



Contrast Media-Induced Nephropathy: Is Sodium Bicarbonate the Optimal Hydration Fluid?

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Contrast media-induced nephropathy (CIN) is the acute, and often transient, deterioration of kidney function that occurs after parenteral administration of contrast media. CIN is defined as a rise in serum creatinine (SCr) following contrast exposure. SCr peaks 3 to 5 days after contrast administration and returns to baseline within 1 to 3 weeks.¹ Multiple therapies have been evaluated for prevention of CIN including mannitol, furosemide, theophylline, dopamine, fenoldopam, calcium channel blockers, and ascorbic acid; none of these have proven effective.¹ N-acetylcysteine has been used for renal protection; however, studies report conflicting results regarding the efficacy of this therapy.² To date, the strategies most utilized for prevention of CIN include discontinuation of nephrotoxic medications, use of low- or iso-osmolal agents, minimizing the contrast volume, and hydration with intravenous fluid. Hydration is a mainstay of therapy to prevent CIN; however, the optimal fluid has been a point of controversy.

Decreased CIN rates have been reported with sodium bicarbonate hydration when compared to sodium chloride,³⁻⁶ however, in the September 3rd issue of JAMA, Brar and colleagues report trial findings about the use of sodium bicarbonate versus sodium chloride for the prevention of CIN.⁷ The study aimed to validate the proposed superiority of sodium bicarbonate. Between January 2, 2006 and January 31, 2007, 353 patients undergoing coronary angiography with baseline glomerular filtration rates (GFR) ≤

60 ml/min/1.73 m² and at least one risk factor for CIN (diabetes, hypertension, chronic heart failure, age ≥ 75 years) were randomized to either IV hydration with normal saline or sodium bicarbonate.¹ Study fluids were infused at the same rate in each treatment group (3 ml/kg for 1 hour before angiography, decreased to 1.5 ml/kg/h during and 4 hours prior to procedure completion). The primary endpoint was CIN incidence, defined as a decrease in GFR ≥ 25% occurring 24 to 96 hours after contrast exposure.¹

Patients were followed for 6 months after contrast exposure. Secondary endpoints included ≥25% increase in serum creatinine (SCr), need for hemodialysis, and all cause mortality at 30 days post-procedure. Additionally, clinical adverse events including all-cause mortality, myocardial infarction, cerebrovascular accident, and dialysis were reported at 30 days and 6 months. Baseline characteristics were well balanced at study entry, with a median patient age of 71 years. N-acetylcysteine use, contrast volume, and procedural duration were all similar between treatment groups. Primary endpoint and clinical event results at 30 days and 6 months are summarized in Table 1.¹

Table 1. Results: Primary Endpoint and Selected Clinical Outcomes

Event	Normal Saline (%)	Sodium Bicarbonate (%)
Primary Endpoint		
Estimated GFR, ≥25% at 24-96h*	14.6	13.3
30-day Outcomes		
All-Cause Mortality	1.7	1.7
Dialysis	1.1	0.6
30-Days to 6 Month Outcomes		
All-Cause Mortality	2.3	0.6
Dialysis	1.1	0.6

*p = 0.75

The reported CIN incidence was not statistically different between the sodium bicarbonate and the sodium chloride groups. Persistent renal impairment rates in patients who developed CIN (defined as $\geq 25\%$ decrease in GFR between 2 and 8 weeks post contrast exposure) were similar between groups. Furthermore, there was no significant difference in the secondary endpoint ($\geq 25\%$ change in SCr between 24 and 96 hours) or in the rates of death, dialysis, myocardial infarction, or cerebrovascular events at 30 days or at 30 days to 6 months.¹

The investigators concluded that "the results of the study do not suggest that hydration with sodium bicarbonate is superior to hydration with sodium chloride in patients with moderate to severe kidney disease who undergo coronary angiography."¹ As the largest randomized controlled trial comparing the two prophylactic hydration regimens with the longest follow up period to date, these study results conflict with the prior reports claiming that sodium bicarbonate is superior to sodium chloride for the prevention of CIN.⁴⁻⁷

The difference in results may be explained by a longer follow up period for the primary endpoint in the most recent study. Investigators in previous trials evaluated change in renal function within 48 hours of contrast exposure³⁻⁶, compared to 96 hours in the current study.⁷ References have described CIN as a change in renal function that usually peaks between 3 and 5 days after contrast exposure;¹⁻² therefore, 48 hours may not be an adequate follow up time for diagnosis of CIN, because SCr levels may continue to rise. While SCr is a well-accepted marker of renal function, rates of increase do not necessarily represent clinical outcomes. In those studies showing increased rates of CIN with sodium chloride compared to sodium bicarbonate, no significant differences in the rates of dialysis or death were reported.³⁻⁶

These inconsistent findings and the lack of significant difference in the occurrence of clinically relevant endpoints add questions to an already controversial issue, and should prompt future investigation. At this time, the best prevention of CIN, is appropriate patient selection, use of low- or iso-osmolar contrast agents, and sodium chloride or sodium bicarbonate hydration.

References

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