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Effect of Increasing the Speed of Pumped Blood Volume Delivered to the Dialyzer on the Sleep Quality of Patients Undergoing Hemodialysis

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ABSTRACT

Aims Sleep is one of the basic physiological needs of human beings, and sleep quality is an effective criterion on the quality of life of hemodialysis patients. Therefore, paying attention to sleep and its improvement should be a priority in nursing care. This study aimed to determine the effect of increasing the pumped blood volume delivered to dialyzer on sleep quality in hemodialysis patients.
Materials & Methods This semi-experimental study is a clinical trial carried out on 50 hemodialysis patients referred to the hospitals affiliated with Tehran University of Medical Sciences in 2011. Convenience sampling selected samples and randomly divided them into control and intervention groups through permuted block randomization. Data were collected by Pittsburgh Sleep Quality Index in the three stages before intervention and 2 and 4 weeks after intervention. The blood volume delivered to the dialyzer increased by 25ml in the first two weeks and 50ml in the second two weeks compared to before the intervention. Data were analyzed by SPSS 21 software using repeated measures ANOVA and Kruskal-Wallis test.
Findings The mean score of sleep quality in the intervention group before the intervention and two and four weeks after the intervention were 10.2±2.6, 8.8±3.4 and 6.9±2.9, respectively and in the control group were 11.4±2.8, 12.5±3.3, and 12.6±3.4, respectively. There was no significant difference in the total score of sleep quality and some of its dimensions between the intervention and control groups ($p<0.05$).
Conclusion Increasing blood volume delivered to the dialyzer has improved hemodialysis patients' sleep quality, and this improvement seems to be clinically significant.

Keywords Sleep; Hemodialysis; Patient

CITATION LINKS

[1] The ubiquitin ligase NEDD4-2/NEDD4L regulates both ... [2] Depressive symptoms and dietary ... [3] Brunner and Suddarth's textbook of medical ... [4] Management of insomnia in hemodialysis ... [5] Special nursing preparation in section ICU ... [6] Effectiveness of a treatment algorithm for ... [7] Prevalence of chronic kidney disease-associated ... [8] Sleep quality on maintenance hemodialysis ... [9] Levels of trace blood elements associated with ... [10] Quality of sleep in hemodialysis ... [11] Sleep quality in patients on maintenance ... [12] Quality of sleep and its relationship ... [13] Fundamentals of ... [14] An assessment of quality of sleep and the ... [15] Sleep disorders in patients with end-stage ... [16] Sleep disorders in hemodialysis ... [17] Sleep quality and its correlation with ... [18] Effects of sleep loss in men and women ... [19] Skin problems in chronic ... [20] The effect of quality of sleep on depression ... [21] Sleep disturbances in dialysis ... [22] Sleep quality in patients undergoing ... [23] Effects of exercise training on restless legs ... [24] The effectiveness of progressive muscle ... [25] Effect of implementing continuous care ... [26] Effect of intravenous vitamin C supplementation ... [27] Clinical evidence for acupressure with ... [28] Effect of aromatherapy interventions on ... [29] Handbook of dialysis ... [30] Harrison's principles of internal ... [31] Effect of increased blood ... [32] Handbook of ... [33] Effect of increased blood flow velocity ... [34] Reliability and validity of the Persian version ... [35] The effect of increasing blood flow rate ... [36] Quality of sleep in dialysis ... [37] The effect of increasing blood flow rate ... [38] The effect of increasing blood flow rate ... [39] The effect of increasing blood flow rate ...

Introduction

Chronic kidney disease, defined as decreased kidney function, affects nearly 10% of the world's population [1], and it is a growing public health problem with significant physiological and socio-economic consequences for the individual, family, and society. Despite advances in technology and medical care, the disease remains serious and life-threatening through high mortality and low quality of life [2]. Due to the impossibility of accessing the kidney for transplantation, dialysis or hemodialysis is the most common way for kidney patients to survive [3, 4]. Despite the beneficial effects of dialysis, hemodialysis patients experience many physical, psychological, and social problems, including decreased blood pressure, muscle cramps, nausea, vomiting, headache, back pain [5], itching [6, 7], and sleep disturbance [8]. The prevalence of sleep disorders in hemodialysis patients has been 46-83% [9-12]. Sleep quality in healthy people may depend on medication, lifestyle, emotional stress, environment, exercise, fatigue, and food and calorie intake [3, 13]. However, in people with chronic diseases, other factors such as pain and duration of hospitalization can also affect the quality of sleep [14]. The quality of sleep in hemodialysis patients may be affected by patient age, alcohol consumption, duration of dialysis, polyneuropathy [15], uremic pruritus [7], Interleukin-6, albumin level, dialysis adequacy [16], and phosphorus [17]. On the other hand, research results have shown a relationship between sleep quality and disease coping methods, quality of life [18], physical and mental health [19], the prevalence of depression [20], and reduced health and mortality rate. Since sleep quality affects the quality of life of hemodialysis patients [21]; therefore, paying attention to sleep and its quality as one of the challenging problems [22] should be prioritized. In addition to drug therapy [22, 23], non-pharmacological methods have been considered to improve the sleep quality of hemodialysis patients [22, 23]. Among the non-pharmacological measures, we can mention progressive muscle relaxation and Benson relaxation [24], follow-up care [25], vitamin C administration [26], acupuncture [27] and aromatherapy [28]. In addition, dialysis adequacy can affect patients' sleep, which is one of the indicators for measuring the therapeutic effects of hemodialysis [29], and consists of the parameters K= Clearance dialyzer, T= Time, and V= distribution Volume of urea [30]. Dialysis adequacy can be assessed by calculating Kt/v and is influenced by three factors: membrane capability in waste transfer, blood flow rate, and dialysis fluid flow rate [29]. Increasing blood flow velocity is a useful method for increasing Kt/V and purifying small molecules [31]. During hemodialysis, increased blood flow speed indicates the volume of blood pumped per minute through the arterial needle by pumping the dialyzer from the patient's body into the arterial tube [32]. Therefore, one of the parameters of dialysis adequacy is the volume of blood delivered (pump speed) to the smooth, which is also confirmed by the results of the study of Kakhgi *et al.* [33].

Chronic kidney disease has a high prevalence and is developing, and hemodialysis is the most common treatment in these patients. Also, hemodialysis patients experience several problems, including sleep disorders caused by the accumulation of waste products in the body and affect their quality of life. Therefore, this study aimed to evaluate the effect of increasing the pumped blood volume delivered to the dialyzer on the sleep quality of hemodialysis patients.

Materials and Methods

This semi-experimental study is a clinical trial carried out on 50 hemodialysis patients referred to the hospitals affiliated with Tehran University of Medical Sciences in 2011. The samples were selected by convenience sampling and randomly divided into control and intervention groups through permuted block randomization. In this regard, the factorial law was used, and considering that the two groups participated in the study, the arrangement was made as 2!=2×1=2. To determine the required sample volume at 95% confidence level and test power of 80% and assuming that increasing blood flow velocity reduces at least d=0.36 of sleep disorder in the test group and according to the estimate of $S^2 = 0.2$ [33], the required sample size in each group was calculated to be 25. Considering the 20% probability of sample decline in each group, the number of samples was estimated to be 30. The experimental and control groups were labeled by A and B blocks, respectively. Therefore, the blocks were in binary, i.e., AB and BA, and the difference in the arrangement of the samples in each block was different. Ten specimens were excluded from the study due to hospitalization and systolic blood pressure less than 100mmHg immediately before increasing the pump speed per session (normal systolic and diastolic blood pressure lower than 100/60mmHg). The inclusion criteria were following treatment for at least six months, being hemodialysis three 4-hour sessions per week, lack of severe heart disease, tendency to participate in the study, getting a score of 5 or higher on the Petersburg Questionnaire. The demographic questionnaire was used to collect personal information, and the Pittsburgh Sleep Quality Questionnaire was used to assess the sleep quality of the samples. This questionnaire includes 18 items in 7 subscales of mental quality of sleep (1 item), delay in falling asleep (2 items), duration of sleep (1 item), sleep adequacy (3 items), sleep disorders (2 items), use of hypnotics (1 item), and daily living dysfunction (2 questions). The total scores of the subscales were considered the total score of sleep quality (0-21). The items of each scale were scored by a rating scale of 0-3. A score of 5 or higher indicates poor sleep quality. The validity of the questionnaire has been confirmed in the Persian language [34]. The reliability of the questionnaire was confirmed at a coefficient level of 0.7 based on Cronbach's alpha coefficient. This study is approved by the ethics committee of Tehran University of Medical Sciences. Informed and written consent was obtained from the participants. The principles of confidentiality of sample information, voluntary participation in the study, and the right to cancel participating in any study stage. Data were collected in three stages before the intervention, two and four weeks after the intervention. The duration of the intervention was four weeks. For intervention, the volume of blood delivered to the dialyzer was determined first. To obtain the baseline volume of blood delivered to the dialyzer, the average volume of blood delivered in 2 sessions of hemodialysis was calculated before the intervention. The volume of blood delivered to the dialyzer was then changed during two stages of the intervention; so that, in the first two weeks of the intervention, 25ml/min was added to the average volume of blood delivered to the patients. This volume change lasted for two weeks. Then, in the next two weeks, 25 and 50ml/min of blood volume was added compared to the previous two weeks and before the intervention, respectively. The average blood volume during the three steps can be expressed as X, X+25ml/min, and X+50ml/min, respectively. Before starting hemodialysis, patients' blood pressure was measured and recorded by the researcher. The control group underwent hemodialysis before starting the study, and there was no increase in the volume of blood delivered to the dialyzer. Data were analyzed using SPSS 21 software by measuring central tendency, dispersion indices, Fisher's exact, independent T, repeated measures ANOVA, and Kruskal-Wallis tests with a confidence level of 95%. Considering the normal distribution of sleep quality scores, a parametric test was used. However, due to the abnormality of the distribution of scores, a non-parametric Kruskal-Walis test was used for data analysis.

Findings

Twenty-five males (50%) and 25 females (50%) with an average age of 56.5±15.00 (24-87 years old) participated in the study. There was no significant difference in the control and experimental groups (p>0.05; Table 1).

There was no significant difference between the experimental and control groups in the mean volume of blood delivered to the filter in the first round of the pump (before the intervention) (p>0.05). There was a significant difference in the mean volume of blood delivered to the filter in the second round of the pump (first intervention) and the third round of the pump (second intervention) between the experimental and control groups (p=0.05; Table 2).

Table 1) Comparison of demographic variables in experimental and control groups

Variable		Experimental		Control		p-value
		M±SD	N (%)	M±SD	N (%)	
Age (year)		56.1±13.6	-	56.9±16.5	-	0.12
Hemodialysis (year)		6.2±5.9	-	6.5±6.2	-	0.88
Gender	Female	-	8 (32)	-	17 (68)	0.01
	Male	-	17 (68)	-	8 (32)	
Marital status	Single	-	2 (8)	-	5 (20)	0.05
	Married	-	23 (92)	-	20 (80)	
History of diabetes	Yes	-	8 (32)	-	9 (36)	1
	No	-	17 (68)	-	16 (64)	
History of lupus	Yes	-	1 (4)	-	0	0.77
	No	-	24 (96)	-	25 (100)	

Table 2) Comparison of mean±standard deviation of blood volume delivered to dialysis pump (pump speed) in the studied groups

Group	First round of pump	Second round of pump	Third round of pump	p-value
Experiment	272.4±20.9	296.8±21.0	319.2±20.2	0.001
Control	270.4±18.8	271.2±19.0	272.4±20.3	

There was a significant difference in the mean total score of sleep quality in terms of intervention duration (pump speed), groups, and the interaction between pump speed and the studied groups (p<0.05; Table 3). Inter-group comparison of mean differences showed no significant difference in the overall mean of sleep quality between the experimental and control groups in the first round of the pump (first intervention) (p>0.05); however, a significant difference was observed in the mean total score of sleep quality in the second and third rounds of the pump (first and second interventions) between the experimental and control groups (p<0.05). Also, an intergroup comparison of the total mean of sleep quality in the experimental group showed a decrease in the dialysis pump in the second and third rounds. In other words, patients' sleep quality was improved, so that there were significant differences between the total score of sleep quality by 1.4 between the first and second round of the pump, and between the direst and third round of the pump by 3.3, and between the second and third round of the pump by 1.9. However, intergroup comparison of the control group showed that the mean total score of sleep quality was not significant in terms of the speed of the dialyzer pump (p>0.05). Due to the abnormality of the data distribution of sleep quality subscales, non-parametric tests were used. There was a significant difference in the mean score of the dimensions of mental quality of sleep, delay in falling asleep and sleep disorders between the experimental and control groups based on the results of the Kruskal-Wallis test (p<0.05), but no significant difference was observed in other dimensions (p>0.05; Table 4).

Table 3) Mean±SD of sleep quality score in patients in experimental and control groups according to the duration of intervention

Total score	Experiment	Control	Mean difference	p-value
First round	10.2±2.6	11.4±2.8	1.2	0.001
Second round	8.8±3.4	12.5±3.3	3.7	
Third round	6.9±2.9	12.6±3.4	5.7	

Table 4) Comparison of mean±SD of scores of sleep quality dimensions of patients in experimental and control groups

Dimensions	Experiment	Control	p-value
Mental quality of sleep			
First round of pump	1.8±0.8	1.6±0.9	0.5
Second round of pump	1.0±0.7	1.7±0.9	0.04
Third round of pump	0.4±0.4	1.7±0.9	0.001
Sleep adequacy			
First round of pump	2.6±0.7	2.5±1.0	0.6
Second round of pump	2.2±1.1	2.9±0.9	0.2
Third round of pump	1.9±1.1	2.5±1.0	0.06
Sleep duration			
First round of pump	0.4±0.8	0.9±0.7	0.2
Second round of pump	2.3±0.7	2.5±0.6	0.2
Third round of pump	2.0±0.5	2.5±0.6	0.3
Delay in falling asleep			
First round of pump	2.2±1.0	2.4±0.8	0.3
Second round of pump	1.5±1.0	2.5±0.7	0.03
Third round of pump	1.2±0.8	2.6±0.7	0.001
Sleep disorder			
First round of pump	1.8±0.6	1.6±0.5	0.2
Second round of pump	1.2±0.5	1.7±0.5	0.005
Third round of pump	0.9±0.4	1.7±0.5	0.001
Daily dysfunction			
First round of pump	0.6±0.8	0.6±0.7	0.7
Second round of pump	0.3±0.5	0.5±0.6	0.3
Third round of pump	0.1±0.3	0.5±0.6	0.04

Discussion

Sleep quality affects the quality of life, physical and mental health, and even mortality rate, and in hemodialysis patients, it is affected by factors such as hemodialysis adequacy. Therefore, paying attention to this category and consequently the quality of sleep of these patients should be a priority. It is considered that dialysis adequacy is measured by the volume of blood delivered to the dialyzer.

The results revealed that although increasing the volume of blood delivered to the dialyzer improved the overall sleep quality of hemodialysis patients, but is not effective in some subscales of sleep quality. There were no studies on the effect of increased blood volume delivered to the dialyzer on sleep quality in research backgrounds; however, the effect of this intervention on other variables in hemodialysis patients has been investigated. Among the studies, we can mention the study of Borzou *et al.* [35], which showed the effect of increasing phosphorus uptake and hemodialysis adequacy on the increase of pump speed. Another study confirmed the increase in blood flow velocity on phosphorus uptake [36].

The results of Kim *et al.*'s study also confirmed the effect of increased blood flow velocity on dialysis adequacy in hemodialysis patients, so that increasing the blood flow speed by 15-20% increased the adequacy of dialysis [37]. In addition, Shahdadi *et al.* found that a proper increase in blood flow velocity could improve the quality of dialysis [38]. The mentioned studies have measured the quality of dialysis by increasing the speed of blood flow in one session; however, we measured the increase in blood flow volume delivered to the dialyzer during four weeks (12 sessions). Therefore, it can be said that effective results can probably be achieved in fewer sessions. On the other hand, the sleep quality of hemodialysis patients may be affected by Kt/v [41] and hyperphosphatemia [18], and the effect of increasing blood flow velocity on these indicators has been confirmed in the mentioned studies. Therefore, the effect of increasing the volume of blood delivered to the dialyzer on the overall quality of sleep can be explained. Aliasgharpoor *et al.* revealed that sleep disorders of hemodialysis patients could be improved by increasing the speed of blood flow and improving uremic pruritus [39]. In the mentioned study, the number of waking cases was considered by the researcher-made questionnaire; however, we used the Pittsburgh questionnaire. Kakhki *et al.* found that increasing blood flow velocity increases urea excretion, interleukin-6, and dialysis adequacy and reduces fatigue in hemodialysis patients. Also, they mentioned the increase in excretion of urea and toxins and the quality of dialysis as the reasons for the reduction of fatigue [33], which supports the present study's findings. The study of Yamamoto *et al.* Also reported increasing blood flow velocity as a useful method for increasing Kt/v and excretion of small molecules [31].

According to the results, increasing the volume of blood delivered to the dialyzer can improve sleep quality, and increasing blood flow is an intervention that can be performed during hemodialysis without spending extra time, additional costs, and medication to improve the sleep quality of these patients; therefore, it can be suggested as an effective nursing intervention in hemodialysis wards. On the other hand, the present study has some limitations that should be considered in generalizing the results. One of the limitations was the proper index for measuring the quality of sleep; However, a reliable and valid self-reported questionnaire has been used in this study; individuals' physical, cognitive, and mental condition is effective in answering its items. Therefore, it is suggested to use more objective methods for measuring the effectiveness of such interventions. In particular, although some differences have been reported to be statistically significant, they require clinical accuracy.

Conclusion

Increasing the volume of blood delivered to the dialyzer has improved the overall sleep quality of hemodialysis patients.

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