Prevention of Contrast Induced Nephropathy – Adult –
Inpatient/Ambulatory
Clinical Practice Guideline

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CPG Contact for Changes Content:
Name: Philip Trapskin, PharmD, BCPS
Phone Number: 265-0341
Email Address: ptrapskin@uwhealth.org

Updated by: Cindy Gaston, PharmD, BCPS

Coordinating Team Members: Cindy Gaston, PharmD, BCPS

Review Individuals/Bodies:
Myron Pozniak, MD; Maryl Johnson, MD; Jessica Robbins, MD; Peter Chase, MD; Laura Maursetter, DO

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Executive Summary

Guideline Overview
The guideline reviews the treatment options for the prevention of intravenous or intra-arterial contrast reagents in adult patients.

Target Population
Adult patients receiving intravenous or intra-arterial contrast reagent.

Key Practice Recommendations
Some patients are at higher risk of developing contrast induced nephropathy (CIN) and modifiable risks should be addressed whenever possible (e.g., hypotension, volume depletion, anemia, administration of concomitant nephrotoxic medications, heart failure symptoms). Metformin should only be held in select patients. Renal function should be evaluated prior to administration of contrast in patients with risk factors for CIN. Patients should receive intravenous hydration before and after administration of iodinated contrast in conjunction with the smallest dose of contrast.

Current literature does not support the routine use of sodium bicarbonate, acetylcysteine, mannitol or furosemide for the prevention of CIN.

Companion Documents
Algorithm for Prevention of Contrast-Induced Nephropathy
Recommendations for Holding Metformin with IV Iodinated Contrast Administration

Pertinent UWHC Policies & Procedures
NA

Patient Resources:
NA
Scope

Disease/Condition(s):
Prevention of contrast induced nephropathy in adult patients

Clinical Specialty:
Radiology, nephrology, cardiology, pharmacy

Intended Users:
Physicians, mid-level providers, pharmacists, nurses.

CPG objective(s):
To provide evidence-based guidelines for the prevention of contrast induced nephropathy.

Guideline Metrics:
Incidence of contrast induced nephropathy reported through the Patient Safety Network (PSN).

Methodology

Methods Used to Collect/Select the Evidence:
The UWHC Guidelines for the Prevention of Contrast-induced Nephropathy in Adults was updated with a literature search using MEDLINE, Cochrane, Agency for Healthcare Research and Quality Reports and International Pharmaceutical Abstracts (IPI) from 2011 to 2014 and evaluation of referenced literature. Searches were extended to reviews and studies conducted in humans and published in English. Reference lists of relevant studies were also reviewed.

Rating Scheme for the Strength of the Evidence and Recommendations:
A modified Grading of Recommendations Assessment, Development and Evaluation (GRADE) developed by the American Heart Association and American College of Cardiology has been used to assess the Quality and Strength of the Evidence in this Clinical Practice Guideline (Figure 1).1

Methods Used to Formulate the Recommendations:
Recommendations were based on strength of evidence, clinical expert consensus and cost assessment

Definitions

Contrast induced nephropathy is a sudden deterioration in renal function within 48 to 72 hours of contrast administration in patients without other attributable factors for renal insufficiency.2 The requirements for determining reduction in renal function vary by trial. Some define renal deterioration as a 20 to 50 % increase in serum creatinine; others use absolute increases in serum creatinine of 0.5 to 2 mg/dL.3,4 Most clinical trials limit evaluation of renal function to 48 to 72 hours after contrast administration. All increases in serum creatinine cannot be interpreted as CIN since intrapersonal variation in creatinine occurs and coadministered medications and comorbidities can confound data. Studies illustrate that in adult inpatients not receiving contrast over 50% of patients experience at least a 25% increase in serum creatinine within five consecutive days.

For the purposes of this guideline CIN is considered an increase in serum creatinine of greater than 0.5 mg/dL or 25% above baseline within 72 hours, which is consistent with the majority of trials.5

Introduction

Many diagnostic procedures require administration of intravascular or intra-arterial infusion of iodinated contrast material and the number of patients treated with these agents is increasing. The potentially serious complication of CIN in patients with normal renal function is relatively low, but reports of incidence
vary depending on the defined criteria for CIN and patient comorbidities.\textsuperscript{7, 8} Patients with renal insufficiency and diabetes are more likely to experience CIN after administration of iodinated contrast material.\textsuperscript{9, 10} In patients receiving intra-arterial infusions of contrast for coronary angiogram the risk is also higher, which some have attributed to comorbidities associated with cardiac disease rather than the contrast.\textsuperscript{11} Most cases of CIN are generally mild and transient; however, there are reports of acute renal failure requiring dialysis and increased mortality.\textsuperscript{8, 12-14}

Gadolinium based contrast reagents are well tolerated at usual doses and the risk of CIN is extremely rare.\textsuperscript{2, 15-22}

The exact mechanism of CIN is unknown, but considered multifactorial and attributed to direct tubular injury as a consequence of proximal tubule cell exposure to contrast media, as well as a decrease in renal perfusion due to vasoconstriction.\textsuperscript{13, 23} In addition, animal studies demonstrate tubular damage from oxygen free radicals generated after administration of contrast media.\textsuperscript{24, 25}

Based on the attributed causes of CIN multiple strategies have been evaluated to minimize the incidence in high risk patients, but despite the expansive literature reported and meta-analyses there is no universal approach for prevention. There is consensus among clinicians that modifiable risk factors for CIN should be minimized.\textsuperscript{2}

**Recommendations**

1. **The risk of CIN is higher in patients with concomitant morbidities, procedures and conditions and all patients should be assessed for risk and monitored closely.**\textsuperscript{2, 6, 14, 26-28} Steps should be taken to minimize all potential risk factors such as of hypotension, volume depletion, anemia, heart failure symptoms, and administration of concomitant nephrotoxic medications. (Class I, Level A)

   The following are associated with an increased risk of CIN:
   - Renal insufficiency (serum creatinine > 1.5 mg/dL or glomerular filtration rate (GFR) <60 mL/min/1.73 m\textsuperscript{2})
   - Diabetes
   - Heart failure
   - Cirrhosis
   - Anemia
   - Hypotension
   - Age over 75 years
   - Intravascular volume depletion
   - Concomitant administration of nephrotoxic medications
   - Intra-arterial administration of contrast
   - High volume of contrast or multiple sequential procedures requiring contrast.

2. **In patients with a high risk for CIN iodinated contrast administer iodinated contrast only when the risk outweighs the benefit.**\textsuperscript{2} (Class I, Level C)

3. **Evaluate kidney function prior to the procedure in select patients.**\textsuperscript{29} (Class 1, Level A)

   3.1. If a patient has suspected renal dysfunction or is at risk for CIN (as listed under item 1 above) then evaluate a baseline serum creatinine or GFR.\textsuperscript{2} (Class 1, Level C) Also consider creatinine measurements in the following patients:
   3.1.1. History of kidney disease, renal tumor, renal transplant or prior renal surgery
   3.1.2. Family history of kidney failure
   3.1.3. Paraproteinemia syndromes (e.g., multiple myeloma)
   3.1.4. Collagen vascular disease (e.g., scleroderma, systemic lupus erythematosus)
   3.1.5. Diagnosis of hypertension
   3.1.6. Inpatients
3.1.7. Patients taking the following medications: metformin, chronic or high dose non-steroidal anti-inflammatory agents, aminoglycosides

3.2. For high risk patients (Class I, Level C):
   3.2.1. Obtain a serum creatinine within two weeks of planned contrast administration.
   3.2.2. Estimate GFR.
   3.2.3. In patients with acute renal failure, administer contrast only when the benefit outweighs the risk.  

The risk of CIN is low and adequately controlled trials demonstrated no increase in CIN in patients receiving low-osmolar contrast with a serum creatinine below 1.8 mg/dL.4, 7, 30, 31 Outpatients without previous renal disease or diabetes are unlikely to have unidentified increases in serum creatinine.32

A pooled analysis of patients receiving intravenous contrast demonstrated a 0.6% incidence of CIN in patients with GFR greater than 40 mL/min, versus 4.6% with GFR less 40 mL/min and 7.8% with GFR less 30 mL/min.33 Patients with GFR less than 60 mL/min/1.73 m2 and concomitant diabetes are considered at an even higher risk for CIN.10, 29

Serum creatinine is limited as a measure of renal function in that it is impacted by gender, age, and muscle mass and nutritional status. An alternative method for evaluating renal function is estimating creatinine clearance using the Cockcroft-Gault formula or GFR which is estimated by the Modification of Diet in Renal Disease (MDRD) formula.2, 34, 35 The Cockcroft-Gault equation:

$$[(140-\text{age}) \times \text{Actual Body Weight (kg)}] / (\text{Serum Cr} \times 72)$$ multiply the result by 0.85 for females

is utilized in Health Link to estimate creatinine clearance. UWHC Laboratory calculates “eGFR” on outpatients with a measured serum creatinine using the MDRD equation:

$$\text{GFR (mL/min/1.73m}^2) = 175 \times (\text{SCr})^{-1.154} \times (\text{Age})^{-0.203} \times (0.742 \text{ if female}) \times (1.212 \text{ if African American})$$

If requested, the GFR can be calculated for inpatients. Alternatively, an online calculator is on the National Kidney Foundation website.34 A limitation of both equations includes development in select a population with stable renal function.

4. Creatinine monitoring after contrast administration is only required for patients at risk with a recommended baseline serum creatinine (see item 2).2 The optimum time for creatinine monitoring after contrast administration is undefined, but usually within 96 hours. If creatinine increases by 0.25 mg/dL or over 25% above baseline, then continue to monitor serum creatinine. If serum creatinine does not return to baseline within 1 week, consult nephrology. (Class I, Level C)

5. Hold metformin containing agents prior to administering iodinated contrast in select patients only.2 (Class I, Level C)

Several case reports of lactic acidosis occurred in patients receiving iodinated contrast dye while on metformin.36 These reports resulted in a change in labeling to hold metformin prior to and 48 hours after the administration of contrast and restart only after renal function is re-evaluated.37 The rationale for this recommendation is that CIN could cause an accumulation of metformin and result in lactic acidosis. Based on this rationale, only patients at a higher risk for CIN require withholding of metformin.2 Further evaluation of the case reports revealed that most cases of reported lactic acidosis with iodinated contrast and metformin occurred in patients with comorbidities (e.g., renal disease, alcohol abuse, cardiac failure).

The American College of Radiology provides the following recommendations for holding metformin:2
Category 1: For patients with eGFR ≥ 45 mL/min without liver dysfunction, alcohol abuse, cardiac failure, myocardial or peripheral muscle ischemia, sepsis or severe infection:

Do not hold metformin* or check creatinine after contrast administration.

Category 2: For patients with eGFR ≥ 45 mL/min with liver dysfunction, alcohol abuse, cardiac failure, myocardial or peripheral muscle ischemia, sepsis or severe infection:

Hold metformin* for 48 hours. The procedure for assessing renal function and time to restart metformin will be determined by the radiologist and practitioner and communicated to the patient.

Category 3: For patients with impaired renal function, eGFR < 45 mL/min:

Hold metformin* at the time of contrast administration and follow renal function until metformin can be re-instituted safely.

* Trade names of medications include (but are not limited to): ActoPlus Met®, ActoPlus Met XR®, Avandamet®, Fortamet®, Glucophage®, Glucophage XR®, Glucovance®, Glumetza®, Invokamet®, Janumet®, Janumet XR®, Jentadueto®, Kazano®, Kombiglyze XR®, Metaglip®, PrandiMet®, Riomet®, Xigduo XR.

6. **Hold potentially nephrotoxic medications whenever possible.**² (Class I, Level C)
   Hold non-steroidal anti-inflammatory medications (NSAIDs) such as ibuprofen, naproxen, celecoxib.

7. **In patients at high risk for CIN undergoing cardioangiography holding ACEI and ARB may be considered, but effectiveness is not well established.**³⁸⁻⁴¹ Consider the risk versus benefit of holding an ACEI or ARB especially in patients established on therapy for HL. (Class IIb, Level C)
   Current studies evaluating CIN incidence in patients on chronic ACEI or ARB therapy report conflicting results which may be explained by differences in populations, retrospective design, and single center studies.

8. **Ensure patients are fully hydrated.**² (Level 1, Class A)
   If a patient has been kept NPO or there is potential for hypovolemia, then the patient should be hydrated with 0.9% sodium chloride solution at a rate of 1 – 1.5 mL/kg/hour initiated 2 -12 hours prior to the contrast administration.², ⁴² (Level I, Class A)
   Not all trials have demonstrated hypovolemia as a major risk factor for CIN, but renal blood flow is diminished in hypovolemic patients and decreased perfusion could enhance the toxicity of iodinated contrast reagents.⁴³, ⁴⁴

9. **Isotonic intravenous hydration is preferred over hypotonic or oral fluid hydration.**², ⁴⁴ (Class I, Level B)
   In one trial administration of 0.45 or 0.9% sodium chloride 12 hours prior to and after contrast in renal insufficiency patients significantly reduced the incidence of CIN in patients undergoing angiography.⁴⁶ However, another trial indicated 0.45% saline was not as effective as 0.9% saline.⁴⁴

10. **Consider iso-osmolar (iodixanol) contrast reagents in patients with renal insufficiency and diabetes who are receiving intra-arterial administration of contrast.**
   10.1. Intravenous administration of iso-osmolar iodixanol does not reduce CIN compared to low-osmolarity contrast (iohexol) after intravenous administration without underlying comorbidities of renal dysfunction or diabetes.⁴, ⁴⁶⁻⁴⁹ (Class 1, Level A)
10.2. Intra-arterial administration in high-risk patients with iso-osmolar contrast (iodixanol) may provide a lower risk of CIN.\textsuperscript{46, 48, 50} (Class IIb, Level B)

A meta-analysis of 25 trials comparing iso-osmolar iodixanol with nonionic low-osmolar contrast media failed to demonstrate a reduced incidence of CIN for iodixanol.\textsuperscript{46} In subgroup analysis there was no reduction in CIN with administration of iodixanol after intravenous administration or in patients with renal insufficiency. However, in the subgroup with renal insufficiency and intra-arterial administration of contrast, there was a reduced risk for CIN when iodixanol was compared to iohexol. When comparing iodixanol to low-osmolar contrast agents other than iohexol, no reduction in CIN was identified.

A randomized, double-blind multicenter trial of 129 diabetic patients with a serum creatinine of 1.5 to 3.5 mg/dL undergoing coronary angiography or aortofemoral angiography demonstrated a smaller mean peak in increase of serum creatinine with iso-osmolar iodixanol than low-osmolar iohexol (0.13 mg/dL vs 0.55 mg/dL, \( p=0.001 \)).\textsuperscript{51} However, further trials evaluating intra-arterial infusion of contrast do not demonstrate a reduction in CIN for iodixanol compared to low-osmolar contrast reagents.\textsuperscript{52, 53} A Swedish Coronary Angiography an Angioplasty registry demonstrated a higher incidence of renal failure in patients receiving iodixanol.\textsuperscript{54} A meta-analysis of 2727 patients in 16 double-blind randomized controls evaluated patients undergoing cardiac angiography compared the incidence CIN in patients receiving iso-osmolar contrast reagent (iodixanol) versus low-osmolarity contrast.\textsuperscript{56} Patients with chronic kidney disease experienced a lower incidence of CIN with iso-osmolar intra-arterial contrast than low-osmolar contrast.

11. **Minimize the amount of contrast administered.**\textsuperscript{2, 26, 57} (Class I, Level A)

Automated contrast injector administration for cardiac imaging can decrease the amount of contrast administered and incidence of CIN.\textsuperscript{59}

12. **In patients with chronic renal insufficiency balance the risk of worsening impairment against the diagnostic value of the procedure. When necessary use low or iso-osmolar agents and the lowest dose possible, hydrate before and after the procedure, and measure renal function 48 – 72 hours after contrast administrations.**\textsuperscript{59} (Class I, Level C)

13. **Current data does not support the routine use of isotonic sodium bicarbonate infusions for the prevention of CIN.** (Class IIb, Level C)

Bicarbonate infusions should not be administered to patients with pulmonary edema, uncontrolled hypertension (SBP>160 or DBP >100, or patient at high risk for severe fluid overload. (Class III, Level C)

The use of isotonic sodium bicarbonate solution to prevent CIN is controversial. Multiple single-center, prospective trials have evaluated the use of isotonic sodium bicarbonate infusions with mixed results.\textsuperscript{35, 60-67} One trial of 353 patients with stable renal insufficiency, in addition to one risk factor for CIN, compared isotonic sodium bicarbonate to sodium chloride at a rate of 3 mL/kg for 1 hour prior to coronary angiography, 1.5 mL/hour during the procedure and for 4 hours after completion of the procedure.\textsuperscript{67} No difference in the primary endpoint of 25% or greater decrease in GFR or secondary endpoints of death, dialysis, myocardial infarction or cerebral vascular events was identified.

A systematic review of 23 published and unpublished randomized, controlled trials of sodium bicarbonate that specified the outcome of CIN included 3563 patient with 396 CIN events determined there was significant heterogeneity across studies (\( I^2 = 49.1\% \), \( p = 0.004 \)) which limits the validity of further analysis.\textsuperscript{68} Smaller, non-blinded trials prior to 2008 with fewer CIN events were more likely to demonstrate benefit from sodium bicarbonate.

A retrospective cohort study evaluated contrast administration in 11,516 exposures of contrast media and specifically identified the use of sodium bicarbonate in 268 cases.\textsuperscript{62} The use of
bicarbonate infusion was associated with an increase in risk of CIN after adjustment for hydration, medication, age, gender, prior creatinine, contrast iodine load, type of imaging and comorbidities.

UWHC isotonic bicarbonate solution is prepared as dextrose 5% with sodium bicarbonate 200 mEq for a total volume of 1250 mL. Most trials administered bicarbonate solution at 1-3 mL/kg/hour prior to the procedure, and then 1 mL/kg/hour after the procedure. 62

14. Current data does not support the routine use of acetylcysteine (Mucomyst®) for the prevention of CIN. 69,70 (Class IIb, Level C)

The use of N-acetylcysteine in the prevention of CIN is controversial since multiple studies and meta-analysis demonstrate conflicting data. 69,71 Heterogeneity of trials with moderate quality may account for the discrepancies. A recent large randomized controlled trial of 2308 patients with one risk factor and undergoing an angiographic procedure did not demonstrate a reduction in CIN after administration of acetylcysteine 1200 mg BID. 69 Similarly, the subgroup analysis of patients with renal insufficiency (serum creatinine >1.5 mg/dL), diabetes, age over 70 years or high volumes of contrast did not demonstrate benefit. 72

A few trials have evaluated the combination of isotonic sodium bicarbonate and acetylcysteine, with mixed results. 68, 73,74 A multicenter trial of diabetic patients with renal insufficiency receiving oral acetylcysteine did not demonstrate a decreased incidence of CIN in patients receiving sodium bicarbonate infusion compared to sodium chloride infusion. 73 Alternatively a trial of patients receiving contrast for emergency percutaneous intervention and administered acetylcysteine demonstrated a reduction in CIN in patients receiving bicarbonate infusion as compared to sodium chloride infusion. 74

Due to conflicting literature, minimal toxicity and low cost, some clinicians choose to order acetylcysteine 800 mg orally twice daily for two days with initiation prior to contrast administration. Intravenous acetylcysteine offers no advantage over oral and is associated with a higher incidence of adverse events, notably anaphylaxis. 75

15. Mannitol does not reduce the incidence of CIN in patients with chronic renal insufficiency (serum creatinine >1.6 mg/dL) when included with saline hydration. 76 (Level III, Class B)

16. Furosemide administered along with hydration prior to the administration of contrast reagent does not reduce the incidence of CIN in patients with chronic renal insufficiency. 76 (Level III, Class B)

UW Health Implementation

Potential Benefits:
Implementation of recommendations within this guideline provides a consistent approach to minimizing CIN while avoiding adverse drug reactions from unnecessary medications.

Potential Harms:
Patients may become fluid overloaded after administration of fluid to prevent CIN.

Qualifying Statements
There are several studies and meta-analyses on treatment modalities for the prevention of CIN; however, treatment doses, administration methods, and outcomes are variable. As new data becomes available recommendations may change.
**Implementation Plan**

The guideline update will be disseminated to clinical staff frequently using iodinated contrast reagents in their practice and posted electronically at point of use sites. This guideline will be posted on UConnect and associated with medication order records for iodinated contrast material and on the medication administration record.

**Implementation Tools**

The guideline will be associated with the medication records for contrast media.

**Disclaimer**

CPGs are described to assist clinicians by providing a framework for the evaluation and treatment of patients. This Clinical Practice Guideline outlines the preferred approach for most patients. It is not intended to replace a clinician’s judgment or to establish a protocol for all patients. It is understood that some patients will not fit the clinical condition contemplated by a guideline and that a guideline will rarely establish the only appropriate approach to a problem.

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## Appendix A
Quality of Evidence and Strength of Recommendation Grading Matrix

<table>
<thead>
<tr>
<th>SIZe OF TREATMENT EFFECT</th>
<th>LEVEL A</th>
<th>LEVEL B</th>
<th>LEVEL C</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CLASS I</strong></td>
<td>Benefit &gt;&gt; Risk</td>
<td>Benefit &gt;&gt; Risk</td>
<td>Benefit &gt;= Risk</td>
</tr>
<tr>
<td>Procedure/Treatment SHOULD be performed/administered</td>
<td>Additional studies with focused objectives needed</td>
<td>IT IS REASONABLE to perform procedure/administer treatment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Recommendation in favor of treatment or procedure being useful/effective</td>
<td>Some conflicting evidence from multiple randomized trials or meta-analyses</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sufficient evidence from multiple randomized trials or meta-analyses</td>
<td>Greater conflicting evidence from multiple randomized trials or meta-analyses</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Recommendation’s usefulness/efficacy less well established</td>
<td>Evidence from single randomized trial or nonrandomized studies</td>
<td></td>
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<tr>
<td></td>
<td>Sufficient evidence from single randomized trial or nonrandomized studies</td>
<td>Greater conflicting evidence from single randomized trial or nonrandomized studies</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Recommendation that procedure or treatment is useful/effective</td>
<td>Only diverging expert opinion, case studies, or standard of care</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Only expert opinion, case studies, or standard of care</td>
<td>Evidence from single randomized trial or nonrandomized studies</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Recommendation’s usefulness/efficacy less well established</td>
<td>Not recommended</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Suggested phrases for writing recommendations</td>
<td>is not recommended</td>
<td></td>
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</tbody>
</table>

- Multiple populations evaluated*
- Data derived from multiple randomized clinical trials or meta-analyses

- Limited populations evaluated*
- Data derived from a single randomized trial or nonrandomized studies

- Very limited populations evaluated*
- Only consensus opinion of experts, case studies, or standard of care
Appendix B

Algorithm for Prevention of Contrast-Induced Nephropathy

Assess patient risk factors:
- Serum creatinine > 1.5 mg/dL or GFR <60 mL/min/1.73m²
- Diabetes
- Heart failure
- Cirrhosis
- Anemia
- Hypotension
- Age > 75 years
- Intravascular volume depletion
- Concomittant administration of nephrotoxic medications such as metformin, chronic or high dose NSAIDs, aminoglycosides
- Intra-arterial administration of contrast
- Anticipate high volume contrast administration
- Multiple sequential procedures with contrast media

[Class I, Level A]

Evaluate serum creatinine in select patients prior to procedure:
- Patients with a risk factor for CIN
- History of kidney disease, renal tumor, renal transplant or prior renal surgery
- Family history of kidney failure
- Paraproteinemia syndromes (e.g., multiple myeloma)
- Collagen vascular disease (e.g., scleroderma, systemic lupus erythematosus)
- Diagnosis of hypertension.
- Inpatients
[Class I, Level C]

Is patient at risk for CIN based on risk factor assessment?

NO
YES

Perform original test.
No additional measures needed.

Is appropriate alternative test available?

NO
YES

Perform alternative test.
No additional prophylactic measures required.

Perform original test in high risk patient.
- Hold metformin if GFR < 45 mL/min or patient has history of hepatic dysfunction, alcohol abuse, cardiac failure, myocardial or peripheral ischemia, sepsis or severe infection [Class I, Level C]
- Hold potentially nephrotoxic medications prior to contrast [Class I, Level C]
- Ensure patients are sufficiently hydrated [Class I, Level A]
- Recommend administration of 0.9% sodium chloride [Class I, Level A]
- Limit contrast dose [Class I, Level A]
- Recommend low or iso-osmolar contrast for intra-arterial administration [Class IIb, Level B]
- May consider sodium bicarbonate infusion [Class IIb, Level C]
- May consider acetylcysteine [Class IIb, Level C]
- Monitor creatinine and GFR post contrast [Class I, Level C]

Abbreviations:
GFR – glomerular filtration rate
CIN – contrast induced nephropathy
Appendix C

Recommendations for Holding Metformin with IV Iodinated Contrast Administration

Category 1: Estimated eGFR > 45 and no comorbidities*:
No need to discontinue Metformin or check creatinine.

Category 2: Estimated eGFR > 45 and comorbidities*:
Withhold Metformin for 48 hours. Patient should communicate with their doctor prior to restarting Metformin. The clinician may elect observation, serum creatinine measurement, and/or hydration to ensure stable renal function. Serum creatinine measurement is not required in the absence of recent risk factors for renal damage. (i.e. nephrotoxic drugs)

Category 3: Estimated eGFR < 45:
Metformin should be suspended at the time of contrast administration and cautious follow-up of renal function should be performed until safe reinstitution of Metformin can be assured.

*Comorbidities:
- Liver dysfunction
- Alcohol abuse
- Cardiac failure
- Myocardial or peripheral muscle ischemia
- Sepsis or severe infection

Medications containing metformin include (but are not limited to):

<table>
<thead>
<tr>
<th>Generic Ingredients</th>
<th>Trade Names</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metformin</td>
<td>Glucophage, Glucophage XR, Fortamet, Glumetza, Riomet</td>
</tr>
<tr>
<td>Alogliptin/metformin</td>
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<td>Sitagliptin/metformin</td>
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