

Study The Effect of Na concentration, Dialysate Temperature on Intra Dialytic Hypotension on Regular Hemodialysis Patients

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ABSTRACT

Background: Intradialytic hypotension (IDH) is common complication in stage 5 chronic kidney disease patients on hemodialysis. Incidence ranges from 15 to 30%.

Objective: This study aimed to check the effect of Na concentration, dialysate temperature on intra dialytic hypotension on regular hemodialysis patients.

Patients and Methods: Our sample consist of 84 patient we divide them into 2 subgroups: Group 1 (Test group) included 42 patient. Group 2 included 42 patient (placebo). Group1 divided into: O L carnitine group 11 patient, O NA and temperature group (21 patient: (A: 7, B: 7 and C: 7). O WT based UF group (10 patient). Group 2 divided into: P1 (11 patients), P2 (21 patient: (A: 7 B: 7 C: 7). P3 (10 patient). All sub groups were monitored for 6 months. In order to know the effect of changing dialysate NA and temperature during hemodialysis session. In this paper we studied only changes to dialysate NA and temperature.

Results: Regarding the mean Pre-HD SBP was 131.4 ± 17.56 in group Na, T. The mean Pre-HD DBP was 80.20 ± 9.19 in group Na, T. The mean Post-HD SBP was 119.23 ± 11.45 in group Na, T. The mean Pre-HD DBP was 71.20 ± 5.54 in group Na, T. The mean Pre-HD SBP was 130.15 ± 16.21 in group P. The mean Pre-HD DBP was 79.55 ± 8.22 in group P. The mean Post-HD SBP was 129.79 ± 15.23 in group P. The mean Pre-HD DBP was 76.78 ± 5.43 in group P. There were high significant difference between pre and post in Na, T group as regards SBP and DBP (mmHg). There were insignificant difference between pre- and post- in P group regarding SBP and DBP (mmHg).

Conclusion: We found significant difference between subgroups regarding dialysate NA and T.

Keywords: Na concentration, Dialysate temperature, Intra dialytic hypotension, Regular hemodialysis.

INTRODUCTION

The high mortality of end-stage renal disease (ESRD) patients persists despite recent improvements in dialysis methods, and the majority of patients rely on haemodialysis (HD) to replace renal function. Because dialysis patients tend to be older than the general population and concomitant conditions like diabetes mellitus and heart failure (HF) are becoming more common, intradialytic hypotension (IDH) is one of the most frequent consequences of HD in clinical practise⁽¹⁾. IDH is described as a drop in SBP of 20 mmHg or a decline in mean arterial pressure of 10 mmHg, the presence of end-organ ischemia, and the need for intervention to raise BP or alleviate symptoms by the National Kidney Foundation Disease Outcomes Quality Initiative (KDOQI). But the concept of IDH has recently come under scrutiny and was examined in further detail. The change in intradialytic SBP (DiSBP) was not as closely correlated with mortality as nadir-based definitions of IDH⁽²⁾.

Cramps occurred in 74.3% of HD sessions⁽³⁾, along with nausea, vomiting, and dizziness, as the most prevalent symptoms. Demographic risk factors that are specific to the patient and are not modifiable, such as diabetes mellitus, cardiovascular disease, including systolic and diastolic dysfunction, ischaemic heart disease, arrhythmias, and vascular calcification, autonomic dysfunction, female sex, age > 65 years, pre-dialysis SBP100 mmHg, high body mass index, and severe anaemia⁽⁴⁾.

Patient-related variables include hyperphosphatemia, anti-hypertensive drug usage,

eating a meal before to hemodialysis, higher body mass index, decreased albumin levels, and weight gain between dialysis sessions. These factors are more susceptible to therapy⁽⁵⁾.

High IDWG may also be a predisposing factor in relation to the dialysis prescription since it may call for a higher UFR. Additionally, it was hypothesised that in thrice-weekly HD, a greater IDH risk was linked to the first HD session of the week. Total volume elimination and UFR are related risk factors. Cardiovascular mortality is independently correlated with IDH and UFR⁽⁶⁾. Dialysate temperature, salt, and calcium concentrations are other parameters connected to dialysis⁽⁷⁻⁸⁾.

Hemodialysis (HD) patients frequently experience the condition known as intradialytic hypotension (IDH). Cardiovascular morbidity and mortality, myocardial stunning, myocardial infarction, arrhythmias, vascular access thrombosis, and insufficient dialysis dosage have all been linked to IDH. IDH has further been linked to hypoxia-induced white matter ischemia and brain shrinkage in HD patients⁽⁹⁾.

IDH is the final outcome of the interplay between cardiac output, arteriolar tone, and ultrafiltration rate (UFR). As a result, excessive ultrafiltration may reduce cardiac output, particularly when compensating mechanisms such increased heart rate, myocardial contractility, vascular tone, and splanchnic flow changes are not appropriately recruited⁽¹⁰⁾. One of the most common preventative strategies for IDH is to cool the dialysate down to below the core body temperature. In fact, EBPGs advise using cold dialysate as a primary

method of avoiding IDH. By causing vasoconstriction and stimulating the sympathetic nervous system. Cool dialysate reduces the possibility of developing IDH⁽¹¹⁾.

UFR: Decrease the UFR by increasing the length or frequency of your dialysis sessions, or by preventing weight gain between treatments. By continually adjusting the UFR in response to fleeting variations in blood volume and BP, the adoption of biofeedback mechanisms may decrease the influence on the length or frequency of dialysis sessions. Avoiding high UFRs (13 mL/h/kg) in an effort to reduce the prevalence of IDH⁽¹²⁾.

Sodium profiling: During HD, waste is removed via diffusion, which lowers the osmolarity of extracellular fluid and results in a shift of extracellular fluid into cells. Raising the sodium concentrations in the dialysate prevents this shift by reestablishing the osmotic gradient and plasma filling. However, a rise in sodium concentration leads to thirst, volume expansion, and an increase in blood pressure. In addition to its negative osmotic effects, excess sodium can also increase endothelial cell stiffness, which can inhibit nitric oxide production and increase sympathetic outflow. It is suggested to use sodium profiling to reduce such harmful consequences. Dialysate sodium concentration is high at the start of the dialysis session and gradually decreases as waste solutes are removed from plasma during sodium profiling (modelling)⁽¹³⁾.

The aim was to study the effect of Na concentration, dialysate temperature on intra dialytic hypotension on regular hemodialysis patients.

PATIENTS AND METHODS

A) Clinical trial study was carried out in Met Ghamr Hospital of Nephrology and Urology.

B) **Sample size:** Assuming that percentage of IH in l-carnitine group 13.3% and in placebo group 43.3% so the sample size will be 84 (42 in each group) using epi info power 80% CI 95%⁽¹⁴⁾.

Inclusion criteria: Men and non-pregnant women. No breastfeeding. Aged 18 to 85 years. Regular attendance to hemodialysis sessions. At least twice a week, spent the previous 6 months on hemodialysis treatment. Patients who had two or more IDH episodes in the past 6 months not taking high blood pressure medications.

Exclusion criteria: Septic history in the previous 6 months. Pregnancy. Lactation. History of hypersensitivity or contraindication to LC. Patients with malignant disease. Patients with advanced cardiovascular disease. Shock. Patients with active infection.

Methods:

History taking: Complete clinical examination with special emphasis on blood pressure (pre- and post-dialysis) and dialysate Na and T.

Changes on dialysis machine dialysate temperature 36°C, sodium dialysate concentration at the beginning

of HD will be 140 mmol/L, which will be decreased linearly every hour until it reach 135 mmol/L in the last hour of dialysis session.

We divide sample into 3 groups to study the effect of l carnitine, changes to dialysate Na, temperature and WT based ultrafiltration on IDH on regular hemodialysis patients.

In this paper we studied only changes to dialysate Na, temperature: Na and temperature group 21 patients and 21 patients (placebo).

Hemodialysis settings:

- All patients were dialyzed with bicarbonate dialysis.
- Thrice weekly for 4 h with a poly ethaline high flux hollow-fiber dialyzer FRESSNUS4008s hemodialysis machine.
- The blood flow rate was 350 mL/min, dialysate flow rate was 500 mL/min, dialysate temperature used was 36.5°C, and all were kept constant throughout the study period.
- The dialysate composition was: sodium 138 mmol/L, potassium 2 mmol/L, calcium 1.75 mmol/L, bicarbonate 32 mmol/L, acetate 3 mmol/L, glucose 1 g/L, Mg, 50 mmol/L, Cl 10⁹, 5.

Na concentration and dialysate temperature: Na and temperature group 21 patients, and 21 patients (placebo).

Including:

- Placebo (dialysate temperature: ; 36.5°C routine sodium concentration: 135 mmol/L)
- Na and temperature group 3 protocols were administered:
(1) Dialysis mode A (dialysate temperature: 36°C; routine sodium concentration: 135 mmol/L).
(2) Dialysis mode B (dialysate temperature: 36.5°C; sodium dialysate concentration at the beginning of HD was 140 mmol/L, which was decreased linearly every hour until it reached 135 mmol/L in the last hour of the dialysis).
(3) Dialysis mode C (dialysate temperature 36 °C. Sodium dialysate concentration at the beginning of HD was 140 mmol/L, which was decreased linearly every hour until it reached 135 mmol/L in the last hour of dialysis).

Every patient in this research had three sessions of dialysis using each of the treatment modalities. Each patient received the identical dialysis machine, the same number of sessions, and the same kind of dialysis. Additionally, there was no discernible difference in the weight increase of the patients across all sessions and modes. Additionally, a checklist was used to evaluate a few clinical symptoms of patients, including weariness, chills, thirst, and other symptoms in all sessions and modes.

Hemodialysis settings:

- All patients were dialyzed with bicarbonate dialysis- thrice weekly for 4 h with a poly ethaline high flux hollow-fiber dialyzer.

- FRESSNUS4008s hemodialysis machine.
- Blood flow rate was 350.
- Dialysate flow rate was 500 mL/min.
- Dialysate Na and temperature changed throughout the study period.
- THE dialysate composition was: sodium 138 mmol/L, potassium 2 mmol/L, calcium 1.75 mmol/L, bicarbonate 32 mmol/L, acetate 3 mmol/L, glucose 1 g/L, Mg, 50 mmol/l, Cl 109,5.

Ethical approval: This experiment was ethically approved by Zagazig University's Ethical committee. After being fully informed, all participants provided written consents. The study was conducted out in line with the Helsinki Declaration.

Statistical analysis

Descriptive statistics were performed using SPSS version 26.0 for numerical parametric data using mean, SD (standard deviation), minimum and maximum of the range, and for numerical non parametric data using

median and first and third interquartile range, while they were performed using number and % for categorical data. For quantitative variables, inferential analyses were performed using the independent t-test when there were two independent groups and parametric data, and the Mann Whitney U when there were two independent groups and non-parametric data.

Chi square test for independent groups was used for inferential analysis of qualitative data. The statistical significance of the variation of a non-parametric variable between related samples was evaluated using the Wilcoxon Rank test. P values ≤ 0.05 were used to determine significance; values beyond this threshold are non-significant. The p-value is a statistical indicator of the likelihood that the findings of a research may have been the product of chance.

RESULTS

Figure (1) showed that there was no significant difference between both groups as regard sex characteristics.

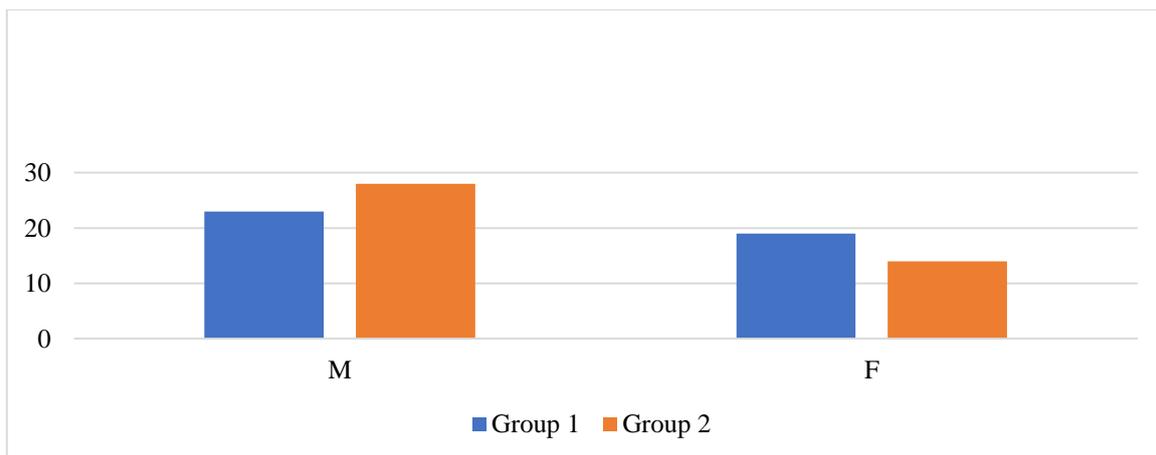


Figure (1): Sex among the studied groups.

Figure (2) showed that the mean age was 47.57 ± 11.91 years in group 1, and 47.59 ± 10.93 years in group 2.

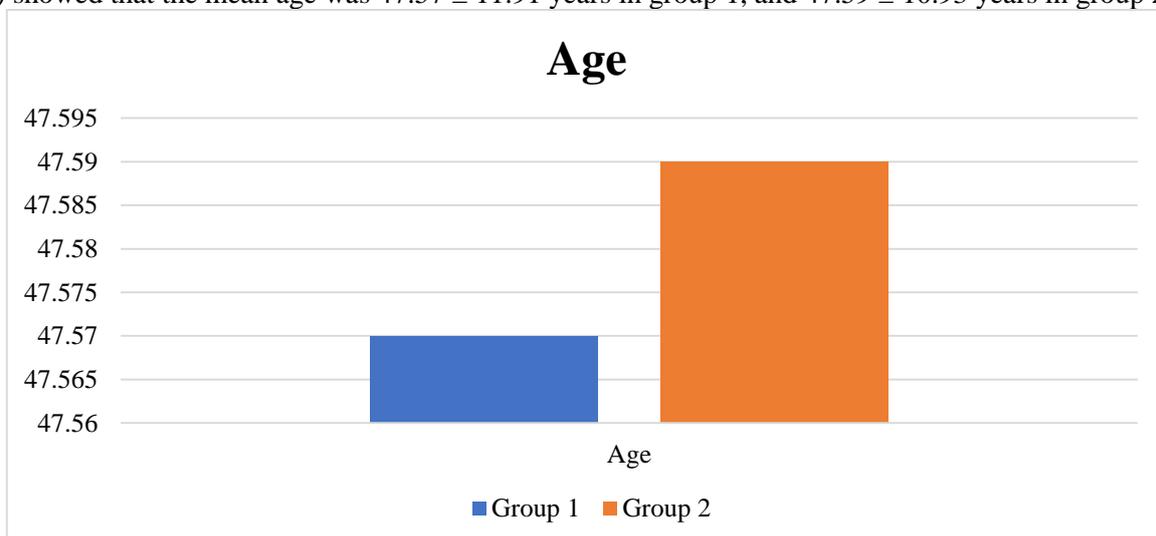


Figure (2): Age among the studied groups.

Table (1) showed history of past illness among the two studied groups. In group (1), there were 19.04 % with HTN, 23.8% with DM and 2.3% with cerebrovascular stroke. In group 2, there were 16.67 % with HTN, 19.04% with DM, There were 4.7% with cerebrovascular stroke. There were no insignificant difference between both groups as regards history of past illness.

Table (1): History of past illness among the studied groups

	Group 1 (n = 42)		Group 2 (n = 42)		Test value	P-value
	N	%		%		
HTN	8	19.04%	7	16.67%	0.088	0.76
DM	10	23.8%	8	19.04%	0.3175	0.5731
Cerebro-vascular stroke	1	2.3%	2	4.7%	0.3509	0.5536

P value< 0.05 is significant, P value< 0.01 is highly significant, SD: Standard deviation, X²= Chi- Square test.

Table (2) showed that BP characteristics among the two studied groups. The mean Pre-HD SBP was 132.2 ± 18.0 in group 1 and the mean Pre-HD SBP was 131.1 ± 16.20 in group 2. The mean Pre-HD DBP was 81.81 ± 9.12 in group 1 and the mean Pre-HD DBP was 80.52 ± 8.44 in group 2. The mean Post -HD SBP was 121.98 ± 11.88 in group 1 and the mean Post -HD SBP was 129.86 ± 11.96 in group 2. The mean Post -HD DBP was 72.90 ± 5.18 in group 1 and the mean Post -HD DBP was 76.88 ± 5.32 in group 2. The mean change in SBP was -11.12 ± 9.26 in group 1 and the mean Post -HD SBP was -3.55 ± 5.23 in group 2. The mean change in DBP was -9.23 ± 6.88 in group 1 and the mean change in -HD DBP -2.65 ± 5.10 in group 2. There were high significant difference between pre and post in group 1. As regards SBP and DBP (mmHg), there were high significant difference between pre- and post- in group 2 as regards DBP (mmHg). There were high significant difference between both groups as regards change in SBP (mmHg).

Table (2): BP characteristics among the studied groups

		Group 1 (n = 42)	Group 2 (n = 42)	Test value	P-value
Pre-HD BP (mmHg)	SBP	132.2±18.0	131.1±16.20	1.23	0.50
	DBP	81.81±9.12	80.52±8.44	1.167	0.62
Post-HD BP (mmHg)	SBP	121.98±11.88	129.86±11.96	1.622	0.12
	DBP	72.90±5.18	76.88±5.32	1.193	0.57
SBP		^a p=0.008	^b p=0.05	-	-
DBP		^a p=0.0004	^b p=0.003	-	-
Change in BP (mmHg)	SBP	-11.12±9.26	-3.55±5.23	3.134	0.0003
	DBP	-9.23±6.88	-2.65±5.10	1.819	0.058

P value< 0.05 is significant, P value< 0.01 is highly significant, SD: Standard deviation, ^zMWU = Mann- Whitney U test. ^ap<

0.05= significant between pre and post in group 1. ^bp< 0.05= significant between pre and post in group 2.

Table (3) showed BP characteristics among dialysate Na and temperature (Na, T) group and placebo group (P). The mean Pre-HD SBP was 131.4 ± 17.56 in group Na, T. The mean Pre-HD DBP was 80.20 ± 9.19 in group Na, T. The mean Post -HD SBP was 119.23 ± 11.45 in group Na, T. The mean Pre-HD DBP was 71.20 ± 5.54 in group Na, T. The mean Pre-HD SBP was 130.15 ± 16.21 in group P. The mean Pre-HD DBP was 79.55 ± 8.22 in group P. The mean Post -HD SBP was 129.79 ± 15.23 in group P, The mean Pre-HD DBP was 76.78 ± 5.43 in group P. There were high significant difference between pre- and post- in Na, T group as regard SBP and DBP (mmHg). There were insignificant difference between pre and post in P group as regards SBP and DBP (mmHg).

Table (3): BP characteristics among dialysate NA and Temperature (Na, T) group and placebo group (P)

		Na, T Group (n = 21)	P Group (n = 21)	Test value	P-value
Pre-HD BP(mmHg)	SBP	131.4±17.56	130.15±16.21	1.17	0.72
	DBP	80.20±9.19	79.55±8.22	1.24	0.62
Post-HD BP (mmHg)	SBP	119.23±11.45	129.79±15.23	1.622	0.21
	DBP	71.20±5.54	76.78±5.43	1.04	0.92
SBP		^a p=0.05	^b p=0.051	-	-
DBP		^a p=0.02	^b p=0.06	-	-

P value< 0.05 is significant, P value< 0.01 is highly significant, SD: Standard deviation, ^zMWU = Mann-Whitney U test. ^ap< 0.05= significant between pre and post in group 1. ^bp< 0.05= significant between pre and post in group 2.

DISCUSSION

We examined the rate of IDH for group1 subgroups and group2 subgroups during a 6-month period. SBP and DBP (mmHg) were highly negligible in the P group between pre- and post. Our results contradict those of **Ibarra-Sifuentes et al.** (14) on the impact of LC before a session on IDH. In this randomised experiment, intravenous administration of LC before each hemodialysis session showed positive preventative benefits on IDH episodes. In this study, we discovered that patients receiving intravenous LC before each hemodialysis session showed a statistically significant risk decrease in IH episodes of 23.9% compared to those receiving placebo (P 0.001). **Ahmad et al.** (15) reported an IH episode decrease of 44% to 18% in the carnitine group (P 0.02) when given intravenously during hemodialysis sessions in the observational randomised study. In their meta-analysis published in 2007, **Lynch et al.** (16) used five clinical trials to demonstrate that LC supplements had an odds ratio of 0.28 (confidence interval 95%, 0.04-2.23; P = 0.2).

Chewcharat et al. ⁽¹⁷⁾ reported secondary outcomes and showed that LC did not substantially reduce the symptoms of IH (P = 0.5; I² 0%, P-heterogeneity 0.83). Pre-HD BP (mmHg) SBP p value 0.85 DBP p value 0.75, as demonstrated in our study. SBP p-value for post-HD BP (mmHg) was 0.99; DBP p-value was 0.95.

An analysis of the five trials that were previously published and looked at how L-carnitine supplementation affected intradialytic hypotension produced a pooled OR of 0.28 (95% CI, 0.04 to 2.23). Despite the low point estimate, there was a lot of uncertainty that makes it difficult to judge if L-carnitine could have a positive effect. Additionally, the results of one research by **Casciani et al.** ⁽¹⁸⁾ accounted for the majority of the pooled estimate's input. The pooled OR after excluding this trial was 0.84 (95% CI, 0.38 to 1.90).

AS regard dialysate Na and temperature: There was significant difference between subgroups regarding dialysate Na and T, which is similar to findings of **Ebrahimi et al.** ⁽¹⁹⁾. The results of this study showed that patients in modes D (dialysate temperature: 35°C; sodium dialysate at the beginning of HD was 150 mmol/L which was decreased linearly every hour until it reached 138 mmol/L in the last hour of dialysis) and C (dialysate temperature: 37°C; sodium dialysate at the beginning of HD was 150 mmol/L, which was decreased linearly every hour until it reached 138 mmol/L in the last hour of dialysis) had higher mean systolic and diastolic blood pressure than those in mode A (dialysate temperature: 37°C; sodium concentration 138 mmol/L), and this difference was statistically significant.

In our study dialysate Na and temperature protocols tested were as follows; 1-dialysis mode A (dialysate temperature: 36°C; routine sodium concentration: 135 mmol/L) 2-dialysis mode B (dialysate temperature: 36.5°C; sodium dialysate concentration at the beginning of HD was 140 mmol/L, which was decreased linearly every hour until it reached 135 mmol/L in the last hour of the dialysis), 3-dialysis mode C dialysate temperature 36 °C; sodium dialysate concentration at the beginning of HD was 140 mmol/L, which was decreased linearly every hour until it reached 135 mmol/L in the last hour of dialysis).

Our study showed high significant difference between pre and post in Na, T group as regard SBP and DBP (mmHg) Pre-HD BP (mmHg) SBP p value 0.72 DBP p value 0.62 Post-HD BP (mmHg) SBP p value 0.21 DBP p value 0.92. The incidence of intradialytic hypotension in patients undergoing cold dialysis method as well as the combined methods of cold dialysis and gradual reduction of sodium was lower than in the standard method, and this difference was statistically significant. **Shahgholian et al.** ⁽²⁰⁾ study showed that combination dialysis frequently results in hypotension, and demonstrate a significant difference between subgroups in that group cold dialysis, sodium

concentration 3, and UF profile 3 had a lower sodium concentration and UF profile than in the cold dialysis group. According to the research's findings, there was a substantial difference, just like in the current investigation.

In a study with a longer follow-up, **Song et al.** ⁽²¹⁾ investigated the effects of various salt and ultrafiltration profile combinations in patients who were prone to pain associated with intradialytic hypotension. There were four different D-Na protocols tested: fixed (138 mEq/L), sodium-balance-positive (time-averaged mean D-Na 143 mEq/L) step-down, sodium-balance-neutral (time-averaged mean D-Na 138 mEq/L) step-down, and sodium-balance-neutral alternating forms. This study discovered that sodium-balance-positive methods invariably increased sodium loading, which led to an increase in IDWG and ultimately negated the beneficial impact on intradialytic blood pressure during a 6-week observation period.

This retrospective analysis demonstrated a lower risk of intradialytic hypotension events and a decreased chance of receiving dialysis treatments accompanied by a hypotension event when the weight-based UF rate limit was 13 mL/kg/h.

CONCLUSION

We found significant difference between subgroups regarding dialysate Na and T.

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Conflict of interest: The authors stated no conflict of interest.

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