Are Cooling Dialysate and Patient Education Can Decrease Intradialytic Hypotension?

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Abstract

Background: Intradialytic hypotension (IDH) is a common and distressful complication of hemodialysis. It can cause uncomfortable symptoms for patients, lower dialysis efficiency, and result in vascular access thrombosis. Therefore, preventing this complication is essential. **Aim:** To evaluate the effects of cooling the dialysate and patient education on decreasing intradialytic hypotension. **Design** A Quasi-experimental study design was used. **Methods** A purposive 70 patients undergoing hemodialysis in a hospital in Egypt participated in the study. Tool I (Structured Interviewing Questionnaires Sheet) and Tool II (Intradialytic hypotension Assessment Sheet) were used to collect data. Interventions include educate patients some instructions help in decrease IDH. In addition, lower dialysate temperature. **Results** A statistically significant difference in the occurrence of intradialytic hypotension was observed between pre and post intervention during every hour of hemodialysis ($p < 0.01$). Also, more than half of the patients reported symptoms of intradialytic hypotension before intervention, including fatigue, sweating, cramps, and dizziness with a statistically significant difference from those after intervention ($p = 0.001$). **Conclusion:** As a result of the intervention done, the symptoms observed during dialysis and the prevalence of IDH decreased. **Recommendations:** Cooling the dialysate and educating patients instructions regarding diet and dealing with drugs can be routinely applied to prevent IDH in hemodialysis units.

Key words: cooling dialysate, patient education, intradialytic hypotension, nursing

Introduction

Hemodialysis (HD) is a lifesaving procedure for patients with end-stage kidney disease (Kuo et al., 2019). There is no estimated prevalence for patients undergoing hemodialysis, but in El-Sharkia governorate, Egypt 2017 the prevalence of patients on maintenance HD is 442 per million population (0.0442%) **(Ahmed et al., 2020).**

Hemodialysis is associated with several complications like intradialytic hypotension (IDH), with an incidence rate reaching approximately 20%–30% worldwide while, in a study conducted in Egypt, this rate was reported as 90% **(Narouz & El-Sayed, 2019).** IDH is described by the European Best Practice Guidelines as a reduction in systolic blood pressure (SBP) during dialysis by 20 mmHg or a 10 mmHg decrease in the mean arterial pressure, followed by common related symptoms i.e., nausea, vomiting, abdominal discomfort, muscle cramps, pruritis, fatigue and light-headedness which need nurses' intervention **(Georgianos & Agarwal, 2019; Park et al., 2019; Molin et al., 2019).**

The main causes of IDH related to patient factors can be divided into three categories. Firstly, blood volume-related factors, including ultrafiltration volume, ultrafiltration rate, and plasma refilling rate (PRR). Vascular tone-related causes, including sympathetic dysfunction, body temperature, and blood redistribution due to meals during dialysis, represent the second category **(Koda & Aoike, 2019).** As according to kanbay et al., (2020), it has been reported that food intake may cause hypotension by causing dilatation of the splenic vein. As well as, cardiac factors such as ischemic heart disease, diastolic dysfunction, arrhythmia, myocardial stunning, and regional wall motion abnormalities comprise the third cause. Among these, a large ultrafiltration volume is a primary factor in the induction of IDH **(Okoye, Slater, & Rajora, 2017).**

Patients who are at risk of IDH need thorough and regular monitoring during every session, and the nurse should be aware of these patients. Preventing IDH remains a major challenge in intermittent renal replacement therapy. To prevent it, various approaches have been suggested based on the modulation of ultrafiltration ("ultrafiltration profiling") to 4% of body weight and qualitative changes in the

dialysate composition (e.g., the use of high sodium concentrations) **(Yu et al., 2018).**

As well, lowering the dialysate temperature as it is a nonpharmacological, simple, and easily applicable method without additional cost. It decreases the risk of IDH by inducing vasoconstriction through activating the sympathetic nervous system, which preserves the central blood volume, improves cardiac output, and increases peripheral vascular resistance. Furthermore, it decreases pruritus during dialysis, that makes patients more relaxed **(Mustafa et al., 2016; Rad, Jaghouri, Sharifipour, & Rakhshani, 2017).**

Additionally, patients with limited health knowledge have less control over their diseases. Therefore, patient education is crucial. In this way, satisfaction, quality of life, and independence are increased. Besides complications, anxiety, and cost are reduced **(Arad et al., 2021).** Nephrological nurses play a critical role in preventing and managing IDH. Nurses guide, empower, and enable HD patients to adhere to treatment plans (Bradshaw, Ockerby, & Bennett, 2015). Patient education delivered by nephrological nurses is an important and essential aspect of healthcare, affecting patient outcomes. Nurses should interact with nephrologists, nutritionists, social services, staff, patients and their families to obtain better outcomes **(El-Sheikh & Abed elsatar, 2017).**

Significance of the study:

IDH, a distressing complication, has a negative impact on patients' status. It is associated with symptom burden, increased incidence of access failure, and up to 30% of HD patients shorten their dialysis sessions **(Sornmo, Sandberg, & Solem, 2012; Chou, Kalantar-Zadeh, & Mathew, 2017; Alvarez et al., 2020).** Moreover, it decreases the efficacy of HD treatment, increases risk of vascular access thrombosis and future cardiovascular morbidity and mortality rates **(Stefánsson et al., 2014; Bradshaw, Ockerby, & Bennett, 2015; Park et al., 2019).**

Aim of the study:

The study aimed to evaluate the effects of cooling the dialysate and patient education on decreasing intradialytic hypotension.

Materials and methods:

Research hypothesis:

The prevalence of IDH will be decreased after intervention compared with that before intervention among the study participants.

Study design

A Quasi experimental, pre- and post-intervention, study design was employed.

Participants

Purposive sample with the following inclusion criteria: 18 to 60 years, adult patients with end-stage kidney disease undergoing regular HD. The exclusion criteria were as follows: psychiatric patients, chronic hypotension, heart disease and patients with high body temperature.

Sample size:

The sample size for this study was calculated using DSS Research (https://www.DSS research.com /calculating sample size using percentage). The prevalence of IDH was 51.6% (Ozen & Cepken., 2020) and lowered to 17.6% after intervention, with an alpha error of 5% (95% confidence level) and β error of 10.0% (study power of 90%). Then, a sample size of 64 patients will be included for pre- and post-assessment. We included a purposive sample of 70 adult HD patients.

Setting:

A central hospital, Dakahlia, Egypt. The HD unit is located on the first floor and consists of three large halls with 24 HD machines with each hall containing eight HD machines. The unit functions in two shifts/day: morning shift (from 6:00 am to 10:00 am) and afternoon shift (from 10:30 am to 2:30 pm).

Tools for data collection:

Data were collected using the following tools:

Tool I: Structured Interviewing Questionnaires Sheet:

This tool was developed by the researchers based on review of related literatures **(Palmer & Henrich, 2008; Agarwal, 2012; Kaze et al., 2015; Kuipers et al., 2016; Ozen et al., 2017),** It comprised three main parts. Part one consisted of five questions about demographic data, including

age, gender, level of education, occupation, and residence. Part two consisted of six questions about health-related data, including the primary causes of HD, presence of additional chronic diseases, current medications, last time for antihypertensive drugs before HD session, and smoking status. Part three was designed to assess the patients' characteristics during HD. It covered all baseline data needed, which comprised seven questions, including weight, height, body mass index, dry weight, type of current vascular access used, total time on HD, duration of HD sessions, frequency of HD sessions per week, machine parameters, and patient diet.

Tool II: Intradialytic Hypotension Assessment Sheet:

This tool was developed by the researchers to evaluate the effects of cooling the dialysate and patient education on decreasing IDH, based on review of related literatures and experts' opinions **(Palmer & Henrich, 2008; Agarwal, 2012; Kuipers et al., 2016; Larkin et al., 2017).** The tool was filled by the researchers and included two main parts as follows: The first part included measuring blood pressure before the HD session, every hour during the session, and after the HD session to detect and record IDH episodes. The second part included clinical events during the HD session, such as a decrease in SBP of ≥20 mmHg with or without symptoms, which need nursing interventions. Moreover, this part was used to assess symptoms indicating the development of IDH, such as fatigue, cramps, sweating, dizziness, nausea, vomiting, shortness of breath, abdominal discomfort, inadequate blood flow, chest pain, and headache.

Validity and reliability:

Content validity was assessed by a jury of five experts. The jury consisted of two professors of Medical–Surgical Nursing (Faculty of Nursing, Cairo University, Egypt), one professor of Medicine, one professor of Nephrology, and one lecturer of Biostatistics (Faculty of Medicine, Mansoura University, Egypt). The experts examined the study tools for completeness, feasibility, clarity, relevance, and applicability for implementation, and necessary modifications were made accordingly.

Pilot study:

A pilot study was conducted involving 10% of the total study sample (n = 7) using the aforementioned setting to ascertain the relevance, objectivity, and applicability of the developed tools. They were excluded from the actual study.

Data Collection

The study was conducted from the beginning of March 2021 to the end of August 2021 at the HD unit in a central hospital in Egypt. The study was conducted through the following phases:

Preparatory phase:

Patients who met inclusion criteria were individually interviewed. The researchers interviewed 5–10 patients per day where the patients were asked about demographic and medical data then complete characteristics during HD from the patients' medical record using tool I.

Then, based on the data achieved from the first assessment, in addition to the literature **(Selby & McIntyre, 2006; Mustafa et al., 2016; Larkin et al., 2017; Chou, Kalantar-Zadeh, & Mathew, 2017; Georgianos and Agarwal, 2019 and Jelicic, 2021)**, the researchers planned the nursing approaches. A simple coloured brochure was developed for the patients in simple, clear, and obvious Arabic that supported with figures for more clarification and covered all items related to IDH prevention (i.e., dietary recommendations and time of medication administration). The main objective of this brochure was to ascertain that there weren't any other variables that may cause IDH.

Implementation phase:

Part I: The effect of routine hospital care on the prevalence of IDH (pre-intervention) was evaluated, which includes lowering the dialysate temperature to 0.5°C below the patient body temperature, limiting the ultrafiltration rate to less than 4% of body weight during each dialysis session, and using a dialysate containing bicarbonate.

Part II: This part consisted of the nursing approaches applied to all patients in the study, including health teachings given for each patient through lectures and discussions based on the patient's needs and level of understanding.

- It was performed in two sessions (15 min for each): The first session included knowledge of IDH, while the second session included

knowledge about dietary recommendations and drug administration.

- At the beginning of the sessions, an orientation to the aim of the study and goals of the nursing approaches occurred. Moreover, the patients were oriented about the phases of the study and the health teaching sessions (i.e., time, duration, place, and contents).
- Each session started with a summary of the previous session and objectives of the new session using a simple slang language that suits the level of the patients without ignoring motivation and reinforcement techniques.
- Different teaching and learning methods were used during the sessions, which included interactive demonstration and instructional media, including pictures and a printed brochure, which was presented in a clear and concise form to be used as a memorial reference.
- Direct reinforcement in the form of a copy of the coloured brochure was provided as a reward for each patient to use it as a future reference.
- At the end of each session, a summary was provided by the researchers.
- The patients were allowed to ask any interpretation, elaboration, or explanation of any item included in the sessions.

Part III: Moreover, some nursing approaches were employed during the HD sessions:

Ensuring the limitation of the ultrafiltration rate to less than 4% of body weight during each dialysis session and ascertaining that a dialysate containing bicarbonate is used to prevent IDH **(Chou, Kalantar-Zadeh & Mathew, 2017; Jelicic, 2021)**. Then, lowering the dialysate temperature to 35.5°C for patients who experience IDH during the sessions before interventions with limited range from (0.5-1.0° c) lower than patients' body temperature. **(Sadaji et al., 2016; Rad et al., 2017; Kanbay et al., 2020).** Furthermore, minimizing the use of blood pressure-lowering medications before the dialysis sessions (Halle, et al., 2020). As well, providing dietary education regarding the limitation of fluid and salt intake (**Rifai, 2021; Kayikcioglu, et al., 2009; Rozensky, Sweet, and Tovian, 2013; Ozen, et al.,2021).** Finally, discouraging eating immediately before or during dialysis, which could reduce the frequency of hypotension that may be increased by eating **(Kanbay et al., 2020; Fotiadou, et al., 2020).**

Evaluation phase:

The researchers used tool II during the HD sessions to assess the prevalence of IDH and compare the results before and three months after intervention.

Ethical consideration:

A written approval of the study protocol was obtained from the ethics and research committee of Mansoura University, Egypt with Ref. No. P.0224. Also, the study was conducted according to principles of the Declaration of Helsinki. During data collection, a verbal and written agreement was obtained from each participant after clear and proper explanation of the study purpose and importance for them. The patients' privacy, confidentiality of the collected data, and the right to withdraw from the study at any time were considered. Also, an official letter was issued with approval from the hospital manager after explanation of the study purpose and schedule of data collection. The nature and aim of the study were verbally explained to the nursing staff and patients.

Statistical analysis

The data were collected, reviewed, and fed to Statistical Package for Social Sciences version 21 (IBM Corp., Armonk, NY, USA). All statistical methods used were two-tailed, with an alpha level of 0.05. Differences were considered statistically significant if the p value was less than or equal to 0.05. Descriptive analysis was performed by prescribing frequency distribution and percentage for study variables, including the patients' personal data, medical history, and HD data. The primary (i.e., IDH) and secondary (i.e., antihypertensive drug intake time, symptoms change, and dietary habits) outcomes were compared before and after intervention using the McNemar test for related categorical outcome variables.

Results:

Among the 70 patients under study, 71.4% were male, and 74.3% were aged between 50 and 60 years (Table 1). Concerning the level of education, approximately two-thirds (60.0%) of the study population were below the secondary educational level. Furthermore, most patients were unemployed and living in rural areas (85.7% and

87.1%, respectively). Moreover, more than two-thirds (68.6%) never smoked.

More than half of the patients under study (51.4%) had chronic health problems. Particularly, most patients (91.2%) had anemia. Regarding the current medications taken, the proportion of patients who take erythropoietin was almost the same as that of patients who take calcium channel blockers (53.6% and 50.7%, respectively). ((not shown here due to restricted number tables)

Table 2 shows that approximately two-thirds of the patients under study (65.7%) had hypertension, which represents as the primary causes of dialysis, and most patients had an arteriovenous fistula (81.4%) as the most current vascular access used. In relation to the total time on HD, less than half of the patients under study (42.9%) underwent HD for less than one year. Furthermore, all patients under study (100%) had a dialysis schedule of three sessions per week, and approximately two-thirds (60.0%) of the patients had sessions that last four hours per session.

Before intervention, among the patients under study, 7.1% were taking antihypertensive drugs at the night of the HD session, whereas, after intervention, approximately two-thirds (60.0%) of the patients were taking antihypertensive drugs (Table 3). Furthermore, a statistically significant difference in dietary habits was observed between before and after intervention.

More than half of the patients reported symptoms of IDH before intervention, including fatigue (54.3%), sweating (52.9%), cramps (51.4%), and dizziness (51.4%) with a statistically significant difference from those after intervention; 11.4% of the patients had symptoms of IDH after intervention (Table 4). Moreover, the prevalence of IDH symptoms decreased greatly after intervention with a statistically significant difference ($P \leq 0.05$).

According to (Table 5) patients body temperature before intervention were near that after intervention as mean were (36.8643 and 36.3957 respectively).

Among the patients under study, 41.4% and 50.0% had IDH at the first and second hours of HD session, respectively, before intervention compared with 11.4% and 10.0% who had IDH at the first and second hours of HD session, respectively, after intervention (**Figure 1**). Moreover, the prevalence of IDH greatly decreased after intervention with a statistically significant difference, indicating that cooling the dialysate and patient education are effective ($P \leq 0.05$).

Table 1. Demographic characteristics of the patients under study (n = 70).

Personal data	**No**	**%**
Gender		
Male	50	71.4%
Female	20	28.6%
Age in years		
18–29	3	4.3%
30–39	3	4.3%
40–49	12	17.1%
50–60	52	74.3%
Level of education		
Below secondary	42	60.0%
Secondary	4	5.7%
University or above	24	34.3%
Occupation		
Not working	60	85.7%
Manual work	9	12.9%
Administrative work	1	1.4%
Residence		
Urban	9	12.9%
Rural	61	87.1%
Smoking		
Non-smoker	48	68.6%
Current smoker	13	18.6%
Ex-smoker	9	12.9%
Data are expressed as frequency (percentage).		

Table 2. Hemodialysis-related data of the patients under study (n = 70).

Hemodialysis data	**No**	**%**
Primary causes of hemodialysis		
Hypertension	44	65.7%
Nonsteroidal anti-inflammatory drugs	13	19.4%
Glomerulonephritis	11	16.4%
Systemic lupus erythematosus	3	4.5%
Current vascular access		
Arteriovenous fistula	57	81.4%
Arteriovenous graft	6	8.6%
Central venous catheter	7	10.0%
Duration of hemodialysis		
<1 year	30	42.9%
1–5 years	27	38.6%
6–10 years	9	12.9%
>10 years	4	5.7%
Frequency of hemodialysis		
3 sessions/week	70	100.0%
Duration of hemodialysis session (hours)		
3.0	2	2.9%
3.5	26	37.1%
4.0	42	60.0%
Average weight gain (kg)		
Range	1–6	
Mean ± SD	2.4 ± 1.0	
Data are expressed as frequency (Percentage).		

Table 3. Comparison among the patients under study before and after intervention according to their drug intake and dietary habits (n = 70).

Dietary habits	***Pre- intervention***		***Post- intervention***		**P-value**
	No	**%**	**No**	**%**	
Time of antihypertensive drug taken					
At night	5	7.1%	42	60.0%	
2 hours before HD	15	21.4%	4	5.7%	0.001*
Immediately before HD	2	2.9%	1	1.4%	
Stopped drug intake	48	68.6%	23	32.9%	
Dietary habits					
Low salt diet	26	37.1%	60	85.7%	0.001*
Low fluid diet	16	22.9%	57	81.4%	0.001*
High salt diet	44	62.9%	10	14.3%	0.001*
High fluid diet	54	77.1%	13	18.6%	0.001*
Prohibit food	15	21.4%	62	88.6%	0.001*
Eating during dialysis	55	78.6%	8	11.4%	0.001*
P: McNemar test for related groups	** P < 0.05 (significant)*				

Table 4. Comparison among the patients under study before and after intervention according to IDH symptoms (n= 70).

Symptoms	***Pre- intervention***		***Post- intervention***		**P-value**
	No	**%**	**No**	**%**	
Fatigue	38	54.3%	8	11.4%	0.001*
Sweating	37	52.9%	8	11.4%	0.001*
Cramp	36	51.4%	8	11.4%	0.001*
Dizziness	36	51.4%	8	11.4%	0.001*
Nausea	27	39.1%	8	11.4%	0.001*
Vomiting	22	31.4%	4	5.7%	0.001*
Shortness of breath	21	30.0%	6	8.6%	0.001*
Abdominal discomfort	11	15.7%	1	1.4%	0.003*
Inadequate blood flow	16	22.9%	7	10.0%	0.040*
Chest pain	9	12.9%	0	0.0%	0.002*
Headache	15	21.4%	7	10.0%	0.064
P: McNemar test for related groups	** P < 0.05 (significant)*				

Table 5. Comparison among the patients under study before and after intervention according to peripheral body temperature (n = 70).

Peripheral body temperature	*Pre- intervention*	*Post- intervention*
Mean	*36.8643*	*36.3957*
Std. Deviation	*0.23959*	*0.20319*
Minimum	*36.00*	*36.00*
Maximum	*37.00*	*36.70*

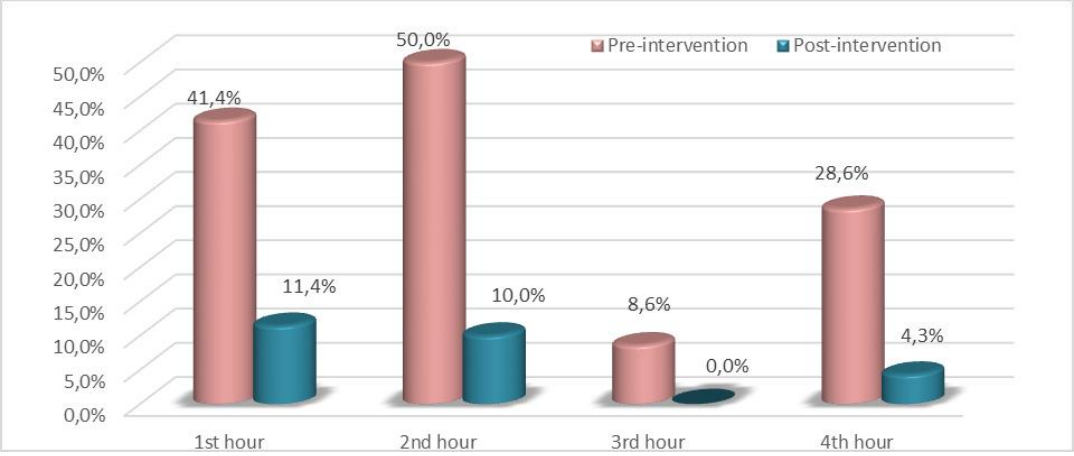

Figure 1. Intradialytic hypotension among the patients under study before and after intervention every hour of the hemodialysis session (n = 70) ($p < 0.01$ for all comparisons).

Discussion

In the current study it was determined that the prevalence of IDH significantly decreased after patient education and cooling of the dialysate (Figure 1). This is in line with Arad et al., (2021), whose results showed the effectiveness of patient education as disease occurrence, drug use, fluid restrictions, and diet compliance were better in HD patients who received training and nurse follow-up by telephone. Similarly, Yangöz et al. (2021) also determined that education and self-management interventions have a beneficial effect on compliance to fluid intake, diet, and medication management. The results obtained from this study and examined in the literature revealed the importance of education for HD patients, although they are on different complications.

Besides patient education for reducing IDH, another important intervention in this study is dialysis fluid cooling. In a meta-analysis conducted on this subject, it was determined that low-temperature dialysates reduced the rate of IDH development by 70% **(Mustafa et al., 2016; Rad et al., 2021).** Moreover, the dialysate with a temperature of 35.5°C increased the systolic and diastolic blood pressures of HD patients and improved their hemodynamics. These results are similar to that obtained from Hasan et al., (2010) regarding mean of body temperature.

Moreover, the symptoms of fatigue, cramps, sweating, and dizziness, which were present before education and cold dialysate applications in HD patients, significantly decreased with the intervention (Table 4). In the study by Ghanzanfari et al. (2021), education-based programs were effective in reducing fatigue in HD patients. Furthermore, Meredith et al. (2015) have shown a strong relationship between low blood pressure during dialysis and dizziness & cramps. Similarly, in a study by Bayoumi (2018), which included practices based on nursing evidence in managing intradialytic hypotension during HD, it was stated that vomiting, nausea, cramping, headache, and dizziness developed relative to hypotension. These results support the conclusion of this study that cooling the dialysate reduces symptoms, such as dizziness and cramps by increasing blood pressure.

Additionally, a statistically significant difference in eating habits was observed before and after intervention (Table 3). Although HD patients should follow a strict diet, unfortunately, it is impossible to say that their

dietary compliance is at the desired level. In a study by Durose et al. (2004) involving HD patients, have found that more than one-third of the patients did not comply with at least one dietary restriction.

Furthermore, patients' knowledge of the medical consequences of noncompliance was poorer than their knowledge of renal dietary restrictions. This result reveals the educational needs of the patients. In a systematic review of HD patients, education has many positive effects (Idier et al. 2011). In a study investigating the effects of education provided to HD patients on knowledge and quality of life, a significant difference in the knowledge and quality of life was observed between the intervention and control groups (Ebrahimi et al. 2016). The results obtained from this study support the aforementioned results.

Conclusions

As a result, with patient education and cooling of the dialysate to 35.5°C, the dietary compliance of HD patients increased, the symptoms observed during dialysis decreased, and the prevalence of IDH decreased.

Recommendations

Patient education and cooling of the dialysate can be routinely applied to prevent IDH in HD units. Additionally, randomized controlled trials with a larger sample size can be conducted to assess the long-term effects of patient education and dialysate cooling.

Limitations of the study

This study is limited in being an uncontrolled study in only a single centre and the patients were given only one course and that the knowledge status of the patients was not measured before and after the training.

Relevance to clinical practice and future studies

Considering that hemodialysis is frequently used as a vital treatment for individuals, it can be said that treatment efficiency and patient satisfaction will be enhanced with the prevention of intradialytic hypotension. Additionally, randomized controlled trials with a larger sample size can be conducted to assess the long-term effects of patient education and dialysate cooling.

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Conflict of interest

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