RESEARCH ARTICLE

Effect of staged intervention on adherence, anaemia, heart function, and pro-inflammatory factors in chronic kidney diseases haemodialysis patients

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Abstract

Objective: To analyse the effects of staged intervention on adherence, anaemia, cardiac function and pro-inflammatory factors in chronic kidney disease patients undergoing haemodialysis.

Method: The retrospective study was conducted at Qinhuangdao Haigang Hospital, China, and comprised data from January to December 2023 of chronic kidney disease patients undergoing dialysis treatment. The patients were divided into two cohorts based on intervention methods. Those in control group A received routine intervention, while those in observation group B were given intervention with changes at different stages. Comparisons were made with respect to treatment adherence, anaemia, heart function and pro-inflammatory factors. Data was analysed using SPSS 20.

Results: Of the 100 patients, 50(50%) were in group A; 25(50%) males and 25(50%) females. The mean age was 53.20±8.25 years. Group B had 50(50%) patients; 26(52%) males and 24(48%) females. The mean age was 53.85±8.40 years (p>0.05). Treatment adherence of group B was higher than that of group A (p<0.05). After the intervention, group B had higher levels of haemoglobin, albumin, haematocrit, cardiac index score, stroke volume and left ventricular ejection fraction (p<0.05), but lower C-reactive protein, procalcitonin and interleukin-6 levels (p<0.05) than group A.

Conclusion: Staged interventions could improve treatment adherence, alleviate anaemia symptoms, enhance heart function, and reduce the levels of pro-inflammatory factors in individuals with chronic kidney disease undergoing dialysis treatment.

Keywords: Staged intervention, Chronic kidney disease, Haemodialysis, Adherence, Heart function, Pro-Inflammatory factors. (JPMA 76: 191; 2026) **DOI: https://doi.org/10.47391/JPMA.22266**

Introduction

Individuals with end-stage chronic kidney disease (CKD) may develop chronic renal failure. When the disease progresses to this stage, renal replacement must be performed to sustain the life of patients if renal transplantation is impossible to apply.[1,2] Haemodialysis (HD) is one of the main therapeutic options for patients with CKD clinically, which can remove metabolic waste, toxic substances and surplus fluids from the body of individuals with CKD to preserve essential bodily functions.[3] Those receiving dialysis treatment are prone to various complications, like osteoporosis and nutritional deficiencies, which may have a negative impact on their activities of daily living (ADLs). Patients undergoing maintenance dialysis frequently experience frailty, which can lead to negative emotions.[4] Therefore, emphasis on physicians' intervention during dialysis treatment plays a particularly important role in promoting the relief of negative emotions and improving ADLs of the affected patients. In general, conventional intervention is relatively simple, but with unsatisfactory effect on individuals with CKD undergoing dialysis treatment. Significantly, intervention with changes at different stages is a changeable strategy-based behavioural intervention based on the demands of patients at various stages of their condition to give corresponding interventions to enhance their health-related practices, promoting the intervention effect, and enhancing their health status.[5]

The current study was planned to explore the effect of intervention with changes at different stages on treatment adherence, anaemia, heart function and pro-inflammatory factors in individuals with CKD undergoing HD treatment.

Materials and Methods

The retrospective study was conducted at Qinhuangdao Haigang Hospital, China, and comprised data from January to December 2023 of CKD patients undergoing dialysis treatment. After approval from the stitutional ethics review committee, the sample size was calculated using OpenEpi v3.01.[6] Based on preliminary data from a pilot observation of 20 patients at our center, it was expected that the mean haemoglobin (Hb) of the observation group would increase by 15±12g/L post-intervention. Based on previous studies,[7] the significance level was set at α=0.05, test

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efficacy 1-β at 0.80, and effect size Cohen's d at 0.5. The sample size was inflated by >10%. Written informed consent had been obtained from all the participants.

Those who met the diagnostic criteria[8] and underwent dialysis treatment were included, while patients with kidney transplant, low adherence, and considerable impairment in other systems were excluded. The sample was raised using purposive sampling technique. The patients were divided into two cohorts based on intervention methods. Those in control group A received routine intervention, while those in observation group B were given intervention with changes at different stages. in group A, specific measures included maintaining patients' dialysis treatment access, assessing their vital signs, guiding them to follow doctors' medical advice, informing them of dietary precautions, carrying out rehabilitation exercise, distributing education material, and implementing verbal education for patients on admission.

Patients in group B received a structured, multi-stage behavioural intervention, the design of which was informed by the Stages of Change model (Transtheoretical Model).[9] In the pre-thinking stage: active health education was focussed upon while ensuring scientific justification of objectives and strategies, and understanding the elements that affected the subjects' emotions. The patients were facilitated in handling their emotional problems. Group health instruction in 45 minute sessions and personalised guidance 30-minute per session were delivered once a week.

In the preparation stage, proper dietary guidance was provide to the patients, encouraging them to take three meals a day regularly, increase nutrient intake, and control sodium intake. Psychological intervention and active communication with patients were maintained. Patients' economic status as well as levels of family and social support resources were comprehensively evaluated, and the patients were guided towards proactively seeking community assistance, like encouraging their active participation in social events, and guiding their relatives and friends to provide psychological and emotional support. Psychological state assessments for patients was regularly conducted, and the underlying causes of negative feelings were evaluated in order to provide tailored counselling based on the particular triggers to correct patients' misconceptions. The patients were guided to release psychological stress reasonably, and enhance their confidence in disease treatment. Patients' families were guided to interact more with the patients, and offer emotional support to them.

In the behavioural stage, the patients were informed of the symptoms of common complications to facilitate their identification voluntarily. They were informed of the reasons for the occurrence of complications, and they were enabled to actively minimise exposure to potential complications in their life routines. Emphasis was put on the protection of arteriovenous fistula to prevent external stressors, lower the chances of infection, and discourage the patients from independently removing their catheters. Venous pulse examination was regularly conducted, changes in their blood pressure and pulse were monitored, and the patients were informed of the need to seek medical advice promptly in case of any abnormal condition. The patients were encouraged to write home-based diaries for dialysis treatment, recording the types and doses of daily used medicines, including fluctuations in blood pressure and weight, to evaluate their physical status. The patients were asked to record bodyweight using a weight scale, and were told that the weight-gain must be limited to not more than 5% of their dry weight during two dialysis treatment sessions, and intervention was provided to control water intake when the weight-gain was >5%. The tourniquet was loosened post-dialysis to avoid blockage and harm to the fistula vessels.

in the maintenance stage, the patients were encouraged to promptly inform their doctors of any problems they encounter at home during follow-up via telephone so that the doctor could timely adjust the administration of drugs and treatment orders for dialysis if the patients had ineffective control of blood pressure or experienced severe fluctuations. The frequency of follow-up was increased if the patients encountered more problems at home. Regular home-based visits were conducted for the patients, and psychological counselling as well as social support was provided. Patients with good control were incited to deliver speeches at a symposium so that they may share their own home-based self-care experience, and enhance the confidence in treatment. Patients' family situations were taken into account, and effort was made to apply for sickness benefits for patients coming from economically disadvantaged families to alleviate their financial burden.

The study's outcome measures included treatment adherence; Hb, albumin (Alb) and haematocrit (Hct) levels determined using an automatic haematology analyser after the collection of 5mL of morning fasting venous blood from each patient; heart function indicators pre- and post-intervention, such as cardiac index (CI), stroke volume (SV), and left ventricular ejection fraction (LVEF) using a colour Doppler ultrasound diagnostic instrument (LOGIQ7; GE Healthcare, Chicago, IL, USA). C-reactive protein (CRP), procalcitonin (PCT) and interleukin-6 (IL-6) levels were detected using an enzyme-linked immunosorbent assay

(ELISA).

Data was analysed using SPSS 20. The comparison of continuous variables was conducted using the independent sample t-test or the paired t-test, and the data were presented as mean±standard deviation. Normality of all continuous variables was verified using the Shapiro-Wilk test (p>0.05), and the homogeneity of variance was confirmed by the use of Levene test. If the data was not normally distributed, the Mann-Whitney U test or the Wilcoxon signed rank test was used instead. Counting data was presented as frequencies and percentages, and were compared using chi-square test. P<0.05 was taken as statistically significant.

Results

Of the 100 patients, 50(50%) were in group A; 25(50%) males and 25(50%) females. The mean age was 53.20±8.25 years. Group B had 50(50%) patients; 26(52%) males and 24(48%) females. The mean age was 53.85±8.40 years (p>0.05). The course of disease in group A was 2.50±1.02 years, while it was 2.551.16 years in group B (*p*>0.05).

Treatment adherence of group B was higher than that of group A (*p*<0.05) (Table 1).

Post-intervention levels of Hb, Alb and Hct were significantly higher in group B than in group A (*p*<0.05) (Table 2).

Group B showed significantly improved cardiac function parameters post-intervention, with higher levels of CI, SV and LVEF compared to group A (*p*<0.05).

Post-intervention levels of pro-inflammatory factors CRP, PCT and IL-6 were significantly lower in the group B than in group A (*p*<0.05) (Table 3).

Table-1: Comparison of treatment adherence between the cohorts.

Groups	Control cohort (n=50)	Observational cohort (n=50)	x^2	*p*-value	Effect size (φ)	95% CI for φ
Full adherence	22 (44.0)	37 (74.0)				
Partial adherence	20 (40.0)	12 (24.0)				
Non-adherence	8 (16.0)	1 (2.0)				
Overall adherence	42 (84.0)	49 (98.0)	4.396	0.036	0.21	0.02-0.04

CI: Confidence interval.

Table-2: Comparison of the levels of anaemia variables between the cohorts before and after intervention.

Variables	Control cohort (n=50)	Observational cohort (n=50)	*t*-test	*p*-value	Cohen's d (95% CI)
Hb (g/L)					
Before intervention	61.50±12.25	61.80±10.28	0.133	0.895	
After intervention	81.45±12.35	97.25±10.84	6.799	0.001	1.31 (0.78-1.86)
Alb (g/L)					
Before intervention	32.60±6.28	31.88±5.92	0.590	0.557	
After intervention	33.20±5.22	36.90±4.17	3.916	0.001	0.76 (0.32-1.20)
Hct (%)					
Before intervention	25.60±4.18	25.92±4.87	0.353	0.725	
After intervention	28.65±6.32	35.20±5.29	5.620	0.001	1.08 (0.55-1.61)

Hb: Haemoglobin, Alb: Albumin, Hct: Haematocrit, CI: Confidence interval.

Table-3: Comparison of heart function indicators and pro-inflammatory factors between the cohorts post-intervention.

Variables	Control cohort (n=50)	Observational cohort (n=50)	*t*-test	*p*-value	Cohen's d (95% CI)
CI (L/min)	2.45±0.62	3.15±0.45	6.461	0.001	1.28 (0.75-1.81)
SV (mL)	46.60±6.21	54.90±7.82	5.877	0.001	1.18 (0.66-1.70)
LVEF (%)	61.20±6.23	66.10±7.65	3.512	0.001	0.70 (0.28-1.12)
CRP (mg/L)	82.62±8.52	60.42±10.26	11.771	0.001	2.36 (1.72-2.99)
PCT (μg/L)	2.65±0.63	2.25±0.42	3.736	0.001	0.75 (0.33-1.17)
IL-6 (ng/L)	355.26±35.62	268.45±32.13	12.796	0.001	2.56 (1.90-3.22)

CI: Cardiac index, SV: Stroke volume, LVEF: Left ventricular ejection fraction, CRP: C-reactive protein, PCT: Procalcitonin, IL-6: interleukin-6.

Discussion

In middle-aged and elderly people, CKD is common, especially in the elderly. It is difficult to plan interventions in these patients because the majority has chronic course of disease, and lower levels of understanding. HD is a common treatment for CKD. However, multiple complications occur commonly during dialysis treatment, which can also affect the normal life of patients.[11] In addition, during maintenance dialysis treatment, patients may develop sleep disorders and fatigue, potentially triggered by the activation of cytokine release. Additionally, the pruritus associated with end-stage renal disorder can disrupt the patients' sleep quality, affecting their daytime status due to insufficient sleep, leading to problems with concentration and hindrance in ADLs. In order to improve patients' ADLs, there is a need to actively provide auxiliary medication for patients, and also pay attention to their physiological and psychological needs.[11] Intervention to maintain optimistic psychological state of patients is important to ensure smooth implementation of dialysis treatment.[12] During intervention, doctors can provide timely health education based on the analysis of related psychological problems to build a positive and supportive relationship between healthcare providers and patients, and encourage the patients to get proactively involved in their treatment plan.[13]

The results of the current study showed that staged intervention significantly improved the treatment compliance of patients. This finding was consistent with earlier research.[14] In the current study, the observation cohort showed increased anaemia indicators and heart function indicators as well as reduced levels of pro-inflammatory factors than the control cohort following the intervention. For the improvement of anaemia indicators, staged intervention may play a role through the precision of nutritional intervention and inflammation control. Guidance was provided for individualised nutritional needs, such as controlling sodium intake and increasing protein, during the preparation stage, which is consistent with the "nutrition-inflammation-anaemia" pathway proposed by Chen et al.[15] Staged intervention of reduced pro-inflammatory factors may improve iron metabolism disorders, thereby alleviating anaemia.[16] The improvement of cardiac function may be related to mechanisms, such as volume management and inflammation-myocardial repair. Flythe et al.[17] reported that water control during the behavioural stage reduced the heart preload. Moreover, the decrease of IL-6 level may alleviate myocardial fibrosis.[18]

Patient on dialysis treatment can experience the effect of the treatment and the role the medical staff may improving their treatment adherence.[19] CKD can weaken the patients' overall health. Staged interventions can offer effective dietary guidance during the preparation period, provide dietary assistance, strengthen their immune system, and improve their anaemia indicators.[20]

At the same time, prolonged dialysis treatment is required for individuals with CKD, which can increase their sensitivity and aggravate their irritable emotions, leading to retarded progress of treatment. Active health education is beneficial for improving their consciousness of health and ability to manage their own care, thereby enhancing their treatment adherence.[21] Additionally, dialysis treatment can also impact the heart function of patients to some extent. During the implementation of intervention with changes at different stages, patients can develop good lifestyle habits, and actively cooperate with the treatment, which may improve their heart function.[22]

The current study has limitations as it had no long-term follow-up beyond 3 months to assess the sustainability of effects, a known challenge in behavioural interventions.[23] Also, the study had a small sample, though post-hoc power was adequate ($1-\beta=0.82$). Finally, there was a potential selection bias owing to the use of purposive sampling technique. Future studies should prioritise multicentre trials with ≥12-month follow-up, larger samples ($n\geq300$), and objective adherence measures, like dialysis logs.

Conclusion

Staged interventions improved adherence, anaemia markers, and cardiac function in CKD patients on HD.

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Author Contribution:

DW & JS: Design, preparation, responsible for the accuracy or integrity of work and final approval. Both considered as co-first authors.

FG & YW: Revision and final approval.