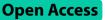**RESEARCH**

Construction of a home-based self-management program for patients with indwelling peripherally inserted central catheter based on the IMB model

Jing Fu[1†], Lihong Jin[1*†], Xuli Shang[1†], Congmei Zhang[1] and Lu Chen[1*†]

Abstract

Background   PICC is an essential route of drug delivery for cyclic oncology treatment, significantly improving the convenience of continuous therapy for oncology patients. However, the management of PICC catheters by oncology patients while they are at home is not yet at a satisfactory level, which increases the risk of PICC indwelling complications to a certain extent and affects the cancer treatment and patients' quality of life.

Objective   Construct a home-based self-management program for patients with indwelling PICC based on the information-motivation-behavioral skills (IMB) model to improve patient self-management.

Methods   Based on the literature review and qualitative interviews, the first draft of the home-based self-management program for patients with indwelling PICC was constructed, and two rounds of Delphi expert consultation determined the final items of the program, and the weights of the items were determined by adopting Saaty's Analytic Hierarchy Process (AHP).

Results   The Delphi panel consisted of 18 experts, and the positive coefficients of the two rounds of expert consultation were 100%, with authority coefficients (Cr) of 0.958 and 0.964, Kendall's coordination coefficients (Kendall's W) of 0.212 and 0.301 ($P < 0.01$), and coefficient of variation (CV) of 0.048 to 0.231 and 0.000 to 0.176, respectively. The finally constructed home-based self-management program for patients with indwelling PICC was established by experts' consensus, including 3 primary items, 8 secondary items, and 34 tertiary items. Among the primary items, behavioral skills have the highest weight coefficient of 0.393.

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Conclusion The program constructed in this study has high scientific validity and practicality, which can provide strong support for home self-management of patients with indwelling PICC and provide a valuable reference for nurse-led health education.

Keywords Information-motivation-behavioral skills model, Home-based self-management, Peripherally inserted central catheter, Delphi method

Introduction

According to data released by the International Agency for Research on Cancer(IARC), there were approximately 20 million new cancer cases worldwide in 2022, and this number is expected to rise to 35 million by 2050 [1]. Additionally, an analysis of global epidemiological data from 2020 indicates that the number of new cancer cases in China has reached nearly 4.5 million [2]. Chemotherapy, as a crucial method for cancer treatment, prevention of recurrence, and metastasis, has been widely utilized in clinical practice. Studies have shown that over 2.5 million patients globally choose to undergo continuous chemotherapy via peripherally inserted central catheter (PICC) each year [3], making it the preferred vascular access route for patients receiving continuous chemotherapy [4].

PICC is a well-established intravascular interventional procedure. It involves percutaneous puncture of a peripheral vein, followed by guiding the catheter retrogradely along the vein towards the superior vena cava [5]. The advantages of PICC include reduced patient discomfort and a high success rate of catheter placement [6]. Due to the PICC catheter's unique material and structural characteristics, it can remain in the body for several weeks to months and sometimes for over a year [7]. In clinical treatments requiring frequent or long-term intravenous infusions, such as chemotherapy for malignant tumors, prolonged antibiotic therapy, and nutritional support therapy, PICC has significant clinical value [8]. Furthermore, using a PICC reduces the number of peripheral vein punctures, protects peripheral veins, enhances the safety of drug infusions, improves patients' quality of life, and increases medical work efficiency [9]. It also provides great convenience for patients requiring periodic intravenous therapy [10].

However, the long-term placement of PICC is also associated with the risk of complications. Literature reports indicate that complications can be as high as 12.5–48.1% [11–13], including catheter occlusion, catheter-related infections, catheter-associated skin injuries, and catheter migration. Complications related to PICC placement are more likely to occur during the patient's homestay, which may adversely affect the continuity and effectiveness of treatment and increase the patient's treatment burden.

Research indicates [14] that the duration of PICC placement is related to complications, the catheter maintenance skills of nurses, and the patient's self-management.

Through self-management, patients can prevent and reduce PICC-associated complications, extend the catheter dwell time, and improve their health behaviors and health status [15–17]. Therefore, implementing meticulous self-management and complication-prevention strategies is particularly important for patients with indwelling PICC during their homestay. Currently, the management of patients with indwelling PICC primarily relies on the health guidance of medical staff. In contrast, patients lack proactive self-management awareness, and their self-management abilities are generally at a medium or below-medium level [18].

The information-motivation-behavioral skills (IMB) model posits that targeted improvements in an individual's information, motivation, and behavioral skills can effectively support changes in health behaviors and enhance self-management abilities. This model views the formation of health behaviors as the result of the interplay among information, motivation, and behavioral skills, providing a scientific theoretical framework for health education and behavioral interventions. Since its introduction by Fisher et al. in 1992 [19], the IMB model has been widely applied in health behavior research and self-management interventions [20, 21], demonstrating favorable application outcomes.

This study aims to develop a scientific and systematic home-based self-management program for patients with indwelling PICC based on the core elements of the IMB model—information acquisition, motivation enhancement, and behavioral skills. The goal is to improve the home self-management abilities of these patients, reduce the incidence of PICC-associated complications, and provide references and insights for future clinical practice and academic research in related fields.

Methods

Establishment of the research team

The research team comprised seven members, including a director of the nursing department, an oncologist, two intravenous therapy nurses, a clinical nursing specialist (nurse manager), a master-level nurse, and a bachelor-level nurse. The study work was organized as follows: The bachelor-level nurse and the intravenous therapy nurse were responsible for developing a search strategy, conducting a comprehensive literature search, and extracting data. The clinical nursing specialist, the oncologist, and the intravenous therapy nurse were tasked with initially

constructing an item pool for the program. The nursing department director was responsible for selecting the expert panel and ensuring quality control during the Delphi process. The postgraduate nurses designed and distributed the consultation questionnaire and organized and analyzed the data. All research team members were engaged in intravenous therapy and oncology clinical work, each with 8 or more years of clinical nursing practice experience.

Identification of the expert panel
In December 2023, a purposive sampling method was used to select clinical experts in intravenous therapy nursing, oncology nursing, and teaching. A total of 18 experts were identified after discussion within the study group and under the selection criteria for Delphi experts [22]. The inclusion criteria were as follows: (1) more than 10 years of clinical practice experience in oncology nursing, intravenous therapy, PICC teaching, and PICC management; (2) possession of a bachelor's degree or higher; (3) holding a professional title of nurse supervisor or above; (4) informed consent to participate in the study voluntarily.

Initial construction of the home-based self-management program for patients with indwelling PICC
Literature review
Literature searches were performed on CNKI, Wanfang, Wikipedia, PubMed, Web of Science, Cochrane Library, and CHINAL. The search timeframe was from the establishment of the database to January 2024. The search was conducted by combining MeSH terms and free words. The search terms were "peripherally inserted catheters/ self-management/self-treatment." Comprehensively analyzing the literature related to home self-management of indwelling PICC patients, according to the construction principle of the index system, the research team discussed, reformed, and screened to form the first draft of the home-based self-management program for indwelling PICC patients, which included 3 primary items, 8 secondary items, and 34 tertiary items.

Qualitative research
Twenty-one patients with indwelling PICC were purposively selected, and in-depth semi-structured interviews were conducted. The researcher preliminarily formulated the interview guide according to the research purpose and literature review and pre-interviewed two patients with indwelling PICC. Based on the results of these pre-interviews, the study group adjusted the interview questions and their phrasing to create the final interview guide. The interview questions included:

1. What is the impact of having an indwelling PICC on your daily life? Could you specify the changes in your daily routine?
2. What problems and difficulties have you encountered during your homestay because of the indwelling PICC? What are your coping strategies?
3. How do you maintain the PICC catheter?
4. What help would you like to receive to manage and maintain the PICC catheter better?

Interviews were terminated when data saturation was reached, and no new themes emerged [23]. Data analysis was performed using the Colaizzi method. The researcher introduced the study's purpose before the interview and explained the procedures for audio recording, informed consent, and privacy protection. After obtaining participants' permission, the researcher conducted face-to-face interviews with participants in a quiet, undisturbed room in the hospital for 30–60 min [24].

Development of the expert consultation questionnaire
The expert consultation questionnaire includes four parts: consultation description, personal information of the experts, expert judgment basis and familiarity, and consultation content. (1) Consultation description: including the background of the study, the purpose of the study, the significance of the questionnaire, and the specific requirements and methods for filling out the questionnaire. (2) Personal information of experts: gender, age, education, professional title, years of experience, position, affiliation, and professional domain. (3) Expert judgment basis and familiarity: expert judgment basis was calculated through four dimensions: theoretical analysis, practical basis, reference materials, and intuitive judgment. Theoretical analysis was assigned a value of 0.1 ~ 0.3, practical basis was assigned a value of 0.3 ~ 0.5, reference materials and intuitive judgment were assigned a value of 0.1, and the influence of each dimension on the expert judgment basis was divided into three levels: large, medium and small. Expert familiarity was evaluated using the Likert 5-level scale, with "very unfamiliar" to "very familiar" assigned values of 0.2, 0.4, 0.6, 0.8, and 1.0, respectively [25]. (4) Consultation content: Three dimensions of information acquisition, motivation enhancement, and behavioral skills were included. Each dimension comprises primary, secondary, and tertiary items. Each item has options for "delete," "add," and a "modification comments section."

Distribution and collection of the expert consultation questionnaires
3 rounds of expert consultation were completed between February and April 2024. The questionnaires were sent to the experts by e-mail and collected within 2 weeks. The

researchers conducted a statistical analysis of the data obtained from the 1st round of expert consultations, which included expert personal information, item values, and modification suggestions. Items that met both the "mean importance score > 3.50" and "CV < 0.25" criteria were retained. The research team discussed and incorporated the experts' modification suggestions to form the 2nd round of expert consultation questionnaires, which included 3 primary items, 8 secondary items, and 35 tertiary items, along with the feedback from the 1st round of expert consultations. After the 2nd round of consultations, the research team discussed, modified, and statistically analyzed the expert feedback, resulting in 3 primary items, 8 secondary items, and 34 tertiary items. Since the expert opinions showed consistency, the consultation was concluded. The 3rd round of expert consultations utilized Saaty's AHP [26], where the same panel of experts rated the importance of each item to calculate the weight values for each item.

Ethical statement

This study was approved by the Ethics Committee of Lishui People's Hospital, Zhejiang Province, China (No. 2023 – 198). The researchers have provided all participants with detailed information about the study. The research was conducted on the premise that participants were informed and voluntarily agreed to participate.

Table 1 General information of the consultation experts (*n* = 18)

Item	Number	Proportion (%)
Gender		
Female	18	100
Age (years)		
30–39	4	22.22
40–49	12	66.67
≥ 50	2	11.11
Years of work		
10–19	4	22.22
20–29	11	61.11
≥ 30	3	16.67
Education		
Bachelor	8	44.44
Master	9	50.00
Doctor	1	5.56
Professional title		
Intermediate	7	38.89
Associate Senior	9	50.00
Senior	2	11.11
Professional domain		
Nursing Management	9	50.00
Clinical Nursing	8	44.44
Nursing Education	1	5.56

Statistical methods

Two researchers verified and entered the data obtained from the expert consultation into Excel. Statistical analysis was performed using SPSS 23.0. Measurement data were represented by means and standard deviations, while frequencies and percentages represented count data. The experts' positive coefficients were indicated by the effective response rate of the questionnaire; the authority coefficients (Cr) measured the reliability of the consultation results, Ca represented experts judgment basis, Cs represented expert familiarity with the consultation content, Cr=(Ca + Cs)/2; The CV and Kendall's W represented the coordination degree of the experts' opinions. The judgment matrix was constructed using Saaty's AHP method, and the weights of the primary, secondary, and tertiary items were calculated [27].

Results

General information of the consultation experts

The 18 experts participating in the Delphi consultation were from 18 comprehensive hospitals in Zhejiang Province, Shanghai, Beijing, and Chongqing, China. Their professional domains covered clinical nursing (PICC outpatient clinic, oncology department, general surgery), nursing management, and nursing education. All were female (100%), with ages ranging from 30 to 52 years (42.11 ± 5.89) and years of work ranging from 15 to 32 years (25.00 ± 4.89). The general information of the experts is shown in Table 1.

Experts positivity

A total of 18 questionnaires were distributed, and 18 valid questionnaires were collected in all 3 rounds of expert consultation, with a response rate of 100%. In the 1st round of consultation, 10 experts proposed 39 suggestions for modifications; in the 2nd round, 3 experts proposed 13. Overall, the experts demonstrated high engagement and positivity for participating in this study.

Experts authority

Based on the experts' academic level, familiarity with the consultation content, and judgment basis in this study, the Cr for the experts was calculated to be 0.958 and 0.964 for the 1st and 2nd rounds, respectively. The Cs values were 0.956 and 0.967, with Ca values at 0.961. These results indicated that the experts demonstrated a high level of authority, as their Cr values exceed 0.7, which is generally considered acceptable for reliability [28].

Expert coordination and consistency

The coefficient of variation for the 1st round of expert consultation ranged from 0.048 to 0.231, with an overall Kendall's W of 0.212 for all items. In the 2nd round, the coefficient of variation ranged from 0.000 to 0.176, with

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an overall Kendall's W of 0.301 and all P-values < 0.001. These results indicated good coordination and consistency among the experts in both rounds of consultation, as shown in Table 2.

Expert consultation results

Results of the 1st round expert consultation

The questionnaire for the 1st round of expert consultation included 3 primary items, 8 secondary items, and 34 tertiary items. 11 experts proposed 39 recommendations. The study group integrated clinical practices and, according to statistical requirements of the Delphi method, collectively reviewed and modified the items as follows: ① Modifications to 8 tertiary items: Change "Understanding the basic knowledge of PICC catheters (such as the basic concept of PICC, purposes of catheterization, advantages and disadvantages, placement, effects of catheterization, etc.)" to "Understanding the basic knowledge of PICC catheters (such as the basic concept of PICC, purposes of catheterization, advantages and disadvantages, placement, etc.)"; Change "Functional exercises for the arm with PICC catheter placement (such as fist clenching, finger movements, wrist rotation, etc.)" to "Functional exercises for the arm with PICC catheter placement (such as fist clenching, finger movements, wrist rotation, shoulder joint activities, etc.)"; Change "General daily life activities: washing face, brushing teeth, combing hair, eating, dressing, etc." to "Daily life activities during PICC catheterization (such as washing face, brushing teeth, combing hair, eating, dressing, bathing, lifting heavy objects, etc.)"; Change "Integrity of the skin around the PICC puncture site" to "Presence of abnormalities around the PICC puncture site (such as damage, rash, blisters)"; Change "Presence of blood return in the lumen of the PICC catheter" to "Presence of blood return from the exposed part of the PICC catheter"; Change "Complete dislodgement of the PICC catheter" to "Partial or complete dislodgement of the PICC catheter"; Change "Create a good self-management environment to enhance confidence in self-management" to "Create a harmonious home atmosphere to enhance confidence in self-management"; Change "Identify abnormalities in the skin around the PICC puncture site and dressings" to "Identify abnormalities in the skin around the PICC puncture site." ②

Addition of one new tertiary item: Under the secondary item "Self-identification of the PICC catheter abnormalities," add the tertiary item" Identifying abnormalities in the PICC Catheter (including catheter dislodgement, blood return, etc.)."

Results of the 2nd round of expert consultation

The questionnaire for the 2nd round of expert consultation includes 3 primary items, 8 secondary items, and 35 tertiary items. 3 experts proposed 13 modification suggestions. After discussion, the group made the following changes to the items: ① Modifications to two tertiary items: Change "Partial or complete dislodgement of the PICC catheter" to "Handling partial or complete dislodgement of the PICC catheter"; change "Damage or fracture of the PICC catheter" to "Handling damage or fracture of the PICC catheter." ② Deletion of one item: Delete "Create a harmonious home atmosphere to enhance confidence in self-management." The final program includes 3 primary items, 8 secondary items, and 34 tertiary items, as shown in Table 3.

Results of the 3rd round of expert consultation

The 3rd round of expert consultation adopted Saaty's AHP method, where experts rated the importance of each item. Combining the results of the expert consultation and hierarchical analysis, the weights and combined weights of each item were calculated. For details, see Table 3.

Discussion

The home-based self-management program for patients with indwelling PICC based on the IMB model demonstrates solid scientific validity

The development of this program was founded on a systematic review of relevant literature, analyzing and integrating the latest research findings and theories in the field of home-based self-management for patients with indwelling PICC. This provides a solid theoretical foundation and extensive clinical practice evidence for the program's construction. Additionally, qualitative interviews gathered real and rich experiences and information regarding home-based self-management from patients with indwelling PICC. This allowed researchers to deeply understand the patient's needs, adding practical, solid evidence to the program's formulation. It ensures the program aligns with patients' real situations and addresses practical issues.

Additionally, the IMB model has been extensively validated and applied across various domains of health behavior change. It emphasizes the importance of information, motivation, and behavioral skills in self-management. The tight integration of these three elements—information, motivation, and behavioral

Table 2 Kendall's W and significance tests for the results of the 1st and 2nd rounds of expert consultation

Round	Item	Kendall's W	X²	P
1st	Primary items	0.178	6.400	0.041
	Secondary items	0.163	20.552	0.004
	Tertiary items	0.231	132.912	<0.001
2nd	Primary items	0.181	6.500	0.039
	Secondary items	0.217	27.349	<0.001
	Tertiary items	0.329	195.160	<0.001

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Table 3 The home-based self-management plan for patients with indwelling PICC based on the IMB model

Item	Importance score (Mean±SD)	Coefficient of variation	Weight	Combined weight
I-1 Information Acquisition	4.89±0.323	0.066	0.300	0.300
II-1.1 Knowledge of the PICC catheter	4.78±0.428	0.090	0.178	0.053
III-1.1.1 Understanding basic knowledge of the PICC catheter (such as basic concepts, purposes, advantages and disadvantages, catheter placement, etc.)	4.56±0.511	0.112	0.160	0.009
III-1.1.2 Mastering the PICC self-monitoring content (such as the integrity of the puncture site skin, external length of the catheter, condition of dressing fixation, etc.)	4.89±0.323	0.066	0.325	0.017
6III-1.1.3 Understanding maintenance contents of the PICC at home (such as flushing the catheter weekly, sealing, changing dressings and connectors, etc.)	4.89±0.323	0.066	0.261	0.014
III-1.1.4 Understanding available resources for catheter maintenance (such as local formal medical institutions, community hospitals, internet home services, etc.)	4.89±0.323	0.066	0.254	0.014
II-1.2 Daily management of the PICC catheter	5±0	0.000	0.245	0.073
III-1.2.1 Fixation and protection of the PICC Catheter	4.83±0.383	0.079	0.152	0.011
III-1.2.2 Cleaning treatment around the PICC catheter puncture site	4.72±0.461	0.098	0.145	0.011
III-1.2.3 Regular maintenance interval for the PICC catheter	4.94±0.236	0.048	0.149	0.011
III-1.2.4 Functional exercises for the arm with the PICC catheter placement	4.89±0.323	0.066	0.127	0.009
III-1.2.5 Daily life management during catheterization	4.89±0.323	0.066	0.131	0.010
III-1.2.6 Precautions for special examinations such as CT, MRI	4.94±0.236	0.048	0.125	0.009
III-1.2.7 Dietary adjustments to maintain nutritional balance	4.17±0.618	0.148	0.080	0.006
III-1.2.8 Timely psychological counseling to maintain emotional stability	4.28±0.752	0.176	0.091	0.007
II-1.3 Self-monitoring of the PICC catheter	4.94±0.236	0.048	0.254	0.076
III-1.3.1 Checking for bleeding or leakage at the PICC puncture site	4.89±0.323	0.066	0.127	0.010
III-1.3.2 Checking for redness or pain at the PICC puncture site	4.94±0.236	0.048	0.136	0.010
III-1.3.3 Checking for abnormal skin around the PICC puncture site	4.89±0.323	0.066	0.128	0.010
III-1.3.4 Checking for curling, loosening, damage, or moisture in the PICC dressing	4.94±0.236	0.048	0.153	0.012
III-1.3.5 Checking if the PICC catheter is displaced or dislodged	4.5±0.618	0.137	0.154	0.012
III-1.3.6 Checking for swelling or pain in the arm with PICC catheter placement	4.5±0.707	0.157	0.165	0.013
III-1.3.7 Checking for blood return in the exposed PICC catheter	4.56±0.616	0.135	0.137	0.010
II-1.4 Handling emergencies with the PICC catheter	5±0	0.000	0.324	0.097
III-1.4.1 Handling partial or complete dislodgement of the PICC catheter	4.56±0.616	0.135	0.374	0.036
III-1.4.2 Handling damage or fracture of the PICC catheter	4.17±0.618	0.148	0.626	0.061
I-2 Motivation enhancement	4.72±0.461	0.098	0.306	0.306
II-2.1 Internal motivation enhancement	4.72±0.575	0.122	0.583	0.179
III-2.1.1 Encouraging the development of a reasonable self-management plan to cultivate self-efficacy	4.72±0.461	0.098	0.329	0.059
III-2.1.2 Reinforcing self-worth through affirmation and encouragement	5±0	0.000	0.327	0.058
III-2.1.3 Enhancing positive emotional experience through positive psychological interventions	4.89±0.323	0.066	0.344	0.061
II-2.2 External motivation enhancement	4.5±0.707	0.157	0.417	0.128
III-2.2.1 Establishing a fixed emotional support system to promote self-management motivation	4.89±0.323	0.066	0.341	0.044
III-2.2.2 Establishing an appropriate reward mechanism to stimulate self-management enthusiasm	4.94±0.236	0.048	0.264	0.034
III-2.2.3 Regular follow-up and timely feedback to supervise the positive effects of self-management	4.78±0.732	0.153	0.395	0.050
I-3 Behavioral skills	4.94±0.236	0.048	0.393	0.393
II-3.1 Daily behavioral skills	4.83±0.383	0.079	0.442	0.174
III-3.1.1 Coping with daily Work and household activities during catheterization	4.89±0.471	0.096	0.540	0.094
III-3.1.2 Choosing daily exercise methods	4.89±0.471	0.096	0.460	0.080
II-3.2 Self-identification of the PICC catheter abnormalities	4.94±0.236	0.048	0.558	0.219
III-3.2.1 Identifying Abnormalities at the PICC Catheter puncture site	4.78±0.548	0.115	0.186	0.041
III-3.2.2 Identifying abnormal skin around the PICC catheter puncture site	4.78±0.732	0.153	0.176	0.039
III-3.2.3 Identifying abnormalities in the PICC catheter fixation	4.83±0.383	0.079	0.176	0.039
III-3.2.4 Identifying abnormalities in the arm with PICC catheter placement	4.83±0.383	0.079	0.230	0.051
III-3.2.5 Identifying abnormalities in the PICC catheter (including catheter dislodgement, blood return, etc.)	4.94±0.236	0.048	0.230	0.051

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skills—not only provides a clear theoretical framework for home self-management of patients with indwelling PICC but also ensures the systematic and comprehensive construction of the program.

The Delphi method is a consensus-reaching approach that utilizes multiple iterations and expert feedback [29]. In this study's 3 rounds of Delphi expert consultation, experts reviewed and modified the plan based on their professional knowledge and practical experience, ensuring its scientific validity and practicality. This process enhanced the authority and credibility of the program. The Kendall's W for the 1st and 2nd rounds of expert consultation were 0.212 and 0.301, respectively, with both P-values less than 0.01. The coefficients of variation (CV) were between 0.048 and 0.231 and 0.000 to 0.176, indicating consensus among expert opinions.

Saaty's Analytic Hierarchy Process (AHP) utilized in this study is a structured decision analysis method that breaks down complex decision problems into multiple levels and factors. It assesses them through a combined qualitative and quantitative approach [30]. In developing the program, AHP prioritized and assigned weights to program items. Consistency checks ensured that the CR for each item was < 0.1, indicating reasonable weight allocation across the hierarchy of items [27]. This ensured the systematic and focused nature of the program. Moreover, the quantitative analysis made the program items more specific, actionable, and measurable.

The home-based self-management program for patients with indwelling PICC based on the IMB model exhibits high reliability

This study engaged 18 experts from comprehensive hospitals renowned for high medical standards in Zhejiang Province, Shanghai, Beijing, and Chongqing, China. These experts are highly authoritative and representative, with 14 having over 20 years of clinical experience, indicating 77.78% possess extensive practical insights to offer reliable information from their clinical perspectives. The CR for the 1st and 2nd rounds of expert consultation were 0.958 and 0.964, respectively. Ten experts hold master's degrees or above, and eleven hold senior professional titles or higher, affirming their credibility and authority to provide authoritative opinions from academic and research perspectives.

Their professional domains encompass clinical nursing (PICC outpatient clinics, oncology department, general surgery), nursing management, and nursing education. Eleven experts serve on various levels of vascular therapy committees, enhancing their specialty representation. Additionally, the 1st and 2nd rounds achieved a 100% response rate, with 61% and 17% of experts providing textual modification suggestions, demonstrating their high engagement and enthusiasm for this study. In conclusion, the engaged experts possess significant authority, representation, and familiarity in the research field, indicating the constructed plan content is highly reliable.

The home-based self-management program for patients with indwelling PICC based on the IMB model demonstrates strong practicality

Domestically, interventions for home-based self-management of patients with indwelling PICC primarily rely on healthcare professionals' health guidance, lacking comprehensive and systematic plans. Moreover, patients often lack initiative, resulting in generally low self-management abilities with PICC catheters [27]. This underscores the importance and necessity of constructing a comprehensive and systematic self-management program. Guided by the IMB model, this study developed a home-based self-management program comprising 3 primary items, 8 secondary items, and 34 tertiary items for patients with indwelling PICC.

In the IMB model, information is the primary factor in individual behavior change. The program constructed in this study provides patients with comprehensive, detailed, and accurate information on PICC catheter self-management, including daily care procedures, prevention of complications, and handling of emergencies. This ensures that patients fully understand and master relevant knowledge, enabling effective self-management in their daily home life.

In addition to information, motivation is crucial in influencing behavior change within the IMB model. The self-management program developed in this study emphasizes individual patient needs and motivation differences. It achieves this by understanding patients' psychological status, family environment, and social support to formulate personalized motivation enhancement strategies. Furthermore, motivation enhancement is not limited to initial interventions but extends throughout the self-management process. This is achieved through reminders and encouragement, continuously strengthening patients' willingness and drive for self-management. Consequently, patients are more likely to carry out self-management behaviors autonomously. Moreover, behavioral skills are critical to ensuring individuals can successfully execute desired behaviors. The content of behavioral skills in this context closely aligns with patients' everyday life realities. Mastering basic self-management skills is essential for patients with indwelling PICC during their homestay. This includes knowing how to protect the catheter and observe and manage complications effectively.

This study conducted a hierarchical analysis of the primary items—information acquisition, motivation enhancement, and behavioral skills—scoring their importance as 0.300, 0.306, and 0.393, respectively. This

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indicates that experts consider all three core elements of the IMB model highly significant, with behavioral skills being the most crucial factor in facilitating health behaviors. This finding aligns with Fisher's research [31], which suggests that information, motivation, and behavioral skills are fundamental factors in promoting healthy behaviors, as patients must possess adequate confidence, motivation, and necessary skills to adopt healthy behaviors [19].

Home-based patients with indwelling PICC have corresponding resource needs in several areas, including professional medical care (including how to observe the catheter condition, how to change dressings, how to manage abnormal situations, etc.), information and education (including PICC care manual and online educational courses, with one detailed PICC care manual covering steps for catheter maintenance, precautions, common issues, and solutions), psychological support (including psychological counseling and guidance, as well as patient support groups), and daily living assistance (including specialized protective sleeves or socks, or tools for dressing and undressing). Medical institutions, social organizations, and family members should work together to provide comprehensive and detailed support and services to ensure that patients can safely and effectively use the PICC catheter and improve their quality of life.

This study integrates the conditions of patients with indwelling PICC and the IMB model to develop a home-based self-management program for these patients. The home-based self-management program for patients with indwelling PICC developed is applicable to various environments, including the home environment, work environment (if applicable), social and leisure environments, and medical care environments. Patients need to develop a self-management plan tailored to their specific circumstances and based on the advice of their doctors, and strictly adhere to the relevant precautions and operational procedures. Ulteriorly, this program enhances patients' self-efficacy and confidence, improves their self-management abilities with PICC catheters, reduces the occurrence of PICC-associated complications, and enhances patients' overall quality of life.

From the patient's perspective, this means they can significantly reduce household medical expenses and alleviate financial burdens without compromising their quality of life. From the hospital's perspective, the long-term effective use of the PICC catheter reduces the need for repeated catheter placements, lowering the frequency and cost of catheterization procedures. From a national standpoint, this efficient use of medical resources not only helps reduce overall national healthcare expenditures and optimize resource allocation, but it may also contribute to forming a more efficient and economical healthcare system, benefiting more patients with indwelling PICC.

Limitations of the study
The study's qualitative interviews focused on patients from selected hospitals in Zhejiang Province, China, limiting the generalizability of findings to a broader population managing indwelling PICCs at home. Future research should consider expanding the sample size and further exploring characteristics of larger patient groups to refine home self-management strategies for patients with indwelling PICC.

Conclusions
Based on the IMB model, this study constructed a specific and highly operational home-based self-management program for patients with indwelling PICC through literature review, qualitative interviews, and Delphi expert consultation. The program is characterized by its scientific rigor, reliability, and practicality, providing clear and practical guidance for home self-care of patients with indwelling PICC. It is also expected to assist clinical nurses in health guidance for these patients. Furthermore, the research outcomes offer new perspectives and methodological references for developing this field.

Declarations

Ethics approval and consent to participate
The study clung to the tenets of the Declaration of Helsinki. This study was approved by the Ethic Committee of Lishui People's Hospital, Zhejiang Province, China (approval number: 2023 – 198). Informed consent was provided and obtained from all participants before the study commenced.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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