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Construction and Application of Maintenance Intervention Program for Autologous Arteriovenous Fistula in Elderly Hemodialysis Patients Based on IFSMT Theory

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Abstract: *Objective:* To analyze contextual factors influencing self-management of arteriovenous fistulas (AVFs) among elderly patients on maintenance hemodialysis based on the Individual and Family Self-Management Theory (IFSMT), to develop an intervention model centered on patient-family-healthcare collaboration for AVF maintenance, and to evaluate its effectiveness. *Methods:* This study consisted of two phases. The first phase was a cross-sectional survey involving 165 participants, with 157 valid questionnaires collected to identify contextual factors affecting AVF self-management in elderly maintenance hemodialysis (MHD) patients. The second phase was a randomized controlled trial designed to assess the effectiveness of the intervention model developed based on IFSMT. Elderly AVF patients admitted to the hemodialysis unit of a tertiary hospital in Hebei Province between September 2025 and March 2026 were randomly assigned to either a control group or an intervention group using a random number table, with 63 patients in each group; ultimately, 60 patients completed follow-up in each group. The control group received standard care, while the intervention group received the IFSMT-based intervention in addition to standard care over a three-month period. *Results:* The mean self-management score for elderly AVF patients was 45.662 ± 7.701, indicating a moderate overall level. Factors including dialysis duration, daily care, daily AVF exercise, daily AVF self-checking, history of AVF failure or complications, anxiety, depression, general self-efficacy, and family support were identified as significant contextual factors influencing AVF self-management. After the intervention, the incidence of AVF abnormalities and failure was significantly lower in the intervention group compared to the control group ($p < 0.05$). The total scores and subscale scores of the AVF self-management scale were higher in the intervention group than in the control group ($p < 0.05$). The self-efficacy scores and family support index scores were also significantly higher in the intervention group ($p < 0.05$). Additionally, quality-of-life scores were higher in the intervention group ($p < 0.05$). *Conclusion:* The self-management program based on IFSMT can improve AVF maintenance outcomes, reduce the occurrence of AVF complications and failure rates, enhance patients' self-management capacity and general self-efficacy, and improve

family support and quality of life.

Keywords: Individual and family self-management theory; Elderly hemodialysis; Fistula maintenance; Self-management; Family care level

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1. Introduction

In recent years, the incidence of end-stage renal disease (ESRD) in China has been on the rise. According to the China National Renal Data System (CNRDS) in 2024, the number of hemodialysis patients in China has reached over 910,000 [1]. Ninety percent of ESRD patients opt for hemodialysis as their primary treatment modality, among which autogenous arteriovenous fistula (AVF) is the preferred vascular access for maintenance hemodialysis (MHD) due to its lower infection risk and longer patency duration [2]. However, stenosis, thrombosis, infection, bleeding, and hematoma can still lead to reduced or lost function of the access [3]. Elderly patients face higher risks due to multiple comorbidities, impaired sensory and cognitive functions, and inadequate caregiving resources [4]. Guidelines recommend incorporating patient self-monitoring and daily maintenance into vascular access management to facilitate early identification of abnormalities and prolong the lifespan of AVFs [5,6].

Previous interventions have primarily focused on knowledge dissemination or single-skill training, with insufficient integration of psychological beliefs, behavioral regulation, and family support. The Individual and Family Self-Management Theory (IFSMT) posits that individual and family contexts influence proximal behaviors and distal health outcomes through processes such as knowledge and beliefs, self-regulation, and social facilitation [7]. This theory aligns well with the characteristics of long-term, highly family-involved disease management in elderly MHD patients. This study first identified contextual factors related to AVF self-management and constructed an IFSMT-based intervention program. Subsequently, a randomized controlled trial was conducted to evaluate its effects on AVF-related abnormalities, self-management abilities, family care levels, general self-efficacy, and quality of life.

2. Methods

2.1. Study design

This study employed a two-phase design. The first phase involved evidence retrieval, cross-sectional surveys, and Delphi expert consultations to formulate and revise the intervention program. The second phase was a single-center, randomized controlled trial to evaluate the effects of the 12-week intervention. The study was conducted in the hemodialysis unit of a tertiary Grade A hospital in Hebei Province.

2.2. Phase 1: Construction of the intervention program

2.2.1. Research team and literature search

The research team consisted of two hemodialysis physicians, one head nurse, three specialist nurses, one master's supervisor, and one nursing graduate student, responsible for evidence evaluation, program design, clinical implementation, and quality control. Databases including CNKI, China Biology Medicine disc

(CBMdisc), Wanfang, VIP, PubMed, Web of Science, ScienceDirect, Embase, and Cochrane Library were searched for literature related to MHD, AVF, vascular access dysfunction, self-management, and self-care, with the search period spanning from the establishment of the databases to June 2025. A total of 662 articles were retrieved, and after deduplication, screening, and quality evaluation, 10 guidelines, expert consensus documents, systematic reviews, or intervention studies were included to extract intervention elements applicable to elderly AVF maintenance.

2.2.2. Contextual factor survey

Using convenience sampling, 165 elderly MHD patients with AVF receiving treatment in the hemodialysis unit of Hebei General Hospital from June 2025 to August 2025 were selected as the study subjects. Based on the description of contextual factors in the IFSMT, self-designed general contextual data questionnaires, the AVF Self-Management Scale, the General Self-Efficacy Scale (GSES), the Hospital Anxiety and Depression Scale (HADS), and the Family APGAR Index were used for analysis [8–11]. A total of 157 valid questionnaires were obtained. With the total score of AVF self-management as the dependent variable, univariate analysis was first conducted, followed by multivariate linear regression incorporating statistically significant and theoretically important variables to screen for intervenable factors.

2.2.3. Delphi expert consultation

A preliminary draft of the program was formulated based on literature retrieval and contextual factor surveys. Sixteen experts with ≥ 10 years of experience in hemodialysis, vascular access, or nursing management were selected for two rounds of consultations. Experts provided opinions on the importance, feasibility, and wording of items; the research team revised the program based on the mean, variability, expert authority level, and program suggestions.

2.3. Phase 2: Randomized controlled trial

2.3.1. Study subjects, sample size, and random grouping

Eligible patients were continuously enrolled from September 2025 to March 2026. Inclusion criteria were: age ≥ 60 years; meeting MHD and AVF-related diagnostic and treatment criteria [12]; regular hemodialysis for ≥ 3 months, three times a week; using AVF as the access; able to read or complete assessments with the assistance of researchers; and voluntarily participating and signing informed consent. Exclusion criteria were severe life-threatening heart, lung, or liver diseases, significant cognitive, psychiatric, or communication disorders, and concurrent participation in similar interventions. Patients who discontinued due to disease deterioration, death, voluntary withdrawal, or absence from ≥ 2 interventions were excluded.

Based on a two-sample rate comparison, using the formula $n = \frac{2\overline{pq}\left(z_a + z_\beta\right)^2}{\left(p1 + p2\right)^2}$, and referring to a similar study ($p_1 = 0.068$, $p_2 = 0.3167$), $\bar{p} = 0.19235$ and $\bar{q} = 0.80765$ were calculated [13]. Substituting these values into the formula yielded n1 = n2=53. Considering an approximate 15% dropout rate, 126 cases were planned to be enrolled. Patients were randomly assigned to the intervention and control groups in a 1:1 ratio using a random number table, with 63 cases in each group. This study was approved by the hospital's ethics committee [(2025) Scientific Research Ethics Review No. (520)].

2.3.2. Intervention measures

The control group received routine care, including disease and AVF maintenance education, pre-dialysis access assessment, complication prevention, exercise guidance, and necessary psychological support. The intervention group received the IFSMT program in addition to routine care. Researchers were uniformly trained before implementation; patients and their families received age-appropriate knowledge manuals, record books, and online support. The intervention focused on knowledge and beliefs, self-regulation, and social facilitation, integrating goal setting, AVF self-examination and skill training, family collaboration, peer demonstration, and continuous healthcare provider feedback. The main contents are shown in Table 1. The research team reviewed the implementation every two weeks and addressed individualized issues without altering the core intervention components.

Table 1. IFSMT-Based AVF maintenance self-management intervention program

Process dimension	Intervention program	Intervention content	Intervention method	Intervention time	Intervention personnel	Intervention location
1. Knowledge Information and Self-Efficacy	1.1. Goal Alignment	1.1.1. Introduce to the patient the content, purpose, and significance of the intervention, and establish appropriate goals based on the patient's individual circumstances. 1.1.2. Conduct motivational interviews to assess the patient's relevant nursing knowledge and self-efficacy levels, facilitating the development of tailored training content in the later stages.	One-on-one communication	2 hours after enrollment	Researcher	Hemodialysis Room

Process dimension	Intervention program	Intervention content	Intervention method	Intervention time	Intervention personnel	Intervention location
	1.2. Patient-related disease and nursing knowledge information	1.2.1. Utilize large-print, visually engaging knowledge booklets combined with mind maps, integrating both online and offline methods, to explain to patients knowledge about dialysis principles, arteriovenous fistula (AVF) function, influencing factors, abnormal conditions, related complications, and more. 1.2.2. Emphasize the importance of AVF self-care and provide specific instructions, such as avoiding prolonged weight-bearing on the arm with the puncture site, refraining from taking blood pressure or drawing blood from that arm, and wearing loose and comfortable clothing. 1.2.3. Focus on explaining and providing guidance on items with low self-management scores.	In-person instruction; remote teaching	Once a day for 30 minutes each session in the first week.	Researchers and specialist nurses	Hemodialysis Demonstration Classroom; Remote Medical Conference Room
	1.3. Self-efficacy	1.3.1. Explain the definition and significance of self-efficacy, introduce positive case studies through kidney patient support groups, invite exemplary patients to share their experiences, and play video case studies to inspire patients to enhance their self-efficacy. 1.3.2. Provide non-monetary positive feedback or health-promoting small gifts as rewards to outstanding patients who share their experiences.	Introduce cases; facilitate communication.	Once a week for 1 hour per session at weeks 2, 4, 6, and 8.	Researchers and specialist nurses.	Hemodialysis demonstration classroom; online conference.
2. Self-regulation skills and abilities	2.1. Goal setting	2.1.1. Motivational interviewing is employed to understand the patient's level of self-care ability, self-needs, and expectations, and to collaborate with family members in formulating an action plan that clearly outlines goals and methods for each stage. Monthly progress reports are presented during discussion sessions.	One-on-one communication	2 hours after enrollment	Researcher	ward

Process dimension	Intervention program	Intervention content	Intervention method	Intervention time	Intervention personnel	Intervention location
	2.2. Internal fistula maintenance skills	2.2.1. Employ relaxation training and palpation exercises to reduce anxiety responses during internal fistula manipulation. 2.2.2. Self-monitoring: Instruct patients on the methods and key points of "looking, touching, listening, and raising" to identify issues through alternating operation and make corrections. 2.2.3. Observation and identification methods for complications: Check for vascular thrill, redness on the skin surface, changes in vascular murmurs, etc., to determine the presence of abnormalities such as stenosis, thrombosis, infection, swelling, or bleeding. 2.2.4. Exercise training: Teach patients to use tolerable exercise methods, such as internal fistula exercises and grip balls, to enhance internal fistula function, and develop personalized exercise plans. 2.2.5. Nutritional guidance: Enable patients to clearly understand their nutritional needs, identify the nutrient content of various foods, and calculate dietary intake requirements. 2.2.6. Fluid management: Instruct and demonstrate the correct methods and timing for monitoring blood pressure and measuring body weight.	On-site demonstration, one-on-one guidance, group discussion, and video playback.	Weeks 1, 3, 5, and 7 Twice a week, 1 hour per session	Researcher Specialist Nurse/Doctor Dietitian	Hemodialysis room, hemodialysis demonstration classroom

Process dimension	Intervention program	Intervention content	Intervention method	Intervention time	Intervention personnel	Intervention location
	2.3. Planning and Implementation	2.3.1. Family members participate in joint goal-setting, with the patient, family member, and nurse collaboratively breaking down internal fistula maintenance into monthly sub-goals. 2.3.2. Patients conduct daily self-examinations through "visual inspection, palpation, auscultation, and elevation"; family members are responsible for recording and reminding, with data uploaded to a WeChat group check-in mini-program; nurses conduct weekly online reviews and provide timely feedback. 2.3.3. Patients weigh themselves daily upon waking to monitor weight changes; on dialysis days, they measure blood pressure in the morning and take antihypertensive medication as prescribed by medical staff or according to a pre-established medication guide, avoiding self-discontinuation or dosage adjustments. 2.3.4. Exercise plan: Perform internal fistula exercises 30 minutes before dialysis and engage in 20 minutes of aerobic exercise on non-dialysis days, accompanied by family members who verbally count repetitions; an exercise log is posted in the living room, and patients can redeem prizes monthly upon completion of the plan using the log. 2.3.5. Monthly positive feedback is provided based on goal achievement, with unmet goals jointly revised for the next cycle's plan.	Monthly exchange meetings, visual tools, and online guidance.	At the end of weeks 1, 4, 8, and 12 Once a week 30 minutes per session	Researcher, specialist nurse, and doctor.	Hemodialysis Demonstration Classroom

Process dimension	Intervention program	Intervention content	Intervention method	Intervention time	Intervention personnel	Intervention location
3. Social Support	3.1. Professional Medical Guidance	3.1.1. Healthcare professionals provide positive encouragement and feedback on the patient's behaviors. 3.1.2. Before dialysis puncture, healthcare professionals communicate with the patient about the specific condition of their internal fistula, such as the exact puncture site, enabling effective dialogue between the patient and the nurse responsible for the next puncture, while offering professional guidance on any abnormal conditions or issues.	One-on-one commun'ication.	During each dialysis session.	Specialist nurses and doctors.	Hemodialysis room.
	3.2. Family Collaboration	3.2.1. Provide family members with theoretical and practical training to equip them with the foundational knowledge, observational skills, and emergency response capabilities necessary for daily care of the internal fistula, enabling them to assist patients in self-management. 3.2.2. Guide family members to express support through verbal affirmation and non-verbal means, avoid accusatory language, learn to recognize and appropriately respond to the patient's emotional changes, and enhance the patient's sense of self-efficacy. 3.2.3. Family collaboration and participation: Family members remind patients daily to perform self-checks of the internal fistula, monitor blood pressure, measure weight, engage in exercise, and take medications on time, accompany them during medical examinations, and promptly contact healthcare professionals to report any abnormalities. 3.2.4. Building a family support network: Researchers establish a family mutual aid group chat where family members regularly share caregiving experiences and provide emotional support to one another.	On-site instruction, online communication, and video playback	Accompanying time for family members during dialysis at weeks 2, 4, 6, and 8: 2 times per week, 30 minutes per session.	Researchers, specialist nurses, and doctors.	Waiting area for family members in the hemodialysis room.

2.3.3. Outcome measures

The following outcomes were evaluated at baseline and at 4, 8, and 12 weeks of intervention.

(1) AVF-related abnormal complications

Researchers recorded in real-time abnormal conditions and complications such as dysfunction, bleeding, hematoma, stenosis, thrombosis, and infection. AVF dysfunction was determined based on a significant reduction or disappearance of thrill or bruit, dialysis blood flow < 200 mL/min not meeting dialysis needs, or ultrasound confirmation of thrombosis or intimal hyperplasia stenosis [14].

(2) AVF self-management scale

Comprising 16 items covering complication identification, management, and prevention, with a total score ranging from 16 to 80. Higher scores indicate better self-management, with Cronbach's $\alpha = 0.905$ [8].

(3) Family APGAR index questionnaire

Consisting of 5 items, with a total score ranging from 0 to 10. Higher scores indicate better family functioning and support, with Cronbach's $\alpha = 0.855$ [11].

(4) General self-efficacy scale

Comprising 10 items, with a total score ranging from 10 to 40. Higher scores indicate higher self-efficacy, with Cronbach's $\alpha = 0.91$ [9].

(5) Kidney disease quality of life (KDQ) scale [15]

Comprising 26 items covering physical symptoms, fatigue, depression, relationships with others, and frustration, with a total score ranging from 26 to 182. Higher scores indicate better quality of life. The Hospital Anxiety and Depression Scale was used only for investigating situational factors in the first phase.

2.3.4. Data collection and quality control

Researchers and uniformly trained specialist nurses conducted on-site evaluations using standardized instructions. After questionnaire collection, two members verified completeness and independently entered or reviewed the data. The research team regularly reviewed intervention records, online feedback, and adverse events to ensure implementation consistency and data quality.

2.3.5. Statistical analysis

Data were analyzed using SPSS 27.0. Categorical variables were presented as counts and percentages, with comparisons between groups using the chi-square test or Fisher's exact test. Normally distributed continuous variables were presented as mean ± standard deviation, with comparisons between baseline groups using independent samples *t*-tests. Non-normally distributed variables were presented as M (P25, P75) and compared using the Wilcoxon rank-sum test. Longitudinal continuous outcomes were analyzed using repeated measures analysis of variance to test for group effects, time effects, and interaction effects; comparisons between groups at each time point were conducted using independent samples *t*-tests. A two-sided p-value < 0.05 was considered statistically significant.

3. Results

3.1. Results of intervention program construction

In the cross-sectional survey, the total AVF self-management score for 157 patients was 45.66 ± 7.70, indicating a moderately low level. Behaviors with lower scores mainly involved daily observation, palpation

or auscultation of the AVF, identification of skin and peripheral circulation changes, and proper handling of bleeding, hematoma, and skin injuries. Multiple regression analysis showed that dialysis vintage, daily care, daily fistula exercise, daily self-examination, previous fistula dysfunction or complications, anxiety, depression, general self-efficacy, and family care were associated with self-management, explaining 68.4% of the variance. Based on these findings, the research team focused on strengthening modifiable factors, including monitoring and motor skills, coping with negative emotions, self-efficacy, and family collaboration.

Two rounds of Delphi consultations yielded 16 valid questionnaires each, with a response rate of 100%. The expert authority coefficients were 0.81 and 0.88, respectively, and Kendall's W coefficients of concordance were 0.153 and 0.265, respectively. Based on expert opinions, redundant knowledge items were merged, operations that might cause improper compression were removed, and emergency responses for hematoma, bleeding, and disappearance of thrill were added, along with family shared goals and coordination of puncture information. The final program included 3 process dimensions, 8 intervention items, and 25 intervention contents.

3.2. Comparison of general information between two groups of patients

A total of 126 patients were randomly assigned; 3 patients in the intervention group and 3 in the control group did not complete the study, resulting in 60 patients in each group included in the final analysis. There were no statistically significant differences between the two groups in terms of age, gender, marital status, education level, daily care situation, per capita income, medical expenses, daily AVF behavior, primary disease, comorbidities, dialysis vintage, and previous AVF dysfunction or complications (all $p > 0.05$; see Table 2).

Table 2. Comparison of general information between two groups of patients

Variable	Category	Intervention group (n = 60)	Control group (n= 60)	χ^2/Z	p
Age	60–69 years	33(55.00)	31(51.67)	1.233[a]	0.540
	70–79 years	17(28.33)	22(36.67)		
	≥ 80 years	10(16.67)	7(11.67)		
Gender	Male	31(51.67)	25(41.67)	1.205[a]	0.272
	Female	29(48.33)	35(58.33)		
Marital status	Married	48(80.00)	41(68.33)	4.278[a]	0.233
	Unmarried	0(0.00)	3(5.00)		
	Widowed	9(15.00)	13(21.67)		
	Divorced	3(5.00)	3(5.00)		
Education level	Primary school or below	22(36.67)	20(33.33)	-0.301[b]	0.763
	Junior high school	23(38.33)	30(50.00)		
	High school/ technical secondary school	7(11.67)	5(8.33)		
	College	6(10.00)	4(6.67)		
	Bachelor or above	2(3.33)	1(1.67)		

Variable	Category	Intervention group (n = 60)	Control group (n= 60)	χ^2/Z	p
Daily care situation	Spouse	32(53.33)	32(53.33)	6.910[a]	0.141
	Children	17(28.33)	13(21.67)		
	Siblings	4(6.67)	1(1.67)		
	No care/ accompaniment	6(10.00)	7(11.67)		
	Other	1(1.67)	7(11.67)		
Per capita monthly household income	< 3000 yuan	25(41.67)	20(33.33)	-0.308[b]	0.758
	3000–5000 yuan	18(30.00)	26(43.33)		
	> 5000 yuan	17(28.33)	14(23.33)		
Medical expenses	Urban and rural resident medical insurance	28(46.67)	23(38.33)	1.262[a]	0.738
	Employee medical insurance	22(36.67)	23(38.33)		
	Commercial insurance	7(11.67)	9(15.00)		
	Selfpaid	3(5.00)	5(8.33)		
Daily AVF exercise	Yes	22(36.67)	20(33.33)	0.147[a]	0.702
	No	38(63.33)	40(66.67)		
Daily selfexamination of AVF	Yes	20(33.33)	14(23.33)	1.477[a]	0.224
	No	40(66.67)	46(76.67)		
Daily blood pressure monitoring	Yes	20(33.33)	24(40.00)	0.574[a]	0.449
	No	40(66.67)	36(60.00)		
Primary disease	Diabetic nephropathy	9(15.00)	16(26.67)	2.480[a]	0.648
	Hypertensive nephropathy	20(33.33)	17(28.33)		
	Chronic nephritis	16(26.67)	14(23.33)		
	Polycystic kidney disease	7(11.67)	6(10.00)		
	Other	8(13.33)	7(11.67)		
Number of comorbidities	≤ 3	24(40.00)	28(46.67)	0.543[a]	0.461
	≥ 4	36(60.00)	32(53.33)		
Dialysis vintage	< 3 years	22(36.67)	19(31.67)	-1.242[b]	0.214
	3–5 years	25(41.67)	20(33.33)		
	> 5 years	13(21.67)	21(35.00)		
Previous AVF failure or complications	Yes	25(41.67)	22(36.67)	0.315[a]	0.575
	No	35(58.33)	38(63.33)		

Note: a represents χ^2 value, b represents Z value. * $p < 0.05$, ** $p < 0.01$.

3.3. AVF-related abnormalities

During the intervention period, the intervention group recorded 3 cases of AVF-related abnormalities, while the control group recorded 21 cases; the overall incidence in the intervention group was lower ($p = 0.004$).

The descriptive distribution of various events is shown in Table 3.

Table 3. AVF-related abnormal events in both groups

Category	Number of cases	Bleeding	Hematoma	Stenosis	Thrombosis	Infection
Intervention group (60)	3	1 (1.67)	1 (1.67)	0 (0.00)	1 (1.67)	0 (0.00)
Control group (60)	21	4 (6.67)	6 (10.00)	2 (3.33)	5 (8.33)	4 (6.67)
χ^2	17.413					
p	0.004					

3.4. Self-management, family care, self-efficacy, and quality of life

At baseline, there were no statistically significant differences in scores on the various scales between the two groups. After 4, 8, and 12 weeks of intervention, the intervention group scored higher than the control group on all four measures (all $p < 0.001$). Repeated measures analysis of variance revealed statistically significant group effects, time effects, and interaction effects for AVF self-management, family care index, general self-efficacy, and quality of life (all $p < 0.001$; Table 4), indicating that the magnitude of improvement in the intervention group increased over time.

Table 4. Comparison of outcome measure scores between the two groups of patients

Outcome	Group	Baseline	4 weeks	8 weeks	12 weeks	F group	F time	F interaction
AVF self-management	Control group	41.30 ± 4.25	41.90 ± 4.99[a]	42.87 ± 5.47[ab]	43.38 ± 5.68[ab]	466.219	256.936	317.366
	Intervention group	40.87 ± 3.43	49.67 ± 2.30[a]	57.92 ± 1.74[ab]	63.48 ± 1.38[abc]			
Family care	Control group	6.42 ± 1.21	6.50 ± 1.83	6.58 ± 2.00	6.72 ± 2.06	20.279	14.529	10.844
	Intervention group	6.40 ± 1.20	7.47 ± 1.23[a]	7.90 ± 1.36[ab]	8.13 ± 0.70[ab]			
General self-efficacy	Control group	21.08 ± 3.38	21.78 ± 5.59	21.97 ± 4.77[a]	22.25 ± 4.78[a]	107.600	189.926	140.400
	Intervention group	21.00 ± 3.69	26.03 ± 2.21[a]	30.97 ± 1.52[ab]	34.05 ± 0.85[abc]			
Quality of life	Control group	81.98 ± 12.37	82.63 ± 13.37	83.53 ± 13.05[b]	84.30 ± 13.74[ab]	267.927	111.964	206.384
	Intervention group	85.73 ± 12.84	95.93 ± 7.75[a]	110.53 ± 5.20[ab]	120.35 ± 2.68[abc]			

Note: [a] $p < 0.05$ compared with baseline; [b] $p < 0.05$ compared with week 4; [c] $p < 0.05$ compared with week 8. The group, time, and interaction effects for all outcomes were $p < 0.001$.

4. Discussion

4.1. Scientific rationale and feasibility of the intervention program construction

This study utilized the Individual and Family Self-Management Theory (IFSMT) as a framework to translate situational factor identification, literature analysis, and expert consensus into an implementable patient-family-healthcare provider collaborative program [16]. The program was not limited to one-time knowledge dissemination but also encompassed knowledge and beliefs, self-regulation, and social facilitation. It

enhanced behavioral execution through age-appropriate materials, repeated demonstrations, staged goals, family reminders, and continuous feedback. The two rounds of expert consultations demonstrated high participation and authority, and the program content aligned with the low-scoring behaviors and controllable factors identified in the preliminary survey, supporting its content validity and clinical feasibility.

4.2. Impact on AVF abnormalities and self-management

The intervention group had significantly fewer AVF-related abnormalities than the control group, likely due to the combined effects of daily self-examination, abnormality identification, and timely communication. Structured education improved patients' sensitivity to tremors, bruits, skin changes, and post-puncture abnormalities, enabling problems to be detected and addressed before complete fistula failure [17]. Integration of weight, blood pressure, exercise, and volume management may also reduce triggers such as hypotension, low blood flow, and local injury. For elderly patients with decreased sensory, cognitive, and operational abilities, pictorial tools, teach-back exercises, and family co-monitoring can compensate for the limitations of oral instruction alone [18].

The continuous increase in AVF self-management scores in the intervention group suggests that repeated training and feedback facilitate the translation of knowledge into stable behaviors. IFSMT emphasizes that the self-management process is shaped by information, skills, and the social environment; this study enhanced patients' mastery of complication identification, prevention, and management through a closed loop of demonstration-practice-correction-recording-feedback. This is consistent with research findings that elderly patients with multiple comorbidities require continuous, individualized, and multidimensional support [19].

4.3. Impact on family care, general self-efficacy, and quality of life

The gradual improvement in family care levels and general self-efficacy was an important finding of this study. Family members participated in goal setting and behavioral reminders and received training in observation and emergency response, shifting from "managing on behalf of the patient" to "supporting the patient in completing management". This collaboration reduced blame and conflict, enhanced patients' sense of control and success experiences, and aligned with evidence on family-engaged chronic disease management [20,21]. Peer case studies, staged goals, and positive feedback provided vicarious experiences, mastery experiences, and social persuasion, potentially explaining the increasing trend in self-efficacy over time [22].

The improvement in quality of life may be the cumulative result of multiple proximal changes. Better AVF maintenance reduces access abnormalities and related concerns, while enhanced self-efficacy and family support help alleviate the burden of disease management. Continuous healthcare provider contact increases security. Previous studies have also shown that vascular access experience, psychological state, and social support are closely related to the quality of life of hemodialysis patients [23,24]. Therefore, AVF interventions should not focus solely on patency rates but also incorporate patient experience and family resources into outcome evaluations.

4.4. Clinical implications, strengths, and limitations

This program can be integrated into routine dialysis procedures: initial assessment and skill training are completed centrally, with subsequent support provided continuously using dialysis time, family

accompaniment time, and online tools, demonstrating good replicability. Age-appropriate materials, teach-back methods, and visual recording are particularly suitable for patients with slower learning speeds or requiring repeated practice [25]. When clinically promoting this program, the frequency of instruction can be adjusted based on available resources, but core components such as shared goals, self-monitoring, family collaboration, and professional feedback should be retained.

This study has limitations. First, it was a single-center study with a limited sample size, and the external validity of the results requires verification through multicenter studies. Second, the intervention lasted 12 weeks, making it impossible to determine long-term access patency and behavioral maintenance. Third, blinding of participants and implementers was difficult, and some outcomes were self-reported scales, potentially introducing implementation and reporting biases. Fourth, this study reported AVF abnormalities as event counts; future studies should predefine criteria for AVF abnormalities and failure, standardize the recording of first and recurrent events, and extend follow-up time to more accurately evaluate the impact of interventions on AVF complications and long-term patency.

5. Conclusion

The AVF maintenance program for elderly patients on maintenance hemodialysis, constructed based on IFSMT, organically integrates age-appropriate education, self-monitoring and skill training, goal setting and feedback, family collaboration, and continuous healthcare provider support. A 12-week intervention improved AVF self-management, family care, general self-efficacy, and quality of life and may reduce AVF-related abnormalities. Future studies should further validate its effectiveness and generalizability through multicenter, long-term follow-up, and standardized event evaluation.

Disclosure statement

The authors declare no conflict of interest.

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