

# A Cross-sectional Study on the Extended Role of Clinical Pharmacist in Assessing the Risk Factors for Developing Diabetic Foot Ulcers among the Diabetic Patients

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## Abstract

A diabetic foot ulcer (DFU) is the prime cause of poor quality of life among diabetic patients. DFU leads to physical disability and an enormous economic burden on diabetic patients. The development and prognosis of DFU are preventable in most patients by modifying the risk factors for DFU. Programs intervened by clinical pharmacists can enhance rational drugs use and improve the early identification and prevention of DFU. This study intended to prove the beneficial outcome in identifying the risk factors and the provision of patient-tailored referral advice regarding DFU among diabetic patients. This cross-sectional study assessed the neuropathy through Michigan Neuropathy Screening Instrument (MNSI), Monofilament and Vibration test using Tuning Fork and Handheld Doppler for assessing the lower limb vascular disease as per NICE guideline among 137 diabetic patients. 64% of patients were found to have symptoms of neuropathy through the neuropathy assessment test whereas 36% did not have the symptoms. Foot sensory using monofilament test was found to be normal in 49.64% of DFU patients, reduced in 43.80%, and absent in 6.57% of DFU patients. The Ankle Brachial Index (ABI) was found to be normal in 48% of patients, mild in 34% of patients, moderate in 12% of patients, and incompressible in 6% of patients. Clinical Pharmacist intervened risk assessment through Hand-held Doppler, MNSI instrument, and Vibration test helped in screening the DFU patients for Neuropathy, and implementation of effective per patient-tailored education was found to be beneficial in the early identification of DFU and referral to specialty hospitals.

**Key words:** Diabetic foot ulcer, clinical pharmacy services, patient counseling, foot care guideline, screening program

## INTRODUCTION

Diabetic foot ulcer (DFU) complications are the main contributor for the non-traumatic lower extremity amputations among the diabetic patients around the world.<sup>[1-5]</sup> The risk of amputation is estimated to be 15–46 times more in diabetic population than the non-diabetics.<sup>[2,6,7]</sup> More than 25% of admissions are related to DFU rendering economic burden to the diabetic populations.<sup>[8-15]</sup>

Many risk factors are responsible for the development of DFU among the diabetic patients.<sup>[16-20]</sup> The most important predictor is peripheral vascular disease (PVD) and diabetic neuropathy (DN).<sup>[4]</sup> Other notable risk factors include the chronic uncontrolled HbA1c levels, previous history of DFU and previous

amputation history. Foot ulcers along with comorbid conditions can diminish the quality of life (QOL) of patients and lead to lifelong disability.<sup>[21-28]</sup>

Early identification, referral and appropriate treatment can help in the prevention of amputation by 85%.<sup>[29-31]</sup> Regular and careful foot check with inexpensive but effective ways can prevent the development of foot complications.<sup>[32-37]</sup>

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Unfortunately, many of the diabetic patients were not aware of prevention techniques and the costly crowded populations of the hospitals prevent them from getting regular check-ups from the podiatrist care.

Studies involving clinical pharmacy services in identifying risk factors among the diabetic population are scarce in India, and hence, this study<sup>[38,39]</sup> is the pioneer work on the same to identify patients with risk factors to develop DFU and provided with patient-tailored referral advice to mitigate the prognosis and complications of DFU.

## MATERIALS AND METHODS

### Study setting, design, and study period

A cross-sectional study was conducted at a tertiary care hospital outpatient department setting from June 2016 to June 2017. The hospital is a teaching, research, and referral hospital for diabetes patients by the surrounded towns and villages. The study population and the methodology are like the article published by Bunting *et al.*<sup>[10]</sup>

### Study participants and eligibility criteria

Diabetes patients of 18 years and more with or without DFU of either gender, willing to participate were included in the study. The patients were not compelled to follow a specific protocol. Patients who have advanced infective ulcers were excluded from the study.

### Study variables

The patients were assessed for the risk of developing DFU by NICE guidelines. The blood pressure, glucose level, HbA1c level, and the results of Ankle Brachial index were also considered. Advanced patient education was provided as a usual procedure after visiting the physician for the treatment of illness. The co-morbidities and risk factors were noted from the medical records of the patients.

### Sample size and sampling technique

Required sample size was calculated using single population proportion formula based on normal distribution value at 95% confidence interval and margin of error 5%. Based on the average number of patients visiting the facility, the required population is found to be 155. The final sample size after applying 10% of contingency was 110.

### Data collection

Data collection form was framed after tremendous study done with previous literatures published from authorized sources.

Clinical Pharmacist, the researcher had prior training and experience in diabetes and DFU patient counseling and was a certified patient educator by the International Diabetes Federation, India.

### Data processing and analysis

The collected data were entered, and analysis was done using statistical package for social sciences (SPSS) 24. Descriptive data were explained by frequency and percentage. The obtained results were explained by means and standard deviations.

### Ethics approval and consent to participate

Informed consent form was provided to all patients with research information and explained verbally in vernacular languages. This study was approved by the Institutional Ethical Committee separately for phase I and II for a tertiary care hospital. Institutional Ethical Clearance No: IEC No: 1043/IEC/2016 and IEC No: 1168/IEC/2017.

### Risk assessment using hand –held Doppler

It is intended for vascular applications [Figure 1]. It has all the standard features like that of a traditional ultrasound vascular Doppler Figure 1, and the special features are listed [Table 1]. The instrument is supplied with a gel tube, cord, padded carry bag, software for Ankle Brachial Index (ABI) calculation and finally a manual.

The instrument has many best features like a display to show pulse rate digitally and 8MHz Doppler probe with an excellent sound quality. There is an inclusion of the battery recharger. The machine is made with the compatible mode that it can work even with dry cells in case of emergency situations where there are no rechargeable batteries available. The various application of the Doppler is listed [Table 2].



Figure 1: Hand-held doppler machine

The assessment of ABI is done by comparing the blood pressure of upper and lower limbs.<sup>[40-46]</sup> The clinical pharmacist calculated ABI using the software provided by dividing the ankle arterial blood pressure by the brachial arterial blood pressure. If the ratio ranging from 0.91 to 1.30 means the absence of peripheral arterial disease (PAD), 0.71 to 0.90 mild PAD, 0.41 to 0.70 moderate PAD, <0.40 is severe PAD and >1.30 means the presence of incompressible calcified artery.

### Risk assessment using the monofilament test

A standardized 10 g monofilament is pressed against the different parts of the feet to identify the presence of neuropathy.<sup>[47-52]</sup> Application must be repeated twice at the same site, but a single mock application is done in an alternative site in which the filament is not touched. It is considered that there is protective sensation if the patient answered correctly at each site at least 2 out of 3 applications. If the answers are wrong, then it noted that the patient is lacking protective sensation and there is a risk for foot ulceration depicted [Figure 2]. Limb ischemia, ulceration, callus, inflammation, infection, deformity, Charcot arthropathy, and gangrene can



Figure 2: Foot examination using monofilament

Table 1: Features of hand-held doppler machine

S. No	Features of hand-held doppler machine
1	Interchangeable Doppler Probes
2	Unidirectional Doppler
3	8MHz Standard Vascular Probe
4	Continuous Wave Doppler
5	5 and 8MHz Vascular probes
6	Chargeable Battery Operation
7	ABI software to generate results

Table 2: Applications of hand-held doppler machine

S. No	Applications
1	Arterial and venous blood flow examination
2	Ankle brachial index
3	Carotid bifurcation
4	Penile artery study

be identified by viewing patient foot carefully and using monofilament test.

### Risk assessment using the vibration sensation

Vibration sensation must be performed with the unsupported great toe. It is tested bilaterally with the use of a 128 Hz tuning fork.<sup>[53-64]</sup> It is placed over the dorsum of the great toe on the bone projection of the joint. Patients were asked to report when they can no longer sense the vibration with their eyes closed. The clinical pharmacist examined the vibration on his/her distal forefinger first whether they can feel for 5 s or longer. If the vibration is felt over 10 s, then it is decreased. There can be a mock trial with the fork not vibrating for making sure the patients answer with any clue. The scores are given as 1 for present, 2 for reduced, and 3 for absent that is no vibration detected.

### Survey instrument: The Michigan neuropathy screening instrument (MNSI)

The MNSI is used for identifying diabetic neuropathy in T2DM outpatients. The instrument has 15 questions stating “yes” or “no” sensation of pain in the foot, numbness, and sensitivity of temperature.<sup>[65-72]</sup> Of the score is 13 points which indicates more of the neuropathic symptoms. The questionnaire is designed as a self-administered questionnaire to find the self-history by the patient. Summations of all the responses are done to obtain the total score for each patient. One point was given to responses of “yes” to items 1-3, 5-6, 8-9, 11-12, 14-15 and “no” response on items 7 and 13<sup>th</sup> item. Impaired circulation is measured as item number 4 and general asthenia is measured as 10.

## RESULTS AND DISCUSSION

This cross-sectional study was designed to assess the neuropathy through MNSI, Monofilament and Vibration test using Tuning Fork and Hand-held Doppler for assessing the lower limb vascular disease as per NICE guideline. The neuropathy assessment was done for screening purpose only. All the test results were utilized for the individualization of patient education according to the corresponding results.

The Ankle Brachial Index was found to normal in 48% of patients, mild in 34% of patients, moderate in 12% of patients and incompressible in 6% of patients [Table 3].

Foot sensory using monofilament test was found to be normal in 49.64% of DFU patients, reduced in 43.80% and absent in 6.57% of DFU patients as represented [Figure 3]. Foot sensory using vibration test was found to be normal in 53.54% of DFU patients, reduced in 39.37%, and absent in 7.09% of DFU patients as represented [Table 4].

The study called “The Asheville Project” which was initiated in the year 1997 in the city called Asheville, North Carolina. It provided education and personal advice to the employees of the city with chronic illness such as diabetes, asthma, hypertension, and dyslipidaemia.<sup>[73-85]</sup> The research provided intensive education with follow-up by the team of pharmacists. They were counselled for their medications and lifestyle changes. They were able to produce clinical and economical results by highlighting 50% of improvement clinically and significant reduction in total health care cost.<sup>[86-96]</sup>

Table 5 represents the neuropathy assessment by MNSI Instrument. 64% of patients found to have symptoms of neuropathy through the neuropathy assessment test whereas 36% of patients did not have the symptoms of neuropathy. A study by Shahbazian on the risk assessment of DFU among 269 DM patients in the year 2013 revealed that 63% were female and 37% were found to be male. 23% were found to have disturbed sense of vibration, 26% had decreased sensitivity by the monofilament test and 17% were reported to have decreased pain sensation. ABI was found to be abnormal in 6% of the total population.

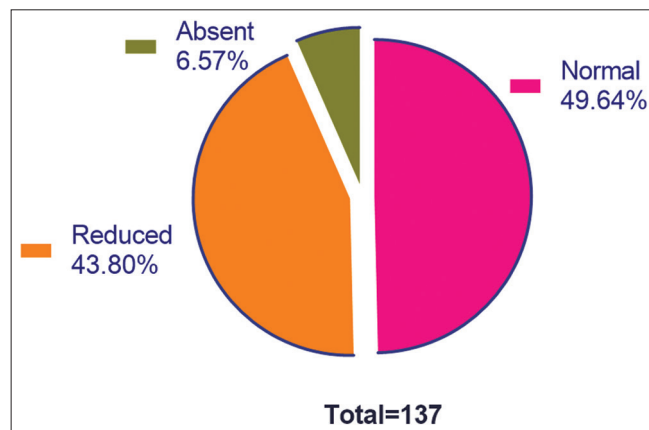


Figure 3: Assessment of foot sensory by monofilament test

The prior history of having ulcer was reported by 7% of the patients. In our study, the 64% of T2DM patients were found to have symptoms of neuropathy symptoms assessed through the neuropathy assessment test whereas 36% did not have the symptoms. Foot sensory using monofilament test was found to be normal in 49.64% of DFU patients, reduced in 43.80%, and absent in 6.57% of patients. Foot sensory using vibration test was found to be normal in 53.54% of DFU patients, reduced in 39.37% and absent in 7.09% patients. The ABI was found to be normal in 48% of patients, mild in 34% of patients, moderate in 12% of patients, and incompressible in 6% of patients. Figure 4 depicts the actual scenario of foot examination performed by clinical pharmacist among



Figure 4: Foot Examination performed by clinical pharmacist among diabetic patients

Table 3: Ankle Brachial Index Report by Hand-held Doppler

Group (n=137)	Ankle Brachial Index				
	Normal (%)	Mild (%)	Moderate (%)	Severe (%)	Incompressible (%)
Interventional group	66 (48)	47 (34)	16 (12)	0	8 (6)

Table 4: Assessment of Foot Sensory Through Vibration Test

Group (n=137)	Foot Sensory		
	Normal (%)	Reduced (%)	Absent (%)
Interventional group	68 (50)	60 (44)	9 (6)

Table 5: Assessment of Neuropathy by MNSI Instrument

Group (n=137)	Neuropathy			
	Present	Percentage (%)	Absent	Percentage (%)
Interventional group	88	64	49	36

diabetic patients in two selected study centers during the research study.

## CONCLUSION

This study is the first successful initiative study by a clinical pharmacist. There are many studies done on KAP assessment, but none demonstrated the effectiveness of clinical pharmacist services in identifying the risk that diabetic patients develop into DFU. Identification and implementing preventive program are the best part any healthcare professional can do. Clinical Pharmacist intervened risk assessment through Hand-held Doppler, MNSI instrument, and Vibration test helped in screening the DFU patients for Neuropathy, and implementation of effective per patient-tailored education was found to be beneficial in the early identification of DFU and referral to specialty hospitals.

## REFERENCES

- International Diabetes Federation. IDF Diabetes Atlas. 7<sup>th</sup> ed. Brussels, Belgium: International Diabetes Federation; 2019. Available from: <http://www.diabetesatlas.org>
- Singh N, Armstrong DG, Lipsky BA. Preventing foot ulcers in patients with diabetes. *JAMA* 2005;293:217-28.
- Pecoraro RE, Reiber GE, Burgess EM. Pathways to diabetic limb amputation. *Basis Prev Diabetes Care* 1990;13:513-21.
- Jeffcoate WJ, Harding KG. Diabetic foot ulcers. *Lancet* 2003;361:1545-51.
- Nabuurs-Franssen MH, Huijberts MS, Kruseman AC, Willems J, Schaper NC. Health-related quality of life of diabetic foot ulcer patients and their caregivers. *Diabetologia* 2005;48:1906-10.
- Vileikyte L. Diabetic foot ulcers: A quality-of-life issue. *Diabetes Metab Res Rev* 2001;17:246-9.
- Robbins JM, Strauss G, Aron D, Long J, Kuba J, Kaplan Y. Mortality rates and diabetic foot ulcers is it time to communicate mortality risk to patients with diabetic foot ulceration. *J Am Pediatr Med Assoc* 2008;98:489-93.
- Ramachandran A, Snehalatha C, Shetty AS, Nanditha A. Trends in prevalence of diabetes in Asian countries. *World J Diabetes* 2012;3:110-7.
- Canavan RJ, Unwin NC, Kelly WF, Connolly VM. Diabetes- and nondiabetes-related lower extremity amputation incidence before and after the introduction of better organized diabetes foot care: Continuous longitudinal monitoring using a standard method. *Diabetes Care* 2008;31:459-63.
- Bunting BA, Smith BH, Sutherland SE. The Asheville project: Clinical and economic outcomes of a community-based long-term medication therapy management program for hypertension and dyslipidemia. *J Am Pharm Assoc* (2003) 2008;48:23-31.
- Wild S, Roglic G, Green A, Sierce R, King H. Global prevalence of diabetes estimates for the year 2000 and projections for 2030. *Diabetes Care* 2004;27:1047-53.
- Nagaraj C, Ramakuri M, Konapur KS. Burden of foot problems in diabetic subjects a community-based study among urban poor in Bangalore, India. *J Diabetic Foot Complicat* 2014;6:60-6.
- World Health Organization. Definition, Diagnosis and Classification of Diabetes Mellitus and its Complications: Report of a WHO Consultation, Department of Noncommunicable Disease Surveillance. Geneva: World Health Organization; 1999.
- EUDIP Group. Establishment of Indicators Monitoring Diabetes Mellitus, and its Morbidity. EUDIP Group; 2002.
- Gebrekirostos K, Solomon G, Fantahun A. Prevalence and factors associated with diabetic foot ulcer among adult patients in ayder referral hospital diabetic clinic Mekelle, North Ethiopia. *J Diabetes Metab* 2015;6:8.
- Prompers L, Schaper N, Apelqvist J, Edmonds M, Jude E, Mauricio D, *et al.* Prediction of outcome in individuals with diabetic foot ulcers: Focus on the differences between individuals with and without peripheral arterial disease. The EURODIAB study. *Diabetologia* 2008;51:747-55.
- Nyamu PN, Otieno CF, Amayo EO, McLigeyo SO. Risk factors and prevalence of diabetic foot ulcers at Kenyatta national hospital, Nairobi, East. *Afr Med J* 2003;80:36-43.
- Spanos K, Saleptsis V, Athanasoulas A, Karathanos C, Bargiota A, Chan P, *et al.* Factors associated with ulcer healing and quality of life in patients with diabetic foot ulcer. *Angiology* 2017;68:242-50.
- Ramsey SD, Newton K, Blough D, McCulloch DK, Sandhu N, Gayle R, *et al.* Incidence, outcomes, and cost of foot ulcers in patients with diabetes. *Diabetes Care* 1999;22:382-7.
- Cancienne JM, Werner BC, Hassanzadeh H, Anuj S, Shen FH, Shimer AL, *et al.* The association of perioperative glycemic control with deep postoperative infection after anterior cervical discectomy and fusion in patients with diabetes. *World Neurosurg* 2017;102:13-7.
- Guzman JZ, Skovrlj B, Shin J, Hecht AC, Qureshi SA, Iatridis JC, *et al.* The impact of diabetes mellitus on patients undergoing degenerative cervical spine surgery. *Spine* 2014;39:1656-65.
- Yasmee Khan, M. Manal, M. Khan, Raza Farooqui, Diabetic foot ulcers: A review of current management. *Int J Res Med Sci* 2017;5:4683-9.
- Gulam-Abbas Z, Lutale JK, Morbach S, Archibald LK. Clinical outcome of diabetes patients hospitalized with foot ulcers, Dar es Salaam, Tanzania. *Diabet Med* 2002;19:575-9.
- Almobarak AO, Awadalla H, Osman M, Ahmed MH. Prevalence of diabetic foot ulceration and associated risk factors: An old and still major public health problem in

- Khartoum, Sudan, *Ann Transl Med* 5;2017;17:340.
25. Lavery LA, Armstrong DG, Wunderlich RP, Mohler MJ, Wendel CS, Lipsky BA. Risk factors for foot infections in individuals with diabetes. *Diabetes Care* 2006;29:1288-93.
  26. Thewjitcharoen Y, Krittiyawong S, Porramatikul S, Parksook W, Chatapat L, Watchareejirachot O, *et al.* Outcomes of hospitalized diabetic foot patients in a multi-disciplinary team setting: Thailand's experience. *J Clin Transl Endocrinol* 2014;1:187-91.
  27. Tewahido D, Berhane Y. Self-care practices among diabetes patients in Addis Ababa: A qualitative study. *PLoS One* 2017;12:e0169062.
  28. Bekele F, Fekadu G, Bekele K, Dugassa D. Incidence of diabetic foot ulcer among diabetes mellitus patients admitted to Nekemte referral Hospital, Western Ethiopia: Prospective observational study. *Endocrinol Metab Syndr* 2019;8:300.
  29. Agha RA, Borrelli MR, Vella-Baldacchino M, Thavayogan R, Orgill DP. For the STROCSS group, the STROCSS statement: Strengthening the reporting of cohort studies in surgery. *Int J Surg* 2017;46:198-202.
  30. Wagner FW. The dysvascular foot: A system for diagnosis and treatment. *Foot Ankle* 1981;2:64-122.
  31. Lipsky BA, Cornia PB, Pile JC, Peters EJ, Armstrong DG, Deery HG, *et al.* Infectious diseases society of America clinical practice guideline for the diagnosis and treatment of diabetic foot infections. *CID* 2012;54:e132-73.
  32. Pscherer S, Dippel FW, Lauterbach S, Kostev K. Amputation rate and risk factors in Type 2 patients with diabetic foot syndrome under real-life conditions in Germany. *Prim Care Diabetes* 2012;6:241-6.
  33. Nelson RG, Gohdes DM, Everhart JE, Hartner JA, Zwemer FL, Pettitt DJ, *et al.* Lower-extremity amputations in NIDDM 12-yr follow-up study in Pima Indians. *Diabetes Care* 1988;11:8-16.
  34. Mariam TG, Alemayehu A, Tesfaye E, Mequannt W, Temesgen K, Yetwale F, *et al.* Prevalence of diabetic foot ulcer and associated factors among adult diabetic patients who attend the diabetic follow-up clinic at the university of Gondar referral hospital, Northwest Ethiopia, 2016: Institutional-based cross-sectional study. *J Diabetes Res* 2017;2017:2879249.
  35. Margolis DJ, Taylor L, Hoffstad O, Berlin J. The association of wound size, wound duration, and wound grade on healing. *Diabetes Care* 2002;25:1835-9.
  36. Wong ML, Coppini DV. Diabetic foot infections: An audit of antibiotic prescribing in a diabetic foot clinic. *Pract Diabetes Int* 2006;23:401-5.
  37. Eneroth M, Larsson J, Jan A. Deep foot infections in patients with diabetes and foot ulcer: An entity with different characteristics, treatments, and prognosis. *J Diabet Complicat* 1999;13:254-63.
  38. Pittet D, Wyssa B, Herter-Clavel C, Krusteiner K, Vaucher J, Lew PD. Outcomes of diabetic foot infection treated conservatively. *Arch Intern Med* 1999;159:851-6.
  39. Lipsky BA. Diabetic foot infections: Current treatment and delaying the post-antibiotic era. *Diabetes Metab Res Rev* 2016;32:246-53.
  40. Deribe B, Woldemichael K, Nemera G. Prevalence and factors influencing diabetic foot ulcer among diabetic patients attending Arbaminch hospital, South Ethiopia. *J Diabetes Metab* 2014;5:322.
  41. Saleem S, Hayat N, Ahmed I, Ahmed T, Rehan AG. Risk factors associated with poor outcome in diabetic foot ulcer patients. *Turk J Med Sci* 2017;47:826-31.
  42. Ferguson TS, Tulloch-Reid MK, Younger NO, Wright-Pascoe RA, Boyne MS, McFarlane SR, *et al.* Diabetic foot complications among patients attending a specialist diabetes clinic in Jamaica: Prevalence and associated factors. *West Indian Med J* 2013;62:216-23.
  43. Nather A, Bee CS, Huak CY, Chew JL, Lin CB, Neo S, *et al.* Epidemiology of diabetic foot problems and predictive factors for limb loss. *J Diabetes Complicat* 2008;22:77-82.
  44. Formosa C, Vella ML, Gatt A. Characteristics predicting foot ulceration outcomes in the diabetic foot. *J Am Podiatr Med Assoc* 2017;107:180-91.
  45. Marzoq A, Shiaa N, Zaboon R, Baghlany Q, Alabood MH. Assessment of the outcome of diabetic foot ulcers in Basrah, Southern Iraq: A cohort study. *Int J Diabetes Metabol* 2019;25:33-8.
  46. Global Lower Extremity Amputation Study Group. Epidemiology of lower extremity amputation in centres in Europe, North America and East Asia. *Br J Surg* 2000;87:328-37.
  47. Icks A, Haastert B, Trautner C, Giani G, Glaeske G, Hoffmann F. Incidence of lower-limb amputations in the diabetic compared to the non-diabetic population. *Exp Clin Endocrinol Diabetes* 2009;117:500-4.
  48. Reiber GE. The epidemiology of diabetic foot problems. *Diabet Med* 1996;13:S6-11.
  49. Bild DE, Selby JV, Sinnock P, Browner WS, Braveman P, Showstack JA. Lower-extremity amputation in people with Diabetes. *Epidemiol Prev Diabetes Care* 1989;12:24-31.
  50. Edmonds ME. Progress in care of the diabetic foot. *Lancet* 1999;354:270-2.
  51. Winkley K, Sallis H, Kariyawasam D, Leelarathna LH, Chalder T, Edmonds ME, *et al.* Five-year follow-up of a cohort of people with their first diabetic foot ulcer: The persistent effect of depression on mortality. *Diabetologia* 2012;55:303-10.
  52. Brod M. Quality of life issues in patients with diabetes and lower extremity ulcers: patients and care givers. *Qual life Res* 1998;7:365-72.
  53. Popkin BM, Gordon-Larsen P. The nutrition transition: Worldwide obesity dynamics and their determinants. *Int J Obes Relat Metab Disord* 2004;28 Suppl 3:S2-9.
  54. Unwin N. The diabetic foot in the developing world. *Diabetes Metab Res Rev* 2008;24 Suppl 1:S31-3.
  55. Boulton AJ, Vileikyte L, Ragnarson-Tennvall G, Apelqvist J. The global burden of diabetic foot disease. *Lancet* 2005;366:1719-24.

56. Abol Hassani F, Tehrani MR, Tabatabaei O, Larijani B. Burden of diabetes and its complications in Iran in the year 2000. *Iran J Diabetes Lipid Disord* 2005;5:35-48.
57. Boulton AJ. Why bother educating the multi-disciplinary team and the patient the example of prevention of lower extremity amputation in diabetes. *Patient Educ Couns* 1995;26:183-8.
58. Cavanagh PR, Lipsky BA, Bradbury AW, Botek G. Treatment for diabetic foot ulcers. *Lancet* 2005;366:1725-35.
59. Beuker BJ, Van Deursen RW, Price P, Manning EA, Van Baal JG, Harding KG. Plantar pressure in off-loading devices used in diabetic ulcer treatment. *Wound Repair Regen* 2005;13:537-42.
60. Hilton JR, Williams DT, Beuker B, Miller DR, Harding KG. Wound dressings in diabetic foot disease. *Clin Infect Dis* 2004;39 Suppl 2:S100-3.
61. Edmonds M, Foster A. The use of antibiotics in the diabetic foot. *Am J Surg* 2004;187:25S-28.
62. Brem H, Balledux J, Bloom T, Kerstein MD, Hollier L. Healing of diabetic foot ulcers and pressure ulcers with human skin equivalent: A new paradigm in wound healing. *Arch Surg* 2000;135:627-34.
63. Veves A, Falanga V, Armstrong DG, Sabolinski ML. Graftskin, a human skin equivalent, is effective in the management of non-infected neuropathic diabetic foot ulcers: A prospective randomized multicentre clinical trial. *Diabetes Care* 2001;24:290-5.
64. Ballard K, Baxter H. Developments in wound cares for difficult to manage wounds. *Br J Nurs* 2000;9:405-8, 410, 412.
65. Osterberg L, Blaschke T. Adherence to medication. *N Engl J Med* 2005;353:487-97.
66. Belatti DA, Phisitkul P. Declines in lower extremity amputation in the US Medicare population, 2000-2010. *Foot Ankle Int* 2013;34:923-31.
67. Bowering CK. Diabetic foot ulcers. Pathophysiology, assessment, and therapy. *Can Fam Physician* 2001;47:1007-16.
68. Fard AS, Esmaelzadeh M, Larijani B. Assessment and treatment of diabetic foot ulcer. *Int J Clin Pract* 2007;61:1931-8.
69. DiPreta JA. Outpatient assessment and management of the diabetic foot. *Med Clin North Am* 2014;98:353-73.
70. Shahbazian H, Yazdanpanah L, Latifi SM. Risk assessment of patients with diabetes for foot ulcers according to risk classification consensus of international working group on diabetic foot (IWGDF). *Pak J Med Sci* 2013;29:730-4.
71. Shaw JE, Sicree RA, Zimmet PZ. Global estimates of the prevalence of diabetes for 2010 and 2030. *Diabetes Res Clin Pract* 2010;87:4-14.
72. Cavanagh PR, Lipsky BA, Bradbury AW, Botek G. Treatment for diabetic foot ulcers. *Lancet* 2005;366:1725-35.
73. Leone S, Pascale R, Vitale M, Esposito S. Epidemiology of diabetic foot. *Infect Med* 2012;20 Suppl 1:8-13.
74. Richard JL, Schuldiner S. Epidemiology of diabetic foot problems. *Rev Med Interne* 2008;29 Suppl 2:S222-30.
75. Nather A, Bee CS, Huak CY, Chew JL, Lin CB, Neo S, *et al.* Epidemiology of diabetic foot problems and predictive factors for limb loss. *J Diabetes Complications* 2008;22:77-82.
76. Bakri FG, Allan AH, Khader YS, Younes NA, Ajlouni KM. Prevalence of diabetic foot ulcer and its associated risk factors among diabetic patients in Jordan. *J Med J* 2012;46:118-25.
77. Iraj B, Khorvash F, Ebneshahidi A, Askari G. Prevention of diabetic foot ulcer. *Int J Prev Med* 2013;4:373-6.
78. Fard AS, Esmaelzadeh M, Larijani B. Assessment and treatment of diabetic foot ulcer. *Int J Clin Pract* 2007;61:1931-8.
79. Snyder RJ, Hanft JR. Diabetic foot ulcers--effects on QOL, costs, and mortality and the role of standard wound care and advanced-care therapies. *Ostomy Wound Manage* 2009;55:28-38.
80. Vileikyte L. Diabetic foot ulcers: A quality-of-life issue. *Diabetes Metab Res Rev* 2001;17:246-9.
81. Tennvall GR, Apelqvist J. Health-economic consequences of diabetic foot lesions. *Clin Infect Dis* 2004;39 Suppl 2:S132-9.
82. Boulton AJ, Vileikyte L, Ragnarson-Tennvall G, Apelqvist J. The global burden of diabetic foot disease. *Lancet* 2005;366:1719-24.
83. Frykberg RG, Zgonis T, Armstrong DG, Driver VR, Giurini JM, Kravitz SR, *et al.* Diabetic foot disorders. A clinical practice guideline. *J Foot Ankle Surg* 2006;45:S1-66.
84. Bortoletto MS, de Andrade SM, Matsuo T, Haddad Mdo C, González AD, Silva AM. Risk factors for foot ulcers--a cross sectional survey from a primary care setting in Brazil *Prim Care Diabetes* 2014;8:71-6.
85. Patout CA, Birke JA, Horswell R, Williams D, Cerise FP. Effectiveness of a comprehensive diabetes lower-extremity amputation prevention program in a predominantly low-income African American population. *Diabetes Care* 2000;23:1339-42.
86. Driver VR, Madsen J, Goodman RA. Reducing amputation rates in patients with diabetes at a military medical centre: The limb preservation service model. *Diabetes Care* 2005;28:248-53.
87. Sumpio BE, Aruny J, Blume PA. The multidisciplinary approach to limb salvage. *Acta Chir Belg* 2004;104:647-53.
88. Wraight PR, Lawrence SM, Campbell DA, Colman PG. Creation of a multidisciplinary, evidence based, clinical guideline for the assessment, investigation and management of acute diabetes related foot complications. *Diabet Med* 2005;22:127-36.
89. Aydin K, Isildak M, Karakaya J, Gürlek A. Change in amputation predictors in diabetic foot disease: Effect of multidisciplinary approach. *Endocrine* 2010;38:87-92.
90. Lepántalo M, Apelqvist J, Setacci C, Ricco JB, de Donato G, Becke RF, *et al.* Diabetic foot. *Eur J Vasc Endovasc Surg* 2011;42 Suppl 2:S60-74.

91. Mensing C, Boucher J, Cypress M, Weinger K, Mulcahy K, Barta P, *et al.* National standards for diabetes self-management education. *Diabetes Care* 2015;28 Suppl 1:S72-9.
92. Malone JM, Snyder M, Anderson G, Bernhard VM, Holloway GA, Bunt TJ. Prevention of amputation by diabetic education. *Am J Surg* 1989;158:520-3; discussion 523-524.
93. Gershater MA, Pilhammar E, Apelqvist J, Alm-Roijer C. Patient education for the prevention of diabetic foot ulcers: Interim analysis of a randomised controlled trial due to morbidity and mortality of participants. *EDN* 2011;8:102-7.
94. Dorresteijn JA, Kriegsman DM, Assendelft WJ, Valk GD. Patient education for preventing diabetic foot ulceration. *Cochrane Database Syst Rev* 2012;10:CD001488.
95. Cranor CW, Christensen DB. The Asheville project: Short-term outcomes of a community pharmacy diabetes care program. *J Am Pharm Assoc (Wash)* 2003;43:149-59.
96. Shahbazian H, Yazdanpanah L, Latifi SM. Risk assessment of patients with diabetes for foot ulcers according to risk classification consensus of international working group on diabetic foot (IWGDF). *Pak J Med Sci* 2013;29:730-4.

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