

The Intervention of Foot Care Education in the Prevention of Diabetic Foot Ulcers: A Literature Review

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Abstract

Purpose: The aim of this literature review was to get an overview of the methods and strategic interventions of foot care education in the prevention of diabetic foot ulcers (DFU).

Methodology: The literature search focused on 'foot care education in the prevention of diabetic foot ulcers'. A number of databases such as Springer Link, EBSCOhost (*Academic Search Complete*), ProQuest, and Science Direct were searched for relevant articles. Literature search using keywords such as "type 2 dm", "education", "prevention" and "diabetic foot ulcer." All types of articles were included for the study, such as systematic reviews, randomized controlled trial, quasi-experiment, and literature review with the range 2010-2020. Only articles in English are included in this review.

Results: Based on keywords, it was identified nine articles that focus on intervention of foot care education to prevent diabetic foot ulcers. The literature review summarized the discussion about the methods of providing education, duration and follow up, the teams involved, and the effectiveness of educational interventions. The objectives of providing educational interventions are individuals, families and groups. The method of providing education was carried out face-to-face in clinics, hospitals, and at home, by phone and through android applications such as youtube. The intervention of foot care education effectively improves foot care knowledge, self-efficacy of foot care, foot care behavior, glycemic control, reduce skin and nail problems, improve diabetic foot, decrease DFU incidence, and improve the quality of life.

Applications/Originality/Value: This review can be a reference for nurses and other health professionals in choosing the best methods and strategies for foot care education tailored to existing resources.

Keywords: foot care education, prevention, diabetic foot ulcers, type 2 DM, literature review.

Background

Diabetic Foot Ulcer (DFU) is a serious complication of diabetes mellitus (DM) which can increase morbidity and mortality. 15% - 20% of the DM population has diabetic foot ulcers (Francia et al., 2019). It is estimated that within one year, 60% of patients with diabetic foot ulcers will experience a recurrence of the wound with an increased risk of amputation (Nigi et al., 2018). About one million amputations were performed on people with complications of diabetic foot ulcers. This shows that every 30 seconds in the world, the lower extremities are lost in people with diabetic leg injuries (Palumbo & Melton, 1985; Burgess, 1990). The rate of recurrence of people affected by DFU in five years was 70%. The 85% chance of amputation is preceded by DFU. People with diabetes mellitus had a 50% mortality rate in 5 years after an early amputation (Green-morris, 2019).

The global prevalence of DM in 2015 is estimated to reach 415 million (Abbas, 2017) and at the age of 18 years and above increased from 4.7% in 1980 to 8.5% in 2014 (WHO, 2016). Indonesia ranks fourth with the largest number of diabetics in the world after India, China and the United States (Wild et al., 2004). Riskesdas data in 2018, prevalence of diabetes mellitus (DM) in Indonesia at the age of ≥ 15 years increased by 8.5% from the previous year 2013 by 6.9% (Kemenkes RI, 2018). Information about the risk of DM complications and diabetic foot ulcer events are still inadequate in Indonesia. Some studies mention the main complications of DM in Indonesia are neuropathy (13% - 78%), microvascular complications (16% - 53%) and diabetic foot ulcers range from 7.3% - 24% (Abrar et al., 2019).

Diabetic foot ulcers are defined as infection, ulceration or destruction of the inner tissues associated with neurological disorders and various peripheral vascular diseases in the lower limbs (Sucipto et al., 2019). Neurological damage or peripheral neuropathy to diabetes is the most important risk factor in DFU. Neurological damage from the DM affects motor fiber, sensory, and autonomic, leading to muscle weakness, atrophy, and paresis. Sensory neuropathy leads to loss of pain protection, pressure, and heat. Autonomous function disorder

causes vasodilatation and a reduction in percolation, resulting in loss of skin integrity, providing a place of microbial infection (Alexiadou & Doupis, 2012).

Factors significantly related to the occurrence of diabetic foot ulcers include: age, long suffering from DM > 10 years, poor glucose control, peripheral neuropathy and peripheral artery disorders, barefoot walking, illiteracy, low socioeconomic status, delays in patients checking their health, ignorance of diabetic foot care between primary treatment and high degree of trust in alternative treatment (American Diabetes Association, 2004; Pendsey, Abbas, & Uk, 2007; Younis et al., 2018). From all these factors, peripheral neuropathy is the most frequent contributory factor (Younis et al., 2018). Among these are peripheral neuropathy caused by hyperglycemia, elevated cholesterol levels, triglycerides, macrovascular disease, smoking, and weight (Adler, 2001).

The prevention of DFU requires adequate management. The management of diabetes foot ulcers prevention includes: optimizing glycolic control, risk identification, identification and examination of feet, prevention and management of high-risk conditions experienced by DFU, and patient education. DFU prevention education programs need to be provided to health professionals and DM clients (Valk et al., 2002). There are five main pillars of diabetic foot prevention that are important for health professionals to know are: 1) Regular examination of foot and footwear, 2) high risk identification in DM clients, 3) education of high-risk DM clients, relatives, friends, and health workers, 4) appropriate footwear for DM clients, 5) non ulcerative pathology treatment (Abbas, 2017).

Education is a major intervention in preventing DFU. In primary health care facilities such as health centers, DM clients still have limited knowledge about foot care (Abbas, 2017). The principle of examination and treatment of the feet are important to be known by DM clients themselves. Therefore, the DFU prevention education program is still very necessary in society to prevent DFU complications in developing countries such as Indonesia.

Education about appropriate risk factors and management in individuals with high-risk foot conditions should be carried out. Clients should understand the implications of decreased/loss of foot sensation, the importance of wearing the footwear and monitoring of foot and footwear daily, proper foot care, nail and skin care and appropriate selection of footwear. Evaluation of the patient's knowledge and ability to perform foot care should be done periodically (American Diabetes Association, 2004; Kotru et al., 2015).

Several studies have shown that intensive educational interventions can reduce the risk of diabetic foot ulcers (Adiewere et al., 2018; Priyadarshini et al., 2018). Monami et al (2015) research to assess the feasibility and efficacy of short educational programs obtained the results that a short 2-hour education program is effective in preventing DFU in high-risk patients. Another study by Malone et al (1989), explained that an hour-long group educational intervention by podiatrist showed a decrease in the incidence of diabetic foot ulcers. A more specific emphasis on diabetes education plays a very important role in the provision of health care in DM patients (Wendling & Beadle, 2015). However, a different result with the research of Gershater et al (2011) states that regular foot care education interventions for six months were not effective to reduce the DFU. The same results were also from Ronnema & Hamalainen (1997) study, showing no effect of patient education on the average occurrence of diabetic foot ulcers and amputations, but showing positive results of increased knowledge of foot care.

The aim of this literature review was to get an overview of the methods and strategic education of foot care in the prevention of diabetic foot ulcers that have been done in several studies both that provide meaningful and meaningless results.

Method

The literature search focused on "foot care education in the prevention of diabetic foot ulcers". A number of databases such as Springer Link, EBSCOhost (*Academic Search Complete*), ProQuest, and Science Direct were searched for relevant articles. Literature search using keywords such as "type 2 diabetes mellitus", "education", "prevention" and "diabetic foot ulcer." All types of articles were included for the study, such as systematic reviews, randomized controlled trial, quasi-experiment, and literature review with the range 2010-2020. Only articles in English are included in this review.

Result

Based on keywords, it was identified nine articles that focus on educational interventions to prevent diabetic foot ulcers (table 1). This literature review discusses the methods of providing education, duration and follow up, the teams involved, and the effectiveness of educational interventions.

Method of providing education

Educational objectives and media

The objectives of providing educational interventions are individuals, families and groups. The method of providing education was carried out face-to-face in clinics, hospitals, and at home, by phone (Fan et al., 2013), through video, as well as through android applications such as YouTube. Educational media include booklets, basic foot education modules (Green-morris, 2019), Power Point (PPT) presentations, pamphlets (Khuzaimah et al., 2018), audio-visuals and pamphlets (Rahaman & Viveka, 2018) and foot care videos using regional languages (Abrar et al., 2019).

Intervention materials and procedures

Routine treatment in the prevention of diabetic foot ulcers is education on glycemic control, dietary advice, exercise, medications, and foot care provided by health workers in the outpatient unit (Rahaman & Viveka, 2018). In general, foot care education intervention procedures (Green-morris, 2019; Liu et al., 2019) is the first, nursing preparation stage, which is the nurses formulating the appropriate educational modules for the client, the expected goals and results, as well as checking the client's health records. Second, the stage of educational intervention was to provide education about foot care and prevention of complications due to diabetes; the facilitators read the booklet to the participants and shows how to conduct self-examination; the facilitator then pushed the demonstration back and answered questions from the participants. Third, the evaluation stage/assessment of the results was to evaluate related knowledge, attitudes and behaviors of foot care, quality of life, and self-management of diabetes.

Five steps of daily foot care are daily foot washing, daily checking of foot problems, moisturizing, massaging; wearing the right shoes and socks; nail care; and know the right time to seek help from a health professional (Fan et al., 2013). The recommended foot treatment for DM clients at high-risk are: 1) daily foot wash with soft soap and keep them moist, 2) avoid walking barefoot, 3) checking the feet daily, 4) contact a doctor or podiatrist expert if there are any red or swollen or small ulcers, 5) wearing appropriate shoes to give sufficient space to move the toes, 6) wearing special shoes if necessary, 7) consult a doctor if there is callus on the foot, 8) avoid using hot water bottles, 9) wearing soft socks if necessary (Priyadarshini et al., 2018). DM clients are encouraged to use a mirror to check their feet daily. The client's family also needs to be trained to assist DM clients in performing foot care, such as checking the water temperature before washing the feet and using monofilament to check for foot sensations (Liang et al., 2012).

Things to note related to the skin of the feet condition include: 1) dry and chapped skin, 2) fissures, i.e. long and narrow openings or slits that can extend to the dermis, dry or moist, 3) corns: conical, horn induration and thickening of the skin at the tips of the toes, 4) calluses: manifested by a layer of skin caused by pressure or friction, which can spread throughout the ball of the foot or along the outer edge of the heel or toe, 5) blisters, i.e. fluid vesicula (clear or containing blood or pus) under the outer layer of the skin, 6) lesions/ulcers of the skin, which involves the loss of the upper part of the skin (epidermis) and the lower part (dermis), and 7) fungal infections manifested by itching, itchy foot skin with small blisters (Fan et al., 2013).

Green-morris (2019) divided foot care education into six sessions. The first and second sessions were material about introductions and overviews of diabetic feet as well as giving instructions and demonstrations of daily foot examinations. The third and fourth sessions were instruction and demonstration on foot hygiene, skin and toenail care, selection of shoes and socks and avoiding extreme temperatures. The fifth and sixth sessions were giving instructions on the importance to health care facilities to report diabetic foot complications.

Duration and follow up of educational interventions

From the existing literature, the duration of educational interventions and follow-ups ranged from three weeks to 24 months. Intervention sessions also vary from 1 session a week (Khuzaimah et al., 2018), 4 sessions in three weeks (Rahaman & Viveka, 2018), 6 sessions in 4 weeks where each session lasts 15-45 minutes (Green-morris, 2019). In the study of Monami et al (2015), interactive discussions lasted for 90 minutes. Evaluation of interventions is carried out on a daily day (Rahaman & Viveka, 2018), every three months (Monami et al 2015; Liu et al., 2019), four months (Maslampak et al., 2018), six months (Monami et al., 2015), one year and even 24 months (Liang et al., 2012; Liu et al., 2019).

Teams involved

Educational interventions was carried out by nurses, diabetes educator nurses or multidisciplinary teams consisting of nurses, diabetes educator nurses, doctors, pharmacists, nutritionists, and other health workers (Abrar et al., 2019; Liu et al., 2019; Maslampak et al., 2018; Green-morris, 2019; Khuzaimah et al., 2018; Liang et al., 2012; Monami et al., 2015; Rahaman & Viveka, 2018).

Effectiveness of Foot care education

Based on the literature found, the outcomes of foot care education interventions include: knowledge of foot care, self-improvement of foot care, foot care behavior, glycemic control and blood pressure, diabetic foot sensitivity, DFU events, and quality of life.

Knowledge

Transitional care method significantly increases the knowledge score of foot care in cases and control groups ($p < 0.05$) (Liu et al., 2019). Foot ulcer prevention education in the rural clinic network effectively improved participants' understanding that foot ulcers were caused by not caring for their feet. Participants believed that wearing the right shoes prevents foot ulcers, and believe that skin moisturizers prevent the formation of foot ulcers. Participants also believed that diabetes and blood sugar control prevented loss or decreased sensation in their feet. Participants who agreed that checking their feet reduced the likelihood of ulcer formation increasing from 44.4% to 77.8% (Green-morris, 2019). The study of Rahaman & Viveka (2018) to look at the effectiveness of foot care education modules in DM patients was obtained as a result of increased knowledge scores in the intervention group. The video of foot care education using regional language improved their knowledge of foot care so that they could detect the risk of foot ulcers and prevented the occurrence of diabetic foot ulcers (Abrar et al., 2019). In the research group that received diabetes didactic education, foot care and diabetes education classes were given every 3 to 6 months showed significant results in increased knowledge in 1 and 2 years of observation (Liang et al., 2012). Other studies with two hours program interventions provided to the group, including a 30 minutes face-to-face lesson on risk factors for foot ulcers, and a 90 minutes interactive session with practical exercises on behavior to reduce the risk of improving foot care knowledge (Liang et al., 2012).

Foot care behavior

Study by Khuzaimah et al. (2018) to evaluated the effectiveness of health education programs showed that foot care behavior, foot care efficacy of self (efficacy expectations), expectation of foot care outcome and health care scores significantly increased in the first week and 4th week after being given intervention ($p < 0.01$). Education used foot care modules increased the score of foot care practices in intervention groups (Rahaman & Viveka, 2018).

Incidents of diabetic foot ulcers

There were five articles with outcome looking at incident of diabetic foot ulcer and diabetic foot problems. One study said education was meaningless in preventing the incidence of leg injuries. Liu et al. (2019) research to found out the effect of transitional treatment on the prevention of diabetic foot ulcers (DFU) in patients at high risk of diabetic legs stated that DFU events differed significantly in both groups. DFU incidence in the control group was higher at 33 cases (23.2%) while in the group of cases as many as 16 cases (11.3%). Study of Maslampak, Shahbaz, & Parizad (2018) stated that education cannot prevented diabetic leg wounds, but could reduce the incidence of ischemia, infection, edema, neuropathy, aspects of topography, depth, area, and wound

healing phase. Another finding was the foot care of education intervention were doable and acceptable to adult patients with two type of diabetes mellitus.

Foot care of education intervention were effective in reducing the occurrence of small foot skin problems and nail problems in follow-up 3 months (Fan, Sidani, Cooper-brathwaite, & Metcalfe, 2013). Study of Liang, Dai, Zuojie, Zhou, & Meijuan (2012) used diabetes didactic education methods, customized foot care and focused teaching for 2 hours, then followed up in clinics every month with systematic foot examinations, diabetes education classes gave every 3 to 6 months showed significantly lower reductions in diabetic foot complications. Patients in the control group were about 24 times more likely to had leg ulcers compared to patients in the study group. Other studies with two-hour program interventions provided to the group, including a 30-minute face to face of lesson on risk factors for foot ulcers, and a 90 minutes interactive session with practical practice on behavior to reduce risk, showed that a relative risk outcome of foot ulceration of 0.08 (0.00-1.34) (Liang et al., 2012).

Glycemic control and blood pressure

Transitional care of methods lower fasting blood sugar, HbA1c, and quality of life scores (DQOL) in the case group and control significantly ($p < 0.05$). Triglyceride levels (TG), total cholesterol (TC), lipoprotein cholesterol Low density (LDL-C), and high-density lipoprotein cholesterol (HDL-C) showed that no significant difference between the two groups before and after transitional treatment. Systolic and diastolic blood pressure, in the case group decreased significantly ($p < 0.05$), but changed in the control of group were insignificant ($p > 0.05$) (Liu et al., 2019).

Diabetic foot sensitivity

Research of Maslampak et al. (2018) state that education of foot care in groups increases the sensitivity of diabetic feet. Positive level of monofilament nylon fiber test were 10-g, and the normal leg artery pulse rate in the case group decreased significantly ($p < 0.05$), and changes in the control group were insignificant ($p > 0.05$) (Liu et al., 2019).

Discussion

DFU prevention was very important given the complications caused affecting quality of life and a fairly high mortality rate. Management of self and treatment of diabetic feet were key to DFU prevention. One of the proven intervention strategies in preventing DFU was through transitional treatment (Liu et al., 2019). Transitional care was the treatment provided to the client in the event of a transfer of the treatment place from the hospital to the next place of care. Treatment included discharge planning and follow up as soon as leaved the hospital.

Nursing of education innovations to improved outcome in the prevention of diabetic foot injuries continue to be carried out. Ordinary treatment seemed to have few benefits, so needed to modify with additional treatment. Transitional care methods had been showed to increase widely positive outcomes in diabetic legs such as knowledge, foot care behavior, self-efficacy, FBG values, HbA1c and reduce the incidence of leg injuries (Liu et al., 2019).

Intensive self of care and follow up of education could prove the development of diabetic foot infection. The important advice by given to DM client was information about the risk of walking barefoot, the importance of using the right shoes and checking the feet daily, and the importance of direct visits to the doctor (Maslampak et al., 2018). In line with the research by Nguyen et al (2019), foot care education intervention had been showed to improve preventive foot care practices. Green-morris (2019) study also increased the percentage of knowledge gained from education provided. This was in line with Rahaman & Viveka (2018), education with routine care and coupled with education through audiovisual and pamphlet prevented to improve knowledge of diabetic foot care. The professional of health were responsible for providing information related to foot care either through face to face or other media such as audio visual.

The short term of education positively affected DM clients' knowledge of foot care, but the decline in DFU event still requires adequate evidence (Rahaman & Viveka, 2018). Adequate client knowledge in self-management

affected the incidence of lower diabetes complications (Asha et al., 2004). There were still many patients who suffer from DM for several years, having limited knowledge of how diabetes could be affected of the legs.

Multidisciplinary team collaboration had proven to reduce DFU and amputation rate and improve the quality of life of DM clients. Multidisciplinary team members in foot care consist of general practitioners, educator nurses, orthopedics, foot disease experts, vascular surgeons, endocrinologists, dietitians, infectious disease specialists and orthopedic surgeons. Nurses were more often acting as educators (Kaya & Karaca, 2018). Nurses were the main point of contact for patients. The nurse's knowledge of foot care should be adequate as it becomes a source of information by the patient (Kaya & Karaca, 2018). DM clients needed to be involved in education to achieve maximum results from interventions. Evaluation of the ability to produce clinically meaningful changed in the long term such as physiological, behavioral and DM client outcomes needed to be done. High knowledge improved adherence to foot care, conversely low knowledge lead to low foot care behavior, and risk the occurrence of foot ulcers (Sheila et al., 2016).

Conclusion

The objectives of foot care education were: individuals, families and groups. Educational media was through face to face, pamphlet, audio-visual, telephone, and YouTube. Foot care education improved knowledge and efficacy of foot care, lowers the incidence of leg injuries, improves glycemic control and improves blood pressure, improves leg sensitivity and improves quality of life.

Acknowledgement

The writing of this review literature was part of the requirements in completing the academic process during the doctoral education in nursing. Therefore, I would like to thank the Education Fund Management Institute (LPDP) for providing scholarships during the doctoral education in nursing.

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Table 1. Characteristics of the Articles (n = 9)

Number	References	Purpose	Method	Sample & setting	Measurement	Intervention characteristics	Results
1	(Liu et al., 2019)	To determine the effect of transition care on the prevention of diabetic foot ulcers (DFU) in patients at high risk of diabetic foot.	Case-Control design	284 high-risk diabetic patients	<ul style="list-style-type: none"> • Patient knowledge about foot care. • Quality of life for patients. • Fasting blood glucose (FBG), glycosylated hemoglobin (HbA1c), blood pressure, blood lipids, dorsal leg artery pulses, and 10 g monofilament nylon fiber test. 	The case group was given transitional care in addition to the same methods as the control group.	<ul style="list-style-type: none"> ▪ Improved FBG, HbA1c, and DQOL scores levels ▪ Decreased BP, 10-g monofilament nylon fiber test positive rate, ▪ There is no difference in levels of triglycerides (TG), total cholesterol (TC), low density lipoprotein cholesterol (LDL-C), and high-density lipoprotein cholesterol (HDL-C). ▪ Decreased DFU incidence
2	(Maslakpak et al., 2018)	To investigate the application of Orem's self-care deficit theory on prevention and management of diabetic foot ulcer	Quasi-experimental design	60 patients with DFU	<ul style="list-style-type: none"> - Needs assessment based on Orem model - Saint Elian Wound Score System (SEWSS) 	<ul style="list-style-type: none"> - 60minute self-training session. - home visits once a week for 3 weeks 	<ul style="list-style-type: none"> - There is an increase in the average self-care score - There were significant differences in ischemia, infection, edema, neuropathy, topographical aspects, depth, area and phase of wound healing at the end of the study.
3	(Green-morris, 2019)	Knowing the effectiveness of foot wound prevention education.	Experimental research pre-post one group design	9 patients with type 2 diabetes	<ul style="list-style-type: none"> - Patient Interpretation of Neuropathy - Diabetes Attitude - Diabetes Health Survey 	<ul style="list-style-type: none"> - The facilitator reads the booklet to participants - Demonstration of self-examination. 	Increased perceptions and attitudes about the prevention of diabetic foot wounds.
4	(Khuzaimah et al., 2018)	Evaluating the effectiveness of health education programs	Randomized controlled trial (RCT)	59 diabetic patients	Foot care behavior, Self-efficacy of foot care, foot care outcome expectations, foot care knowledge and quality of life.	<ul style="list-style-type: none"> - Power Point presentations for 20-30 minutes (8-10 participants / group / session). - Face to face discussion for 20 minutes 	There was an increase in foot care behavior, foot care self-efficacy (hope of success), expectation of foot care outcomes, physical symptoms of quality of life and quality psychological function scores.
5	(Rahaman & Viveka, 2018)	To assess the effectiveness of a foot care education module for diabetes.	An Openlabel Randomized Controlled Study.	125 Adult patients (> 18 years) diagnosed with type 1 or 2 diabetes	Knowledge of foot care behavior	The intervention group received routine care and foot care via a short audio-visual screen and was given a pamphlet.	Improved foot care knowledge score.

Number	References	Purpose	Method	Sample & setting	Measurement	Intervention characteristics	Results
6	(Abrar et al., 2019)	To evaluate patients' knowledge level after they viewed the video for diabetic foot care in the traditional languages.	Cross-sectional design	20 diabetic patients	Foot care knowledge.	I. Development of foot care educational content. II. Educational video creation. III. Pilot study	- Overcoming communication barriers in the knowledge transfer process. - Increased patient knowledge about diabetic foot care
7	(Fan et al., 2013)	Exploring the educational effect of diabetic foot.	one group pretest and posttest design	70 patients with type 2 diabetes	Screening for ulceration risk includes foot sensation, circulation, foot deformities, and previous history of foot ulceration.	Foot care education was delivered in 4 sessions over 3 weeks.	Small reduction in foot skin and nail problems at 3-month follow-up
8	(Liang et al., 2012)	Design and implement a foot care program in type 2 DM patients.	RCT	62 Diabetes patients	- diabetes knowledge. - diabetic foot care behavior.	- Didactic diabetes education, customized foot care and 2 hours of focused teaching. - Diabetes education classes were given every 3 to 6 months.	There was a significant increase in diabetes knowledge and foot care behavior
9	(Monami et al., 2015)	To assess the feasibility and efficacy of a brief educational program for the prevention of diabetic foot ulcers in high-risk patients	RCT	Adult type 2 DM patients	- Incidence of ulcers - Patient knowledge of neuropathy.	- 30-minute face-to-face lesson on factors - 90-minute interactive sessions with practical exercises on risk-reducing behaviors.	There was an improvement in respondents' knowledge about foot care.