

Prevention of contrast media nephropathy

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Guidelines

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Summary:

- High risk patients are those with diabetes and renal impairment (creatinine > 130 $\mu\text{mol/l}$), significant renal impairment alone (creatinine > 160 $\mu\text{mol/l}$), or patients with underlying diabetes or renal impairment taking nephrotoxic drugs (especially non-steroidal anti-inflammatory agents).
- All high risk patients should be identified prior to receiving contrast.

- All high risk patients should receive intravenous hydration with 0.9% normal saline - ideally 1 ml/kg/hour for 12 hours before and after contrast administration, but at the least 3-500 ml over 2 hours prior to the procedure and continued for 12 hours after (unless overt pulmonary oedema, significant fluid overload or on dialysis)
- All high risk patients should also receive acetylcysteine 600 mg orally twice per day for 48 hours starting the day before contrast. An alternate may be intravenous acetylcysteine 600 mg given before contrast administration, and 600 mg orally or iv 12 hours later.
- Intravenous acetylcysteine is given as an infusion – 600mg in 250ml of glucose 5% given over 30-60 minutes. (Use oral wherever possible.)
- Patients with moderate risk (creatinine $>140 <160 \mu\text{mol/l}$ but no diabetes) should receive oral hydration.

Definition

1. Radiocontrast nephropathy is defined as an acute deterioration in renal function occurring after the administration of intravenous radiocontrast agents. Although commonly a transient phenomenon, it is occasionally severe enough to require temporary dialysis, and in some cases leads to irreversible renal failure.

Risk Factors

2. Several risk factors have been identified – originally with the use of high osmolality contrast media which are no longer in widespread use – including:

- baseline impairment of renal function from any cause
- diabetes mellitus
- dehydration
- heart failure
- concurrent use of non-steroidal anti-inflammatory or other nephrotoxic drugs
- and in some studies increasing doses (volumes) of contrast media.

3. Contrast nephropathy has been reported with all radiocontrast media and also rarely with gadolinium (at conventional MR doses). Gadolinium given for conventional angiography (significantly higher doses) may be more nephrotoxic.

Mechanism

4. The mechanism of renal damage includes renal vasoconstriction and generation of oxygen free radicals.

Incidence

5. The overall incidence of contrast nephropathy remains poorly defined but is not greater than 10% of all patients (having a rise in serum creatinine of > 25% or 44 $\mu\text{mol/l}$ over baseline) and probably much less (approximately 2%). In high risk patients taking part in controlled trials up to 40% sustain contrast nephropathy. Although irreversible renal failure is rare, it is a catastrophic complication of a contrast procedure or investigation.

Prevention – lack of benefit

6. There is no evidence for benefit of calcium antagonists or dopamine in preventing contrast nephropathy in controlled trials. Theophylline (given intravenously) has been reported to show both beneficial and detrimental effects in prospective randomised trials. Dialysis instituted after the administration of contrast has been shown in a single prospective study to be detrimental to renal recovery and should be avoided.

Prevention – hydration

7. There is clear evidence of benefit of hydration (either oral or intravenous) in reducing the risk of contrast nephropathy. Historically 0.45% saline was used, but a single prospective randomised controlled trial in 1620 patients has compared 0.45% saline with 0.9% (normal) saline in patients undergoing elective or emergency coronary angiography. Contrast nephropathy (defined by an increase in serum creatinine of $> 44 \mu\text{mol/l}$ in the next 48 hours) occurred in 0.7% of patients receiving normal saline and in 2% of those given 0.45% saline ($p=0.04$). Women, patients with diabetes, and those receiving higher contrast loads benefited particularly from isotonic over half-isotonic saline hydration. Fluid was given at 1 ml/kg/hour for 12 hours before and after contrast administration.

Prevention – acetylcysteine

8. There have been 3 prospective randomised studies using acetylcysteine to prevent contrast nephropathy.

Tepel et al randomised 83 patients with stable chronic renal failure undergoing contrast CT with low volume, low osmolality contrast to receive 600 mg acetylcysteine orally twice per day on the day before and the day of contrast use. All patients received intravenous hydration with 0.45% saline at 1 ml/kg/hour for 24 hours. 21% of patients in the control group had acute contrast nephropathy (increase in serum creatinine $> 44 \mu\text{mol/l}$) compared with 2% of those receiving acetylcysteine. Acetylcysteine was associated with a fall in serum creatinine.

The APART study randomised 54 patients with chronic renal failure undergoing elective coronary angiography to 600 mg twice per day oral acetylcysteine for 48 hours or placebo (with hydration in both groups) and showed similar reduction in acute nephropathy - 45% vs 8%.

Briguori et al randomised 183 patients with chronic renal impairment undergoing coronary or peripheral angiography to 600 mg oral acetylcysteine twice daily with 0.45% saline hydration or hydration alone. Contrast nephropathy occurred in 6.5% and 11% of patients respectively (non-significant difference). Somewhat surprisingly only patients receiving low volumes of contrast showed any benefit from acetylcysteine.

9. Oral acetylcysteine is cheap and has not been reported to cause any detrimental effects. Hence the support for its use in selected patients despite relatively sparse data.

10. Intravenous acetylcysteine may be an alternative, especially in patients who did not receive oral acetylcysteine or require emergency angiography. There is no published data, however a single unpublished study performed locally has shown similar benefits to oral acetylcysteine.

11. There is no evidence to support the routine use of acetylcysteine in all patients receiving contrast media.

Recommendations

12. Patients at high risk for contrast nephropathy should be identified prior to all procedures involving contrast media, including peripheral vascular and coronary angiography and angioplasty, contrast CT, venography, IVU. This does not include gadolinium when used for MR studies, but probably should do when gadolinium is used in conventional Xray angiography.

Patients should be identified by their clinician.

High risk patients are those with diabetes and pre-existing renal impairment (creatinine > 130 $\mu\text{mol/l}$), renal impairment alone (creatinine > 160 $\mu\text{mol/l}$), and those taking nephrotoxic drugs prior to the contrast procedure (where they cannot be stopped beforehand) with diabetes and any degree of renal impairment.

13. Creatinine should be measured in patients at high risk for underlying renal impairment prior to receiving contrast (eg patients with diabetes, extensive vascular disease, hypertension). This can be done at the time of ordering the investigation or procedure and does not need to be immediately prior to the contrast use.

14. Diabetic patients taking Metformin should omit the drug on the day of contrast examination, and not restart until their serum Creatinine is less than 150 micromol/l.

[Link to trust policy.](#)

15. All high risk patients should receive intravenous hydration with 0.9% normal saline ideally for 12 hours before and 12 hours after contrast administration at 1 ml/kg/hour (unless fluid overloaded, pulmonary oedema, already on dialysis or some other contra-indication). An alternative is more rapid hydration for 1-4 hours prior to the procedure and continuing after for 12 hours.

16. Moderate risk patients (creatinine >140 $\mu\text{mol/l}$ and no diabetes) should be encouraged to drink 2 litres of fluid during the 12 hours around the time of contrast administration.

17. High risk patients should additionally receive acetylcysteine orally 600 mg twice per day, if possible starting the day before the contrast procedure, for 48 hours. In an emergency it may be preferable to give intravenous acetylcysteine 600 mg immediately before contrast (eg emergency coronary angiography), followed by a second dose orally or intravenously. Intravenous acetylcysteine is given as an infusion – 600mg in 250ml glucose 5% given over 30-60 minutes. The oral route should be used wherever possible.

18. In-patients who may suffer further renal insults should have their serum creatinine checked 48 hours and 96 hours after receiving contrast.

19. Out-patients do not need their serum creatinine checked as a routine, but contrast nephropathy should be considered in the event of subsequent illness, and patients should be advised to avoid non-steroidal anti-inflammatory drugs for at least 96 hours after receiving contrast.

Audit recommendations

20. Identification of high risk patients in notes or on Imaging request form, a laboratory measure of creatinine obtained prior to contrast, use of intravenous hydration in patients with diabetes and renal impairment, use of acetylcysteine in high risk patients, measurement of serum creatinine for inpatients after receiving contrast.

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