



NURSE'S ROLE IN THE PREVENTION OF DIABETIC FOOT ULCER

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<p>Abstract:</p> <p>Diabetic Foot Ulcer (DFU) is one of the severe consequences of diabetes. Approximately, 15% of people with diabetes develop foot ulcer. People with DFU have higher risk of lower limb amputations, which is a complex problem. DFU is also a major cause of hospitalization of the diabetic patient. Assessment, planning, implementation and evaluations are the key factors during the treatment process of foot ulcers for people with diabetes. It is a challenging process. A multidisciplinary health team is required for the treatment and prevention of DFU.</p> <p>AIM: The aim of this research is to explore the causes of Diabetic Foot Ulcer and preventive measures. The role of a nurse as an educator in the prevention of DFU has also been illustrated in the study.</p> <p>METHODOLOGY: The method used in this study is content analysis. 11 articles were reviewed for the study. There were many relevant articles found but due to access problems those articles were discarded.</p> <p>RESULT: Neuropathy, Peripheral Vascular Diseases and Infections are the three main reasons that causes DFU.</p> <p>DFU can be prevented through patient's education and healthy life style.</p>	
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1. Introduction

Diabetes is a non-communicable chronic disease. It is becoming a serious health issue. The prevalence of diabetes is increasing worldwide and is associated with high morbidity and mortality rates (Yokoyama et al., 2007). According to the report of World Health Organization (WHO 2015), the number of diabetic patients by 2025 will increase to 380 million.

Diabetic foot ulcer is one of the severe consequences of diabetes causing large economic burden. Amputation is another severe complication of diabetes, which is preceded by a foot ulcer. According to some studies it has been proven that approximately, 15% of people with diabetes develop foot ulcers eventually resulting approximately 85% of lower limb amputations.

Too many ulcers fail to heal, become indolent, develop infection, and come to amputation. Diabetic patients are between 15-25 times more likely to come a major amputation than patients without diabetes. (Alethea V M Foster, 2006, p. 6)

It is believed that every 30 second, a limb is lost in the world as consequences of diabetes and DFU.

It is believed that 85 percentages of diabetic foot amputations can be avoided with early detection, proper care and education to the patients and their family about diabetes and DFU.

According to WHO (2001), if the capacity of nursing services is fully utilized, nurses can be instrumental in primary prevention efforts by preventing the onset of non-communicable disease through teaching and screening of patients.

Therefore, for the patients' quality of life prevention of foot ulcers is very important. The aim of this study is to investigate how it is possible to reduce the complication of foot ulcers through a care strategy that collaborates the inter professional diabetes care team and most essentially through an extensive patients' education program which teach patients to take their own responsibility for treatment and control along with the health care professionals especially the nurses.

Attendo Oy, Hedvig-Sofia Hemmet, commissioned this study. The contact person is Johanna Börman-Långström, the director of that nursing home. The aim of this work is to find out the preventive measures for diabetic foot ulcer with diabetic patients.

2. Background

Diabetes is a serious, life-long complicated problem affecting 4,2% of the world's population. (Boulton, Meneses, and Ennis, 1999). It is believed that the cost of diabetes varies from 4.6-13.7 billion US dollars annually. (Dawson, Gomes, Gerstein, Blanchard, and Kahler, 2002; Gordois, Scuffham, Shearer, Oglesby & Tobian, 2003).

A three-fold increased amputation risk was demonstrated by Reiber, Pecoraro & Koepsell (1992) for those people with diabetes who had not received formal diabetes education, suggesting significant prevention is possible with appropriate teaching strategies

Nurses being an irreplaceable health care professionals. They are dominant part of health care system that is associated actively in different aspects of health. They work directly with patients. They are considered as primary care providers. They are a caregiver, communicator and most of all they are a teacher. They help patients to deal with all the challenges during and after their illness by providing information about their health, medications, treatments and also instructing patients' family members.

2.1 Definitions and Etiology

Diabetes mellitus (DM)

According to WHO, Diabetes mellitus is a chronic disease caused by inherited or acquired deficiency in production of insulin by pancreas, or by ineffectiveness of the insulin produced. Such a deficiency results in increased concentrations of glucose in the blood, which in turn damage many of the body's systems, in particular the blood vessels and nerves.

There are two types of Diabetes, type 1 and type 2.

Type 1 Diabetes (Insulin-Dependent Diabetes Mellitus) in which pancreas fail to produce the insulin. This form develops most frequent in children and adolescents. Type 2 Diabetes (non-insulin dependent Diabetes Mellitus), which results from the body's inability to respond properly to the action of insulin produced by pancreas. It occurs most frequently in adults.

2.2 Complications of Diabetes

Diabetes is associated with many complications such as retinopathy, neuropathy. These conditions are the result from the duration and the severity of hyperglycemia.

Other serious consequences includes; the development of cardiovascular disease for example: peripheral arterial disease, ischemic feet, and coronary heart disease.

Similarly, one of the most common consequences of diabetes in diabetic patient in the lower extremity is the diabetic foot ulcer.

World Health Organization defines diabetic foot as, "The foot of a diabetic patient that has the potential risk of pathologic consequences, including infection, ulceration, and/or destruction of deep tissues associated with neurologic abnormalities, various degrees of peripheral vascular disease, and/or metabolic complications of diabetes in the lower limb."

It is prevalence in both types of diabetes (Type I and Type II).

Foot ulcers do not erupt spontaneously and are usually the result of some kind of trauma coupled with neuropathy and accompanying infection (Brem et al., 2006).

2.3 Pathogenesis of Diabetic Foot Ulcers

Basically, there are two most underlying causes of foot ulceration; Neuropathy and Peripheral vascular disease (PVD). These are the main contributors to foot disease, are found in more than 10% of people when they are diagnosed with diabetes (Boulton et

al., 2005a). Some other risk factors for diabetic foot ulcerations includes; cigarette smoking, foot deformity, poor glycemic control, previous history of ulcerations, infection, previous amputations, visual impairment, high blood pressure, living alone or lack of social support. (Boulton et al., 2008)

2.3.1 Neuropathy

Neuropathy is defined as nerve damage (Brem et al., 2006). It is mostly asymptomatic. 50% of diabetic patients are affected and diagnosed with neuropathy and risk foot. It is the common and serious complications of diabetes. It is usually characterized by damage to the peripheral nerves causing loss of sensation, autonomic dysfunction, foot deformity and impaired mobility.

People with diabetes have a 30-50% risk of developing chronic peripheral neuropathy, with 10-20% of those diagnosed with neuropathy going on to develop severe neuropathic symptoms (Marshall and Flyvbjerg 2006).

Due to loss of pain and sensation, patient often fails to seek medical care at right time when the damage is already significant.

For example in a study of patients who underwent amputations at a US Veterans Administration Medical Centre, 41% were found unaware of their sensory deficit.

The effects of diabetic peripheral neuropathy are progressive, permanent and varied depending on the type and extent of nerve damage (Bulby 2006).

Although pain is not recognized as the risk factor for ulceration, it can cause range of unpleasant symptoms such as burning and tingling sensations, shooting pains and parenthesis. Symptoms are usually worse at night leading to sleep disturbance and reduced quality of life (Boulton et al., 2004). Chronic persistent pain can be extremely distressing for the individual, and can contribute to feelings of anxiety and depression (Kinmond et al., 2003).

Diabetic peripheral neuropathy is related to the dysfunction of sensory, motor and autonomic neuropathy. These are the three dominant types of peripheral neuropathy causing inevitable ulcerations.

2.3.1.1 Motor Neuropathy

Motor nerves control the muscles. It is mostly prevalent in elderly with type II diabetes. It occurs when there is damage to the nerves supplying the muscles of body. The symptoms like loss of muscle strength, getting fatigue easily, muscle starts getting smaller. In advanced case, patient may experience difficulty in breathing and swallowing. (Boulton et al., 2005b).

The nerves' supplying the muscles fails to maintain the person's healthy foot shape causing deformity. This deformity leads to an alteration in the biomechanics of walking, and foot pressure points during standing and walking. Calluses form in abundance on the new, alien pressure points and sub-metatarsal head fat pads become thin. This increases the force plantar pressure that ultimately results in the formation of a foot ulcer, which has a high risk of becoming infected (Urbancic-Rovan 2005).

2.3.1.2 Sensory Neuropathy

Sensory nerve carries sensation to different parts of the body in the periphery. It is the most common form of diabetes peripheral neuropathy and is closely associated with the development of ulcers (Boulton et al., 2004).

Damage to sensory nerve results in changes in sensation or loss of protective sensation, burning sensations, nerve pain, tingling or numbness or inability to determine joint position, which causes balance problems and risk of falling. (Biellby 2006). The normal sensations experienced by a person are declined (Brem et al 2006).

It is the most common form of diabetes neuropathy, which affiliates ulcer development. (Boulton et al., 2004). Individuals are often unaware of their condition especially, if it develops at the sole of the foot causing delay or failure in discovering it on time until they develop an injury as a result of a relatively innocuous trauma, for example pressure from an ill-fitting shoe or from standing on a sharp object (Ziegler 2009), or when it is detected by a healthcare professional during routine diabetic foot screening (Leese et al., 2011).

2.1.1.3 Autonomic Neuropathy

Autonomic neuropathy is a serious problem. It occurs when the nerves that help to control involuntary functions, including digestion, vascular tone and sweating become damaged. In the foot, this can cause interruption of the sweat glands, leading to dry, non-sweating skin, which is prone to cracks and fissuring (Baker et al., 2005). Then, the foot becomes portal for infection.

2.3.2 Peripheral vascular disease

Patients with diabetes are more likely to get peripheral arterial disease. This is a condition when the fatty deposits or the plaque hinders the blood flow in the legs and feet. This causes stiffening of the elastic layer of the arterial wall, thereby making it less able to constrict and dilate normally (Mills 2010). The combination of hardening and stiffening and narrowing of the artery leads to reduced tissue perfusion and peripheral ischemia, with reduced nutritive blood flow and consequently, reduced tissue viability (Edmonds 2007). The devitalized tissue is therefore unable to withstand pressure on walking and weight bearing or repeated minor trauma, placing the foot at increased risk of tissue breakdown, ulceration and possible amputation (Boulton et al., 2008). The modifiable risk factors for peripheral arterial disease include dyslipidemia, hypertension and smoking. The risk of peripheral arterial disease being present is increased if the patient smokes and has history of stroke or myocardial infarction (Hirsch et al., 2006).

2.3.3 Foot Deformities

It is important to recognize deformity in the diabetic foot; it often leads to bony prominences that are associated with high mechanical pressures on the overlying skin. This results in ulceration, particularly in the absence of protective pain sensation and

when shoes are unsuitable. The most common deformities include Claw toes, Hammertoes, Charcot foot. (Edmonds, Michael E., Foster Alethe V.M, 2008, p 8).

2.3.4 Infection

The intact skin acts as an effective physical barrier to bacterial invasion. (Landis et al., 2007).

The tissues to the foot and ankle are at increased risk to infection, particularly when diabetes induced peripheral neuropathy and arterial disease alongside impaired immune function is present (Turns, 2012). When the skin is damaged, this barrier protection is compromised. This leaves the area of the body at risk to invading bacteria that quickly multiply and can overcome the body's natural defense mechanisms, potentially resulting in tissue infection (White et al., 2001). Foot ulceration provides as a mean of access for pathogens, leading to the development of infection. If an infection is left untreated it can threaten the feasibility of the limb and also the person's life (Kravitz et al., 2007).

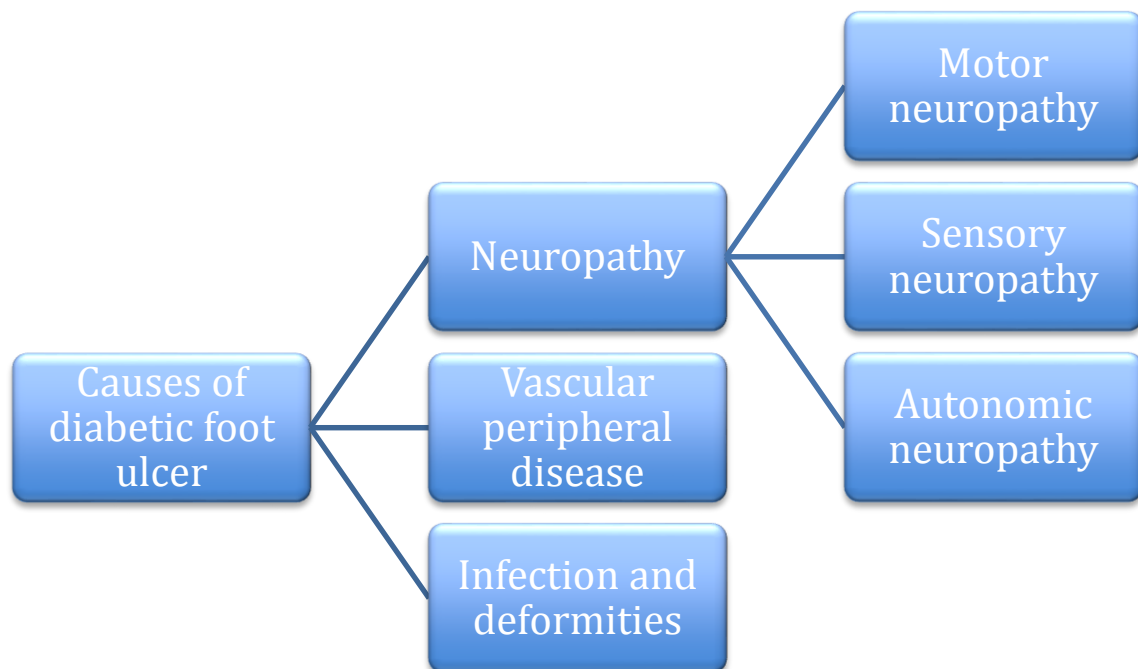


Figure 1. Categories and sub-categories of the causes of DFU.

2.4 Diabetic Foot Assessment

Diabetic foot ulcers are the single greatest cause of non-traumatic limb amputation in people with diabetes: amputations are 15 times more common in those with diabetes than those without the disease (Brem et al., 2006). Amputation carries a higher mortality rate than colon, breast or prostate cancer, and up to 80% of people with diabetes will die within five years of having an amputation (Diabetes UK 2012a). More significantly, (Khanolkar et al., 2008) reported that only 50% of all diabetes-related amputees would survive for two years following surgery.

However, timely and early assessment of the foot at risk can significantly prevent foot ulceration and limb amputation. Guidelines published by the National Institute for Clinical Excellence (NICE) (2004A, 2004B) require that all people with diabetes should have an annual foot examination. There are mainly eight things that can be done for the assessment, which are listed below: -

- Neuropathy
- Ischemia
- Deformity
- Callus
- Swelling
- Skin breakdown
- Infection
- Necrosis

The foot at risk can be detected by three-examination procedure:

Simple inspection, Palpation and Sensory inspection.

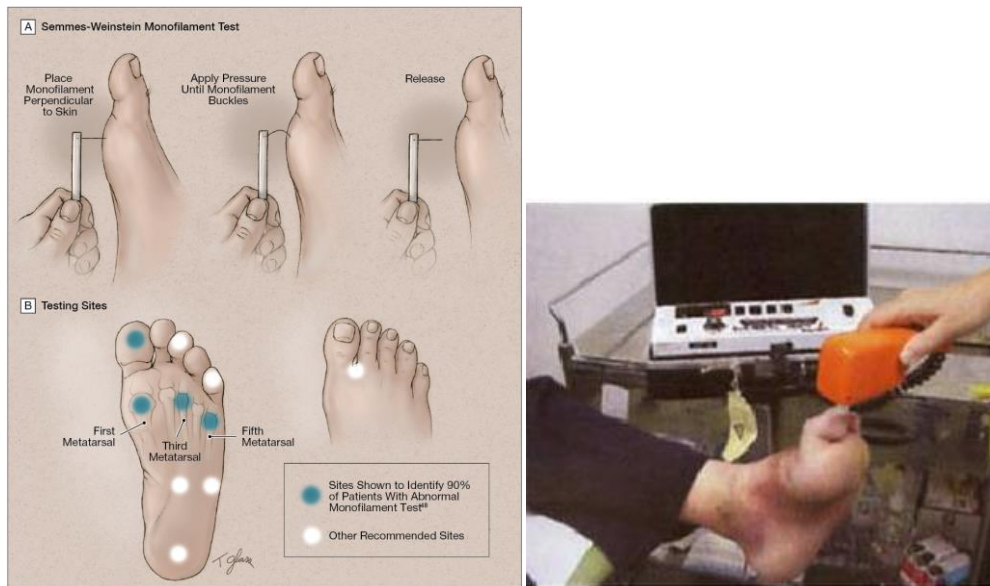


Figure 2: Monofilament test for light touch sensation.

Neurothesiometer, a device which when applied to the foot delivers a vibratory stimulus, which increases as the voltage is raised.

The Semmes Weinstein Monofilament test is a screening tool used in patients with diabetes that helps in determining the presence of protective sensation. This procedure enables early intervention and management to reduce the future risk of ulceration and lower extremity amputation.

This test is carried out mostly in the three distinctive sites, the plantar aspects of the great toe, the third metatarsal and the fifth metatarsal (as shown in the figure above).

The monofilaments are applied to the test site until it is bent perpendicularly. Accordingly, the patients are instructed to say 'Yes' if they feel the monofilament on their foot and on contrary if the patient does not feel the sensation, the test is considered to be insensate. In this way, this test is performed. This procedure is convenient and rapid which is often used in clinical testing and routine self-assessment.

Another common instrument used for the detection of pain sensation is Neurothesiometer. This device produce a vibrating stimulus once applied to the foot and increases when the voltage is raised. If the patient fails to feel 25 volts from the vibratory stimulus, then the patient has high risk of ulceration.

Ischemia is often detected by the palpation of the peripheral pulses.

2.5 Risk categorization system for Diabetic Foot

Category	Risk profile	Check up frequency
0	No sensory neuropathy	Once a year
1	Sensory neuropathy	Once every 6 months
2	Sensory neuropathy and signs of peripheral vascular disease and/or foot deformities	Once every 3 months
3	Previous ulcer	Once every 1-3 months

Table 1: Risk categorization system according to the International Consensus on the diabetic foot.

2.6 Stages of the Diabetic Foot

The diabetic foot can be classified into six stages.

Stage 1: - No risk factors are present. The patient does not have signs of peripheral vascular disease, neuropathy, deformity, callus, numbness and swelling making him vulnerable to foot ulcers.

Stage 2: - Presence of one or more of the risk factors, which may be neuropathic or ischemic.

Stage 3: - The sign of skin break down is prominent on the plantar surface or on the margin of foot causing an ulcer formation.

Stage 4: - The ulcer has developed infection, which is progressive. It also affects the skin and soft tissues underneath.

Stage 5: - Presence of necrosis and gangrene worsens the infection causing tissue destruction.

Stage 6: - The foot cannot be saved and will need a major amputation.

Stage	Clinical condition
1 st	Normal
2 nd	High-risk
3 rd	Ulcerated
4 th	Infected
5 th	Necrotic
6 th	Unsalvageable

Table 2: Staging the diabetic foot

(Edmonds, Michael E., Foster, Althea V.M, 2008, p 19&20).

2.7 Aim of the study and the Research Questions

The aim of this study is to identify the causes of diabetic foot ulcer and to investigate the preventive measures being approached in clinical interventions by the nurses on patient's education and to participate in self-care management. In order to achieve the aim of the research, the following research questions were formulated:

1. What is diabetic foot ulcer?
2. What are the causes of diabetic foot ulcer?
3. How can diabetic foot ulcers be prevented?

3. THEORETICAL FRAMEWORK

Self-Care theory by Dorothea Orem is used as a theoretical framework in this research. Dorothea began to develop her theory of Self care in the 1950s. Her goal was to create an organized framework for nursing knowledge. This nursing theory is based upon the philosophy that Nursing is a response to the incapability to care for oneself and so as to fill that gap nurses assist their patient when needed in order to maintain requisite level of self-care.

Basically, Orem's theory consists of three theories.

1. Theory of nursing systems
2. Theory of self-care deficit
3. Theory of self-care

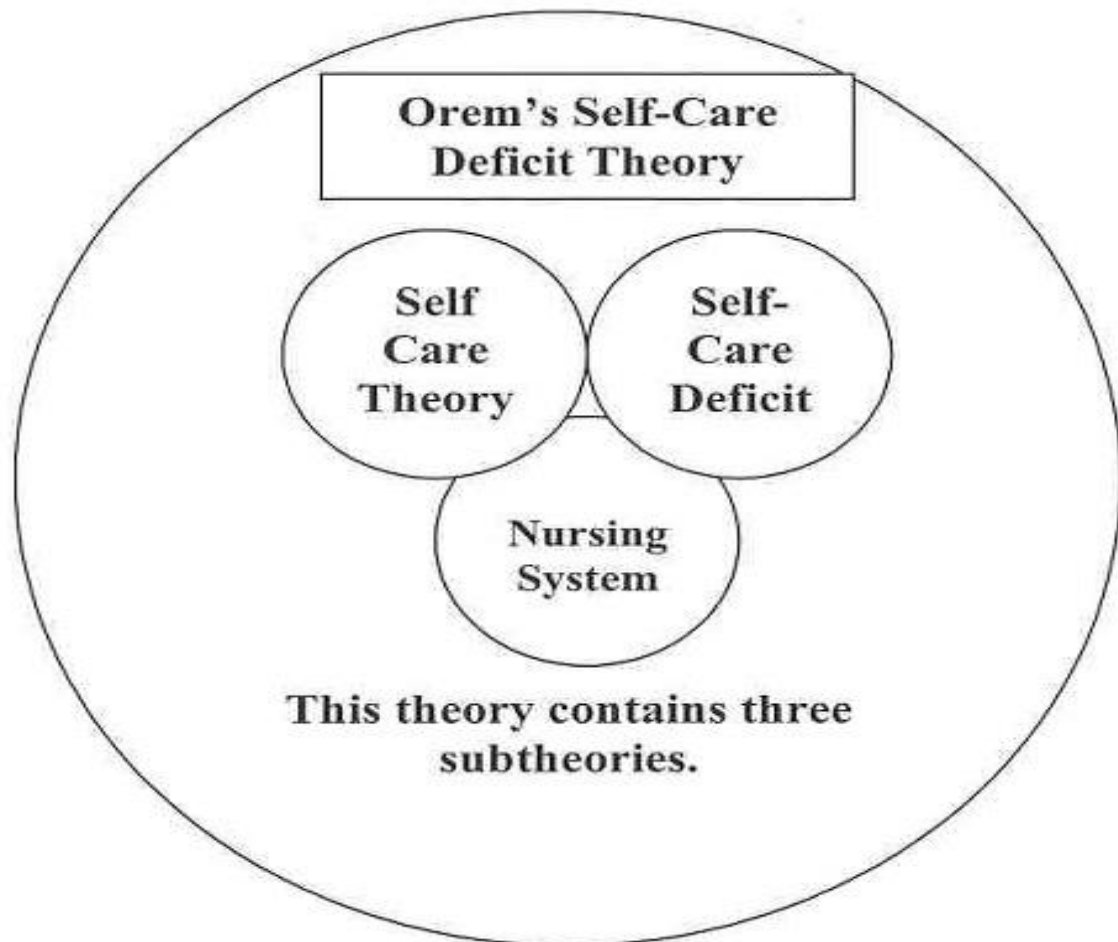


Figure 3: Orem's Self- Care Theory

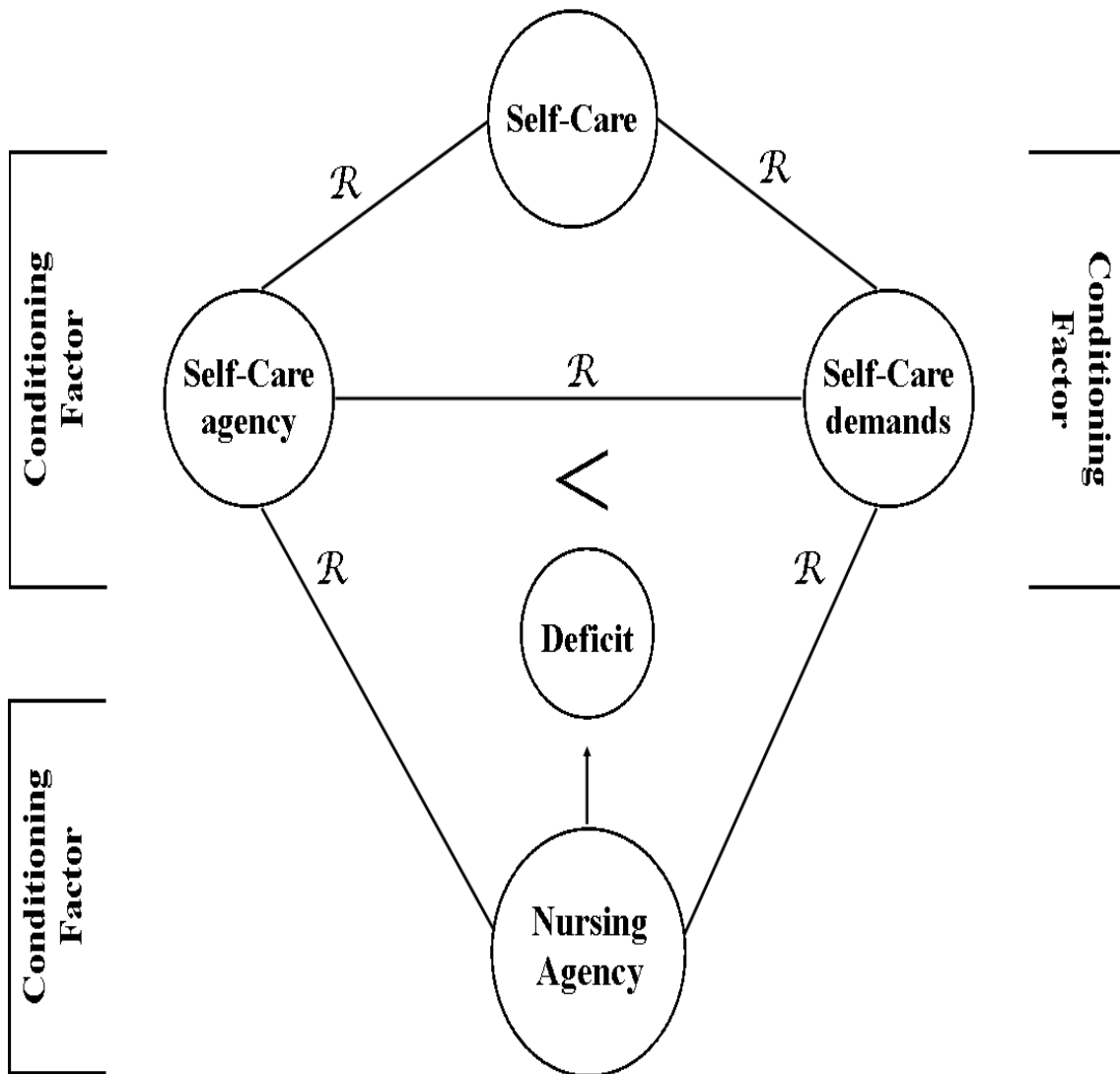


Figure 4: A conceptual framework for nursing. \mathcal{R} , relationship; $<$, Deficit relationship, current or projected.

The theory of nursing systems means that the nursing is a care of art and the production of nursing is the care for others. This theory describes that the nurse, the patient or both can meet how patient needs.

The theory of self-care deficit proposes an answer to the question, "when and why do people require the health service nursing? (Orem 1987, p.72). This means due to limitation in knowledge patients fail to meet their self-care requisites. Therefore, nursing help is needed for the well being and maintaining quality of life.

5 methods nurses use to help patients meet their self-care deficits according to Orem; "Acting for and doing for another, guiding and directing, providing physical and psychological support, providing and maintaining an environment that supports personal development, teaching". (Orem 2001, as cited Masters, 2011, p. 183)

Orem's initial definition of nursing's concern included "man's need for self-care action and the provision and the management of it on a continuous basis in order to sustain life and health recover from disease or injury and cope with their effects". (Orem 1959, p. 3).

The theory of self-care is the main core of this nursing theory. This theory is focused on two ideas: self care as learned behavior and deliberate action. Humans have ability to take care of themselves and their dependents if they learn and perform deliberately in case of needs.

According to Polit and Henderson, each individual has the ability to perform self-care and are responsible for their health and health of their dependents. Self-care is the "the practice of activities that individuals initiates and perform on their own behalf in maintaining life, health and well being". (Cardinal Stritch University Library, 2011).

Assumptions of theory

1. Patient should be independent and capable of performing self-care for themselves and also in their family who is need of care.
2. Nursing is an action that is helping service to others, performed deliberately and purposefully.
3. Human agency is exercised in discovering, developing and transmitting and means to identify needs for, and make inputs into, self and others.
4. Interpersonal communication between people nurtures and teaches self-care.

Dorothea Orem's Theory has three essential sub-theories, which are Theory of Nursing Systems, Self-Care Deficit theory and Theory of Self-Care. The author considered using specifically theory of self-care to guide her work since it the appropriate theory for her study. It is also simple and easy to understand.

“A nurse in an acute care setting may use the theory of self-care deficit, while the nurse in an ambulatory care setting may function primarily within the theory of self-care”. (Taylor, 1990)

Orem defines self-care as, “the practice of activities that individuals initiate and perform on their own behalf in maintaining life, health, and well-being”. (Orem 1991, p. 117)

The patients suffering from diabetes are prone to develop foot ulcers if they are not aware about the self-care activities. Self-care is very essential when it comes to health promotion and it's maintenance. Orem believes that nurses should encourage patients at risk of certain consequences to actively participate in self-care to maintain the quality of life and health. The assertions and proportions of self-care theory are;

1. Self-care activities are greatly influenced by several factors like age, economic condition, life experiences, social background.
2. Self-care capabilities and self-care demands should be stabilized and well balanced by self-care deficit.
3. Nurses motivate and assess patients' potentialities and capacities in achieving and performing their self-care needs.
4. Nurses choose effective and reliable procedure, actions and technologies in achieving requirements for self-care.
5. Nurses, patients and others are engaged and committed in self-care by improving and regulating self-care capabilities.

4. METHODOLOGY

4.1 Literature review

The method used was literature review for the research.

According to Aveyard H. (2010), “A literature review is the comprehensive study and interpretation of literature that relates to a particular topic”. It is important because it seeks to summarize the available amount of literature given for a topic hence, developing new insights.

In this method, a research question is first identified. Secondly, the answers to the questions are sought in a systematic way through searching and analyzing the related literatures. (Aveyard 2010, p. 6)

4.2 Trustworthiness

Based on validity, reliability and credibility the trustworthiness of this study is examined. According to Guba, 1981 and Polit and Hungler, 1999; in a research method the concepts credibility, dependability and transferability have been used to describe various aspects of trustworthiness.

This study is validated as the research aim and questions were well defined. The researcher has analyzed and simplified the data forming categories that has reflected the subject of study in a reliable way. (Kyngäs and Vanhanen 1999)

Graneheim and Lundman 2004 say that, “Credibility of research findings also deals with how well the categories cover the data”.

Polit and Beck 2004 has stated that in order to increase the reliability of the study, it is very essential to demonstrate a link between the results and data.

4.3 Ethical consideration

There are various reasons why it is crucial to adhere to ethical norms when conducting a study or research. There are norms that promote the aims of research, such as knowledge, truth, and avoidance of error. Prohibitions against fabricating, falsifying, or misinterpreting research data promote the truth and avoid error, must be observed. It's common thing today to find ethical and rights violation both to individuals and organizations therefore, research meant for general acceptability or further research work must be kept out of ethic violation. (Robley 1995, p.48) argue that ethics is an important research tools and it can be looked at from various perspectives, ethical reports issued by the ethic committee can be used as a guide and supporting during a review process.

The writer first discussed the topic, goals and aims of the study; this was done in order to ensure all possible guidelines were followed. Before proceeding with the study, permission was sought from the commissioning party (Attendo Oy, Hedvig-Sofia Hemmet). The author ensured that all the material used was obtained from the official academic sources and databases. In order to avoid plagiarism the author made sure that all the quotations were properly done and referenced correctly and to the best of the author ethical knowledge.

Arcada University of Applied Sciences has detailed some good scientific practices that students are required to follow when doing research. Honesty and truth in conducting and reporting the result was followed. The author has adhered to a good ethical conduct during the entire writing process.

4.4 Qualitative content analysis

Qualitative content analysis is one of the several qualitative methods currently available for analyzing data and interpreting it's meaning (Schreier, 2012). A prerequisite for successful content analysis is that data can be reduced to concepts that describe the research phenomenon (Cavanagh, 1997; Elo & Kyngäs, 2008; Hsieh & Shannon, 2005) by creating categories, concepts, a model, conceptual system, or conceptual map (Elo & Kyngäs, 2008; Morgan, 1993; Weber, 1990). The research question specifies what to

analyze and what to create (Elo & Kyngäs, 2008; Schreier, 2012). It is needed when the analysis is based on previous research and knowledge. (Elo & Kyngäs, 2008).

The author has chosen inductive content analysis as the method of analyzing the collected data. It is a popular method for analyzing the written material since it allows the author to conduct the research with ease. By using qualitative data analysis, trustworthy is maintained since it presents the process of content analysis accurately. The author has analyzed the chosen 10 articles, which answered the research questions. The articles were read thoroughly and necessary information was noted. The categories and sub-categories were divided accordingly. The two main categories drawn from the study were Patient's education and Healthy life style. Later subcategories were placed under the suitable categories.

4.5 Data collection

The data used in this study was collected from the Academic Search Elite EBSCO, Science direct, PubMed, and CINAHL databases between the periods 1999-2015 under certain filtration. Little information was extracted from Google Scholar also for instance from WHO.

Keywords such as ('Diabetic foot ulcer', 'Prevention', 'Nurse's role') were used.

There were thousands of hits but in order to limit my search, I have chosen the articles between the periods 1999-2015 in English.

I briefly reviewed the articles from different databases and selected 10 articles, which were utilized for finding answer to my questions.

Search outcomes

Databases	Search items	Year	Results	Used articles
EBSCO	Prevention of diabetic foot ulcer	2000-2015	71	1
SAGE journal	Diabetic Foot, Education,	2000-2015	953	2

	Prevention			
Academic search Elite (EBSCO)	Foot ulcer, Preventive measures	2000-2015	1,541	3
Science direct	Diabetic Foot, Prevention	2000-2015	417	3
Central Pubmed	Nurses' actions, Prevention of DFU	2000-2013	474	1

4.6 Inclusion and Exclusion Criteria

Including criteria	Excluding criteria
Articles published between the time periods 1999-2015	Articles published before 1998
Articles with free access	Articles that charges
Articles mostly with abstract	Non scientific articles
Articles written only in English language	Articles written in other languages than English
Articles available with full Pdf format	Non-relevant articles for the study

4.7 Description of articles selected

The selected articles are presented with the names of the authors, the year of publication and the article titles:-

Author/Year	Title	Aim	Results
M.Annersten	Patient education	This article was	The result shows

Gershater, E Pilhammar, J Apelqvist, C Alm- Roijer- 2011	for the prevention of diabetic foot ulcers	designed to explore if the patient education in-group sessions will contribute to a significantly reduction in new ulceration during 24 months in patients with diabetes and high risk of ulceration.	that participant- driven education as an intervention in the patients with diabetes and a healed foot ulcer is not successful rather this method should be evaluated in patients with lower risk of ulceration.
Cuong N. Dang and Andrew J.M. Boulton- 2003	Changing perspectives in Diabetic Foot Ulcer management	This article discusses about the need for a multidisciplinary team to provide good foot care to diabetic patients is vital for the prevention of diabetic foot ulcers.	The result shows the importance of frequent examination of diabetic foot, risk identification; early diagnosis can prevent foot ulcers and amputations.
Paula Holt- 2013	Assessment and management of patients with diabetic foot ulcers	This article discusses about the long-term complication of diabetes and the risk factor involved.	The result here says prevention is crucial. The early sign and symptoms should be recognized so as to prevent complications of foot ulcer.
Jarrett L- 2013	Prevention and Management of	This article studies about the major risk	The result shows foot inspection to

	neuropathic diabetic foot ulcers	factor for foot ulceration and limb amputation.	detect the presence of foot ulcers as an early diagnosis.
Stephen J. Rith-Najarian and Gayle E. Reiber- 2000	Preventions of Foot problems in patient with diabetes.	This article studies that foot ulcer is preventable with timely screening, self-care management education and appropriate footwear.	The result shows that identifying high-risk patients, screening examinations, correct footwear and healthy living habits, can prevent foot ulceration.
Lillian Delmas-2006	Best practice in the assessment and management of diabetic foot ulcers	This article deals with ulcer prevention strategies, best evidence for ulcer assessment, management and evaluation.	The result shows why people with diabetes have higher risk for ulcers and the main reason is hyperglycemia.
Ileana M. Howard-2009	The prevention of foot ulceration in diabetic patients	The aim of this article is to outline the current understanding of the pathologic process underlying diabetic foot ulceration, the risk factors associated and the interventions that are in use.	The result here shows that the current interventions such as annual foot examinations and glycemic control have not proved to significantly decrease ulceration.
Nalini Singh, David	Preventing foot	The aim of this	The result shows

<p>G. Armstrong, Benjamin A. Lipsky-2005</p>	<p>ulcers in patients with diabetes</p>	<p>article is to review the evidence on the effective methods advocated for preventing foot ulcer in primary setting.</p>	<p>that an appropriate screening of foot at risk can reduce risk factors. Other interventions like education to patients on glycemic control, footwear, smoking cessation can reduce risk of foot ulceration.</p>
<p>M Aalaa, O Tabatabaei Malazy, M Peimani and MR Mohajeri-Tehrani-2012</p>	<p>Nurses' role in diabetic foot prevention and care; a review</p>	<p>This article shows that how nurses' play their educating role in the field of prevention of diabetic foot, foot care and preventing from foot injury.</p>	<p>The result shows that nurses should be trained efficiently with the latest instructions of diabetic foot care</p>
<p>Oscar L Morey-Vargas and Steven A Smith-2014</p>	<p>Be Smart: Strategies for foot care and prevention of foot complications in patients with diabetes</p>	<p>The aim of this article is to provide an overview of the available evidence on preventive diabetic foot care.</p>	<p>This article concludes that the diabetic foot ulcer and lower extremity amputations are preventable if the risk factors are identified timely and the role of patient and provider education.</p>

5. RESULTS

The author has already answered to her first two questions 1. What is diabetic foot ulcer? and 2. What are the causes of DFU? in the background section above.

Interpretation of the process

In this part, the author describes the result of the analysis in categories and in subcategories answering the following research question:

How can DFU be prevented?

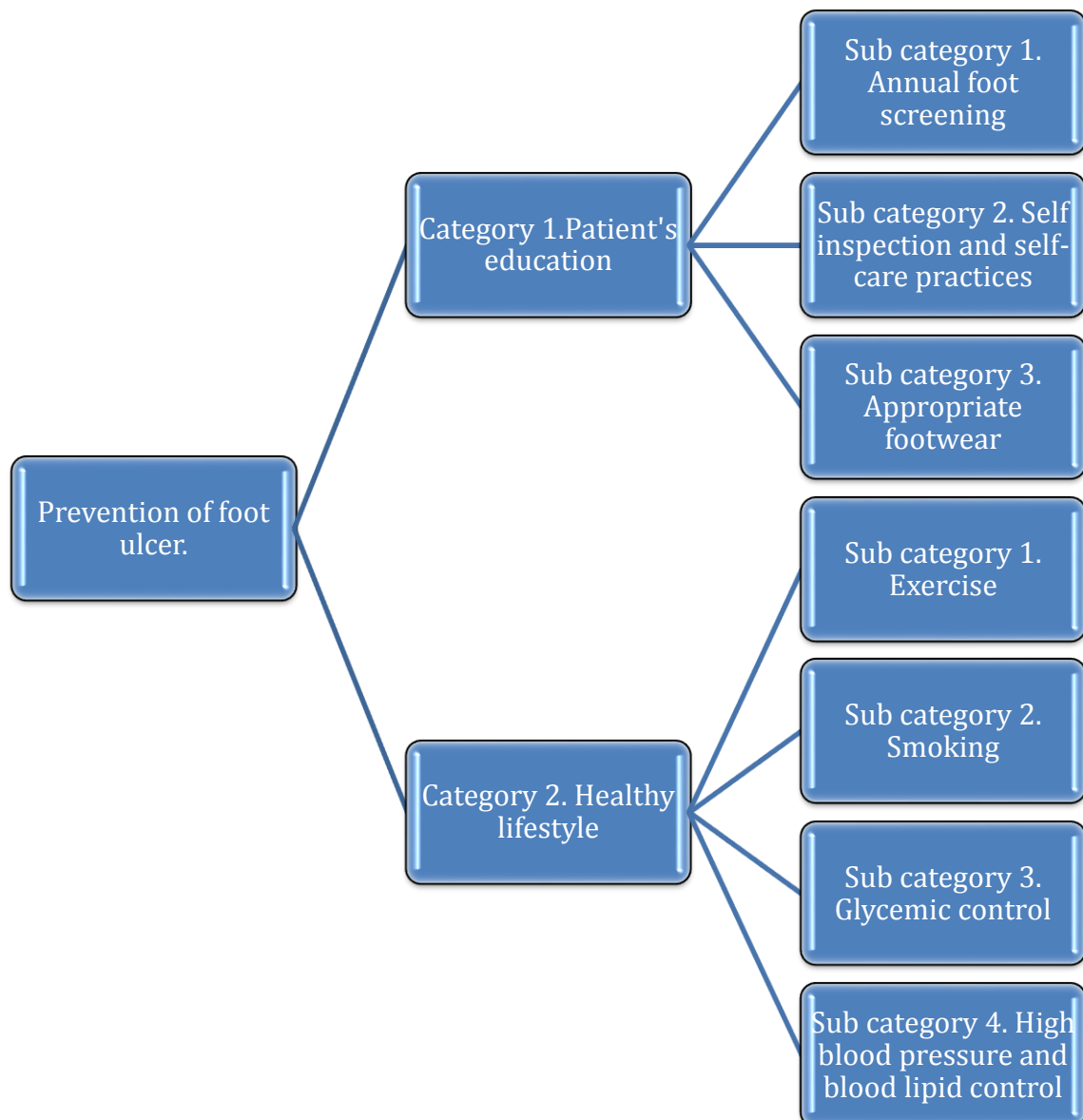


Figure 4: Illustration of prevention of foot ulcer through patient education and healthy lifestyle.

Here, the author has listed two different categories Patient education and Healthy lifestyle as the key factors for the prevention of DFU occurrence on the basis of the study.

5.1 Patient Education (Low risk foot)

Education is the key to prevent diabetic foot. It is one of the most important nursing actions. According to Spraul, M., 2000, ‘approximately 49-85% of all diabetic foot problems are preventable.’ Educating patients at risk for diabetic foot ulceration have been shown to be beneficial (Malone et. al 1989).

Many patients with diabetes lack education about how to care their feet. Therefore it is very important to educate patients regarding proper management and care of their feet to them or families. However, it is also important that the nurses are able to assess the patients self care capacity. A good collaboration of an interprofessional diabetes team and appropriate education to diabetic patients can reduce foot ulcer problems. Baker, K. et al., 2005

5.1.1 Annual foot screening

According to the Guidelines published by the National Institute for Clinical Excellence (NICE) (2004A, 2004B), all patients with diabetes require an annual foot examination. Patients with diabetes should visit for an annual foot examination in order to identify high-risk foot conditions such as foot deformity or callus formation and management of foot problems. Annual foot screening is one of the traditional foot inspections method (Boulton et al 2008). There are evidence suggesting that annual foot screening resulted in a significant reduction in the incidence of foot ulceration and the number of major amputations. Patients should be encouraged to follow up visits regularly.

5.1.2 Self inspection and self-care practice

Good foot care and self-monitoring can decrease the foot ulceration (Mason et al). Patients should inspect their feet on daily bases to identify early signs of abnormality.

Hygiene is also very important. They should wash their feet every day and checking for problems. They should maintain a regular skin care and apply cream if the skin is dry. Skin should be kept moist because the nervous system that controls the sweating of the feet is impaired. Nails should be trimmed especially after the bath when they are softer and easier to cut. Danger signs such as swelling change in color, breaks in the skin and minor wound that does not heal, should seek for medical advice.

5.1.3 Appropriate footwear

The selection of correct footwear is very crucial when it comes to diabetic patient. There is a great possibility in damaging the feet permanently due to the wrong size and style that possibly leads to deformity, callus and ultimately ulcer formation because a diabetic patient with sensory loss may not feel the injury before it is too late (Holt 2009). Hence, patients should be informed about the principles of good and correct footwear so as to prevent ulceration.

About 55% of foot ulcers are caused due to the pressure from the footwear. The tissues of the patients with poor blood circulation and loss of protective sensation is traumatized with ill fitted shoes (Abbott et al., 2002). Patient with diabetic foot should make a wise selection of footwear to reduce ulceration risk since foot deformity is common among patients with diabetes. Therapeutic footwear is essential to protect high-risk foot from injury. It is important that there is sufficient space for the toes in shoes to accommodate minor deformities, broad based for support and traction and extra foam padding for cushioning (Zangaro & Hull, 1999).

5.2 Healthy lifestyle (Low risk foot)

Healthy lifestyle changes such as undertaking regular physical activity, reducing alcohol consumption, non-smoking, blood glucose control prevents the diabetic foot (Haycocks and Chadwick 2012).

5.2.1 Exercise

Weight management is a key factor as a high percentage of people with diabetes are over weight. They should be encouraged to take regular physical activity for approximately 30 minutes daily as this improves insulin sensitivity and lower blood pressure.

5.2.2 Smoking

Tobacco use causes particularly severe health problems in diabetes. In addition to the common awareness that smoking can cause lung cancer, it is essential for people with diabetes to understand and believe that smoking damages blood vessels in the legs and feet, leading to peripheral vascular disease, ulcers, gangrene and major amputations.

However, some but not all the studies have found any relationship between tobacco use and foot ulceration.

A case control study of diabetic patients in the United Kingdom suggests that the risk of leg amputation is low among the South Asian patients comparing to that of European ancestry due to their low smoking rate (31% vs. 57%). In the other hand, in the study done in Jordan among the patients with diabetes found that smoking as a reason of amputation.

5.2.3 Glycemic control

According to, The Diabetes Control and Complications Trial (DCCT) and the UK Prospective Diabetes Study Group (UKPDS), hyperglycemia is a significant factor causing neuropathy. The study has proved that blood glucose control could reduce 60% of nerve damage (neuropathy) and prevention of micro vascular complications such as retinopathy and nephropathy (Boulton 1998). Similarly, the UK Prospective Diabetes Study Group (UKPDS) (1998) has mentioned that unavoidable diabetes complications can be reduced with regular glycemic therapies or glucose control.

Hyperglycemia has an adverse effect on the immune system, which can delay healing of wound. (Lipsky et al, 2004).

5.2.4 High blood pressure and blood lipid control

The American Diabetes Association (ADA) has confirmed the reduction of risk of macro vascular complications is possible through blood pressure and lipid control. High blood pressure is a major risk factor for cardiovascular disease and micro vascular complications and the target should be below 140/80mmHg.

Blood lipid control involves lowering low-density lipoprotein (LDL) cholesterol, raising high-density lipoprotein (HDL) cholesterol. Achieving this reduces macro vascular disease and mortality in patients with type II diabetes. Saturated fat and cholesterol intake has to be avoided by diabetic patient.

6. DISCUSSIONS AND CONCLUSION

This is a literature review done to explore about the Diabetic foot ulcer, it's underlying causes and preventive measures.

The results of this study were analyzed in concordance to 'Self Care theory' by Dorothea Orem. This theory discusses on the self-care behavior where a patient should be motivated to take a responsibility in caring themselves through nurses' assistance or education. Self-care is very essential for the proper maintenance of life, health and well-being.

Most of the articles reviewed for this study conclude that a key factor to prevent DFU is through a proper education and self- care responsibility in the patients with diabetes.

Nurses must take-charge on controlling a situation immediately rather than responding to it after it has happened. The foot ulcer can be well prevented during its 1st Stage where there is a presence of low risk, if the patients are aware and educated of the risk factors. Education is one of the most important nursing actions. Awareness should be raised among patients with minimal risk factors. Preventive education can include

methods of self-care for instance cleaning feet daily and inspecting for any blisters, redness, cuts, swelling, dry skin, cracks and callus, not walking with barefoot, and seeking help early in case of any problems. If self-care is impossible due to cognitive disorder or mobility problem then the nurses should educate the patients' family member in preventive foot care. Besides, education other important nursing interventions to prevent the development of foot ulcer can be regular inspection of the feet, identification of the foot at risk, correct foot wear, consulting to the healthcare professionals immediately in emergency cases.

Thus, to conclude, this study especially focuses on the foot care of diabetic patients is an important part. Many serious foot problems can be avoided with early detections. The early the foot at risk is detected the better will be the prognosis. It is extremely essential to understand that with appropriate assessment, management and education DFU is preventable.

7. RECOMMENDATIONS

Diabetic foot ulcer (DFU) is not only a serious complication in diabetic patients but also a major health care concern throughout the world. The treatment of DFU is very challenging and difficult once it is infected. Nursing interventions are very important in preventing DFU. Nurses should offer interventions, which motivates the diabetic patient at low risk to assume self-care responsibility for maintaining overall wellbeing. The studies have also found self-care as one of the most important factor in preventing DFU along with proper education about the risk factors and appropriate management. Nurses should make critical and careful observation during the examination of a foot to recognize a foot at risk and encourage patient to visit health care professionals frequently to prevent further damage on foot.

DFU and amputation causes morbidity and disability but also have immense negative impacts on people lives for example leading social isolation, psychological stress, trauma, and dependency.

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