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Original Article

The effects of the transtheoretical model combined with nutritional intervention in hemodialysis patients

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Abstract: Objective: To investigate the effects of the transtheoretical model combined with nutritional intervention (TTMNI) in hemodialysis (HD) patients. Methods: The clinical data of 100 HD patients recorded from October 2018 to October 2020 were retrospectively collected and divided into two groups according to the intervention method each patient underwent. Group A (n=49) underwent routine nursing intervention and group B (n=51) underwent TTMNI combined with routine nursing intervention. The two groups were compared before and after intervention in terms of their nutritional indices, Renal Adherence Attitudes Questionnaire (RAAQ) scores, their Renal Adherence Behavior Questionnaire (RABQ) scores, their Subjective Global Assessment (SGA) statuses, their anthropometric indicators such as their serum creatinine (SCr), blood urea nitrogen (BUN), mid-arm muscle circumference (MAMC), triceps skinfold (TSF), body mass index (BMI), urea clearance index (KT/V), and urea reduction ratios (URR%). Results: Compared with group A, group B showed higher transferrin (TRF), prealbumin (PA), and albumin (ALB) levels, higher RAAQ and RABQ scores, higher MAMC, TSF, and BMI levels and lower SGA scores, and lower SCr, and BUN levels ($P<0.05$). After the intervention, the attainment rate of target KT/V was 94.12% in group B, higher than the 63.27% in group A, and the patients with target URR% accounted for 96.07% in group B, higher than the 61.22% in group A ($P<0.05$). Conclusion: TTMNI for HD patients is helps improve patients' nutritional statuses and their dietary compliance as well as their liver function, and it increases their dialysis attainment rate.

Keywords: Hemodialysis, dietary nutrition, transtheoretical model, nutritional status, compliance, renal function

Introduction

Hemodialysis (HD) is an alternative treatment for acute and chronic renal failure. In the HD process, to remove toxins, a special dialysis-fluid flows through the filter to flush the semi-permeable dialysis membrane from the outside, while the blood flows through the hollow fiber, to purify the blood and correct electrolyte disorders [1]. Although patients with acute and chronic renal failure can be treated using HD and obtain ideal therapeutic effects, continuous HD can only replace part of the excretory function of the kidneys, rather than the metabolic and endocrine functions of the body [2, 3]. HD, a lifelong treatment, will inevitably bring trauma to patients and cause a series of complications such as hyperkalemia, hyperphosphatemia, anemia, and malnutrition, and there are still significant limitations to HD treatment [4, 5]. As a result, HD patients have to suffer through physical and mental pain, and they also have a significantly increased financial burden [6].

Studies have shown that diet therapy is an important means to improve the nutritional status, and it also has the effect of delaying the progression of disease and preventing complications [7, 8]. Most routine dietary interventions are done by distributing brochures and conducting outpatient health education, interventions which are easily ignored or forgotten, and the effect is yet to be improved, so this study provided the targeted dietary nutritional intervention. Dialysis adequacy is the measurement of renal dialysis to determine the dialysis treatment regime and to better understand the pathophysiology of renal dialysis, which is usually assessed using comprehensive laboratory indicators and clinical symptoms [9, 10]. In 1983, the American scholar Prochaska first proposed the Transtheoretical Model (TTM), which is an integrative theory of therapy assessing an individual's readiness to act on a new healthier behavior, and providing strategies, or processes of change to guide the individual [11, 12].

There are more clinical studies on dietary interventions performed in HD patients, yet there are relatively few studies on dietary interventions combined with TTM. The present study, however, mainly investigated the effect of the combined intervention of these two therapies and is reported as follows.

Materials and methods

Clinical data

The clinical data of 100 HD patients recorded in our hospital from October 2018 to October 2020 were retrospectively collected, and divided into two groups according to the intervention mode each patient underwent, with 49 patients in group A who underwent routine intervention, and 51 patients in group B who underwent the transtheoretical model combined with nutritional intervention (TTMNI) in addition to the routine intervention. (1) Inclusion criteria: received informed consent from the patients and their families, no contraindications to HD, patient's duration of HD for more than 1 year, stable condition, and a clear consciousness and normal communication abilities. This study was approved by the Medical Ethics Committee of the First People's Hospital of Fuzhou. (2) Exclusion criteria: withdrawal from the study, poor compliance, difficulties in communication, presence of visual or hearing impairment, mental or cognitive impairment, expected survival of less than 3 months, comorbid with serious organ dysfunction such as of the lungs, liver, or heart.

Methods

Group A underwent routine nursing intervention, that is, the nursing staff performed health education for the patients to explain the principles and importance of HD, they monitored the changes in the patients' psychological statuses, strengthened their psychological guidance promptly, corrected the patients' misconceptions regarding the disease, encouraged the patients to face their reality and actively cooperate with the treatment, increased their ward rounds during dialysis to avoid pipeline folding, strengthened the exercise guidance for the patients, and treated their complications promptly.

Group B underwent nutritional intervention and MMT in addition to the treatment administered to group A.

Dietary and nutritional interventions were performed as follows: (1) A Dietary and nutrition assessment and plan development: Data on patients' social backgrounds, education, genders, and ages were collected, and their nutritional statuses were assessed by a professional nutritionist. (2) Distribution of nutrition: Based on each patient's age, the total daily calorie intake was calculated as follows: the amount of calories required for the whole day =1,000+ age × (80-100), and the proportions of protein, fat and vegetable oil, and carbohydrates were 15%-20%, 25%-30%, and 55%-60%, respectively, with 3:4:3 in three meals. (3) Strengthening dietary guidance: Based on the Chinese Food Composition Table [13], foods with low potassium, phosphorus and sodium content and the water content of daily food intake were listed, and the patients were instructed to fully understand the food composition, and were instructed to take more foods with high quality protein, including fish, poultry, beef, milk and egg whites. Meanwhile, the patients were instructed to consume more vegetable oils such as tea oil in their daily diet. The patients were strictly limited in their intake of potassium-containing foods, including peaches, oranges, tomatoes, bananas, spinach, shiitake mushrooms, carrots, greens, bamboo shoots, and oranges. Their sodium intake was strictly limited as well, including pickled food, sauces, salted eggs and pickles, phosphorus-enriched foods, such as chestnuts, peanuts, cashews, walnuts, and melon seeds also had to be avoided. Foods rich in minerals and vitamins were recommended. (4) Dietary monitoring: A daily dietary registry was developed for each patient, and the average daily calorie and protein intake was calculated once a week based on the weight, type, and structure of the diet, and each patient's nutritional status was evaluated based on the change in weight.

TTM: (1) Contemplation: An intervention team consisting of a nurse and four specialist nurses was established to develop a health education plan for each patient, explain the purpose and meaning of behavioral change, help the patients recognize self-management deficits in their daily lives, and encourage their caregivers to actively participate and work together to offer encouragement and support. (2) Preparation: Based on the patients' health education schedules, educational materials were distributed to each patient, and health guidance was

strengthened through group discussions, presentations, and lectures, and the patients were encouraged to apply health knowledge learned in their daily routines. In terms of misconceptions, one-on-one interviews were conducted with the patients to correct their conceptions and change their bad behavioral habits. (3) Action: The nursing staff regularly communicated with the patients' caregivers and encouraged them to strengthen their supervision of the patients. A behavior record sheet during dialysis was issued to each patient, and the caregiver was responsible for filling it out, and the record sheet was returned to the medical staff each time the dialysis treatment was performed. The medical staff assessed and identified behavioral problems, and communicated with the patient to analyze the risk factors, in order to encourage the patient to gradually develop good habits. (4) Maintenance: A monthly seminar was held to consolidate the patients' positive behaviors. Through repeated instruction, reinforcement and re-education, the patients were able to fully, autonomously, and independently achieve their desired behavioral goals.

Outcome measurement

(1) Nutritional indicators: Before and after the intervention, 3 mL of fasting venous blood was drawn from both groups and centrifuged (10 min, 3500 r/min, r=5 cm). The transferrin (TRF), prealbumin (PA) and albumin (ALB) levels were measured using the immunoturbidimetric method.

(2) The Renal Adherence Attitudes Questionnaire (RAAQ) and the Renal Adherence Behavior Questionnaire (RABQ) scores [14, 15]: Before and after the intervention, the RAAQ and the RABQ scores were used to evaluate the attitudes and behaviors of the patients in both groups in terms of their compliance with their diets for kidney disease. The RAAQ is a 26-item questionnaire used to measure general attitudes toward compliance including patients' attitudes toward dietary, self-care, health, and social restrictions on a Likert 5-point scale, with a score of 1 for complete disagreement and 5 for complete agreement, and the higher the score, the better compliance attitude. The RABQ is a 25-item scale measuring adherence to fluid restrictions, potassium and phosphate restrictions, self-care, sodium intake, and in times of particular difficulty on a Likert 5-point scale, with 1 point for never this way and 5 points for always this way, and the higher the score, the better the adherence behavior.

(3) Nutritional status assessment [16]: Before and after the intervention, the SGA scale was used to evaluate the nutritional statuses in both groups, including muscle wastage, loss of subcutaneous fat, complications, mobility, gastrointestinal symptoms, diet and changes in body mass, with a score of 16 and above indicating severe malnutrition, 8-15 indicating mild and moderate malnutrition, and 7 indicating well nourished.

(4) Renal function indices: Before and after intervention, the serum creatinine (SCr) and blood urea nitrogen (BUN) levels were measured using automatic biochemical analyzers in both groups.

(5) Anthropometric indices: Before and after the intervention, the mid-arm muscle circumferences (MAMC), the triceps skinfold (TSF), and the body mass indexes (BMI) were measured in the two groups.

(6) After the intervention, the attainment rate of the urea clearance indexes (KT/V) and urea reduction ratios (URR%) were compared between the two groups, and the attainment criteria were KT/V ≥1.4 and URR% ≥70%.

Statistical methods

SPSS 22.0 was used to analyze the data. The measurement data were expressed as the mean ± standard deviation, and *t* tests were done for the data conforming to a normal distribution, and Mann-Whitney U tests were performed for the data not conforming to a normal distribution. The count data were expressed as [n (%)] and compared using X^2 tests. GraphPad Prism 8 was used to draw the figures. $P<0.05$ indicated that a difference was statistically significant.

Results

Comparison of the baseline data

The baseline data, such as gender, age, duration of the dialysis, and type of primary disease in the two groups, were not significantly different ($P>0.05$) (**Table 1**).

Table 1. Comparison of the baseline data [n (%)]/($\bar{x}$ ± s)

Data		Group A (n=49)	Group B (n=51)	t/X^2	*P*
Gender (cases)	Male	36 (73.47)	38 (74.51)	0.014	0.906
	Female	13 (26.53)	13 (25.49)		
Age (years)		58.96±3.19	59.02±3.17	0.094	0.925
Duration of dialysis (years)		5.16±0.11	5.19±0.22	0.857	0.394
Type of primary disease (cases)					
Polycystic kidney		5 (10.20)	7 (13.73)	0.185	0.996
Glomerulonephritis		9 (18.37)	11 (21.57)		
Hypertensive nephropathy		13 (26.53)	14 (27.45)		
Diabetic nephropathy		22 (44.90)	19 (37.25)		

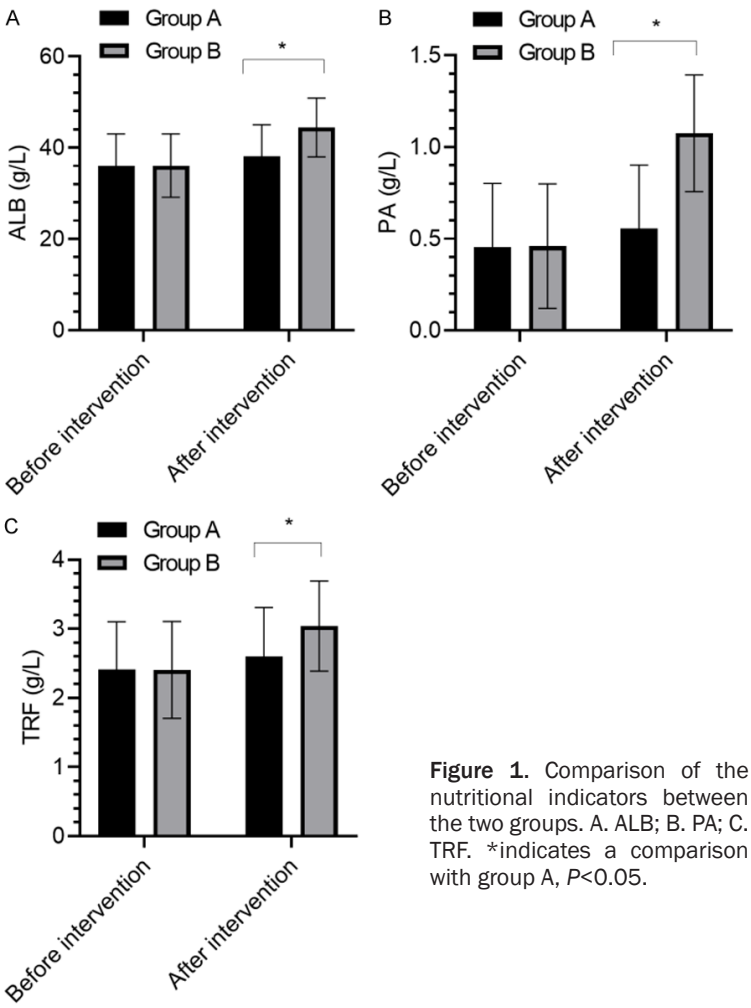

Figure 1. Comparison of the nutritional indicators between the two groups. A. ALB; B. PA; C. TRF. *indicates a comparison with group A, *P*<0.05.

Comparison of the nutritional indicators

There was no significant difference in the TRF, PA, or ALB levels between the two groups before the intervention (*P*>0.05). The TRF, PA, and ALB levels were higher in both groups after intervention compared with their levels before the intervention (*P*< 0.05), and they were higher in group B after the intervention than they were in group A (*P*<0.05) (**Figure 1**).

Comparison of the RAAQ, RABQ, and SGA scores

There were no significant difference in the RAAQ and RABQ scores in the two groups before the intervention (*P*>0.05). The RAAQ and RABQ scores were higher in both groups after the intervention compared with the scores before the intervention (*P*<0.05). The RAAQ and RABQ scores were higher in group B after intervention than they were in group A (*P*<0.05) (**Figure 2**). There was no significant difference in the SGA scores between the two groups before the intervention (*P*>0.05). The SGA scores were lower in both groups after the intervention (*P*<0.05) and they were lower in group B than they were in group A (*P*<0.05) (**Table 2**).

Comparison of the renal function indicators

There were no significant differences in the SCr and BUN levels between the two groups before the intervention (*P*>0.05). Compared with their levels before the intervention, the SCr and BUN levels were lower in both groups after the inter-

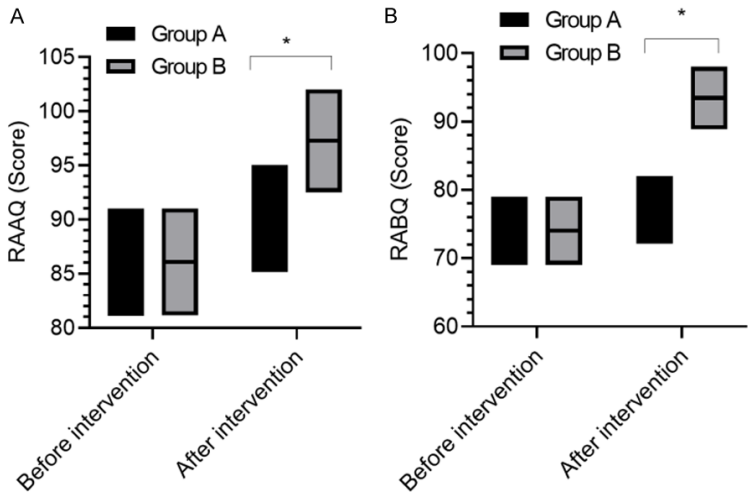

Figure 2. Comparison of the RAAQ and RABQ scores between the two groups. A. RAAQ scores; B. RABQ scores. *indicates a comparison with group A, *P*<0.05.

Table 2. Comparison of the SGA scores ($\bar{x}$ ± s, points)

Group	Pre-intervention	Post-intervention
Group A (n=49)	12.26±2.15	9.15±1.08#
Group B (n=51)	12.31±2.11	6.25±0.12#,*
t	0.117	19.058
P	0.907	<0.001

Note: #indicates a comparison with pre-intervention, *P*<0.05; *indicates a comparison with group A, *P*<0.05.

vention (*P*<0.05), and they were lower in group B than in group A (*P*<0.05) (**Figure 3**).

Comparison of the anthropometric indicators

There were no significant differences in the MAMC, TSF, or BMI levels between the two groups before intervention (*P*>0.05). Compared with their levels before the intervention, the MAMC, TSF, and BMI levels were lower in group A after intervention (*P*<0.05). However, these indicators did not change significantly in group B after the intervention (*P*>0.05). Compared with their levels in group A, the MAMC, TSF, and BMI levels were higher in group B after the intervention (*P*<0.05) (**Figure 4**).

Comparison of KT/V and URR%

After intervention, the attainment rate of KT/V was 94.12% in group B, higher than the 63.27% in group A (*P*<0.05). The attainment rate of URR% was 96.07% in group B, higher than the 61.22% in group A (*P*<0.05) (**Table 3**).

Discussion

The kidney is responsible for stabilizing the body's internal environment, maintaining an acid-base balance, regulating water-electrolyte disturbances, producing urine, and eliminating waste from the body through circulation, so acute or chronic kidney failure can seriously affect normal physiological functions [17, 18]. HD is a renal replacement therapy and is widely used in the treatment of acute or chronic renal failure. Although this treatment can protect residual renal function and delay the progression of renal lesions, long-term maintenance HD therapy will consume a large amount of muscle proteins and reduce the serum albumin levels, contributing to a state of cachexia, inflammation, and malnutrition, which is an important cause of death in patients with renal disease [19, 20]. Secondly, most HD patients suffer from severe physical and mental pain and they also bear a heavy financial burden, which may lead to a low compliance with HD which is not conducive to recovery. There are also some patients who habitually adopt bad behaviors and hold misconceptions about the disease and treatment, which not only affects the treatment efficacy but also may aggravate the condition [21, 22]. In order to change the misbehavior of HD patients and improve their nutritional statuses, this study used TTMNI for the disease intervention.

In this study, the nutritional indicators, the dietary compliance attitudes and adherence behaviors, the anthropometric indexes, the attainment rates of KT/V, and the URR% were higher, and the renal function indices SCr and BUN were lower in group B than they were in group A after the intervention (*P*<0.05), suggesting that TTMNI in HD patients is helps to improve their nutritional statuses, altering the patients' dietary compliance attitudes and behavior, improving liver function, and increasing the attainment rate. The reason may be that this study collected the data of the pati-

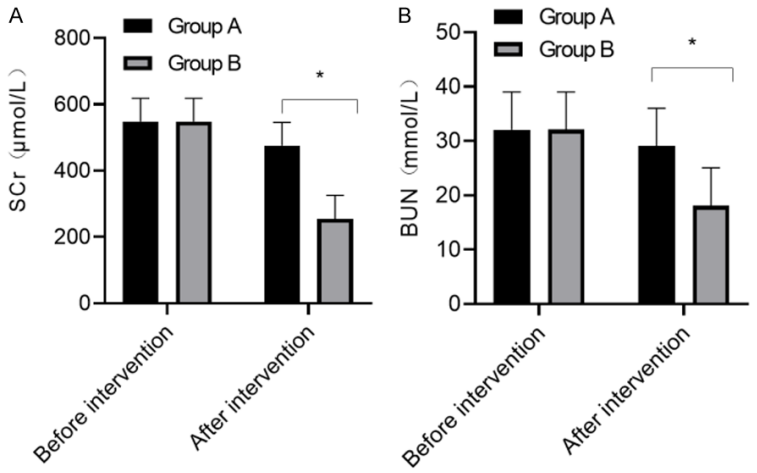

Figure 3. Comparison of the renal function indices between the two groups. A. SCr; B. BUN. *indicates a comparison with group A, $P<0.05$.

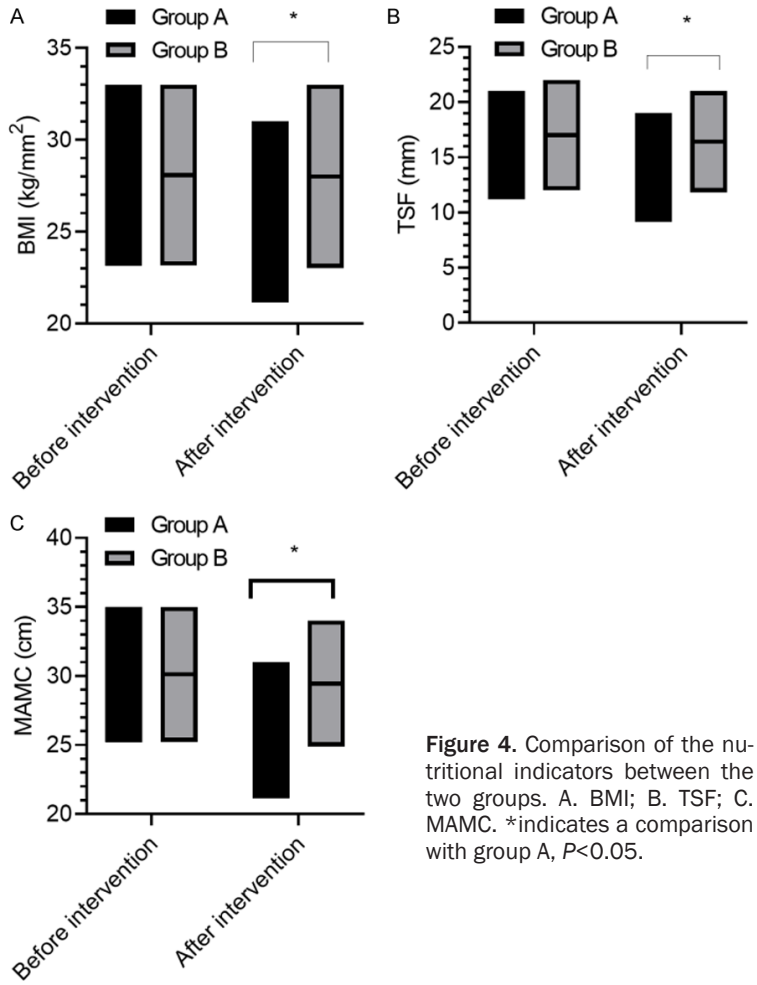

Figure 4. Comparison of the nutritional indicators between the two groups. A. BMI; B. TSF; C. MAMC. *indicates a comparison with group A, $P<0.05$.

ents and the results of the nutritional assessment to develop a targeted nutritional plan for them, which will ensure that the patients receive adequate nutrition and will also effectively prevent and control various complications [23]. Secondly, the patients' total daily intake of calories was comprehensively and scientifically controlled, the nutritional composition of the foods was analyzed, and foods with lower potassium, phosphorus and sodium content as well as the water content of their daily food intake were listed based on the Chinese Food Composition Table, and the patients were informed of the precautions in their daily diets to avoid the intake of foods with a high content of potassium, phosphorus and sodium to improve the body's nutritional status [24]. A varied diet facilitated the improvement of their appetite and ensured a balanced daily intake of major nutrients, namely fat, protein and sugar, as well as inorganic salts and vitamins, to ensure that they receive adequate nutrition on a daily basis [25]. Their caregivers were encouraged to monitor the daily diet of the patients not only to improve the compliance of patients with the diet, but also to improve the nutritional statuses of the patients. The TTM stages included contemplation, preparation, action, and maintenance, and the contemplation phase is when a change in behaviors is contemplated, but the timing has not been determined and no preparation or action has been done [26]. The preparation stage is when the idea of changing behavior has recently emerged and has been partially attempted. The action stage is when it is put into practice. People may exhibit this by modifying their problem behavior or acquiring new healthy behaviors.

Table 3. Comparison of the KT/V and URR% attainment rates [n (%)]

Group	Number of cases	KT/V attainment rate	URR% attainment rate
Group A	49	31 (63.27)	30 (61.22)
Group B	51	48 (94.12)*	49 (96.07)*
X^2		14.338	18.299
P		<0.001	<0.001

Note: *indicates a comparison with group A, $P<0.05$.

The maintenance phase refers to the consolidation of the new behavior [27, 28]. In this study, we helped the patients to fully understand the importance and necessity of HD treatment, raise their awareness of self-management behaviors, continuously change and overcome their previous bad behaviors, and deepen and consolidate these behaviors to improve their dialysis adequacy and attainment rate, thereby improving the nutritional status of the body.

In conclusion, TTMNI in HD patients is beneficial to improving the nutritional status, changing the patients' dietary compliance attitudes and behavior, improving liver function, and increasing the attainment rate.

Limitations: We included a small cohort and followed up the patients for only a short time, and the inflammatory factors and the quality of life were not explored, so these factors need to be explored in a further study.

Disclosure of conflict of interest

None.

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