



Contrast-Media Induced Nephropathy and Diagnostic CT

- Predisposing factors for iodinated contrast media induced nephropathy (CIN) include chronic renal insufficiency, diabetes, dehydration, congestive heart failure, nephrotoxic medications, and age > 70 years
- For those with predisposing factors, an estimated glomerular filtration rate (eGFR) should be calculated to stratify risk
- For those at highest risk, iodinated contrast agents should be avoided unless absolutely necessary
- For those at intermediate risk, prevention is recommended, including hydration and cessation of nephrotoxic medications

Contrast media induced nephropathy (CIN) leading to acute renal failure is a rare event associated with the exposure to iodinated contrast agents. However, because of the increased utilization of procedures that use iodinated contrast particularly diagnostic CT and catheter angiography, CIN has become one of the leading causes of hospital-acquired acute renal failure, accounting for 12% of all cases. While CIN is much more common in hospitalized patients undergoing catheter angiography than in outpatient contrast-enhanced CT examinations, identification of patients at risk for developing CIN in both patient groups as well as implementation of CIN prevention strategies is important for ensuring high quality and safe patient care. In this article we provide a practical approach to CIN prevention through risk stratification and prophylaxis.

Predisposing Risk Factors

Patients with the highest risk of developing CIN (Table 1) are those with pre-existing renal insufficiency or chronic kidney disease. Other risk factors include diabetes, dehydration, congestive heart failure, advanced age, certain medications including prior iodinated contrast administration (Figure 1). The combination of renal insufficiency and diabetes is particularly problematic. However, in patients with diabetes and no renal insufficiency, the risk of developing CIN seems not to be increased. Multiple myeloma had been considered to be a risk factor for CIN. However, it does not appear that this is a significant risk factor when modern contrast agents are used, provided that precautions are taken to ensure that these patients are adequately hydrated and not

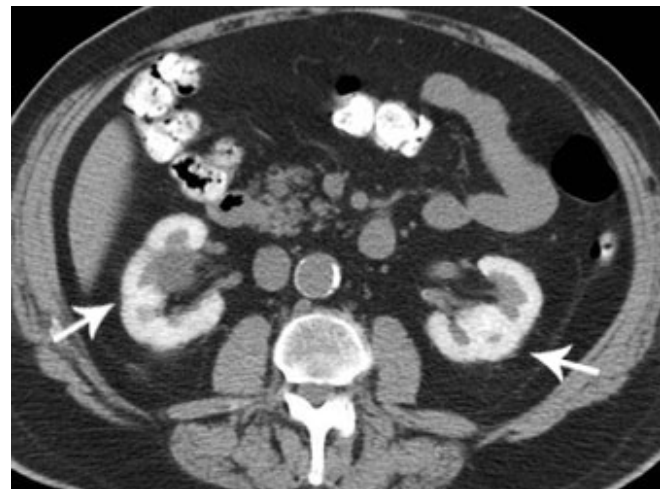


Figure 1. CT scan demonstrating contrast induced nephropathy - A CT without contrast administration in a patient who had undergone a contrast-enhanced CT scan followed by coronary catheter angiography three days before demonstrates retention of iodinated contrast in the renal cortices bilaterally (arrows). Serum creatinine values increased from a baseline of 1.6 to 3.2 at the time of this CT exam.

significantly hypocalcemic. Finally, metformin has been associated with post-contrast administration lactic acidosis and, as a precautionary measure should be discontinued for all patients undergoing a contrast enhanced CT scan and resumed after 48 hours.

The cornerstone of risk stratification is obtaining complete medical history and, in patients with risk factors (Table 1), an estimate of renal function.

Table 1. Predisposing factors for the development of contrast-induced nephropathy with CT examination

Coexisting medical/demographic factors:

- Renal insufficiency
- Diabetes
- Congestive heart failure
- Dehydration
- Age > 75 yrs
- Multiple myeloma

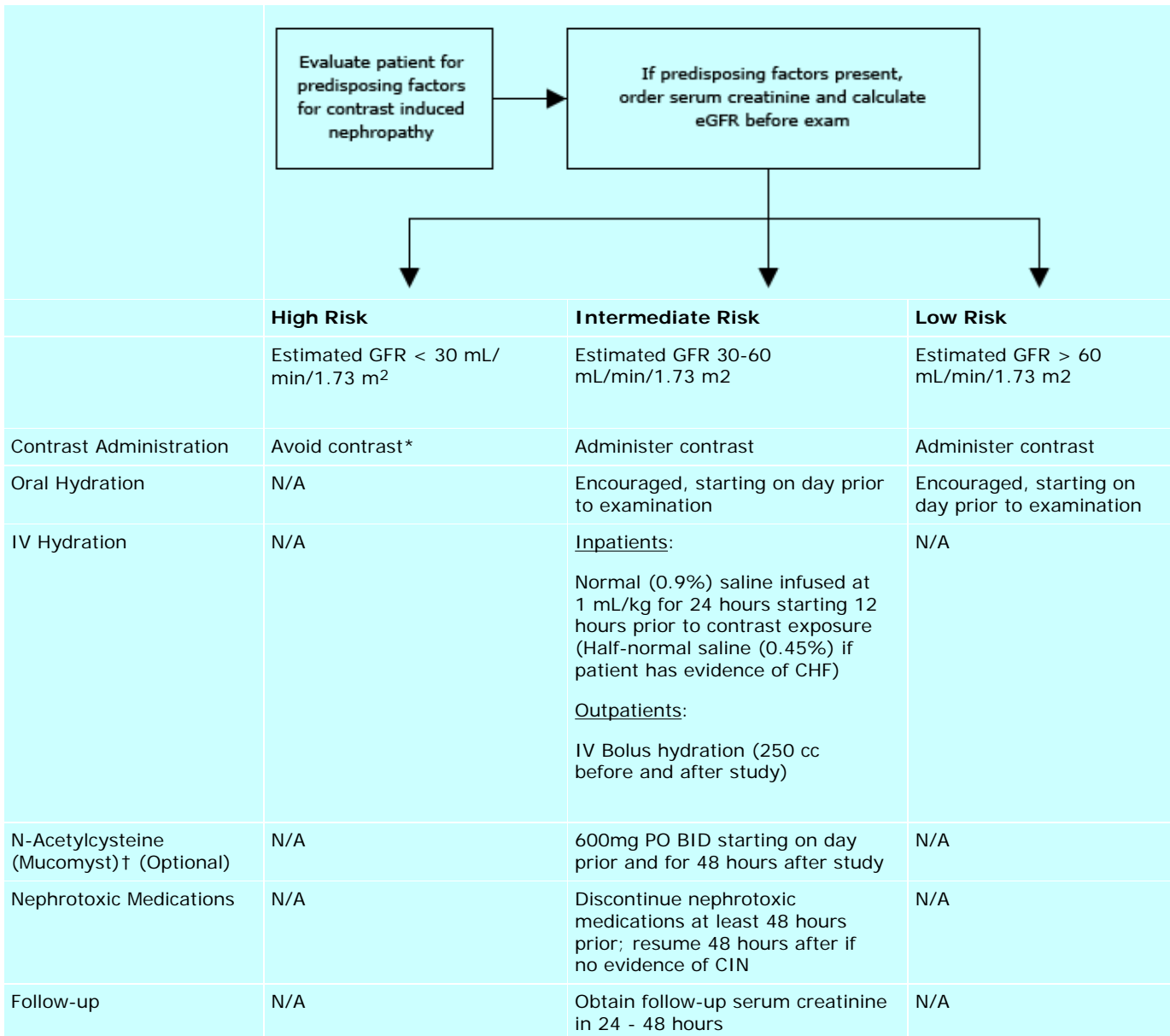
Concurrent use of potentially nephrotoxic medications:

- Non-steroidal anti-inflammatory agents (NSAIDs)
- Cisplatin-based chemotherapy agents
- Aminoglycoside antibiotics
- Iodinated contrast within last 72 hours

Although high serum creatinine levels have traditionally been regarded as an indicator of renal insufficiency, it is now recognized that creatinine levels in isolation are a poor measure of renal function as they vary with muscle mass. Therefore, current recommendations are that the estimated glomerular filtration rate (eGFR), as calculated using the Modification of Diet in Renal Disease (MDRD) equation, be used to determine baseline renal function. The MDRD eGFR equation requires inputs of serum creatinine, patient age, and race as follows:

$$\text{GFR (mL/min/1.73 m}^2\text{)} = 186 \times (\text{Serum Creatinine})^{-1.154} \times (\text{Age})^{-0.203} \times (0.742 \text{ if female}) \times (1.210 \text{ if African American})$$

Figure 2. Guidelines for risk stratification and prophylaxis for CIN



* If contrast administration is required in high-risk patients, direct discussion with a radiologist and clinical nephrology service is recommended for a patient-specific imaging and prophylaxis strategy.

†N-acetyl cysteine is an optional prophylactic measure for CIN as no convincing evidence of efficacy is available.

eGFR is now often provided along with serum creatinine by hospital chemistry laboratories. If unreported, [eGFR calculators](#) can readily be found on the Internet, are available for personal digital assistants, and as handheld plastic quick reference pocket cards.

Thus, prior to a patient undergoing contrast-enhanced CT study, a comprehensive medical history must be obtained to identify any predisposing factors for CIN (Figure 2). Patients with risk factors will require a serum creatinine level to calculate the eGFR prior to the study.

Prophylactic Recommendations

For those at highest risk for developing CIN, contrast should be avoided and alternate diagnostic examinations should be considered.

For all patients with low risk (eGFR > 60 ml / min / 1.73m²) and intermediate risk (eGFR between 30 and 60 ml/min/1.73m²), the following prophylactic measures can be taken to minimize the risk of CIN.

Hydration. The most important prophylactic measure is hydration. Prior to the day of exam, all patients should be encouraged to have oral hydration. Inpatients should receive intravenous normal (0.9%) saline infused at 1 mL/kg for 24 hours starting 12 hours prior to contrast exposure. For patients in whom high salt load is a concern (e.g. advanced congestive heart failure or kidney disease), half-normal (0.45%) saline may be used. Outpatients should be reminded by the referring physician to start hydration on the day prior to the imaging study. Bolus hydration with 250cc before and after imaging study with normal saline is typically administered in the MGH Department of Radiology.

Discontinuation of Nephrotoxic Medications. Nephrotoxic medications, including NSAIDS, cisplatin-based agents, and aminoglycoside, should be discontinued 48 hours before the test if possible and not resumed until either 48 hours after or when renal function is confirmed to have normalized after contrast administration. It is also important to note that metformin, although not directly nephrotoxic, should be discontinued at least one day prior to contrast administration and not resumed until 48 hours after the imaging study.

Follow-up after Completion of CT Examination

For patients at intermediate to high risk for CIN, a follow-up creatinine level and/or eGFR should be determined 24-48 hours after the test as most cases will demonstrate changes in renal function within that time period. If there is any evidence of CIN, a nephrologist should be consulted for further management.

MRI Contrast Agents in Renal Insufficiency Patients

In addition, it should be noted that a newly described disease, Nephrogenic Systemic Fibrosis (NSF), has been linked with exposure to gadolinium contrast in patients with moderate to severe kidney failure. Although very rare, physicians should be aware of this possible complication before considering MRI for patients with kidney disease. More information on this is available on the [PCOI website](#).

Scheduling

CT can be performed at Mass General Imaging in Waltham, Mass General Imaging Chelsea, or the main MGH campus and can be ordered online via the Radiology Order Entry (<http://mghroe/>) or by calling 4-XRAY (617-724-9729)

Further Information

For further questions on contrast induced nephropathy, please contact [Sanjay Saini, M.D.](#), Vice-Chairman, MGH Department of Radiology (617-726-8396) or [Garry Choy, M.D.](#), MGH Radiology Resident.

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