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ORIGINAL ARTICLE

Preventing and managing diabetic foot ulcers: application of Orem's self-care model

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Abstract One of the most common complications of diabetes mellitus is a diabetic foot ulcer. Thus, managing and preventing this complication is a main priority for health professionals, especially for nurses. This study was designed to investigate the application of Orem's self-care deficit theory on prevention and management of diabetic foot ulcer. This quasi-experimental study was conducted in Urmia, Iran. Purposive sampling was used to select 60 patients and they were allocated into two groups. Two patients in the intervention group were excluded due to amputation and four patients from each group left the study because of unwillingness to complete the study. The intervention group received two self-care training sessions and home visits for 12 weeks, but the control group received the routine care. Data were collected using a questionnaire which consisted of four parts (demographic data, self- care status, need assessments based on Orem model, and Saint Elian Wound Score System). Data were analyzed by SPSS software (ver. 16). A significant difference was found between two groups regarding self-care mean scores, number of affected zones, ischemia, infection, and wound healing phase ($p < 0.05$). Application of Orem's self-care model could be helpful for the management of diabetic foot ulcers and could change patients' lives by lowering the risk of amputation and medical costs.

Keywords Diabetes complications · Foot ulcer · Nursing care · Orem self-care model · Self-care

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Introduction

Diabetes has afflicted 150 million people all over the world and it is estimated to grow two times more by 2025 [1]. Diabetes is a major health problem in Iran. More than 1.5 million Iranian people have been diagnosed with diabetes in 2014, and 7.5% of the patients had type 2 diabetes [2]. Diabetes and its complications impose a significant economic burden and health problems on the societies and health care systems [3]. Diabetic foot ulcers (DFUs) are the most significant and debilitating complications of this disease [4]. Poor circulation caused by peripheral vascular disease could lead to DFUs [5]. However, incidence rates vary by gender, age, race, and geographic area. The annual incidence of foot ulcer was reported 6.0% for males and 5.9% for females in 2008 [6]. DFUs are the most leading cause of hospitalization, which is hard to manage and often leads to amputation [7]. Foot ulcer and lower-limb amputation are responsible for significant morbidity, mortality, and health care costs in patients with diabetes [8]. In addition to thoroughly affecting the patients' quality of life, this accounts for a significant economic burden on health care systems [9, 10].

A significant aspect in diabetes care is self-care management [11]. However, patients are often faced with challenges in making the behavioral changes necessary to achieve optimum blood glucose control in order to minimize the risk of diabetic complications [12]. These patients may lack adequate skills and support needed to improve their self-care

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management. A systematic review showed that training for self-care management of diabetic patients enhanced their knowledge, the regularity and accuracy of blood glucose self-monitoring, and dietary habits [13]. The evidence has revealed that self-care behaviors are important for prevention of DFU [14]. These behaviors are influenced by patient's attitudes toward foot care, which also affect foot ulcer outcomes such as wound healing and recurrence [10].

Numerous theories have been created to clarify the concept of self-care. Among these, the Orem's self-care deficit nursing theory (SCDNT) [15] is widely accepted and used by nurses internationally [16]. Therefore, the conceptual framework of Orem's self-care model was used to guide this study. This study aimed to investigate the effect of Orem's self-care model on prevention and management of DFU.

Materials and methods

Design and sample

This is a quasi-experimental (pretest-posttest with control group) study. It was conducted on 60 patients with DFU who were admitted to the endocrinology wards of two educational centers affiliated to Urmia University of Medical Sciences in Iran. The diagnosis was made based on the American Diabetes Association (ADA) criteria for diagnosing diabetes mellitus [17]. The study was conducted from July to December 2014. The results of a previous study conducted by Adib Hajbaghery et al. were used to calculate sample size. In their study μ1, μ2, sd1, and sd2 were respectively equal to 1.05, 0.35, 0.94, and 0.74 [18]. Therefore, by considering a type I error of 0.05 and a power of 0.80, the sample size was estimated to be 22.89 patients for each group. However, a total of 60 patients (30 patients for each group) was recruited because of the attrition rate. Patients' allocation was carried out by utilizing a random number table. (Fig. 1).

After obtaining permission from the ethics committee of Urmia University of Medical Sciences (code number: umsu. rec. 1392.2016), the researchers referred to two educational centers and carried out required coordination with the related authorities to be able to collect data. The inclusion criteria were as follows: patients ranging in age from 20 to 60 years, being literate, being able to perform self-care, willingness to participate in the study, not having significant communication impairments (i.e., visual or auditory loss), being able to make phone calls, and having no severe physical or psychological co-morbidities. Taking immunosuppressive drugs during the study period and patient's decision to leave the study were considered as exclusion criteria.

Measures

A questionnaire used as a data collection tool comprised of four parts:

1. Demographic data: this consists of the personal information, marital status, educational levels, and clinical status and laboratory tests including the blood sugar, hemoglobin A1c, etc.
2. Self-care status: this part consisted of 22 questions about self care activities related to diabetic foot. The questions were developed in the Likert scale (from never = 1 to always = 5).
3. Need assessments based on Orem model: it consisted of 40 questions about patients need in three domains according to the Orem's Self-Care Theory (universal self care requisites, 13 questions; developmental self-care requisites, 7 questions; and health deviation self-care, 20 questions). The questions were developed in the Likert scale (from never = 1 to always = 5). The universal self-care was divided into the following sub-categories, as Orem presents: (a) maintaining sufficient intake of food, air, and

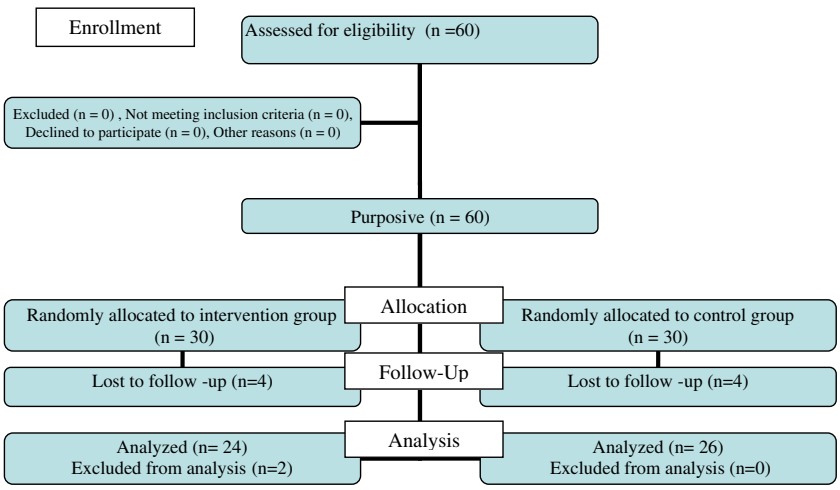

Fig. 1 The sampling framework of the study

water, (b) providing care about process of elimination, (c) balance between rest and activity, between social interaction and solitude, (d) preventing hazards to well being of human life, and (e) promoting of human functioning. The items about the developmental self-care requisites aimed to find what actions the individual performs to promote self-care during developmental processes/or associated with an event. Health deviation self-care investigates the conditions related to the therapy, knowledge about specific foot ulcer care, control of complications, and access to health services. According to the results, patients' needs were categorized in three basic variations in nursing systems: wholly compensatory, partly compensatory, and supportive-educative.

4. Saint Elian Wound Score System (SEWSS): this is used for scoring of the severity of diabetic foot from mild to severe (1 to 3) in the following categories: primary location, area, depth, topographic aspects, edema, ischemia, infection, neuropathy, number of affected zones, and wound healing phase. The score sum was considered as I (score was ≤10, better prognosis for healing wound), II (score was 11–20, partially, foot threatening), and III (score was 21–30, limb & life threatening) [19]. In this study, Rydel-Seiffer (128 Hz) semi-quantitative tuning fork was struck to the dorsal head of the first metatarsal joint of the patients and their sensation was assessed. When the subjects said they were unable to feel the vibration, the scale was read at the apex of the single triangle formed from the initial two triangles. Having no sensation was recorded as 0. The score was graded as 1 when subjects could feel the fork vibration. If subjects could feel the fork vibration when the scale of fork showed five or less, the score was considered as 0.5 [20].

We used content validity for ensuring the validity of data collection tools. The developed tool was assessed by 10 faculty members of Urmia University of Medical Sciences and we modified questionnaires based on their comments. The reliability of the questionnaires was assessed by the test-retest method on 10 patients with an interval of 1 week. The correlation coefficient for self- care status, need assessments based on Orem's model, and SEWSS was 90, 80, and 94%, respectively.

Intervention

The presuppositions of the Orem's theory were used for collecting data, planning, and implementing effective care. After each patient consented to take part in the study, he/she was asked to carefully fill out the questionnaire. Before starting of Orem's self-care program, the intervention group was divided into three small subgroups of 10 patients each. Then, each subgroup was invited to participate in two 60-min training sessions of self-care. The content of these sessions consisted of self-care activities related to diabetic foot care. Then, each patient in the intervention group received home visits once a week for 3 weeks in July 2014. On an average, the visits lasted 1 h. The meetings were scheduled by phone, according to the patient's convenience. During the first visit, we requested the patients to sign the consent form and used the therapeutic requirements form for collecting data. In the other meetings, we referred to the recorded data, emphasized the needed care and evaluated the self-care capacity of the patient. Some steps were adopted during the visits, including:

First visit; we investigated the patient's health situation through filling out the data collection form. After this visit, we obtained the nursing diagnoses, based on the Taxonomy II provided by the North American Nursing Diagnosis Association International (NANDA International) [21]. Then, we detailed the potential interventions which are appropriate with the first phase of Orem's nursing process. If nursing care was actually necessary it was determined in this phase. For each diagnosis, we established goals that served as a guide to assess the interventions delivered.

Second visit; we discussed the intervention priorities with the patient regarding his/her health and adopted a care plan, which was adequate to meet the perceived needs. The goals were compatible with the diagnosis and aimed to enable the patient to become a self-care agent.

Third visit; we evaluated the effectiveness of the interventions. Then, we investigated nursing diagnoses and the need for further interventions. This pointed to the third phase of Orem's theory. The patient was prepared for the independence phase, in which he/she could perform the self-care activities. The patients in the intervention group received twice a week follow-ups at home to reinforce self-care activities for 4 months. Then, all patients filled out the questionnaires again. The patients in the control group received only their usual care during the study. The result indicates no harm or disadvantage toward patients in this study.

Statistical methods

Two patients in the intervention group were excluded due to amputation and four patients from each groups (intervention and control) left the study because of unwillingness to complete the study. Therefore, data were analyzed with 24 patients in the intervention group and 26 patients in the control group. Data were analyzed using SPSS software Version 16.0 (IBM, USA). Descriptive and inferential statistics were used in this study. The frequency of characteristics was presented as number (%), and quantitative results as mean (±standard deviation). Fisher's exact test was performed to compare qualitative

demographic data and student *t* test was used for quantitative data between two groups. All *p* values were two tailed and significance level was considered as $p < 0.05$.

Results

The socio-demographic attributes of both the groups are presented in Table 1. No significant differences were found between the two groups in terms of age, gender, marital status, type of diabetes, smoking, education level, previous amputation, employment status, duration of the disease, family history of diabetes, BMI, FBS, BS, and HbA1c level ($p > 0.05$).

The results of this study showed that the majority of patients in the intervention group allocated to the partly compensatory system, regarding universal self-care, developmental self-care requisites, and health deviation self-care (75, 58.3, 88.3%, respectively) before starting the program (Table 2).

Results showed no significant difference between the control group (63.76 ± 9.77) and the intervention group (70.0 ± 16.65) regarding baseline self-care mean scores ($p = 0.11$). However, a significant improvement was observed in the intervention group (94.25 ± 9.45) compared to the control group (67.26 ± 9.62) regarding self-care means scores at the end of the study ($p = 0.001$) (Table 3).

The Fisher's exact test showed no significant difference between the two groups regarding location, topographic aspects, number of affected zones, infection, ischemia, edema, neuropathy, depth, area, and wound healing phase before the intervention. However, a significant difference was observed between the two groups in terms of ischemia, infection, edema, neuropathy, topographic aspects, depth, area, and wound healing phase at the end of the study (Table 4).

Discussion

The results indicate that application of Orem's self-care program has a positive impact on improving patients' self-care behaviors. Orem believes that patients' self-

Table 1 Comparison of demographic characteristics of the control and the intervention groups

Variable		Group		Fisher's exact test
		Control, *N* (%)	Intervention, *N* (%)	
Gender	Woman	14(53.8)	13(54.2)	$p = 0.603$
	Man	12(46.2)	11(45.8)	
Marital status	Single	7(26.9)	3(12.5)	$p = 0.072$
	Married	17(65.4)	20(83.3)	
	Widow	2(7.7)	1(4.2)	
Type of diabetes	Type 1 diabetes	19(73.1)	16(66.7)	$p = 0.426$
	Type 2 diabetes	7 (26.9)	8(33.3)	
Smoking	Yes	7(26.9)	2(8.3)	$p = 0.089$
	No	19(73.1)	22(91.7)	
Education level	Primary and guidance	18(69.2)	14(58.3)	$p = 0.175$
	High school	8(30.8)	7(29.2)	
	University	0(0)	3(12.5)	
Previous amputation history	No	18(69.2)	21(87.5)	$p = 0.912$
	Yes	8(30.8)	3(12.5)	
Employment status	Unemployed	5(19.2)	5(20.8)	$p = 0.974$
	Housewife	14(53.8)	12(50.0)	
	Employee	7(26.9)	7(29.2)	
Disease duration	Less than 5 years	2(7.7)	8(33.33)	$p = 0.59$
	5–10 years	6(23.1)	6(25.0)	
	More than 10 years	18(69.2)	10(41.7)	
Family history of diabetes	Yes	11(42.3)	11(45.8)	$p = 0.513$
	No	15(57.7)	13(54.2)	
Age (Mean ± SD, years)		54.57 ± 6.04	53.70 ± 9.25	$p = 0.69$*
BMI (kg/m^2)		27.45 ± 5.35	28.46 ± 4.65	$p = 0.48$*
FBS (mg/dl)		207.0 ± 83.28	204.0 ± 70.59	$p = 0.92$*
BS (mg/dl)		290.0 ± 118.64	293.0 ± 84.90	$p = 0.28$*
HbA1c (%)		9.24 ± 1.83	9.13 ± 1.93	$p = 0.83$*

*Independent *t* test result

Table 2 Determining nursing system according to requirements in the intervention group before the self-care program performance

Requisites	Educative development *N* (%)	Partly compensatory *N* (%)	Wholly compensatory *N* (%)
Universal self-care	2(8.3)	18(75)	4(16.7)
Developmental self-care requisites	10(41.7)	14(58.3)	0(0)
Health deviation self-care	3(12.5)	20(88.3)	1(4.2)

care capabilities could be improved and regulated by providing the nursing care to meet their self-care needs [22]. A study by Rubin et al. indicated significant differences in HbA1C levels before and 6 months after self-care education in patients with type 2 diabetes [23]. It has been found that self-care behaviors are effective in preventing DFUs, but there are limited studies to show the impact of self-care behaviors in preventing the progression of DFU. The results of Chin et al.'s study showed that self-care behaviors significantly related to lower risk of DFUs [14]. In another study, Ghafourifard and Ebrahimi showed the positive effect of Orem's self-care model on self-care agency of patients with diabetes [11]. Naji et al. showed Orem's self-care model is effective on recovery of patients with heart failure and their self-care abilities [24]. Our result showed significant differences in terms of ischemia after application of Orem's self-care program between the two groups which indicated the positive impact of the program on improving DFU perfusion in the patients. Diminished perfusion is considered a limiting factor for healing of DFU [25]. However, this finding is not supported by other studies. Parisi et al. revealed that there is no connection between peripheral vascular disease and healing DFUs [26]. However, Gürlek et al. showed that peripheral vascular disease is the most significant reason for lower-limb amputation [27]. Loss of sensation and peripheral artery disease associates with poor outcomes in healing DFU. Prompers et al. reported that one of the baseline predictors for not healing DFUs was peripheral vascular disease [28].

The results showed a significant decrease of diabetic foot infection in the intervention group compared to the control group. Islam et al. reported that educational organizations and institutions can prevent secondary infections of DFUs by training patients about the risk of barefoot walking, the importance of proper shoes, checking feet daily, and importance of immediate visit to the doctor rather than self-treatment [29]. Our results showed that education and following-up of self-care behaviors can significantly prevent the progression of diabetic foot infection. Chiovetti recommended nurses to design and implement educational programs for clients based on the individual educational needs [30]. Moreover, Ren et al. showed that the intensive nursing education could prevent diabetic foot ulceration in patients with high-risk diabetic foot [31]. This study supports the results of our study. Furthermore, results of Horswell et al.'s study indicated that a managed diabetic foot care program could significantly lead to decreasing emergency visits, the number of hospitalizations in health care facilities, and complications such as osteomyelitis and amputation [32]. In line with our study, Chiang et al. showed that applying Orem's theory could improve the knowledge of diabetes and foot care of patients with diabetes [33]. Bakker et al. in their study entitled" Practical guidelines on the management and prevention of the diabetic foot 2011" proposed a structured and organized education as effective strategy for prevention of DFU [34].

This study had some limitations to be considered. The study period was short and it was done in a particular geographical area; several elements such as patients' culture may affect the outcomes. Thus, this study's findings must be analyzed with caution. Therefore, we suggest similar studies to be conducted in other regions with different educational and cultural systems so that the impact of the application of Orem's self-care model can be investigated broadly and used effectively for DFUs if further study corroborates our results. The result of this study can be used for nursing management, diabetes associations, patients with diabetes, patients' families, and further research projects.

Table 3 Comparison of the self-care means scores between the two groups before and after intervention

Self-care status	Intervention Mean ± SD	Control Mean ± SD	Independent *t* test result
Before intervention	70.0 ± 16.65	63.76 ± 9.77	$p = 0.11$
After intervention	94.25 ± 9.45	67.26 ± 9.62	$p = 0.001$
Mean differences between before and after	24.25 ± 10.92	3.50 ± 1.92	$p = 0.001$

Table 4 Comparison of the ulcer-related data between the two groups before and after intervention

Variable		Category	Intervention group *N* (%)	Control group *N* (%)	Fisher's exact test
Ischemia	Before the intervention	No	2(8.33)	5(19.25)	$p = 0.921$
		Mild	2(8.33)	1(3.85)	
		Moderate	10(41.67)	9(34.65)	
		Severe	10(41.67)	11(42.25)	
	After the intervention	No	7(29.2)	2(7.7)	$p = 0.001$
		Mild	10(41.67)	5(19.25)	
		Moderate	7(29.2)	13(50.0)	
		Severe	0(0.0)	9(34.6)	
Infection	Before the intervention	No	3(12.51)	8(30.5)	$XP = 0.296$
		Mild	1(4.15)	3(11.5)	
		Moderate	10(41.67)	5(19.25)	
		Severe	10(41.67)	10(38.5)	
	After the intervention	No	7(29.2)	5(19.24)	$p = 0.009$
		Mild	10(41.67)	2(7.7)	
		Moderate	6(24.98)	9(34.65)	
		Severe	1(4.15)	10(38.5)	
Edema	Before the intervention	No	2(8.33)	2(8.0)	$p = 0.694$
		Periwound	6(24.98)	8(30.5)	
		Affected leg only	6(24.98)	5(19.25)	
		Bilateral secondary to systemic disease	10(41.67)	11(42.25)	
	After the intervention	No	12(50)	1(3.85)	$p = 0.004$
		Periwound	5(20.83)	7(27.0)	
		Affected leg only	5(20.83)	12(53.15)	
		Bilateral secondary to systemic disease	2(8.33)	4(16.0)	
Neuropathy	Before the intervention	No	3(12.48)	5(19.25)	$p = 0.744$
		Protective sensation diminished	5(20.83)	5(19.25)	
		Loss of protective sensation	7(29.2)	7(27.0)	
		Diabetic neuro-steo artropathy	9(37.49)	9(34.5)	
	After the intervention	No	6(24.98)	1(3.85)	$p = 0.012$
		Protective sensation diminished	5(20.83)	8(30.5)	
		Loss of protective sensation	6(24.98)	7(27.0)	
		Diabetic neuro-steo artropathy	7(29.2)	10(38.65)	
Location	Before the intervention	Phalanges/digits	5(20.83)	8(30.5)	$p = 0.942$
		Metatarsal	10(41.67)	11(42.25)	
		Tarsal	9(37.49)	7(27.25)	
	After the intervention	Phalanges/digits	6(24.98)	7(27.0)	$p = 0.403$
		Metatarsal	10(41.67)	12(46)	
		Tarsal	8(33.35)	7(27.0)	
Topographic aspects	Before the intervention	Dorsal or planter	3(12.48)	7(27.0)	$p = 0.826$
		Lateral or medial	12(50)	11(42.5)	
		Two or more	9(37.49)	8(30.5)	
	After the intervention	Dorsal or planter	7(29.2)	3(11.5)	$p = 0.012$
		Lateral or medial	10(41.67)	15(58.0)	
		Two or more	7(29.2)	8(30.5)	
Number of affected zones	Before the intervention	One	5(20.83)	7(27.0)	$p = 0.424$
		Two	7(29.2)	11(42.5)	
		Multiple wounds	12(50)	8(30.5)	
	After the intervention	One	5(20.83)	8(30.5)	$p = 0.107$
		Two	9(37.49)	10(39.0)	
		Multiple wounds	10(41.67)	8(30.5)	
Depth	Before the intervention	Superficial	10(41.67)	7(27.0)	$p = 0.918$

Table 4 (continued)

Variable		Category	Intervention group *N* (%)	Control group *N* (%)	Fisher's exact test
		Deep ulcer	7(29.2)	7(27.0)	
		All layers	7(29.2)	12(46.0)	
	After the intervention	Superficial	13(54.17)	8(30.5)	$p = 0.007$
		Deep ulcer	9(37.49)	10(39.0)	
		All layers	2(8.33)	8(30.5)	
Area (cm^2)	Before the intervention	Small <10	10(41.67)	8(31.0)	$p = 0.714$
		Medium (10–40)	9(37.49)	9(34. 5)	
		Big >40	5(20.83)	9(34. 5)	
	After the intervention	Small <10	13(54.17)	7(27.0)	$p = 0.033$
		Medium (10–40)	9(37.49)	12(46)	
		Big >40	2(8.33)	7(27.0)	
Wound healing phase	Before the intervention	Epithelialization	7(29.2)	8(31.0)	$p = 0.169$
		Granulating	8(33.35)	9(34. 5)	
		Inflammatory	9(37.49)	9(34. 5)	
	After the intervention	Epithelialization	13(54.17)	10(38.5)	$p = 0.014$
		Granulating	10(41.67)	11(42.5)	
		Inflammatory	1(4.15)	5(19.0)	

Conclusion

Diabetes is one of the most common and disabling chronic diseases in the globe. We need to have standardized nursing language to improve communication among nurses. This will increase clients' capability to control their disease and its complications, subsequently. Effective disease control requires the patient's readiness to take care of themselves. This study showed that utilizing nursing theory as a standardized nursing language has an effective role in promoting self-care in patients with type 2 diabetes. Thus, dedicated self-care behaviors to prevent diabetes related morbidity and mortality are vitally needed. In summary, application of Orem's self-care model has been shown helpful for patients with DFUs and could change patients' lives by lowering the risk of amputation and medical costs.

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Compliance with ethical standards

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Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval This study is approved by the ethics committee of Urmia University of Medical Sciences (Approval code: umsu. rec. 1392.2016).

Informed consent Informed consent was taken from all the subjects to use their personal data for research purposes.

Ethical issues None to be declared.

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