

Diabetic Foot Ulcer Nursing



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Abstract

Introduction and Definition: Diabetic foot ulcers “DFU” are chronic, open sores or wounds that occur on the feet of individuals with diabetes mellitus, typically resulting from a combination of neuropathy, poor circulation, and immune system impairments. These complex ulcers are characterised by their difficulty to heal and high risk of infection, often leading to complications such as amputation and mortality in the event of deterioration. DFU are a debilitating complication of diabetes mellitus, affecting approximately 198 million people globally. The development of these ulcers is typically attributed to a combination of peripheral neuropathy, peripheral arterial disease, and poor glycaemic control. Effective nursing management and prevention of DFU are critical in mitigating these risks.

Body: Advances in clinical intervention have progressed from management to prevention, enhancing patient lifespan; however, DFU continue to pose significant challenges to healthcare providers in both primary and secondary settings as a detriment to health-related quality of life. Nurses play an integral role in the comprehensive management of DFU within acute and community healthcare settings. Their responsibilities encompass a wide variety of practices including the identification of risk factors, thorough wound assessments, implementing effective wound care plans and preventing infection, which are all vital for improving patient outcomes. Moreover, nurses are pivotal in educating patients on the importance of blood glucose control, proper foot care, and lifestyle modifications to prevent the onset and recurrence of ulcers. Through interdisciplinary collaboration, nurses work alongside physicians, podiatrists, and other healthcare professionals to develop and execute individualized care plans. This multidisciplinary approach not only enhances the quality of care but also fosters better patient engagement and adherence to treatment protocols. The role of nursing in DFU management is crucial in achieving improved healing rates, reducing complications, and ultimately enhancing the quality of life for affected individuals.

Keywords: diabetic foot ulcers; diabetes; infection; glycaemic control; peripheral neuropathy; ischemia; wound care; interdisciplinary care; tissue viability

Introduction and Definition

The International Working Group on the Diabetic Foot “IWGDF” defines diabetic foot ulcers 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” [1]. They are a devastating complication of diabetes that is associated with infection, amputation, and death, and is affecting increasing numbers of patients with Diabetes Mellitus [2]. Diabetes Mellitus is estimated to affect 537 million people globally, 37% of which reportedly suffer from DFU or around 198 million people [3]. This number is projected to rise, with an estimated 380 million people expected to be diagnosed by 2025 with diabetes in an elderly patient demographic who are >65 years old, exacerbating the economic burden on health systems and patient morbidity [4,5]. These chronic, non-healing wounds

significantly impair health-related quality of life and require long-term wound management strategies [5].

The incidence of DFU is often rising in patients who have co-morbidities such as cardiovascular disease and peripheral neuropathy which can delay healing which is especially prevalent in the current ageing population but not limited to this demographic. Challenges in managing elderly patients’ vascular health, mobility and adherence to DFU treatment plans necessitate complex nursing care to address the multi-faceted needs of these patients effectively [3,5]. Nurses play a pivotal role in assessing the severity of DFU and initiating wound care plans. This requires a comprehensive knowledge base on the stages of wound healing and the efficacy of various dressings and treatment modalities to competently monitor DFU deterioration, mitigate complications and promote healing [4,5]. By understanding the challenges associated with DFU, nurses

are better advocates for implementing effective management techniques, ultimately improving patient care [4].

This encyclopaedia entry on diabetic foot ulcer nursing is based on a comprehensive literature review, utilising only peer-reviewed articles published within the last ten years to provide a robust, reliable analysis.

Body

Pathophysiology of Diabetic Foot Ulcers

DFU etiology can be classified into three categories: 1) purely neuropathic (nerve related skin damage), 2) purely ischaemic (inadequate blood supply resulting in poor perfusion), and 3) mixed neuroischaemic (neuropathy and ischemia) [6-9]. Neuropathy, a micro-vascular complication resulting from prolonged hyperglycaemia (high, out of range blood glucose), leads to a loss of protective sensation in the foot, motor dysfunction and increases susceptibility to infection if skin integrity is impaired from trauma [6,7]. Limited mobility in older patients also reduces circulation in lower extremities contributing to peripheral ischemia and prolongs foot friction, breaking down the skin barrier [4,8].

Ischemia in DFU progression is the inadequate blood supply to the affected extremity (foot) which can delay healing as a consequence of poor blood circulation/perfusion [9]. DFU pathogenesis involves a variety of factors, such as inadequate glycaemic control (the homeostatic regulation of blood glucose in the body) leading to sensory neuropathy and peripheral ischemia (inadequate blood supply to the extremities) [6].

Diabetic patients are twice as likely to suffer from peripheral arterial disease “PAD”, which is caused by atherosclerosis [4]. Atherosclerosis is the build-up of fatty acids that solidify into plaque over time in the arteries, causing occlusion and reduced blood flow eventually leading to PAD [10]. PAD constricts blood flow in stenosed blood vessels, most commonly in the legs, meaning peripheral extremities such as toes receive less oxygenated blood, leading to necrosis over time [9]. Holistic nurse-conducted assessments identify patients who are at high-risk of developing DFU. Looking for cyanosis, palpating pedal and dorsalis pulses using a Doppler Ultrasound, and testing foot reflexes are some examples of nurse-led risk assessments [2,10,11]. Regular assessments can improve the effectiveness of preventative measures in DFU formation as well as monitoring DFU status.

DFU Wound Assessments

Nurses are responsible for documenting the size, location and grade of DFU as well as noting any signs of infection, ischemia or neuropathy [2,4]. Standardised classification systems, such as the University of Texas Diabetic Wound Classification System and the SINBAD Tool, are widely used to grade DFU [11,12].

The University of Texas system grades DFU from 0 to 3 based on depth, with additional stages (A-D) to indicate the presence of infection and ischemia [7]:

- *Grade 0*: Pre-ulcerative or post-ulcerative lesion that is fully epithelialized.
- *Grade 1*: Superficial ulcer not involving tendon, capsule, or bone.
- *Grade 2*: Ulcer penetrating to tendon or capsule.
- *Grade 3*: Ulcer penetrating to bone or joint.

The SINBAD Tool evaluates six criteria: Site, Ischemia, Neuropathy, Bacterial Infection, Area, and Depth. This tool offers a systematic approach and helps nurses identify the severity of the ulcer and the potential need for specialised care [12]. A higher SINBAD score is correlated with developing major adverse foot events “MAFE” in DFU patients [13].

During physical foot exams, nurses examine general DFU characteristics such as the anatomical location of the wound, if there is any malodour, the amount of exudate and its consistency and localized pain [2,4]. These signs can indicate if there is a developing infection [9]. If a patient is suspected of having a systemic infection such as sepsis or osteomyelitis (from exposed bone) or a deep tissue injury based on necrotic (black or blue) skin discoloration, nurses are required to place an immediate referral to acute services and inform the foot specialist team [2,6].

Wound Healing Stages

Promoting healing in DFU patients is a complex and dynamic process that requires time and occurs in several stages on a cellular and molecular level to restore tissue function and skin integrity [4,14]. To competently monitor healing progress or deterioration, nurses are required to be aware of the stages of wound healing to identify abnormalities [14]. The stages of wound healing are:

- *Haemostasis*: A period of vasoconstriction to loosely hold wound edges together.
- *Inflammation*: Increased membrane permeability allowing neutrophils and fibroblasts to accumulate in fluid in the interstitial space.
- *Proliferation*: Fibroblasts that produce a fibrous clot. Angiogenesis (new blood vessel growth) occurs, and granulation (connective) tissue grows to fill the space.
- *Remodelling*: The fibrous plug falls to uncover new, remodelled skin.

Each DFU has an individual healing trajectory however, most DFU do not surpass the inflammatory stage due to persistent ischemia and probable infection which can impede the healing process [9]. Non-healing ulcers can appear over-granulated or with a yellow ‘sloughy’ texture as the body’s natural response to over-inflammation is to produce connective tissue [15]. Other tissue variations that nurses can document include [4,15]:

- *Pink ‘epithelializing tissue’* which indicates early-stage normal tissue remodelling because of angiogenesis.
- *Red ‘granulating’ tissue* that shows a healthy wound bed that is healing.

- *Green 'infected' tissue* that is usually malodorous and requires anti-microbial intervention.
- *Black 'necrotic' tissue* that is debrided by a nurse or podiatrist.

Wound Care and Infection Control

Dressing selection for DFU should provide patient comfort as well as treating underlying infection [11,14]. If the nurse suspects a risk of DFU-related infection, a swab of the DFU is taken to be sent for pathological analysis to determine the infectious agent [15-17]. Localised bacterial infections may be treated with the use of topical antibiotics in a cream or gel. Systemic infections that have progressed further involve the use of broad-spectrum intravenous therapy antibiotics and nurses taking blood cultures prior to commencing specific antibiotic therapy when the diagnosis is confirmed by the physician team [11,15].

Choosing an appropriate dressing ensures adequate infection control and keeps the wound bed moist to encourage epithelization and growth of remodelled skin [16]. Silver Nitrate and Iodine impregnated dressings are commonly used to inhibit bacterial growth [17]. Medical grade honey can also be applied as a topical, anti-microbial barrier on the surrounding skin prior to dressing the DFU [17,18]. All wound care performed by nurses must follow ANTT "Aseptic Non-Touch Technique" to minimise the risk of contamination and subsequent infection [15,17].

Common types of dressings used for DFU include hydrocolloids, alginates, foam, and hydrogels [17,18]. These dressings have specific indications to encourage exudate production to maintain a moist wound bed [16]. Nurses use their clinical judgement based on their wound assessment to select a suitable dressing. However, the chosen dressing should also manage over-exudate levels to prevent further tissue maceration as this will expand the DFU's surface area [15]. If left untreated, patients can develop Moisture Related Skin Damage in conjunction with the DFU resulting in undefined wound edges [16]. Nurses assess the viscosity, colour and odour of the exudate to determine if there is infection and moisture balance – heavily exudated DFU dressings are changed daily by the nurse on shift [16-19].

Patient Education

Patient education is a core tenet of DFU nursing management. Teaching patients how to maintain their blood glucose levels within the normal range (6-9mmol) with a prescribed insulin regimen can reduce the likelihood of recurrent ulcers and contribute to their overall health as a diabetic [20]. Persistent hyperglycaemia impairs neutrophil function thereby increasing the risk of infection [20]. Nurses can encourage patients to be mindful of their diet, check their blood glucose levels regularly and adhere to prescribed medications [6,20].

Restoring adequate blood flow to the affected extremity is essential for wound healing. Nurses must be

knowledgeable about interventions to improve peripheral circulation, such as lifestyle modifications, pharmacological treatments, and surgical options. Advising patient on smoking cessation, regular physical activity, and dietary modifications can enhance vascular health [6,20]. Medications, such as antiplatelet agents and vasodilators, may be prescribed to improve blood flow [11]. In severe cases, revascularisation procedures, such as angioplasty or bypass surgery, may be necessary to restore perfusion to the ischemic limb [12].

Other Barriers to Care

Patients with DFU often face significant mental health challenges including depression, anxiety and reduced health-related quality of life [15]. Living with a chronic wound can hinder normal activities of daily living, eventually leading to social isolation and dependence on others if the DFU deteriorates [16]. Nurses, therefore, adopt a holistic approach addressing the biopsychosocial aspects of patient care [20]. Directing patients to relevant resources such as support groups, counselling and financial services are a few ways nurses advocate for patients with complex needs whilst contributing to health equity among diverse patient demographics [3]. Involving family members in patient care can also support adherence to treatment plans and promote recovery [7].

Offloading

Bedridden DFU patients most often face accelerated deterioration from increased shear between the foot's plantar surface and bedding contact material [21]. Nurses utilise off-loading techniques to combat this especially in neuropathic ulcers [21-24]. They can also offer non-removable casting to offload plantar, non-ischemic, uninfected forefoot and midfoot diabetic ulcers. Alternative offloading devices can be provided until casting can be provided in hospital or dispensed to primary care providers as part of patients' discharge package [25-27]. Community nurses often adapt their documentation to the Roper, Tierney and Logan Model of Activities of Daily Living to assess the impact a DFU has on a patient's individual circumstances at home to identify aspects of daily life that are disrupted [28]. There are several devices that can facilitate offloading for DFU. Some commonly used examples are Total Contact Casts "TCC", Removable Cast Walkers "RCW" and heel offloading devices [21]. A TCC is a custom-moulded cast that evenly distributes pressure across the foot and lower leg [21]. They are used for DFU with neuropathy and without infection or ischemia as the whole foot is covered, causing mild constriction [22-25]. They are underutilised in practice due to a lack of training for clinicians in application, despite being the gold standard for offloading with high healing rates of >80% of DFU within 6-8 weeks [21,22]. RCWs are prefabricated, structured devices that are removable, like TCCs but are easier for patients to remove and care for their own dressing

changes and hygienic needs [22]. Consistent use of RCWs can promote healing however patients are more likely to remove them frequently due to discomfort, causing non-compliance [22]. Nurses are more familiar with RCW due to their widespread use in clinical practice and can educate patients on the importance of adherence to their use of RCWs. Heel offloading devices and insoles are commonly used in hospitals and as part of long-term management plans, especially for non-ambulatory patients for the prevention of pressure ulcer development on bony prominences by reducing shear [21]. They are highly effective but are mostly used in secondary care whereas RCWs and TCCs can be used in the community [21,22].

Interdisciplinary Care

Nurses liaise with other members of the multi-disciplinary team (MDT) to enact a personalised management plan with the patient, emphasising person-centred care [15]. This collaborative approach integrates different skillsets and expertise to optimise patient care. Examples of MDT interaction for DFU care include collaboration with podiatrists, tissue viability nurses (TVN) and physicians to provide specialised foot and ankle care [29]. Podiatrists provide regular assessment and debridement of calluses, monitors foot deformities, prescribes orthotic devices to offload pressure, and ensures appropriate footwear to prevent further tissue damage [23]. Physicians manage systemic factors such as glycaemic control and PAD. They may prescribe antibiotics for infection, perform vascular assessments, or refer the patient for surgical intervention when required [23]. Vascular Surgeons evaluate and intervene in cases of critical limb ischemia through procedures such as angioplasty or bypass surgery, restoring adequate blood supply to the affected area [23].

TVNs are specialist nurses who develop tailored wound care plans for DFU patients. The general nurse-led wound assessment provides TVNs with comparable data on DFU characteristics, depth, proliferation and healing progress [13]. The TVN led plan combines their expertise in selecting appropriate dressings, managing infections and preventing secondary infection and is then implemented regularly by general nurses ensuring consistency and continuity of care [20]. They can also recommend advanced therapies such as larvae therapy, Negative Pressure Wound Therapy “VAC” dressings for DFU with a lot of exudate and Hyperbaric Oxygen Therapy “HBOT” for DFU that are vascularly deficient in blood supply to provide nutrients for remodelling [11,17]. Larvae therapy is an inexpensive treatment used to debride necrotic tissue and keep the wound bed moist [24]. It is also used where there is a risk of infection as maggots can reduce the presence of biofilms [24]. HBOT is used to deliver localised oxygen at the DFU wound site when devices such as nasal cannulas and simple masks are less effective at systemically delivering oxygen to a vascularly impaired patient [25,26]. VAC dressings are

used when simple dressings such as hydrogels and hydrocolloids are unable to manage the level of moisture and over-proliferation of the DFU [28-30]. HBOT and VACs are specialist treatments that are much more effective at reducing the severity of DFU but are expensive, so they are used for wounds with significant progression [26].

Effective communication and meticulous teamwork within the MDT enable nurses to positively influence patient outcomes by providing evidence-based patient education on DFU care, lifestyle adaptations and advocating for patient preferences with the specialists to create an individualised plan [27, 28].

Conclusion

Nurses act in a significant role of DFU care in treating and educating patients to manage their condition. DFU remain a significant complication of diabetes mellitus, requiring comprehensive and multidisciplinary management. Effective nursing practice through comprehensive assessment and management techniques, can mitigate the risk of many severe complications associated with diabetes. Detecting early signs of ischemia and neuropathy enables nurses to refer patients to more specialised treatment before there is irreversible damage. Ongoing education and research within tissue viability and wound management is essential to further enhance the management strategies for DFU and reduce the global burden of this debilitating condition. Emerging treatments such as bioengineered skin substitutes, stem cell therapy, and telemedicine hold transformative potential for managing DFU. Bioengineered skin substitutes, such as *Apligraf* and *Dermagraft*, provide a biologically active scaffold that accelerates healing in chronic wounds by promoting cellular regeneration and reducing inflammation. Stem cell therapy targets ischemic DFU by enhancing angiogenesis and tissue repair, particularly in wounds resistant to standard interventions. Additionally, telemedicine facilitates timely assessment and monitoring of DFU, ensuring early intervention and continuity of care in remote or underserved areas. These innovations highlight critical areas for nursing research, particularly in optimising accessibility and evaluating long-term outcomes.

List of Abbreviations

ANTT: aseptic non-touch technique

DFU: diabetic foot ulcers

HBOT: hyperbaric oxygen therapy

IWGDF: international working group on the diabetic foot

MAFE: major adverse foot events

MDT: multi-disciplinary team

PAD: peripheral arterial disease

RCW: removable cast walkers

TCC: total contact casts

TVN: tissue viability nurse

VAC: negative pressure wound therapy

Conflicts of Interest

The author declares that they have no conflicts of interest in the process of writing this article.

Authors' Contributions

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