone (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>

<table>
<thead>
<tr>
<th>Medication</th>
<th>Dose</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methylprednisolone sodium succinate (Solu-Medrol®)</td>
<td>40 mg IV</td>
<td>Q4H until the procedure.</td>
</tr>
<tr>
<td>PLUS</td>
<td>50 mg</td>
<td>1 hour before procedure.</td>
</tr>
<tr>
<td>OR Hydrocortisone sodium succinate (Solu-Cortef®)</td>
<td>200 mg IV</td>
<td>Q4H until the procedure.</td>
</tr>
<tr>
<td>PLUS</td>
<td>50 mg IV/IM</td>
<td>1 hour before procedure.</td>
</tr>
<tr>
<td>OR</td>
<td>7.5 mg IV</td>
<td>Q4H until the procedure.</td>
</tr>
<tr>
<td>PLUS</td>
<td>50 mg</td>
<td>1 hour before procedure.</td>
</tr>
<tr>
<td>OR</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.
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.
- 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).

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 lorazepam 2 – 4 mg IV.

- 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

Authors

- Richard White, MD
- Amy Gallatin MSRT
- Anil Agarwal, MD
- Jeannie Danker, MPH
- Joici Job, MD
- Danielle Blais, PharmD, BCPS

Guideline Approved


Disclaimer: Clinical practice guidelines and algorithms at The Ohio State University Wexner Medical Center (OSUWMC) are standards that are intended to provide general guidance to clinicians. Patient choice and clinician judgment must remain central to the selection of diagnostic tests and therapy. OSUWMC’s guidelines and algorithms are reviewed periodically for consistency with new evidence; however, new developments may not be represented.