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Comparison of Outcomes Between High and Standard Dose of N-acetylcysteine in Prevention of AKI in Patients with CKD

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Abstract

Background: Patients with chronic kidney disease (CKD) are at a common risk for contrast-induced acute kidney damage (CI-AKI) because of various complications. Intravenous N-acetylcysteine (NAC) in high doses (1200mg) is considered more effective than its conventional dose (600mg) to prevent CIN and related complications. **Objective:** The study aimed to compare the effectiveness of high dose versus standard dose of intravenous N-acetylcysteine (NAC) in the prevention of Acute Kidney Injury in patients with chronic kidney disease. **Material & Methods:** A total of 60 (sixty) patients diagnosed with CKD went to coronary angiography and/or percutaneous coronary intervention (PCI) were selected by simple random technique and categorized into two groups - Group A (30 patients) received high dose NAC (1200mg) and Group B (30 patients) - received standard dose NAC (600mg). For evaluation of renal damage serum creatinine level for at least >3 months, renal imaging revealed bilateral small echogenic kidneys, eGFR (<60 to 15ml/min/1.73m², measured by MDRD formula) and also by ACR >30 mg/gm, associated with IHD, admitted for percutaneous intervention (PCI) were taken in account. Statistical analysis was done by SPSS version 20 with taking 95% confidence interval. The quantitative data were expressed as mean and standard deviation and qualitative data were expressed as frequency distribution and unpaired t-test, Chi-square test, and Fisher exact analytic test were done. **Results:** The observed mean age group of the patients was 65 ± 8 years and 62 ± 7 years in group A and group B respectively with male predominance in both groups. Primary renal disease diabetic nephropathy (DN) more (36.66%) in group A than in group B (30.00%) but patients with Hypertensive nephropathy were the same (33.33%) in both groups. After interventions, S. Creatinine (mg/dl) level, e, GFR (ml/min/1.73m²), were statistically significant in cases of group A patients (P-value 0.001& 0.003 correspondingly) compared to group B Patients (P-value 0.075 & 0.001 respectively). Again, the mean of pre-intervention S. Creatinine was 1.7 ±0.5 in group A whereas this was 1.9 ± 0.8 (p-value, 0.599) in group B and after 48 hours of intervention this was 1.6 ± 0.5 and 2.0 ± 0.5 (p-value, 0.697) In group A and group B respectively. Overall, no patients were detected with nephropathy for high dose NAC whereas 27 (90%) out of 30 had developed CIN in standered dose. **Conclusion:** High-dose N-acetylcysteine (1200mg) is more potent and effective than the standard dose (600mg) in reducing contrast-induced acute kidney injury (CI-AKI) in patients with CKD.

Keywords:- N-acetylcysteine, AKI, CKD.

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INTRODUCTION

Contrast-induced acute kidney injury (AKI) is a great concern for patients having compromised renal function like chronic renal disease (CKD) and that happens after the intravenous or intra-arterial injections of iodine-based contrast media (CM) during enhanced X-ray and computerized tomography (CT) imaging examinations or coronary artery interventions.[1,2,3] In patients with CKD, identified by an estimated glomerular filtration rate (eGFR) of <60 ml/min/1.73 m2 (which roughly corresponds in the elderly to an S Cr 1.0 mg/dl in a woman and 1.3 mg/dl in a man), there is a considerable loss of nephron units, and the residual renal function is vulnerable to declines with renal insults. Hence Chronic kidney disease is both necessary and sufficient for the development of contrast-induced AKI (McCullough PA 2008).[4] N-acetylcysteine (NAC) is an antioxidant that has been recommended for use by the kidney disease: Improving Global Outcomes (KDIGO) guidelines and has also been supported to use in many studies as prophylaxis for contract induced Acute kidney disease (CI-AKI).[5,6,7] CIN was identified as the third major cause of hospital-acquired acute kidney damage, accounting for 12% of all hospitalized AKI patients with considerable morbidity and death (6%) Without appropriate preventative measures, the rising use of contrast medium (CM), may enhance chronic kidney disease (CKD) with an increased rate of contrast-induced nephropathy (CIN).[8] In populations without any risk factors for CIN, the incidence is reported to be 0.6-2.3%, while for individuals at high risk for CIN, the incidence can be as high as 90%.[9] However, some studies recommend using a conventional dosage of N-acetylcysteine in combination with normal saline is sufficient to prevent CI-AKI contrary to that, several study results, in evaluating the efficacy of high-dose N-acetylcysteine for the prevention of contrast-induced nephropathy suggested that comparing the high-dose N-acetylcysteine versus controls, high-dose N-acetylcysteine decreases the incidence of contrast-induced nephropathy.[10,11,12,13] From the national perspective, there are also little data regarding the use of high dose than the conventional dose of N-acetylcysteine as a preventive measure of AKI in CKD patients. So, the study aimed to evaluate the effect of high dose versus standard dose in the prevention of AKI in patients with CKD.

MATERIAL AND METHODS

This randomized control trial was conducted among a total of 60 (sixty) patients diagnosed with CKD at Sir Salimullah Medical College & Mitford Hospital and United Hospital, Dhaka from December 2015 to December 2017 after approval of the institutional review board and after taking the informed written consent from the patients with full instruction. The patients were selected by simple random technique and categorized into two groups as - Group A (30 patients) who received high dose NAC (1200mg) and Group B (30 patients) who received standard dose NAC (600mg). Patients' age, sex, body mass index, blood pressure, glycemic status, hematocrit value, cholesterol level, pre- procedural serum creatinine, and 48 hrs. Post-procedural serum creatinine were noted in the predesigned data sheet. Adult of

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both sexes >18 years were diagnosed with cases of chronic kidney disease with eGFR (<60 to 15 ml/mim/1.73m²) and Ischemic Heart Disease (IHD) patient who was planned for CAG. All the patients were diagnosed with a previous increase in serum creatinine level for at least >3 months, renal imaging revealed bilateral small echogenic kidneys, eGFR (<60 to 15ml/min/1.73m², measured by MDRD formula) and also by ACR >30 mg/gm, associated with IHD, admitted for percutaneous intervention (PCI). Patients who had received a non-steroidal anti-inflammatory agent (except aspirin 75 to 150mg) within 24 hrs of the study and those with a systolic blood pressure <90 mm of Hg or cardiac failure were excluded. No patients with acute kidney disease or end-stage renal disease on dialysis were included. Patients with cardiac failure (cardiac failure is a risk factor for CIN), patients scheduled for primary CAG (emergency requirement of intervention <12 hrs), and history of contrast allergy were also excluded. The eligible patients of both group A and group B received the suggested amount of contrast IV bolus (1200mg for group A, and 600mg for group B) before the procedure and orally (1200mg for group A, and 600mg for group B) twice daily at morning and evening for the 48 hours after CAG intervention. The hydration status of each patient of both groups was maintained with 0.9% NaCl (about 500ml) both before and after 3-4 hours of intervention. As a contrast iso-osmolar, nonionic, radio-contrast agent iodixanol (visipaque) with an average of 100-200 ml, was used for the intervention of all patients. The anti-ischemic, antihypertensive, lipid-lowering, platelet inhibitors, and oral glycemic agents were continued. Serum creatinine level was estimated before and after 48 hours of the procedure (CAG or PCI), In this study, the definition used for contrast-induced AKI was the elevation of serum creatinine by ≥0.3 mg/dl within 48 hours (KDIGO guideline for contrast-induced AKI-2012). The pre-procedural serum creatinine was considered as basal serum creatinine. The rise of serum creatinine by ≥0.3 mg/dl within 48 hours or urine volume <0.5 ml/kg/hr for 6 hours of contrast administration was defined as contrast-induced AKI. Both pre and 48 hours post-procedure estimated GFR (eGFR) was measured by the MDRD formula (4 variables) from the patients who developed CIN. All data were recorded systematically in a preformed data collection sheet (questionnaire). The quantitative data were expressed as mean and standard deviation and qualitative data were expressed as frequency distribution. Statistical analysis was done by SPSS version 20 with taking 95% confidence interval.

RESULTS

In this study, evaluation of demographic, Baseline clinical, and Biochemical characteristics of patients of both groups [Table 1] this was found that in both group A and group B, the man age group was 65 ± 8 & 62 ± 7 respectively that was mean that most of the patients were >60 years of age and male patients were more than female. Comparing the baseline mean of bot groups the p-value of BMI(kg/m²), SBP (mm of Hg), DBP (mm of Hg), Hb (gm/dl), S. Creatinine (mg/dl), eGFR(ml/min/1.73m²), FBS (mmol/L) and LV ejection fraction (%) was 0.854, 0.783, 0.078, 0.471, 0.588, 0.392, 0.383, 0.522 respectively.

Regarding the distribution of primary diseases with comorbid conditions, in the current study [Table 2], group A patients presented with primary renal disease diabetic nephropathy

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(DN) more (36.66%) compared to (30.00%) of group B patients. Patients with Hypertensive nephropathy were the same (33.33%) in both groups (A and B). Undifferentiated was 4 (13.33%) in group A and 7 (23.33%) in group B. The results denoted that, in group B patients' diabetic nephropathy (DN) though less but the frequency of Hypertensive nephropathy patients was more and undifferentiated cases were less in both groups.Considering stage 3 and stage 4 of CKD in both A (19, 63.33%) and B (16,53.33%) groups stage 3 patients were more.

After intervention about the comparative results of Clinical and laboratory parameters between group A (High NAC) & Group B (Standard Dose) patients, this was noted that [Table 3], the p-value of BMI(kg/m²), SBP (mm of Hg), DBP (mm of Hg), Hb (gm/dl), S. Creatinine (mg/dl), eGFR(ml/min/1.73m²), FBS (mmol/L) and LV ejection fraction (%) was 0.968, 0.973, 0.854, 0.183, 0.001, 0.003, 0.300 & 0.283 respectively in group A and 0.788, 0.085, 0.501, 0.461, 0.075, 0.001, 0.216 & 0.821 respectively in group B. All these results demonstrated regarding improvement of all parameters with high dose of NAC.

In the present study, the results of pre-intervention and after 48 hours of intervention showed that [Table 4], the mean of pre-intervention S. Creatinine was 1.7 ±0.5 in group A whereas this was 1.9 ± 0.8 (p-value, 0.599) and after 48 hours of intervention this was 1.6 ± 0.5 and 2.0 ± 0.5 (p-value, 0.697). Comparing the overall results of CIN, patients had no Contrast Nephropathy in group A 30 (100%) patients out of 30 whereas the rate of CIN was 27 (90%)out of 30 in group B.

Table 1: Demographic, Baseline clinical, and Biochemical characteristics of Patients of Group A and group B

Variables	Group A(n=30)	Group B(n=30)	p-Value
Age (years)	65 ± 8	62 ± 7	0.843
Sex (Male: Female)	4.6:1	4.27:1	0.834
BMI(kg/m²)	28.4 ± 4	25.3 ± 3.4	0.854
SBP (mm of Hg)	133 ± 17	135 ± 13	0.783
DBP (mm of Hg)	79 ± 6	80 ± 7	0.078
Hb (gm/dl)	12.3 ± 1.5	11.6 ± 1.7	0.471
S. Creatinine (mg/dl)	1.8 ± 0.7	1.9 ± 0.6	0.588
eGFR(ml/min/1.73m²)	40.6 ± 10	34.8 ± 10.6	0.392
FBS (mmol/L)	8.8 ± 2.4	10.5 ± 8.6	0.383
LV ejection fraction (%)	57.5 ± 6.4	57.8 ± 6.4	0.522

Unpaired t-test and Chi-square test were done to measure the level of significance ($p<0.05$)

Table 2: Frequency distribution of Primary Disease with the comorbid condition and Renal Stages in both group A and B patients.

Variables	Frequency Distribution in percentage (%)	
	Group A	Group B
Diabetic nephropathy	11(36.66%)	9 (30.0%)

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Obstructive nephropathy	5 (16.7%)	4 (13.33%)
Hypertensive nephropathy	10(33.33%)	10 (33.33%)
Undifferentiated	4 (13.33%)	7 (23.33%)
CKD stages		
Stage 3	19 (63.33%)	16 (53.33%)
Stage 4	11 (36.67%)	14 (46.67%)

Table 3: Comparison of Clinical and laboratory parameters between group A (High NAC) & Group B (Standard Dose) patients after intervention

Variables	**Group A (30)**		**p-value**	**Group B (30)**		**p-value**
	Stage 3 (n=19)	**Stage 4 (n=11)**		**Stage 3 (n=22)**	**Stage 4 (n=8)**	
BMI (kg/m2)	27.2±4.8	28.5±8.2	0.968	27.9 ± 3.9	26.8 ± 4.3	0.788
SBP (mm of Hg)	136±15	137±14	0.973	130 ± 15	145 ± 22	0.085
DBP (mm of Hg)	85±6	86±9	0.854	81± 8	79 ± 9	0.501
Hb (gm/dl)	12.0 ± 1.5	11.8 ± 2.3	0.183	12.4 ± 1.8	11.6 ± 1.3	0.461
S. Creatinine (mg/dl)	1.8 ± 0.6	2.8 ± 0.3	0.001	1.8 ± 0.7	2.3 ± 0.8	0.075
eGFR(ml/mim/1.73m²)	41.9 ± 9.5	22.8 ± 4.3	0.003	44.7 ± 8.8	27.5±5.7	0.001
FBS (mmol/L)	7.3 ± 3.3	9.7 ± 6.9	0.300	9.2 ± 4.1	9.9 ± 3.7	0.216
LVEF (%)	58.3 ± 6.7	63.2 ± 4.5	0.283	66.1 ± 7.9	67.5 ± 7.9	0.821

Table 4: Post-intervention Renal Outcome between Group A and Group B patients

Variables		**Group**		**P value**
		Group A(N=30)	**Group B(N=30)**	
Serum Creatinine	Pre-procedure	1.7 ± 0.5	1.9 ± 0.8	0.599
	Post-procedure at 48 hours	1.6 ± 0.5	2.0 ± 0.5	0.697
	Mean difference between pre & post procedure	-0.07 ± 0.17	0.08 ± 0.3	
Estimated GFR	Pre-procedure	34.8± 9.7	40.6 ± 10.0	0.295
	Post-procedure at 48 hours	37.2 ± 10.5	38.8 ± 10.4	0.786
	Mean difference between pre &post procedure	3.3 ± 5.3	-0.9 ± 3.9	
Patients having no Contrast Nephropathy		100% (30)	90% (27)	0.055

DISCUSSION

N-acetylcysteine (NAC), which is a thiol-containing antioxidant, in twice doses has been reported to reduce almost 90% relative risk of the incidence of CIN in patients with chronic kidney disease (CKD).[14,15,16,17] This current study was carried out to assess the effectivity of a high dose (1200mg) of intravenous N-acetylcysteine (NAC) over a standard dose (600mg) for the prevention of contrast-induced AKI in CKD patients with moderate to severe renal failure. In the present study, this was observed that the mean age group of the

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patients was 65 ± 8 years and 62 ± 7 years and the sex (male: female) ratio was 4.6:1& 4.27:1 in group A and group B respectively. The study by Ghani et al,[18] 2009 also showed a higher incidence of CI-AKI in patients more than 60 years of age and like the present study, a study by Tamam et al,[19] 2015 showed a male predominance over females in their study. Regarding the primary diseases with the comorbid conditions, in the current study, group A patients presented with primary renal disease diabetic nephropathy (DN) more (36.66%) than group B patients (30.00%) but patients with Hypertensive nephropathy were the same (33.33%) in both group A and B. This means that in group B patients' diabetic nephropathy (DN) though less but the frequency of Hypertensive nephropathy patients was more. These results were a bit different from the studies of Abe et al,[20] 2009, Ghani et al,[18] 2009 & Colins et al,[21] 2009 where diabetic nephropathy was a principal factor for developing CI-AKI. However, comparing the results of the present and these studies there was no significant variation of primary diseases for CI-AKD except in group B frequency of patients with diabetic nephropathy (DN) was less than the frequency of Hypertensive nephropathy this was because of the male predominance of ischemic heart disease than female (Tamam et al.,2015).[19] Overall, this indicates that diabetic nephropathy (DN) was an independent risk factor for developing CI-AKI. In the present study, this was noted that after intervention S. Creatinine (mg/dl) level, eGFR (ml/min/1.73m²), which were the major indicators of renal damage (both in stage3 and 4 of both groups) all were statistically significant in cases of group A patients (P-value 0.001& 0.003correspondingly) compared to group B Patients (P-value 0.075 & 0.001respectively). This indicates that the use of a high dose (1200mg) of intravenous N-acetylcysteine (NAC) results in the least renal damage (both in stages 3 and 4) than the intervention with a standard dose(600mg). Again, when the mean of pre-intervention and after 48 hours of intervention were taken into account there was found that the mean of pre-intervention S. Creatinine was 1.7 ±0.5 in group A whereas this was 1.9 ± 0.8 (p-value, 0.599) and after 48 hours of intervention this was 1.6 ± 0.5 and 2.0± 0.5 (p-value, 0.697). This means that before and after 48 hours of CAG/PCI, serum creatinine level was significantly increased in the standard dose group though not all developed AKI levels, and contrary to that the level in the high dose group decreased significantly. This result was also consistent with a previous study by Tepel et al.,200015. Similarly, GFR, the other basic indicator for CI-AKI assessment, was also found that the pre-intervention GFR was 34.8 ± 9.7 in group A and 40.6 ± 10.0 in group B (p-value, 0.295) contrary to this after 48 hours of intervention this was changed as 37.2 ± 10.5 and 38.8 ± 10.4(p-value, 0.786). Similarly, a study by Briguori C et al,[16] 2004 & Baker et al,[22] 2003 also found that the rate of contrast-induced nephropathy was lower in patients receiving the high dose of N-acetylcysteine due to lower serum creatinine (1.56mg/dl) relatively high GFR (45±13ml/min/1.73m²) in their subjects. In the present study, comparing the overall patients having no Contrast Nephropathy was detected in 30 (100%) patients out of 30 of group A whereas the rate was 27 (90%) out of 30 in group B. That is almost 100% of patients were free from any CI-AKD of patients' end-stages (stage 3 & 4) CKD. A study of Marenzi et al,[23] 2006 also showed almost similar results where

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CI-AKI developed in 15% of the patient who received standard dose NAC and 8% received high dose NAC.

CONCLUSIONS

High-dose N-acetylcysteine (1200mg) is more effective compared to the conventional standard dose (600mg) for the prevention of contrast-induced acute kidney injury (CI-AKI) in CKD patients. This could be considered as a preventive measure against contrast-induced nephropathy in all patients of advanced CKD undergoing coronary angiogram (CAG) or other percutaneous intervention.

Limitations and Recommendations

However, the study was done with a limited sample size within a relatively short duration, and assessment of all stages of CKD patients or the effect of N -acetylcysteine in different primary etiology of CKD was not evaluated and many other parameters were not observed, hence a large-scale randomized control trial is recommended.

REFERENCES

1. Chew DP, Astley C, Molloy D, Vaile J, De Pasquale CG, Aylward P. Morbidity, mortality and economic burden of renal impairment in cardiac intensive care. Intern Med J. 2006;36(3):185-92. doi: 10.1111/j.1445-5994.2006.01012.x.
2. Bagshaw SM, Mortis G, Doig CJ, Godinez-Luna T, Fick GH, Laupland KB. One-year mortality in critically ill patients by severity of kidney dysfunction: a population-based assessment. Am J Kidney Dis. 2006;48(3):402-9. doi: 10.1053/j.ajkd.2006.06.002.
3. Mehran R, Nikolsky E. Contrast-induced nephropathy: definition, epidemiology, and patients at risk. Kidney Int Suppl. 2006;(100):S11-5. doi: 10.1038/sj.ki.5000368.
4. Azzalini L, Kalra S. Contrast-Induced Acute Kidney Injury-Definitions, Epidemiology, and Implications. Interv Cardiol Clin. 2020;9(3):299-309. doi: 10.1016/j.iccl.2020.02.001.
5. Heard KJ. Acetylcysteine for acetaminophen poisoning. N Engl J Med. 2008;359(3):285-92. doi: 10.1056/NEJMct0708278.
6. Khwaja A. KDIGO clinical practice guidelines for acute kidney injury. Nephron Clin Pract. 2012;120(4):c179-84.
7. Subramaniam RM, Suarez-Cuervo C, Wilson RF, Turban S, Zhang A, Sherrod C, et al. Effectiveness of Prevention Strategies for Contrast-Induced Nephropathy: A Systematic Review and Meta-analysis. Ann Intern Med. 2016;164(6):406-16. doi: 10.7326/M15-1456.
8. Gleeson TG, Bulugahapitiya S. Contrast-induced nephropathy. AJR Am J Roentgenol. 2004;183(6): 1673-89.
9. Topark O. Conflicting and new risk factors for contrast induced nephropathy. J urol. 2007;178: 2277-83.
10. Aspelin P, Aubry P, Fransson SG, Strasser R, Willenbrock R, Berg KJ. Nephrotoxic effects in high-risk patients undergoing angiography. N Engl J Med. 2003;348(6):491-9. doi: 10.1056/NEJMoa021833.
11. Mehran R, Nikolsky E. Contrast-induced nephropathy: definition, epidemiology, and patients at risk. Kidney Int Suppl. 2006;(100):S11-5. doi: 10.1038/sj.ki.5000368.
12. Trivedi H, Daram S, Szabo A, Bartorelli AL, Marenzi G. High-dose N-acetylcysteine for the prevention of contrast-induced nephropathy. Am J Med. 2009;122(9):874.e9-15. doi: 10.1016/j.amjmed.2009.01.035.
13. Richter SK, Crannage AJ. Evaluation of N-acetylcysteine for the prevention of contrast-induced nephropathy. J Community Hosp Intern Med Perspect. 2015;5(3):27297. doi: 10.3402/jchimp.v5.27297.
14. McCullough PA, Wolyn R, Rocher LL, Levin RN, O'Neill WW. Acute renal failure after coronary intervention: incidence, risk factors, and relationship to mortality. Am J Med. 1997;103(5):368-75. doi: 10.1016/s0002-9343(97)00150-2.

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15. Tepel M, van der Giet M, Schwarzfeld C, Laufer U, Liermann D, Zidek W. Prevention of radiographic-contrast-agent-induced reductions in renal function by acetylcysteine. N Engl J Med. 2000;343(3):180-4. doi: 10.1056/NEJM200007203430304.
16. Briguori C, Colombo A, Violante A, Balestrieri P, Manganelli F, Paolo Elia P, et al. Standard vs double dose of N-acetylcysteine to prevent contrast agent associated nephrotoxicity. Eur Heart J. 2004;25(3):206-11. doi: 10.1016/j.ehj.2003.11.016.
17. Cotgreave I, Moldéus P, Schuppe I. The metabolism of N-acetylcysteine by human endothelial cells. Biochem Pharmacol. 1991;42(1):13-6. doi: 10.1016/0006-2952(91)90674-t.
18. Ghani AA, Tohamy KY. Risk score for contrast induced nephropathy following percutaneous coronary intervention. Saudi J Kidney Dis Transpl. 2009;20(2):240-5.
19. Short L, La VT, Patel M, Pai RG. Primary and Secondary Prevention of CAD: A Review. Int J Angiol. 2021;31(1):16-26. doi: 10.1055/s-0041-1729925.
20. Abe M, Kimura T, Morimoto T, Furukawa Y, Kita T. Incidence of and risk factors for contrast-induced nephropathy after cardiac catheterization in Japanese patients. Circ J. 2009;73(8):1518-22. doi: 10.1253/circj.cj-08-0784.
21. Collins AJ, Foley RN, Herzog C, Chavers B, Gilbertson D, Ishani A, et al. United States Renal Data System 2008 Annual Data Report. Am J Kidney Dis. 2009;53(1 Suppl):S1-374. doi: 10.1053/j.ajkd.2008.10.005.
22. Baker CS, Wragg A, Kumar S. A rapid protocol for the prevention of contrast-induced renal dysfunction: the RAPPID study. J Am Coll Cardiol. 2003;41(12): 2114-8. Med. 354: 2773–2782.
23. Marenzi G, Lauri G, Campodonico J. Comparison of two hemofiltration protocols for prevention of contrast-induced nephropathy in high-risk patients. Am J Med. 2006;119(2): 155-62.

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