

Avoidance of lower limb amputation from a diabetic foot ulcer: The importance of multidisciplinary practice and patient collaboration

ABSTRACT

This article explores wound care nursing interventions and inter-professional collaboration for a patient referred with a stage 3 diabetic foot ulcer (DFU). To the patient's distress, he had been informed that he may require an amputation due to the severity of his DFUs. On initial presentation, the patient was symptomatic for peripheral neuropathy, infection and hyperglycaemia. The left lower limb was oedematous and there was a DFU at the metatarso-phalangeal joint of the big toe on his left foot secondary to haemorrhagic callus. Progressive healing of the DFU was realised over time by repetitive debridement; incision and drainage of the DFUs; antibiotic therapy; appropriate footwear; dietary instructions; control of the blood sugar levels (BSLs); and patient and family education.

Wound care nursing interventions were applied in conjunction with medical management of the DFUs. The DFUs were managed using a locally made, two-part zinc oxide gauze dressing known as the Unna boot. A family member was instructed how to continue applying the dressings at home in between clinic visits. Complete wound healing was eventually achieved within four months, thus avoiding the need for amputation.

Keywords Diabetes, diabetic foot ulcer, debridement, nursing interventions, patient education, multidisciplinary collaboration.

For referencing Mungai M and Sirmah E. Avoidance of lower limb amputation from a diabetic foot ulcer: The importance of multidisciplinary practice and patient collaboration. WCET® Journal 2019; 39(2):19–27

DOI <https://doi.org/10.33235/wcet.39.2.19-27>

INTRODUCTION

Diabetes mellitus (DM) will be the seventh leading cause of death by 2030 as predicted by the World Health Organization¹. About 80% of deaths due to DM occur in low- to medium-income countries^{2,3}.

Foot ulceration is the main complication affecting lower limb extremities in patients with DM, the management of which is costly. The global prevalence of risk of diabetic foot ulcers (DFUs) in patients with DM is 40–70%⁴. The prevalence of DM in Kenya ranges between 2.2%⁵ and 2.4%⁶.

The International Working Group on the Diabetic Foot (IWGDF) defines a DFU as an, "Infection, ulceration or destruction of tissues of the foot associated with neuropathy and/or peripheral artery disease in the lower extremity of a person with [a history of] diabetes mellitus"⁷. Within a cohort of 1788 patients with DM at Kenyatta National Hospital, the prevalence of DFUs was 4.6% (n=84)⁸.

DFU development is associated with multiple risk factors, which can be grouped into systemic factors and local factors. The primary systemic factors are diabetic peripheral neuropathy (DPN) and peripheral arterial disease (PAD). Other systemic factors include: peripheral vascular disease, chronic renal disease, male gender, abnormal glycated haemoglobin level (HbA1c), more than 10 years' duration with DM, advancing age, a high BMI, obesity and retinopathy. Local factors include foot deformity, high plantar pressures and haemorrhagic callus formation, infection, shear, pressure and stress on the lower extremities due to poorly fitting footwear, other external trauma; and, suboptimal self-care habits⁸⁻¹¹.

The majority of DFUs develop from minor trauma in the presence of sensory neuropathy or loss of protective sensation, which is associated with poor blood supply due to microvascular disease from DM¹². Foot infection in patients with DM

Margaret Mungai*

MBA-Strategic Mgt, IIWCC, BSC N
Moi Teaching & Referral Hospital
Eldoret, Kenya (East Africa)
Deputy Director Nursing-Clinical Services
Moi Teaching and Referral Hospital in Eldoret Kenya
Email margiemungai@gmail.com/margaretmungai@mtrh.go.ke

Emmy Sirmah

Wound Care Nurse
Wound Care Services Clinic
Moi Teaching and Referral Hospital Eldoret, Kenya

*Corresponding author



Figure 1: Mr MM, a 59-year-old male with DM on Mixtard insulin, but all is not well.



Figure 2: Haemorrhagic callus, painless pressure wound on the left metatarso-phalangeal joint.

is common, with more than 50% of patients with DFUs having an infected ulcer¹³. These infections can range from simple infections, cellulitis and abscess formation to more severe infections such as pyomyositis, osteomyelitis and gangrene^{14,15}.

In addition to the classic signs of infection (heat, pain, redness, swelling) DFUs exhibit signs of inflammation or purulence. Other signs of infection in DFUs are malodour, high temperature within 4 cm of the ulcer margin, non-purulent or purulent secretions, friable or discoloured granulation tissue, undermining of wound edges, continuous wound breakdown, and evidence of poor wound healing^{10,16-18}. Patients with DFUs are at increased risk of infection if they have experienced one or more of the following: a traumatic wound, an ulcer for more than 30 days, a history of walking barefoot, a wound that probes to bone, previous lower extremity amputation and loss of protective sensation¹⁶.

The Wagner Diabetic Foot Ulcer Classification System is commonly used to classify DFUs by grading ulcer depth and presence of infection from 0 to 5. DFUs that have abscesses, joint sepsis or osteomyelitis are usually deep ulcers that are grade 3 within the Wagner Diabetic Foot Ulcer Classification System^{16,19}.

The current approach in the management of patients with DM focuses heavily on the prevention of DFU formation and/or recurrence³ and lower extremity amputations (LEAs). Preventive multidisciplinary care in DFU aimed at conservative treatment is less costly compared to amputation costs incurred by patients and health services²⁰. In addition, health care providers should aim to improve the health-related quality of life of patients with DFUs, which is low in this patient cohort²¹.

CASE STUDY

Patient overview and presenting complaint

Mr MM, a 59-year-old male, was referred from the company clinic to our hospital with uncontrolled DM, gradual loss of vision and a haemorrhagic callus on his left big toe.

On presentation at the Moi Teaching and Referral Hospital DM clinic, Mr MM's left leg was oedematous (Figure 1) and the haemorrhagic callus (Figure 2) at the metatarso-phalangeal joint of the big toe was clearly evident. His medical history indicated he had had DM since 1996, developed hypertension in 2000 and was treated for cellulitis in his right big toe in August 2017 that healed well. His medications included Mixtard insulin 20 international units in the morning and 10 international units in the evening. Mr MM had been unable to control his blood sugar levels (BSLs) and his fasting blood sugar now ranged between 20 and 22 mmol.

Mr MM had not noticed anything untoward with his foot or toe until the area became very painful and he asked his son to check his feet. He thought the problem was due to poorly fitting shoes, which he had used for some time. He reported no history of trauma; however, he had little sensation in the foot area. He had little appetite and had lost weight from 150 kg to 140 kg. His eyesight had deteriorated to the extent that he could no longer read the daily newspaper.

On his initial visit to the wound care clinic, he was brought in a wheelchair and looked depressed. He stated that if he had to have an amputation, he would not be able to use crutches due to his poor eyesight and heavier body weight.

Interventions and wound management plan

Foot assessment

On palpation, both dorsalis pedis and posterior tibial pulses were absent on the left leg, but were well palpable on the right leg.

His ABI was at 0.92 with an ankle systolic pressure of 168 mmHg and an arm systolic pressure of 154 mmHg. Self-foot care assessment indicated that Mr MM required assistance due to body weakness, poor vision and not reaching his feet. Health information on the effects of DM on the foot among other body parts was provided to the son and brother-in-law, who accompanied him including inspection under light for any abnormality/deformities.



Figure 3a: Referred to Moi Teaching Referral Hospital DM clinic for admission and management from the company health clinic.



Figure 3b: Initial debridement of haemorrhagic callus, cleaning with normal saline and tulle gauze was done.



Figure 4: Mr MM developed a second ulcer on 12 November 2018, hence referred to the orthopaedic surgeon at the orthopaedic fracture clinic.

Wound assessment at the wound care clinic upon referral by orthopaedic surgeon for wound care services.



Figure 5: Repeat debridement was done and consult to orthopaedic technology officer for offloading services.

Loss of sensations was detected by touching his foot at different parts with his eyes closed because neither the Semmes Weinstein monofilaments nor the Doppler machine are available at the wound care clinic. Mr MM's capillary refilling time on his toes was 4–5 seconds; however, there was no associated sensation experienced by Mr MM when this assessment was undertaken.

Wound debridement

During Mr MM's initial visit to the DM clinic the callus beneath his left metatarso-phalangeal joint of the big toe was debrided. Following this initial debridement of the callus the wound was classified as a stage 2 DFU using the Wagner Diabetic Foot Ulcer Grade Classification System (Figure 3).

At the first visit in the wound care clinic on 12 November 2018, wound assessment, cleaning with warm water, repeat debridement and application of the locally produced two-part zinc oxide Unna boot was done (Figures 4, 5 and 6) and Mr MM was advised to come back in two days' time.

Mr MM's foot was noted to be very warm with localised swelling and pitting oedema on the second visit on 14 November 2018 (Figure 7) when Mr MM was due for the second application of the Unna boot, which we had scheduled on alternate days after the first application. The clinical diagnosis of pyomyositis was arrived at based on the signs and symptoms present in the foot, which were the presence of an abscess and localised oedema.

The affected foot felt hot on palpation, with a body temperature of 37.8°C by use of the clinic infrared thermometer. Mr MM could slightly move all toes of the left foot including a small range of dorsiflexion and plantar flexion upon instructions.

Local incision and drainage of the pyomyositis as well as sharp debridement of necrotic tissue and residual periwound callus was undertaken within the clinic. Antibiotic therapy was commenced with a course of Clindamycin to combat the infection associated with the pyomyositis. This was given at 1 gram orally every 8 hours for 7 days. Unfortunately, a pus swab for culture and sensitivity to identify the specific causative agent was unable to be obtained at the time (Figures 8 –11). Mr MM's DFU was now re-classified to stage 3 on the Wagner Diabetic Foot Ulcer Classification, having developed into a deep ulcer with abscess formation.

Mr MM noticed the first wound, which was painless with haemorrhagic callus (Figure 2), on 5 November 2018; hence he visited the company health facility on 6 November 2018. He was advised to come to our hospital for further management, but only arrived at the DM clinic on 10 November 2018. Debridement of the haemorrhagic callus and grading of the first wound was done (Figure 3a and b).

The second wound was noted on 12 November 2018 when he went for review at the DM clinic as advised and this was when



Figure 6: 12 November 2018 first Unna boot applied by the authors to come back on alternate days for review.



Figure 7: 14 November 2018, Mr MM came for the second time but alarmingly has signs of pyomyositis.



Figure 8: Consulted registered clinical officer orthopaedics in absence of the orthopaedic surgeon who did incision and drainage of pus.



Figure 9a: A third wound upon incision and drainage. Unbeknownst to Mr MM, the three wounds were communicating, as seen during syringing out pus with normal saline upon debridement.



Figure 9b: Serial cleaning, debridement and syringing continued until the communicating sinuses closed.

he was referred to the orthopaedic surgeon at the orthopaedic clinic for further evaluation. It was at this point the orthopaedic surgeon after his review advised the patient to come to our wound care clinic for wound care services.

The third wound developed on 14 November 2018 upon incision and drainage of the pus due to pyomyositis, which was noted on examination of the wound before cleaning (Figures 7 and 8). The three wounds were noted to be communicating when syringing out pus was being carried out upon debridement (Figure 9).

Wound management

At the DM clinic, the wound had initially been cleaned with normal saline, debrided using a surgical blade and artery forceps and dressed with Sufratulle and gauze dressing.

At the wound care clinic, wound cleaning was done with warm tap water, serial sharp debridement using a surgical blade and artery/dissecting forceps was done under no anaesthesia/analgesics as Mr MM was not feeling pain at all and the application of a locally produced two-part zinc oxide dressing was also done.

As Mr MM had a degree of left lower limb oedema (Figure 1) that indicated circulatory stasis this necessitated the use of slight compression during the initial period of Unna boot dressing application. Compression was eventually stopped with consequent dressing once all oedema subsided.

At each subsequent dressing change the wound was debrided as required and application of a locally manufactured zinc oxide dressing (Unna boot) done. The first Unna boot was applied on 12 November 2018 after repeat debridement (Figures 5 and 6). The second dressing change with the Unna boot was carried out on 14 November 2018 after incision and drainage. The third Unna boot dressing change was on 16 November 2018 and thereafter continued every Monday and Friday as an outpatient for a period of two months. The frequency of debridement with debridement was adjusted to every Monday and for the whole of the third month as we taught the son how to undertake the dressing changes at home. He would thereafter change the dressing on a Monday then come to the clinic fortnightly for us to assess the patient and the wound as well as evaluate his dressing change skills. This regime was continued with the locally produced zinc oxide



Figure 10: Serial debridement continued and patient reported improved sensation, general appearance, general well-being and improved sight.



Figure 11: Serial debridement, dietary advice, padded shoes and sugar control. Mr MM bought a glucometer for home monitoring. Much progress achieved.



Figure 12: On 3 January 2019, the wound looking stagnated though on debridement a lot of bleeding was noted.



Figure 13a: Home-based care. Having achieved good progress, we taught his son who could dress and apply the Unna boot at home.



Figure 13 b: Unna boot and crêpe bandage well applied by the son at home.

dressing — Unna boot — as the primary dressing at the clinic and at home until complete healing of the three wounds was achieved on 17 March 2019 after a period of four months.

Multidisciplinary approach

The management of Mr MM's DFUs was complex, requiring a multidisciplinary team approach to guide his care.

Orthopaedic surgeon

Mr MM's first visit and debridement of haemorrhagic callus was on 10 November 2018. The second ulcer developed or was noted on 12 November 2018 when Mr MM came to the DM clinic for the second time after which he was referred to the orthopaedic surgeon. The orthopaedic surgeon evaluated the foot pulses at the dorsalis pedis, posterior/anterior tibial and ordered foot x-rays. Upon reviewing the x-rays report, he referred the patient for wound care services since there was no bone involvement.

Pyomyositis was later diagnosed on 14 November 2018 which led to the development of the third wound upon incision and drainage by the registered clinical officer orthopaedics (Figures 8 & 9a). It was not possible to involve the orthopaedic surgeon at the time, but the clinical officer also specialised in orthopaedics and worked closely with the orthopaedic surgeon completed the incision and drainage as well as prescribing the oral Clindamycin 1 g eight hourly for 7 days.

Orthopaedic technologist: foot and pressure offloading

A key intervention in the management of Mr MM's DFUs was offloading of pressure on his affected foot. He was reviewed by an orthopaedic technologist and was advised about the benefits of offloading as well as changes required to his shoes. In accordance with the advice from the orthopaedic technologist, his shoes were changed to open padded shoes rather than enclosed shoes.

Dietitian

A dietitian, diabetes educator and nursing staff provided advice on dietary requirements, control of BSLs and general health education inclusive of daily foot examination and care to both Mr MM and the relatives.

Psychosocial support

At times, the DFUs showed signs of stagnation in wound healing where there were no changes to the status of the wound (Figure 12). In these instances, counselling and psychological support was offered to Mr MM that this often occurred with wounds of this nature. He was encouraged to continue with all aspects of his treatment regimes.

Discharge planning, community care and long-term follow-up

A family therapy session was undertaken with Mr MM, Mr MM's wife and son on home-based wound care, dietary regime,



Figure 14: On 25 January 2019 during a wound clinic dressing change, wound is healing well. Sugars are well controlled and patient to report back to work but continue with weekly dressing change.



Figure 14: On 17 March 2019, wound healing achieved at last. Mr MM has resumed his normal life but on follow-up care at the DM clinic.

foot examination and BSL monitoring. The importance of Mr MM actively participating in his self-care where possible was stressed to avoid deterioration and/or recurrence of his DFUs and improve his overall well-being.

Mr MM's wife and son were taught how to examine the wound, check for pre-ulcerative signs on the foot and apply the Unna boot wound dressing (Figure 13a and 13b). Education was also provided on how to recognise ill-fitting or inadequate footwear, given that the wearing of adequate footwear is a key factor in preventing DFU recurrence.

Mr MM purchased a glucometer for home monitoring of his fasting BSLs, which had stabilised at 6–8 mmol/L.

DISCUSSION

Most patients with DM will suffer from a DFU at one time during their lifetime²². DFUs are a cause of high morbidity and mortality that also incur substantial financial costs²³.

Diabetic neuropathy causes defects in pain sensation from the loss of sensory perception in the foot; hence the lack of early care-seeking behaviour by patients with diabetic neuropathy. Insensate feet are susceptible to increased shear and pressure

on the plantar surfaces or soles of the foot and consequently increased injury²⁴. Motor neuropathy causes wasting of intrinsic foot muscles while autonomic neuropathy affects sweating with dryness and scaling of the feet. These phenomena lead to ulcer development, foot deformity and defects in joint mobility.

The management of patients with DFUs is, unfortunately, often implemented by health care providers whose existing knowledge and insight into causative factors, diagnosis and management of DFUs is suboptimal. Even in developed countries, diabetes specialists refer patients to community nursing services where the nurses lack the requisite knowledge and clinical competency to manage such wounds proficiently²⁵. As a multifaceted problem, evidence-based protocols, strengthening of multidisciplinary team functioning and specific health care facility clinical regimens achieve better outcomes. Nurse-based foot care programs have been found to be effective in the prevention of DFUs²⁶.

Nurses are responsible for the management of DFUs referred for wound care services at the Moi Teaching and Referral Hospital, Kenya. The hospital management has enabled one orthopaedic surgeon, two nurses, one registered clinical officer, one physiotherapist and one occupational therapist to undertake the IIVCC wound care course at Stellenbosch University RSA from 2010 to date.

Diabetes Kenya, formerly called Kenya Diabetes Association, works closely with the International Diabetes Federation to enable training of multidisciplinary diabetes educators in our hospital who are currently six in number (three nurses, one registered clinical officer and two physicians). These teams (wound/diabetes) organise in-house training for other staff in the hospital as well as attending national conferences and seminars when possible to enhance their knowledge and practice geared towards developing an enthusiastic wound community of practice at the hospital.

Mr MM was referred from a company clinic more than 100 kilometres away due to lack of health care providers who felt comfortable in managing his DFU.

The management of DFUs is often complex and requires a multidisciplinary approach to achieve optimal patient outcomes. The multidisciplinary team can: reduce the incidence of DFU complications and associated severity of those complications; reduce amputations; improve a patient's quality of life; and, increase their life expectancy²². In this case, the collective clinical input from the orthopaedic surgeon, the orthopaedic technologist, dietitian, counsellor and nursing staff in conjunction with Mr MM's family were able to salvage Mr MM's foot, facilitate wound healing and avoid amputation of part or all of his foot. Key interventions in the management of Mr MM's wounds were wound debridement, local wound care, pressure offloading and stabilisation of Mr MM's BSLs, patient education and psychosocial support.

Wound debridement of devitalised, unhealthy tissue to expose healthy, bleeding tissue allows for greater visualisation of the

extent of the ulcer and the presence of indwelling abscesses or sinuses^{27,28}. Further, it decreases the risk of spreading infection, and reduces periwound pressure from the presence of callus, all of which enhance normal wound contraction and healing²⁹. In patients with DFUs, it is estimated that 20% of those with moderate to severe infections require an amputation at some level^{30,31}. Conservative sharp wound debridement was, therefore, undertaken at every dressing change.

The wound care regimen consisted of cleaning with warm tap water, sharp debridement by surgical blade and artery/dissecting forceps, syringing with normal saline using a 20 cc syringe and application of the primary zinc oxide dressing with a 6-inch crêpe bandage for the outer dressing.

The frequency of the serial debridement and dressing change was initially on alternate days for the first week due to the infection, followed by every Monday and Friday (twice a week) and thereafter every Monday (once a week) but the son would do it at home for one week then come to the clinic fortnightly during the fourth month of wound care.

The application of a locally manufactured zinc oxide dressing (Unna boot) alongside key basic wound care principles was used for a period of four months to facilitate wound healing. Zinc oxide within the dressing is thought to decrease inflammation, protect the surrounding skin, enhance re-epithelisation and reduce oedema. The Unna boot zinc oxide bandage dries to form a warm, snug boot around the lower limb that supports venous return by providing high pressure with muscular contraction when the patient walks but little pressure on resting, which aids healing of the ulcer.

While patients are accepting of this dressing it is imperative staff are trained in the correct foot and wound assessment and application of this dressing to avoid constriction of the limb and arterial occlusion in the presence of neuropathy³²⁻³⁴. It was important to assess the vascular flow along the dorsalis pedis and posterior tibial arteries²⁹ before applying any compression to a lower limb. Mr MM reported he felt more secure and confident with his left leg upon application of the Unna boot.

Ideally, management of DFUs requires the person to be non-weight bearing on the affected area to enhance healing. There are a variety of strategies to off-load the pressure from DFUs, including off-the-shelf orthotic footwear, customised footwear including insoles, contact casting and external padding that can be moulded to suit the contours of the foot. The type of offloading used depends on patient and environmental factors, access to and cost of orthotic footwear^{35,36}. Taking these factors into consideration and to facilitate off-loading of Mr MM's DFU, the orthopaedic technologist advised the use of open, padded shoes. The orthopaedic technologist did not place any additional padding on Mr MM's foot, but recommended larger padded, open shoes to alleviate pressure on the wounds. He advised that the shoes Mr MM was wearing were tight with non-padded straps and buckles that led to the development of the second wound.

DFUs seriously affect health-related quality of life due to reduced accomplishment of physical activities of daily living that affects psychological and social well-being. This can lead to social isolation in general, tension that adversely affects family relationships, financial hardship from loss of productivity or job loss and emotional stress and depression within the person with the DFU³⁷. These factors, however, are influenced by an individual patient's clinical characteristics, including social demographic and environmental factors³⁸.

Self-care is a primary factor in attaining optimal health and management of DM. This can be effectively achieved by the use of nursing theories and models such as Orem's Self-care Model³⁸. Borji *et al.* state that, "Self-care is considered as an important and valuable principle because it emphasizes the active role of people in their own healthcare, not the passive. Further, ... Self-care behaviour is affected by the total skills and knowledge that a person (or relatives) has and uses for his practical efforts", to alter those factors that affect a person's health and well-being³⁹.

Consequently, nurses play a key role in patient and family education by assisting patients and their families to understand the underlying causes of DM and DFUs. This knowledge allows patients and their families to play an active role in problem solving and decision making with respect to their clinical and psychosocial care^{40,41}.

Educating Mr MM and his family about his diet and the importance of diet and exercise in assisting to stabilise his DM and BSLs was one example of self-care where Mr MM was able to be an active participant in his care.

Nursing staff also provided clinical education to Mr MM's wife and son on how to manage Mr MM's wounds and foot care at home. This included the application of the Unna boot dressing (Figures 13a and 13b) at home.

As there is a high possibility of developing a new ulcer after successful treatment of a DFU on the same site or on a different site of the same limb or the contra-lateral limb⁴², following up Mr MM as an outpatient has been maintained to ensure his DFU does not re-occur, which is very important.

Variants of diabetic foot complications are more prevalent now. This is due to the increased global incidence of DM as well as the longer life expectancy realised with better management. This requires a paradigm shift for DM care providers to focus on current and emerging trends for prevention, diagnosis and management of DFUs among other diabetic foot complications²⁷. There is the need, therefore, to direct DM education and management of diabetic wounds towards health professionals as much as the patients because health care providers and health professionals can contribute to development as well as deterioration of DFUs⁴³. The increase in DM and DFUs globally requires the attention of all health care professionals and, in particular, the adoption of effective multidisciplinary team approach to diagnosis and management, inclusive of nursing and patient participation⁴⁴.

CONCLUSION

The incidence of DM and DFUs is escalating around the world. Not all health care providers and health professionals are sufficiently educated to assess and manage DFUs. The referral of patients with DFUs to health care facilities with expertise in the assessment and management of DFUs is critical to successful patient and health provider outcomes.

Referral of Mr MM to our hospital, where a multidisciplinary approach to the management of his DFU was adopted, facilitated wound healing, limb salvage and prevention of an unnecessary amputation of his lower left leg, which undoubtedly improved his overall quality of life.

Nurses with expertise in wound management applied self-care theory to educate Mr MM and his family regarding his DM, BSL control and monitoring, care of his wounds and care of his feet within the clinic and community settings.

ACKNOWLEDGEMENTS

We wish to thank Dr Aileen Chang of the University of California and a visiting lecturer at Moi University/Ampath Eldoret, for her guidance in writing this manuscript.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

FUNDING

The authors received no funding for this study.

REFERENCES

1. World Health Organization (WHO). Global Health Estimates: Death by cause, Age, Sex and County 2000–2012. Geneva: WHO; 2014.
2. World Health Organization (WHO). World Health Day 2016: Beat Diabetes.
3. Armstrong DG, Boulton AJM & Bus SA. Diabetic foot ulcers and their recurrence. *New Engl J Med* 2017; 376(24):2367–2375. <https://doi.org/10.1056/NEJMra1615439>
4. Boulton AJM. The diabetic foot: grand overview, epidemiology and pathogenesis. *Diabetes Metab Res Rev* 2008; 24(Suppl 1):S3–6. doi: 10.1002/dmrr.833.
5. International Diabetes Federation (IDF). Diabetes Atlas, 7th edn. IDF; 2015.
6. Mohamed SF, Mwangi M, Mutua MK *et al.* Prevalence and factors associated with pre-diabetes and diabetes mellitus in Kenya: results from a national survey. *BMC Public Health* 2018; 18(Suppl 3):1215. <https://doi.org/10.1186/s12889-018-6053-x>
7. IWGDF Editorial Board. IWGDF Definitions and Criteria. IWGDF; 2019. Available at: <https://iwgdfguidelines.org/definitions-criteria/>. Accessed 04/23, 2019.
8. 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 Jan; 80(1):36–43.
9. Waaijman R, de Haart M, Arts ML *et al.* Risk factors for plantar foot ulcer recurrence in neuropathic diabetic patients. *Diabetes Care* 2014; 37(6):1697–705. doi: 10.2337/dc13-2470.
10. Cutting KE & Harding KG. Criteria for identifying wound infection. *J Wound Care* 1994; 3(4):198–201.
11. Kibachio JM, Omolo J, Muriuki Z *et al.* Risk factors for diabetic foot ulcers in type 2 diabetes: a case control study, Nyeri, Kenya. *African Journal of Diabetes Medicine* 2103; 21(1):20–23.
12. McNeely MJ, Boyko EJ, Ahroni JH *et al.* The independent contributions of diabetic neuropathy and vasculopathy in foot ulceration. How great are the risks? *Diabetes Care* 1995; 18(2):216–19.
13. Prompers L, Hujberts M, Apelqvist J *et al.* High prevalence of ischaemia, infection and serious comorbidity in patients with diabetic foot disease in Europe. Baseline results from the Eurodiale study *Diabetologia* 2007; 50(1):18–25.
14. Bronze MS & Khardori R. Diabetic Foot Infections. <https://emedicine.medscape.com/article/237378-overview2019>.
15. Seah MYY, Anavekar SN, Savige A & Burrell LL. Diabetic pyomyositis: An uncommon cause of a painful leg. *Diabetes Care* 2004; 27(7):
16. Lipsky BA, Berendt AR, Cornia PB *et al.* 2012 Infectious Diseases Society of America Clinical Practice Guideline for the Diagnosis and Treatment of Diabetic Foot Infections. *Clin Infect Dis* 2012; 54(12):132–173.
17. Gemechu FW, Seemant FNU & Curley CA. Diabetic foot infections. *Am Fam Physician* 2013; 88(3):177–184.
18. World Union of Wound Healing Societies (WUWHS). Florence Congress, Position Document. Advances in wound care: the Triangle of Wound Assessment Wounds International. WUWHS; 2016.
19. Varnado M. Lower Extremity Neuropathic Disease. In: Core Curriculum Wound Management. Doughty DB & McNichol LL, eds. Philadelphia: Wolters Kluwer; 2016.
20. Apelqvist JG, Ragnarson-Tennvall G, Lairsson J & Persson U. Diabetic foot ulcers in a multidisciplinary setting. An economic analysis of primary healing and healing with amputation. *J Intern Med* 1994; 235(5):463–467.
21. Khunkaew S, Fernandez R & Sim J. Health-related quality of life among adults living with diabetic foot ulcers: a meta analysis. *J Qual Life Res* 2019 Jun; 28(6):1413–1427. doi: 10.1007/s11136-018-2082-2
22. Yazdanpanah L, Nasiri M & Adarvishi S. Literature review on the management of diabetic foot ulcers. *World J Diabetes* 2015; 15(6(1):37–53.
23. American Diabetes Association. Standards of Medical Care in Diabetes 2016. In: *Diabetes Care* 2016; 39(Suppl 1).
24. Lavery LA, McGuire JB, Baranoski S, Ayello EA & Kravitz SR. Diabetic Foot Ulcers. In: Baranoski S & Ayello EA, eds. *Wound Care Essentials Practice Principles*, 2nd edn. Philadelphia: Williams & Wilkins; 2008.
25. Schaarup C, Pape-Haugaard L, Jensen MH, Laursen AC, Bermark S & Hejlesen OK. Probing community nurses' professional basis: a situational case study in diabetic foot ulcer treatment. *Br J Comm Nurs* 2017; 22(Suppl 3):S46–S52. <https://doi.org/10.12968/bjcn.2017.22.Sup3.S46>
26. Fujiwara Y, Kishida K, Terao M *et al.* Beneficial effects of foot care nursing for people with diabetes mellitus; an uncontrolled before and after intervention study. *J Adv Nurs* 2011; 67(9):1952–1962.
27. Uçkay I, Aragón-Sánchez J, Lew D & Lipsky BA. Diabetic foot infections: what have we learned in the last 30 years? *Int J Infect Dis* 2015; 40:81–91. doi: 10.1016/j.ijid.2015.09.023.
28. Frykberg RG, Armstrong DG, Giurini J *et al.* Diabetic foot disorders: a clinical practice guideline. American College of Foot and Ankle Surgeons. *J Foot Ankle Surg* 2000; 39(Suppl 5):S1–60.
29. Kruse I & Edelvan S. Evaluation and treatment of diabetic foot ulcers. *Clin Diabetes* 2006; 24(2):91–93.
30. Lipsky BA, Berendt AR, Cornia PB *et al.* 2012 Infectious Diseases Society of America Clinical Practice Guideline for the Diagnosis and Treatment of Diabetic Foot Infections. *Clin Infect Dis* 2012; 54:e132–e173.

31. Lavery LA, Armstrong DG, Wunderlich RP, Tredwell J & Boulton AJ. Diabetic foot syndrome: evaluating the prevalence and incidence of foot pathology in Mexican Americans and non-Hispanic whites from a diabetes disease management cohort. *Diabetes Care* 2003; 26:1435–1438.
32. Fonder MA, Lazarus GS, Cowan DA *et al.* Treating the chronic wound: A practical approach to the care of non-healing wounds and wound care dressings. *J Am Acad Dermatol* 2008; 58(2):185–206.
33. Luz BSR, Araujo SC, Novato Castelli Von Atzingen DA & Rodrigues dos Anjos Mendonça A. Evaluating the effectiveness of the customized Unna boot when treating patients with venous ulcers. *An Bras Dermatol* 2013; 88(1):41–9.
34. Matos de Abreu A & Guitton Renaud Baptista de Oliveira B. A study of the Unna Boot compared with the elastic bandage in venous ulcers: a randomized clinical trial¹. *Rev Latino-Am Enfermagem* 2015 July–Aug; 23(4):571–7 DOI: 10.1590/0104-1169.0373.2590
35. American Diabetes Association. Microvascular complications and foot care. Sec. 9. In *Standards of Medical Care in Diabetes 2016*. *Diabetes Care* 2016; 39(Suppl 1):S72–S80.
36. van Netten J, Lazzarini PA, Armstrong DG *et al.* *Journal of Foot and Ankle Research* (2018) 11:2 doi: 10.1186/s13047-017-0244-z
37. Goodridge D, Trepman E & Embil JM. Health-related quality of life in Diabetic patients with foot ulcers: Literature review. *J Wound Ostomy and Continence Nursing* 2005; 32(6):368-377.
38. Nemora J, Hlinskova E, Farsky I *et al.* Quality of life in patients with diabetic foot ulcer in Visegrad countries. *J Clin Nurs* 2017; 26(9–10):1245–1256.
39. Borji M, Otaghi M & Kazembeigi S. The impact of Orem's Self-care Model on the quality of life in patients with type ii diabetes. *Biomedical & Pharmacology Journal* 2017; 10(1):213–220.
40. Aalaa M, Tabatabaei Malazy O, Sanjari M *et al.* *J Diabetes Metab Disord* 2012; 11:24. <http://www.jdmdonline.com/content/11/1/24>
41. Ghafourifard M & Ebrahimi H. The effect of Orem's self-care model-based Training on self-care agency in Diabetic patients. *Scientific Journal of Hamadan Nursing and Midwifery Faculty* 2015; 2(1):5–13.
42. Orneholm H, Apelqrist J, Larsson J & Eneroth M. Recurrent and other new foot ulcers after healed plantar fore foot diabetic ulcer. *Int J Tissue Regen* 2017; 25(2):309–315.
43. Macfarlane RM & Jeffcoate WJ. Factors contributing to the presentation of diabetic foot ulcers. *Diabet Med* 2004; 14 (10):867–870.
44. Sibbald GR, Ayello EA, Eliot J, Smart H & Stelton S. 2016 Cape Town declarations of action on diabetic foot ulcers and insulin access. *WCET Journal* 2016; 36(2):30–37.