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Research Article

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Consensus on the health education of home-based negative pressure wound therapy for patients with chronic wounds: a modified Delphi study

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Abstract

Background: The study aimed to develop consensus on the components of health education of home-based negative pressure wound therapy (NPWT) for patients with chronic wounds.
Methods: A Delphi method was used to achieve consensus on the components of health education and 75% agreement and coefficient of variation (CV) <0.25 were used as cutoff. Sixteen experts were recruited purposefully to finish this study.
Results: Two rounds of consultation were implemented. Consensus was achieved on 36 of the 42 statements. The final agreed list of statements represented three domains: health education before carrying out home-based NPWT, health education for the treatment day of NPWT at hospital and health education for NPWT at home.
Conclusions: This study was the first attempt to develop consensus on the comprehensive components of health education of home-based NPWT for patients with chronic wounds. According to the established framework and components of health education, wound professionals can safely and effectively implement health education of home-based NPWT for patients with chronic wounds and improve their self-care ability and treatment experience at home.

Key words: Wound healing, Negative pressure wound therapy, Home care services, Delphi study, Chronic wound, Self-care

Highlights

- This paper developed consensus on the components of health education of home-based negative pressure wound therapy (NPWT) for patients with chronic wounds through a Delphi method.
- The final framework of health education included three dimensions and 36 statements: health education before carrying out home-based NPWT, health education for the treatment day of NPWT at hospital and health education for NPWT at home.
- This framework and components of health education could help to provide a more detailed and comprehensive reference for the follow-up support of patients with NPWT at home.

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Background

With the deepening of health care reform, chronic wound care tends to be delivered in community settings rather than in acute care [1]. Negative pressure wound therapy (NPWT) is one of the common methods to manage chronic wounds [2]. As technology improves, the versatility of the portable NPWT device enables it to be applied at home or in community settings, making the transition from the hospital to the home setting feasible [3]. Treatment with NPWT means being connected to the equipment 24 h a day, which results in physical, practical and social restraints on everyday life [4]. Patients and their families must therefore be actively involved in the treatment process, which may lead to changes in identities, roles and relationships [4,5].

With expanded usage, safety concerns have also emerged [6]. It has been suggested that a lack of education of patients and caregivers may have been a risk factor for complications, especially with home treatments [7]. Reported adverse effects include pain, retention of foreign bodies from the dressing, bleeding, infection, death and even complications originating from power outages, which result in an unrecognized interruption of therapy [2,8]. Patients should be educated to recognize the early warning signs of possible complications at home.

Generally, portable, single-use NPWT systems include foams, occlusive drapes, drainage tubes, canisters and vacuum machines (such as VAC® therapy devices, Kinetic Concepts, Inc., San Antonio, TX, USA). To ensure that the NPWT system functions properly, it is important to develop a systematic and comprehensive content of health education for patients and caregivers to inform them about NPWT at home so they can actively participate in the process and are aware of the stages that the treatment entails [9,10]. Bolas and Holloway reported that patients need more education not only about the concept but also about day-to-day practicalities and troubleshooting [5]. Some guidelines and studies also mentioned the health education content of home-based NPWT from different perspectives, e.g. patient instruction regarding safe operation of the device and competence in application and reinforcement of the dressing, to dry and prepare the periwound skin, to avoid positioning the patient on the tubing, instruction on the frequency of canister changes, how to disconnect the system to take a shower and how to disconnect the system when toileting [11–13]. However, there is no clear consensus about the content of the health education of home-based NPWT for patients with chronic wounds [8].

Thus, this study aimed to develop the components of the health education of home-based NPWT for patients with chronic wounds using a modified Delphi method, which can enhance the quality of home-based NPWT education and improve patients' self-care capacity and experience.

Methods

The Delphi method is a research technique used for collecting and transforming experts' opinions and information into a group consensus [14]. It is commonly chosen as a way to achieve a consensus for clinical standards, principles and components [15]. The Delphi method has been used in the area of wound healing to achieve consensus principles for wound care research, consensus on the use of dressings in chronic wound management and consensus on current opinions and clinical leanings on the management of diabetic foot ulcers [16–18]. Implementing an anonymous Delphi study by email may overcome some limitations found with decision-making processes in face-to-face committee meetings, with the advantage of less cost and feedback is provided in a controlled form [19]. In the present study, the experts' opinions were collected by two-round questionnaire surveys, and the results of the preceding round were responded to by the researcher in the manner of statistical analysis until a consensus of experts' opinions was reached.

Formulating an original draft of the framework and components of health education for home-based NPWT

First, guided by the Gordon's Functional Health Patterns (FHP) model and perioperative process management framework, we developed an original draft of the health education components of home-based NPWT based on a literature review, patient interviews and clinical experience. Then, we adopted the Delphi method among purposive experts to collect and analyze the experts' opinions to reach an agreement on the final health education components of home-based NPWT. Hospital ethics committee approval was exempt, as this study involved only the opinions of experts, rather than patients or their data.

Gordon's FHP model is one of the comprehensive methods for the assessment stage of the nursing process. It can assess and explain the needs of the individual/family, including 11 functional categories in any setting and for any group at any stage in the health/illness continuum: health perception–health management, nutrition–metabolic, elimination, activity–exercise, cognitive–perceptual, sleep–rest, self-perception–self-concept, role relation, sexuality–reproductive, coping–stress tolerance and value–belief pattern from a holistic and structural perspective [20]. The FHP model has been widely used in clinical nursing practice and education worldwide [21–23].

In light of the perioperative process management framework (preoperative, intraoperative and postoperative stage) [24], we formulated a draft expert questionnaire comprising three dimensions (health education before carrying out home-based NPWT, health education for the treatment day of NPWT at the hospital and health education for NPWT at home). The literature in CNKI (Chinese), Wanfang Data (Chinese), PubMed, OVID, EBSCO, EMBASE, Web of Science and Google Scholar was comprehensively searched using a similar strategy for each database. The search strategy included '(chronic wound OR refractory wound OR diabetic foot ulcer OR pressure injury OR venous ulcer) AND (home care OR community care OR long-term care) AND health

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education'. Only articles published in Chinese or English before January 2019 were screened.

Prior to conducting this study, we adopted a qualitative descriptive study design to explore the experience of NPWT at home among Chinese chronic wound patients (published in another journal [25]). The participants' perceptions included health education deficiency, lack of independence and rationales in making decisions regarding NPWT and poor communication with wound professionals. Patients considered NPWT at home to be a promising regimen, but they also had a feeling of not being prepared and a lack of health education to make medical decisions independently. Patients mentioned some information about the health education content of home-based NPWT in the interview (Table 1).

Selection of the expert panel

We invited potential experts by purposive sampling. There were no rigorous standards for the sample size of the Delphi survey [26]. Experts were selected based on their experience in the field of clinical practice, management or research related to wound care or wound healing. The inclusion criteria were as follows: (1) at least 10 years of work experience and (2) involvement in wound clinical practice, management or research for at least 5 years. A total of 17 experts were invited to join in the Delphi study by email, and 16 of them agreed to participate in the research. The expert panel had 10 doctors, three nurses and three head nurses of wound care. The experts were anonymous to each other and did not receive any reimbursement for participation.

Delphi procedure

The number of Delphi rounds needed is still in debate, but typically, the number of rounds is two or three [26]. In this study, experts participated in two rounds of the Delphi consultation from March to May 2019. The survey questionnaire was sent to each expert by email, and they were given 4 weeks to complete the questionnaires and mail the completed questionnaires to the researcher at each round. A reminder email was sent to the experts if they did not mail the completed questionnaires by 1 week before the deadline.

Round 1 The Delphi expert questionnaire in the first round consisted of three parts. The first part was the research introduction and filling instructions, the second part involved questions about the characteristics of the experts (sex, age, education, professional titles, work field, work experience, etc.) and the third part contained a checklist of the components of the health education of home-based NPWT for patients with chronic wounds. The experts evaluated their level of agreement for the whole checklist and ranked all the components (three dimensions and 42 statements) using a 5-point Likert scale (from '1 = strongly disagree' to '5 = strongly agree') depending on the importance of each item. Moreover, a column of free text for each component was added to allow the experts to revise or comment on the component and to raise additional components of health education for home-based NPWT that they felt were missing. The experts could not communicate with each other in the process, to ensure the independence of their opinions. After the first round of consultations, the researchers sorted and analyzed the suggestions or opinions of the experts. If a consensus was not reached on some statements after group discussion, those statements were deleted in the subsequent round. All consensus outcomes from round 1 would remain in round 2 to allow participants to reprioritize the statements with the feedback attached. Then, the researchers appropriately modified the expert questionnaire for the second round of consultation, based on the results of the preliminary consultation and study team discussion.

Round 2 The Delphi questionnaire in the second round consisted of two parts. The first part was the results of round 1, including the participant's previous score presented as the mean, standard deviation, coefficient of variation (CV), interquartile range (IQR) and percentage of experts rated as strongly agree or agree and a summary of the experts' comments. The second part contained a revised checklist of the components of health education. The experts re-ranked their level of agreement with each statement that constituted the health education of NPWT. If a consensus was reached in round 2, the decision could be made to halt the process; conversely, another round might be set up.

Statistical analysis

Two team members entered the results of the expert consultations from each round independently, and the data analysis was carried out using SPSS 17.0 software. Descriptive statistics were used to summarize the participants' characteristics and their score for each component. Consensus was determined based on >75% agreement (expert score was '4 = agree' or '5 = strongly agree') and CV <0.25 among the experts at each round [15]. If experts made comments on deleting one statement, the research group further discussed whether to delete it. The purpose of group discussion was to reduce the risk of the dismissal of statements that did not meet the consensus criteria mainly based on the clinical importance for patients.

The number of components of health education for home-based NPWT that reached a consensus was calculated after each round. Open comments were analyzed qualitatively using content analysis [27].

Results

Preliminary draft of the framework and components of health education for home-based NPWT

According to the perioperative process management framework (preoperative, intraoperative and postoperative stage), the draft of the framework of health education was divided into three dimensions: health education before carrying out home-based NPWT, health education for the treatment day of NPWT at the hospital and health education for NPWT at home. The components of each dimension mainly stemmed

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Table 1. Draft of health education of home-based NPWT for patients with chronic wounds

No.	Name of statement	Source of statement		
		Clinical Experience	Patient interview	Literature review
I	Health education before carrying out home-based NPWT			
I-1	Concept of home-based NPWT	√		√
I-2	Function and principle of home-based NPWT	√		√
I-3	Advantages and effects of home-based NPWT		√	√
I-4	Indications of home-based NPWT			√
I-5	Contraindication of home-based NPWT			√
I-6	Complication of home-based NPWT			√
I-7	Environmental introduction of NPWT center	√		
I-8	Process of home-based NPWT (including treatment method, time and frequency)	√	√	√
I-9	Introduction of apparatus and equipment for home-based NPWT	√		√
I-10	Wound case introduction of home-based NPWT	√		
I-11	Cost of home-based NPWT	√	√	√
I-12	Periwound skin care before carrying out home-based NPWT			√
I-13	Dietary care before carrying out home-based NPWT	√		√
I-14	If the patient has abnormal physical condition (fever, bleeding, anemia, etc.) before carrying out home-based NPWT	√		√
I-15	To understand patient's disease history (wound history, treatment process, current medication use, etc.) before carrying out home-based NPWT	√		√
I-16	Indication to stop NPWT under normal conditions			√
II	Health education for the treatment day of NPWT at hospital			
II-1	Dress requirement for the treatment day of NPWT			√
II-2	Dietary requirement for the treatment day of NPWT	√		
II-3	Medication use requirement for the treatment day of NPWT	√		
II-4	Method of using negative pressure devices during the process of carrying out NPWT			√
II-5	The method of judging negative pressure suction during the process of carrying out NPWT	√		√
II-6	The method of evaluating wound drainage during the process of carrying out NPWT	√		√
II-7	Pain care during the process of carrying out NPWT	√	√	√
II-8	Position care during the process of carrying out NPWT	√	√	√
II-9	Possible adverse reactions and strategy during the process of carrying out NPWT			√
II-10	Precautions for patient transport from hospital to home-setting on the treatment day of NPWT	√		
III	Health education for NPWT at home			
III-1	Possible treatment risks during the process of NPWT at home			√
III-2	Methods of doing daily activities (e.g. dressing, toilet, bathing, etc.) during the process of NPWT at home	√	√	√
III-3	Position care during the process of NPWT at home	√		√
III-4	Indoor and outdoor exercise guidance during the process of NPWT at home			√
III-5	Sleeping care during the process of NPWT at home	√	√	√
III-6	Dietary care during the process of NPWT at home			√
III-7	Defecation care during the process of NPWT at home	√		√
III-8	Method of equipment maintenance during the process of NPWT at home	√	√	√
III-9	Drainage tube care during the process of NPWT at home	√	√	√
III-10	Solutions to drainage tube shedding during the process of NPWT at home		√	√
III-11	Drape care during the process of NPWT at home	√		√
III-12	Skin assessment surrounding wound (edema, redness, pain, eczema, itching, blisters, etc.) during the process of NPWT at home			√
III-13	Body-image care during the process of NPWT at home		√	√
III-14	Possible discomfort condition (foreign body sensation, wound odour, etc.) during the process of NPWT at home		√	√
III-15	Possible alarms and handling methods for equipment during the process of NPWT at home	√	√	√
III-16	Methods of stopping NPWT in case of emergency	√	√	√

NPWT negative pressure wound therapy

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Table 2. Characteristics of the consulting experts

Characteristic	Round 1, *n* (%) *n* = 16	Round 2, *n* (%) *n* = 16
Sex		
Male	8 (50)	8 (50)
Female	8 (50)	8 (50)
Age (50.62 ± 4.69 years)		
40–50 years	8 (50)	8 (50)
51–60 years	8 (50)	8 (50)
Years of experience (29.69 ± 6.33 years)		
10–20 years	2 (12.5)	2 (12.5)
21–30 years	8 (50)	8 (50)
>30 years	6 (37.5)	6 (37.5)
Profession distribution		
Doctor	10 (62.5)	10 (62.5)
Manager or head nurse	3 (18.75)	3 (18.75)
Wound care nurse	3 (18.75)	3 (18.75)
Highest level of education		
Doctor's degree	8 (50)	8 (50)
Master's degree	5 (31.25)	5 (31.25)
Bachelor's degree	3 (18.75)	3 (18.75)
Years of working experience related to wound care (19.62 ± 4.38 years)		
10–20 years	11 (68.75)	11 (68.75)
20–30 years	5 (31.25)	5 (31.25)

from a literature review guided by Gordon's FHP. Finally, the draft expert questionnaire included 42 statements (Table 1). Of these, 16 statements related to health education before carrying out home-based NPWT, 10 related to health education for the treatment day of NPWT at the hospital and 16 related to health education for NPWT at home.

Delphi expert panel

In total, 17 experts were invited and consented to participate in the study, and 16 of these completely finished the questionnaire in the first round (94.1%). Only 16 participants received the second survey, and the response rate in round 2 was 100% (16/16). The characteristics of the consulting experts are shown in Table 2.

Delphi process

In the first round, the experts put forward 18 opinions and the research group adopted 16 of them (88.9%). We modified some statements according to the experts' opinions. For example, experts suggested modifying the statement 'Method of equipment maintenance during the process of NPWT at home' to 'Basic method of equipment maintenance during the process of NPWT at home ', which referred to patients' need to know the basic maintenance methods when using the NPWT machine at home, such as handle with care, avoid water damage and don't trample, rather than referring to the repair method in the event of machine failure. Some statements were deleted since they were not related to the components of health education for patients. For example, experts pointed out that only wound staff need to realize the 'contraindication of home-based NPWT'. Additionally, some statements were thought to be ambiguous or redundant and were modified. From the open-ended questions in round 1, we extracted 6 additional statements to be rated. At the conclusion of round 1, there were 43 statements to be judged in round 2 (Figure 1). Of these, 15 statements related to health education before carrying out home-based NPWT, 10 related to health education for the treatment day of NPWT at the hospital and 18 related to health education for NPWT at home.

In the second round, the experts put forward 11 opinions, and the research group adopted 8 of them (72.7%). We deleted some statements according to the experts' opinions. For example, experts considered 'Video health education for standard home-based NPWT' to be a method of health education other than the specific content of health education.

At the conclusion of round 2, a consensus was reached on 36 of the 43 statements (Table 3), and no additional statement was proposed in this round. The study group made the decision to halt the Delphi process. Of these, 11 statements related to health education before carrying out home-based NPWT, 10 related to health education for the treatment day of NPWT at the hospital and 15 related to health education for NPWT at home.

Discussion

Earlier patient discharge from the hospital can be successfully facilitated by the use of NPWT in the home setting or community through cooperation between wound staff and patients [10,28]. Studies have shown that health education for NPWT at home is the key factor in improving the self-care

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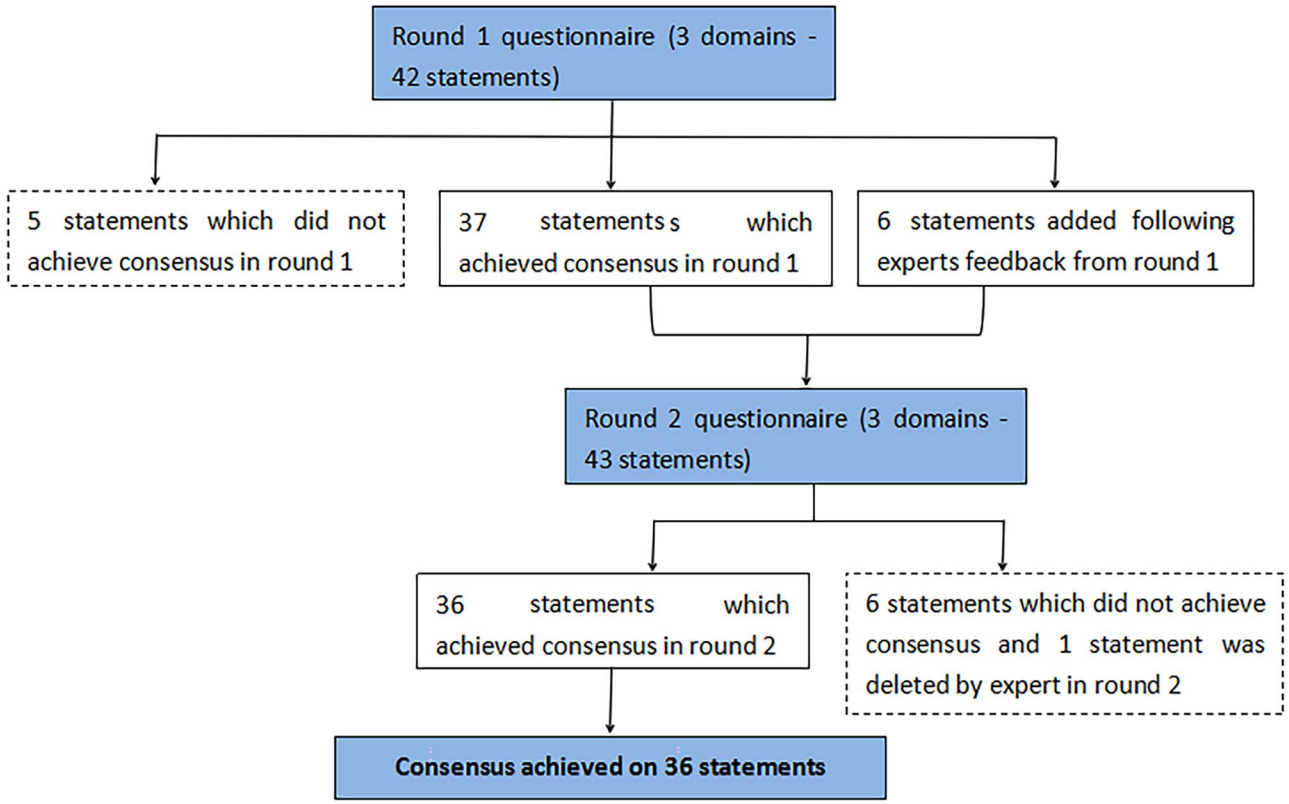


Figure 1 Flow chart of statements screening of each Delphi round

ability and confidence of patients [4,8]. However, due to a lack of consensus on the issue of what constitutes health education for patients with NPWT at home, the implementation of health education for patients with NPWT at home varies greatly among wound staff [8,29]. It is crucial to develop patient-centered and systematic components of health education for patients with home-based NPWT to improve the safety of home treatment and patient experience [30]. This study finally developed the framework and components of health education for patients with home-based NPWT after two rounds of the Delphi study by a group of experts that was related to wound healing care but varied greatly in light of their sociological characteristics and professional backgrounds.

It is recommended that the education of patients and families starts at the beginning of treatment and continues throughout the patient's hospitalization [8,11]. According to the perioperative process management framework, three dimensions (health education before carrying out home-based NPWT, health education for the treatment day of NPWT at the hospital, health education for NPWT at home) were formulated into the framework of health education. To ensure the comprehensiveness and rationality of health education, the statements of each dimension were extracted from a literature review based on Gordon's FHP, which included 11 functional categories of patients' needs. Through Delphi consultation, which has been regarded as an effective method to collect expert opinions objectively, a consensus was reached on the components of each domain and respective statement, indicating that experts had a positive and strong intention to develop a comprehensive and specific model for patients with home-based NPWT.

Without appropriate health education, there may be potential harms associated with NPWT at home [31]. Therefore, the Food and Drug Administration (FDA) endorsed education of the patient and caregivers to improve safety monitoring in the home setting [2]. The components of health education before carrying out home-based NPWT included the basic information, cost, process, possible abnormal conditions and impact on daily life of NPWT at home [11,12,32,33]. If this part of health education is scant or incomplete, patients may lack independence and rationale in making decisions regarding NPWT [25]. However, the experts thought that the 'contraindication of home-based NPW' was not the information that patients needed to understand, and the statement was ruled out in the first round of consultation. Although the new statement 'Video health education for standard home-based NPWT' was not ultimately retained, the experts gave us tips that video can be used as a form of health education, e.g. 'the video of introduction of the home-based NPWT'.

The components of health education for the treatment day of NPWT at the hospital mainly included the matters needing attention and the operation procedure of the therapy. On the

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Table 3. Outcome of expert consultation

Statement	Number of experts		Mean		Standard deviation		Coefficient of variation		Percentage of experts rating statements as strongly agree or agree (%)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
I	16	16	4.75	4.88	0.43	0.34	0.09	0.07	100	100
I-1	16	16	4.38	4.37	0.78	0.80	0.18	0.18	81.25	81.25
I-2	16	–	4.13	–	1.11	–	0.27[a]	–	75	–
I-3	16	16	4.50	4.56	0.71	0.89	0.16	0.19	87.5	87.5
I-4	16	16	4.31	4.31	0.92	0.79	0.21	0.18	81.25	81.25
I-5	16	–	4.06	–	1.30	–	0.32[a]	–	75	–
I-6	16	16	4.56	4.62	0.61	0.61	0.13	0.13	93.75	93.75
I-7	16	–	4.07	–	0.70	–	0.17	–	68.75[a]	–
I-8	16	16	4.75	4.94	0.56	0.25	0.11	0.05	93.75	100
I-9	16	16	4.50	4.31	0.71	0.87	0.16	0.20	87.5	75
I-10	16	–	4.00	–	0.94	–	0.23	–	68.75[a]	–
I-11	16	16	4.63	4.44	0.70	0.81	0.15	0.18	87.5	81.25
I-12	16	16	4.50	4.50	0.94	1.03	0.21	0.23	81.25	93.75
I-13	16	16	3.94	3.62	0.90	1.31	0.23	0.36[a]	81.25	68.76[a]
I-14	16	16	4.53	4.31	0.72	1.13	0.16	0.26[a]	81.25	81.25
I-15	16	16	4.73	4.19	0.44	1.37	0.09	0.32[a]	93.75	81.25
I-16	16	16	4.60	4.44	0.61	0.89	0.13	0.20	87.5	75
I-17	–	16	–	4.81	–	0.54	–	0.11	–	93.75
I-18	–	16	–	4.62	–	0.81	–	0.17	–	93.75
I-19[b]	–	16	–	4.31	–	0.94	–	0.22	–	81.25
II	16	16	4.94	4.75	0.24	0.44	0.05	0.09	100	100
II-1	16	16	4.20	4.25	0.91	1.00	0.22	0.23	75	75
II-2	16	–	3.87	–	0.96	–	0.25[a]	–	75	–
II-3	16	16	4.40	4.12	0.80	0.88	0.18	0.21	75	81.25
II-4	16	16	4.67	4.56	0.47	0.63	0.10	0.14	93.75	93.75
II-5	16	16	4.60	4.75	0.61	0.45	0.13	0.09	87.5	100
II-6	16	16	4.73	4.50	0.44	0.81	0.09	0.18	93.75	93.75
II-7	16	16	4.67	4.44	0.47	0.81	0.10	0.18	93.75	93.75
II-8	16	16	4.73	4.50	0.44	0.63	0.09	0.14	93.75	93.75
II-9	16	16	4.73	4.81	0.44	0.40	0.09	0.08	93.75	100
II-10	16	16	4.73	4.62	0.44	0.50	0.09	0.11	93.75	100
II-11	–	16	–	4.44	–	1.09	–	0.24	–	87.5
III	16	16	4.88	4.94	0.33	0.25	0.07	0.05	100	100
III-1	16	16	4.88	4.94	0.33	0.25	0.07	0.05	100	100
III-2	16	16	4.73	4.75	0.44	0.45	0.09	0.09	93.75	100
III-3	16	16	4.69	4.81	0.58	0.54	0.12	0.11	93.75	93.75
III-4	16	16	4.50	4.75	0.71	0.57	0.16	0.12	87.5	93.75
III-5	16	16	4.56	4.50	0.61	0.73	0.13	0.16	93.75	87.5
III-6	16	16	4.44	4.25	0.61	1.12	0.14	0.26[a]	93.75	87.5
III-7	16	16	4.38	4.56	0.86	0.63	0.20	0.13	87.5	93.75
III-8	16	16	4.38	4.75	0.78	0.57	0.18	0.12	81.25	93.75
III-9	16	16	4.63	4.75	0.60	0.44	0.13	0.09	93.75	100
III-10	16	16	4.75	4.81	0.56	0.54	0.12	0.11	93.75	93.75
III-11	16	16	4.56	4.88	0.70	0.34	0.15	0.07	87.5	100
III-12	16	16	4.88	4.75	0.33	0.57	0.07	0.12	100	93.75
III-13	16	16	3.94	4.12	0.66	1.08	0.17	0.26[a]	75	68.8[a]
III-14	16	16	4.63	4.56	0.60	0.89	0.13	0.19	93.75	87.5
III-15	16	16	4.88	4.62	0.33	0.62	0.07	0.13	100	93.75
III-16	16	16	4.81	4.81	0.39	0.75	0.08	0.15	100	93.75
III-17	–	16	–	4.31	–	1.07	–	0.25[a]	–	87.5
III-18	–	16	–	4.75	–	0.68	–	0.14	–	87.5

In the first Delphi round, 5 statements did not achieve consensus, 37 statements achieved consensus and another 6 statements were added according to the experts' feedback. Then 43 statements entered the second round. In the second Delphi round, 36 statements achieved consensus, but 6 statements did not achieve consensus and 1 statement was deleted by the experts. Finally, the components of health education of home-based negative pressure wound therapy for patients with chronic wounds included three domains and 36 statements. *1st* round 1, *2nd* round 2. - statement was not available in round 1/round 2.
[a]Statement did not achieve consensus. [b]Statement was deleted based on expert's opinion and research discussion

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treatment day of NPWT at the hospital, patients had a direct understanding and experience of NPWT.

This part of health education provides important support to start treatment smoothly and go home safely [11]. Before starting NPWT, wound professionals need to carry out a thorough assessment of the patients, including a medical and pharmacological history and their expectations, to ascertain if this therapy is the right regimen for the right patient at the right time [10]. In terms of dressing, patients are recommended to be able to easily expose wounds and not wear tight clothing or jumpsuits, etc. [28]. Although the statement 'Dietary requirement for the treatment day of NPWT' did not achieve consensus, it should be emphasized that patients do not need fasting from solids and liquids on the day of treatment to avoid hypoglycemia during the operation. Furthermore, we need to make the patient understand the negative effect of the early termination of home-based NPWT in advance to maintain treatment coherence as much as possible, which was proposed by the experts during the first round and reached consensus in the second round. This was in accordance with the view that patient understanding of the treatment and consistent patient compliance with usage, particularly in the home setting, were important to achieve good healing outcomes [10].

Compared to the hospital setting, NPWT in the home setting requires a more self-reliant and self-responsible patient. Patients and their caregivers therefore should be encouraged to proactively participate in the treatment at home, which may lead to changes in relationships and role adaptation [4]. The components of health education for NPWT at home are indispensable content. As wound practitioners, it is our responsibility to ensure that the discharged patients and their caregivers are appropriately educated on the use and safety of NPWT devices that will be used at home [34]. We should check if the patient understands the equipment and the potential complications that may occur in detail.

Hospital-based education for patients with home-based NPWT was not enough and had limitations as patients' needs changed during different periods of treatment. Furthermore, most of the care issues and problems arose only when patients returned home. Follow-up education is helpful for maintenance treatment at home. Based on the literature, patients with home-based NPWT and their family caregivers should also be prepared to safely operate the device, monitor therapy and respond appropriately to issues that arise if the patient continues NPWT at home [8,11,35]. It is noteworthy that home-based NPWT means being closely bound up with the equipment 24 h a day, which results in physical, psychological and social restraints on everyday life [4]. Patients and their caregivers who use the device at home should be trained on how to troubleshoot and who to contact in case of emergency [29,36]. Therefore, the statement 'Effective contact information of the medical team during the process of NPWT at home' was added in round 1 and reached consensus in round 2. In addition, we identified and included some key findings on the safety of home-based NPWT in the final statements. These findings indicated that the safety of NPWT had been strongly considered in the standardized framework. Additionally, these statements on 'Possible alarms and handling methods for equipment during the process of NPWT at home' and 'Methods of stopping NPWT in case of emergency' would ensure that future health education programs improve the safety of home-based NPWT in-depth, including leakage, tube blocking, power outages and death.

This standardized framework could help to provide a more detailed and comprehensive reference for the follow-up support of patients with NPWT at home but also could be used to tailor health education protocols based on clinical evaluation and patients' individualized needs and preferences [9]. On the basis of the results of this study, we can further develop quality indicators consistent with current clinical practices for the health education of home-based NPWT to improve home care quality for patients with chronic wounds. Furthermore, we should carry out intervention research in clinical practice to test the practicality and sensitivity of the components of health education [2,35]. It is noteworthy that components of the health education framework may be adjusted appropriately as technology advances in the future.

To the best of our knowledge, this study is the first to explore in detail the framework and components of health education for home-based NPWT for patients with chronic wounds. Based on published evidence and clinical practice, the framework and components of health education for patients with NPWT at home were finally developed by a consensus panel composed of experts on this topic with the Delphi method. The main strength of this technique was to avoid the domination of the consensus process by one expert and to give equal chance to deliver the opinions of each expert anonymously. One possible problem with the Delphi survey is the high dropout rate of experts, which may influence the results. We achieved high expert response rates in both rounds, so we consider our results credible. The limitations of the study were as follows. First, only 16 experts finished the whole Delphi process. Considering that there are no robust standards for the sample size of the Delphi survey, a group of experts >15 was acceptable. Second, because there is no standard threshold for a consensus, we combined the agreement rate and CV and experts' opinion to make decisions. Last, the consulting experts were all from China. The components of health education may need to be adjusted appropriately according to the patient and wound characteristics in different cultural backgrounds.

Conclusions

We achieved a consensus on the general framework and components of health education for patients with NPWT at home with the Delphi method. This consensus would help wound professionals train patients better and provide a more detailed and comprehensive reference for the follow-up support of patients with NPWT at home.

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Authors' contributions

YH, BM and JH were responsible for the study design. YH and PN administered the data collection. YH and BM performed data analysis. YH and BX were responsible for the drafting of the manuscript. LH and TX made critical modifications to the paper. LH and TX supervised the study.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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