Journal of Clinical and Nursing Research, 2025, Volume 9, Issue 7
http://ojs.bbwpublisher.com/index.php/JCNR
Online ISSN: 2208-3693
Print ISSN: 2208-3685

Exploration and Application of the "Four-Element Linkage" Care Model in the Management of Blood Pressure in Elderly Peritoneal Dialysis Patients

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Abstract: *Objective*: To explore the application of "tertiary hospitals-secondary hospitals and nursing care institutions-community-family" four-dimensional linkage care model in peritoneal dialysis patients. *Methods*: 99 cases of peritoneal dialysis patients were divided into 47 cases in the control group and 52 cases in the intervention group. In the control group, the routine discharge follow-up model was adopted; in the intervention group, the hospital-led medical unit was adopted as the basis of the "tertiary hospitals-secondary hospitals and nursing care institutions-community-family" quadruple linkage care model, and the patients' systolic blood pressure was compared with those in the control group before and after discharge. The systolic blood pressure, diastolic blood pressure, N-terminal brain natriuretic peptide, and sodium were compared between the two groups. *Results*: The systolic blood pressure, diastolic blood pressure, N-terminal brain natriuretic peptide, and blood sodium of patients in the intervention group were significantly better than those of the control group (all $P < 0.001$). *Conclusion*: Based on the "tertiary hospital-secondary hospital and nursing home-community-family" quadratic care model, the blood pressure control rate of elderly peritoneal dialysis patients can be increased to meet the standard, reduce the symptoms of the disease, and improve the satisfaction.

Keywords: Quadruple link; Geriatric peritoneal; Dialysis patients; Blood pressure management

Online publication: August 1, 2025

1. Introduction

The prevalence of chronic kidney disease (CKD) is high and on the rise globally. A study published in The Lancet states that there were 697.5 million CKD patients worldwide in 2017, of which nearly one-third of CKD patients were in China and India, with prevalence numbers of 132 million and 115 million, respectively [1]. With the progress of population aging in the society, the number of elderly patients who enter into end-stage renal is also

gradually increasing. According to epidemiologic surveys, the prevalence of CKD in the Chinese population is 10.8%, and the prevalence of CKD in people aged 60-89 years is 33% [2]. Due to the characteristics of peritoneal dialysis (PD), such as hemodynamic stability, good cardiovascular stability, protection of residual kidneys, lower cost than hemodialysis, convenient operation, and home treatment, the proportion of elderly patients choosing peritoneal dialysis treatment is increasing accordingly. It is generally accepted that both PD and hemodialysis have their advantages and disadvantages for elderly patients with end-stage renal disease, but PD is as good as or even better than hemodialysis in terms of clinical outcomes, quality of life, and cost-effectiveness, and therefore it is considered to be a suitable form of renal replacement therapy for elderly patients [3, 4].

Some studies have pointed out that the incidence of hypertension in peritoneal dialysis patients is up to 80%, and the abnormal elevation of blood pressure increases the risk of cardiovascular and cerebrovascular events, which poses a serious threat to the life safety of patients [5]. And the occurrence of hypertension is closely associated with patient death and cardiovascular and cerebrovascular events [6]. Although peritoneal dialysis patients in various peritoneal dialysis centers have improved the rate of compliance with various indexes through follow-up, the incidence of cardiovascular complications of peritoneal dialysis remains high in the early stage of elderly PD patients, which may be due to the difficulty of independent operation, mobility limitations, rapid forgetting of knowledge, poor communication, irregular outpatient follow-up, etc. At present, the center of gravity of hypertension management in China has shifted to the community, and the combination of large hospitals and community-based comprehensive diagnosis and treatment has become a new management mode of hypertension management, and the National Nursing Career Development Plan (2021-2025) clearly points out that the nursing service in medical institutions will be extended to the community and home, and convenient and professional medical care services will be provided for discharged patients, patients at the end of the life, or mobility impediment, elderly people who are weak, disabled and mentally retarded [7, 8]. Based on this policy background, our center relies on the construction of the medical consortium built by our hospital, promotes the sharing of resources in the region, and carries out the implementation of the “tertiary hospitals-secondary hospitals and nursing care institutions-community-family” quadratic linkage care model, to provide the elderly peritoneal dialysis patients with the most convenient and professional medical care services. This study explores a scientific, efficient, and standardized continuous care model for elderly peritoneal dialysis patients, with a view to improving the compliance of elderly peritoneal dialysis patients and increasing their blood pressure control rate, which is now reported as follows.

2. Information and methodology

2.1. General information

Ninety-nine cases of end-stage renal disease patients who received peritoneal dialysis treatment in Shaanxi Provincial People’s Hospital from July 2021 to April 2023 are selected and divided into two groups using the random number table method. Among them, 47 cases in the control group, 26 male and 21 female, age range 45–78 years old, average (62.65 ± 6.53) years old; duration of peritoneal dialysis 6–48 months, average (14.63 ± 7.20) months; primary disease: 18 cases of chronic glomerulonephritis, 15 cases of diabetic nephropathy, 10 cases of hypertensive nephropathy, and 4 cases of other diseases; 52 cases in the intervention group, 28 males and 24 females, age range 43–76 years old; and 52 cases in the intervention group, 28 males and 24 females, age range 43–76 years old. In the intervention group, there are 52 cases, 28 male and 24 female, age range is 43–76

years old, average (63.15 ± 6.09) years old; duration of peritoneal dialysis is 5–50 months, average (15.32 ± 7.52) months; and the primary diseases are: chronic glomerulonephritis in 20 cases, diabetic nephropathy in 17 cases, hypertensive nephropathy in 11 cases, and others in 4 cases. The differences in general information between the two groups were not statistically significant (all $P > 0.05$) and are comparable.

2.1.1. Inclusion criteria

(1) Regular long-term follow-up at our center.
(2) Systolic blood pressure ≥ 150 mmHg and diastolic blood pressure ≥ 90 mmHg at the first visit.
(3) Age < 80 years old.
(4) Duration of peritoneal dialysis ≥ 3 months.
(5) Taking antihypertensive drugs.

2.1.2. Exclusion criteria

(1) Comorbidity with severe cardiovascular or cerebrovascular diseases or malignant tumors.
(2) Presence of psychiatric disorders or communication disorders that prevented them from cooperating with the interventions.
(3) Recent adjustment of antihypertensive regimen or participation in other intervention studies.
(4) Incomplete clinical data or withdrawal from the follow-up.

2.2. Methodology

2.2.1. Control group

Give routine health education, disease knowledge, medication, diet, exercise, and prevention and identification of common complications, and issue homemade peritonitis prevention knowledge manual, and family members or patients with peritoneal dialysis related knowledge and operation of the assessment of qualified, discharged from the hospital for a fixed 1–3 months follow-up.

2.2.2. Intervention group

The hospital leads the formation of a continuity of care team structured as a four-tier linkage system involving a tertiary hospital, secondary hospital, nursing institution-community, and family. This team is headed by specialist nurses from the tertiary hospital's peritoneal dialysis unit and includes psychotherapists, dietitians, and peritoneal dialysis physicians. By integrating the strengths of the tertiary hospital, secondary hospitals, nursing institutions, community services, and family support, the team delivers comprehensive, continuous, and seamless professional nursing care throughout the entire patient journey.

(1) In the linkage management

Tertiary hospital medical care regularly trains secondary hospitals and care institutions, communities, and family members in knowledge of abdominal dialysis to master the treatment of volume hypertension, selects appropriate follow-up institutions according to the patient's condition and mobility, and patients with stabilized conditions regularly go to regional hospitals in their place of residence to do basic review, follow-up, and education. If the blood pressure remains poorly controlled after the exclusion of volumetric factors, the patient can consult the specialized doctors and pharmacists of tertiary hospitals to adjust the patient's medication, and be referred to the hospital if necessary. For patients in the community with

limited self-care abilities, due to factors such as age, lack of disease knowledge among family members, and inability to recognize potential health risks, community healthcare staff establish contact through platforms like WeChat to provide regular follow-up. This includes monitoring key indicators such as urine output, body weight, blood pressure, and signs of edema. When necessary, staff conduct home visits to assess salt intake, fluid retention, peritoneal dialysis complications, nutritional status, and medication adherence. In addition, the knowledge levels of both patients and their families regarding peritoneal dialysis are evaluated and continuously tracked to support effective disease management. For patients with good self-management ability, patients and their families can report regularly to the community and the hospital through the Internet about changes in home medication, blood pressure, and symptoms of disease discomfort. Collect four-segment blood pressure 2–3 times throughout the day to exclude hypertension in the clinic, and adjust medication and lifestyle, dialysis program, etc., by specialist staff according to blood pressure.

(2) Lifestyle intervention

(a) Assess patients' BMI, diet, medication, adherence, degree of edema, and sleep, instruct patients to establish a healthy lifestyle, quit smoking and alcohol, control weight, avoid late nights and overwork, and ensure adequate sleep at night, and if there are sleep disorders, patients can take sleeping medication according to medical advice.

(b) Special attention should be given to the patient's diet, with an emphasis on low-salt dietary guidance. For patients with normal blood pressure, daily salt intake should be limited to less than 6 grams. For those with edema, salt intake should be further restricted to 2–3 grams per day. High-sodium condiments should be avoided. To accommodate patients with reduced food intake, low-sodium salt may be used to help maintain palatability while adhering to dietary restrictions. According to the degree of edema to develop a diet plan, without edema patients to control the daily intake of fluids (500 ml + the previous 1 d urine + the previous 1 d ultrafiltration), with edema patients fluid intake is equal to (the previous 1 d urine + the previous 1 d ultrafiltration), try to minimize the intake of foods with high water content, to achieve more than the outgoing than the incoming. At the same time, pay attention to nutrition, encourage patients to consume more high-quality protein eggs, daily intake of high-quality protein is greater than 50% of the total protein, to avoid high-fat and high-sugar foods, and consume more high-fiber foods.

(c) According to the patient's blood pressure, physical strength arrangements for appropriate walking, square dancing and other aerobic exercise or muscle strength exercise, each exercise time about 30 min, 2–3 times a week, to the degree that the patient can tolerate, according to the principle of gradual and orderly progress to gradually increase the intensity of exercise.

(d) Measure the blood pressure of four segments in the morning, at noon, in the afternoon, and before going to bed every day, and the systolic blood pressure shall not be higher than 15 mmHg for both medicated and unmedicated blood pressure.

(3) Psychological intervention

To support patients in maintaining emotional stability, leverage the "patient peer effect" by encouraging individuals with successful treatment outcomes to share their experiences in the WeChat group. This peer sharing helps foster a sense of community and boosts confidence in managing and overcoming the disease.

2.3. Observation indicators

Systolic blood pressure (SBP), diastolic blood pressure (DBP), N-terminal brain natriuretic peptide, and blood sodium are measured before and after the intervention in both groups.

2.4. Statistical methods

SPSS 25.0 statistical software is used for data processing. Measurement data with normal distribution are expressed as "mean ± standard deviation", and two independent samples t-test is used to compare the means between groups; non-normally distributed measurement data are expressed as "M (P25,P75)", and the rank sum test is used to compare between groups. The difference is considered statistically significant at $P < 0.05$.

3. Results

After the intervention, the patients' water load and blood pressure control showed significant advantages over the control group, and the difference was statistically significant ($P < 0.05$), as shown in **Table 1** and **Table 2**.

Table 1. Comparison of N-terminal brain natriuretic peptide precursors before and after intervention in the two groups of patients

Groups	NT-proBNP	
	Pre-entry	Post enrollment
Control subjects	7216 ± 315	4396 ± 302
Intervention group	7112 ± 327	3354 ± 129
t	1.61	22.70
p	0.11	< 0.001

Table 2. Comparison of systolic diastolic blood pressure and blood sodium before and after intervention in group 2 patients

Groups	Systolic blood pressure		Diastolic blood pressure		Sodium	
	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention	Pre-intervention	Post-intervention
Control group (n=47)	159.75 ± 31.36	145.48 ± 26.32	110.59 ± 11.26	96.42 ± 9.20	143.21 ± 4.12	140.01 ± 2.26
Intervention group (n=52)	158.92 ± 30.56	137.28 ± 11.12	111.21 ± 10.34	90.29 ± 9.19	142.93 ± 4.23	137.72 ± 2.21
t-value	0.123	2.054	0.286	3.31.	0.333	5.094
p	0.894	0.043	0.776	< 0.001	0.740	< 0.001

4. Discussion

Hospital-community-family linkage is an emerging model of care in recent years, which combines the functions of hospitals, communities, and families to provide a strong assurance of meeting the needs of out-of-hospital patients [9]. The 2015 International Society for peritoneal Dialysis (ISPD) Adult Peritoneal Dialysis Patient

Cardiovascular and metabolic guidelines state that the target blood pressure for continuous peritoneal dialysis patients with blood pressure chronically > 140/90 mmHg should be 140/90 mmHg [10]. Data from the United States Renal Data System (USRDE) and several single-center cross-sectional studies in China in recent years have found that the prevalence of hypertension in peritoneal dialysis patients is up to 80% or more [11]. Refractory hypertension leads to an increasing incidence of stroke and cardiovascular events, and is the main cause of death and withdrawal from peritoneal dialysis [12]. Peritoneal dialysis is often done at home and is often operated independently by the patient or family members, thus placing certain demands on patient compliance. Some studies have shown that low adherence to peritoneal dialysis treatment may lead to water-salt balance disorders, fluid overload, and other problems, which may lead to hypertension, edema, heart failure, and even death [13]. Therefore, strengthening the management of blood pressure in peritoneal dialysis patients and continuous quality improvement is an important part of improving the overall survival rate and technical survival rate of peritoneal dialysis patients.

The results of this study showed that by applying the "tertiary hospitals-secondary hospitals and care institutions-community-family" quadratic linkage care model for the management of peritoneal dialysis patients, N-terminal brain natriuretic peptide precursor, systolic blood pressure and diastolic blood pressure, and blood sodium were significantly lower than those of the control group ($P < 05$) after the intervention. diastolic blood pressure, and blood sodium were significantly lower than those in the control group, and the difference was statistically significant ($P < 0.05$). Chai applied the hospital-community-family "trinity" nursing management model to intervene in peritoneal dialysis patients with diabetic nephropathy, and the results showed that the patients' blood glucose level and self-management ability improved greatly after the intervention, which indicated that the hospital-community-family trinity management model had a good application effect [14]. The quadruple linkage continuity of care model adopted in this study utilizes a shared information technology platform to promote coordinated management among tertiary hospitals, secondary hospitals and care institutions, community health services, and patients' families. This model is built on standardized medication protocols, psychological counseling, and lifestyle interventions aimed at improving patients' understanding of hypertension. Tertiary hospitals conduct regular telephone follow-ups, and every six months, patients' N-terminal brain natriuretic peptide (NT-proBNP) levels are compared with baseline values from their initial discharge to assess treatment effectiveness.

Based on changes in clinical indicators, individualized dietary plans, exercise routines, and dialysis schedules are developed. Each participating institution provides targeted supervision, ongoing monitoring, re-education, and home visits to ensure treatment continuity. This integrated, four-way management system effectively supports the ongoing care needs of home-based peritoneal dialysis patients, improves blood pressure control, and enhances patient adherence to treatment.

5. Conclusion

The implementation of the "tertiary hospital-secondary hospital and nursing home-community-family" quadratic care model demonstrates significant potential in optimizing blood pressure management for elderly peritoneal dialysis patients. By integrating multi-level healthcare resources, this approach not only enhances blood pressure control rates to meet clinical standards but also effectively alleviates disease-related symptoms and improves patient satisfaction. These findings underscore the value of structured, collaborative care systems in managing chronic conditions among aging populations.

Disclosure statement

The authors declare no conflict of interest.

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