

# Challenges Of Caring For Diabetic Foot Ulcers In Resource-Poor Settings

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## Abstract

Foot ulceration is a common occurrence in diabetes worldwide. The burden of diabetic foot ulceration is heaviest in the resource-poor parts of the world where the incidence is high but sophisticated and efficient diagnostic, therapeutic and rehabilitative facilities are sparse. Foot ulceration commonly follows minor trauma to the foot with pre-existing neuropathy and ischaemic disease. Superimposed infections may cause the progression of diabetic ulcers to gangrene requiring limb amputation. The care of diabetic foot ulcers in economically disadvantaged parts of the world is expensive. Physical, emotional, and social disturbances associated with diabetic foot ulcers are clinically significant. Therefore, nursing care plan for individuals with diabetes with foot ulcers must focus on these important physical and emotional care issues. The dearth of specialized care in parts of the developing world compounds the lack of appropriate facilities required for the care of diabetics with foot ulcers. Patient education about foot care as well as frequent and detailed foot assessment by the health care providers may reduce the prevalence of foot ulceration and lower extremity amputation.

## BACKGROUND

Diabetes is the most common endocrine disease among adults in the developing world. Diabetes is also one of the most common chronic diseases in the adult population. The clinical importance of diabetes lies in the associated multitude of morbidities as well as high mortality rate.<sup>[1]</sup>

Characteristically, health care delivery in most resource-poor settings is suboptimal and not widely available. The lack of strong social security system also precludes timely and adequate management of chronic disorders like diabetes mellitus and its complications. In most resource-poor settings, health care services are expensive and many patients with diabetes make out-of-pocket payment for the services. Therefore, the poor accessibility of quality diabetic care can contribute to the complications and mortality associated with diabetes in the developing world.

The prevalence of diabetic foot ulcer (DFU) ranged between 1.0% and 4.1% in the United States (US), 4.6% in Kenya, and 20.4% in Netherlands.<sup>[2],[3],[4]</sup> Similarly, numerous hospital-based studies in Nigeria demonstrated that the prevalence of limb ulcerations was between 11.7% and 19.1% among individuals with diabetes in Nigeria.<sup>[5][6]</sup> The prevalence of DFU among hospitalized patients with diabetes in Iran was 20%.<sup>[7]</sup>

Foot ulcers are chronic complications of diabetes and have been reported to occur after a mean interval of 13 years from the diagnosis of diabetes in a Nigerian population.<sup>[8]</sup> DFU may become more common in clinical practice in the tropics with the increasing prevalence of diabetes in the Nigerian and Ghanaian adult populations.<sup>[9]</sup> A recent community-based Nigerian study showed high prevalence of risk factors for diabetes like alcoholism, sedentary lifestyle and increased adiposity.<sup>[10]</sup>

Three types of DFU are known; neuropathic, ischaemic and neuro-ischaemic ulcers. Neuropathic ulcers are characterized by loss of sensation with intact peripheral pulses while ischaemic ulcers are characterized by absence of peripheral pulses with intact sensation. In neuro-ischaemic ulcers both sensation and peripheral pulses are absent.<sup>[1]</sup> The dominant type of ulcers varies in different populations but the neuropathic ulcer appears to be the most common while the ischaemic type is the least common.<sup>[3]</sup>

## CAUSES AND RISK FACTORS

Poor glycaemic control is highly associated with neuropathic ulcers while dyslipidaemia and diastolic hypertension are significantly associated with ischaemic ulcers. In a study of the association between glycaemic control and risk of peripheral neuropathy, four groups of adults were studied for

the occurrence of peripheral neuropathy in Atlanta, US. The prevalence of neuropathy was lowest among subjects with normal blood glucose level (10.9%) or impaired blood glucose level (11.9%) while it was higher among subjects with undiagnosed diabetes (16.6%) or diagnosed diabetes (19.4%).<sup>[11]</sup>

Bacterial infections have been associated with 52% to 97% of DFU in parts of the developing world.<sup>[3] [12] [13]</sup> The major aetiologies include neuropathy which is characterized by loss of pain and vibration sensation resulting in a high likelihood of trauma to the lower extremities as a result of prolonged exposure of the feet to injurious conditions. Congenital and acquired deformities of the foot place more pressure on the plantar surfaces of the feet and ultimately result in ulceration.

Smoking is a contributory factor as a result of vascular wall thickening, reduction in blood circulation and ischaemic changes in the affected neurons.<sup>[13]</sup> The resultant effect is also loss of sensation and increased predisposition to injuries. High plantar pressure from inappropriate or tight footwear also encourages callus formation and ulceration of the overlying skin. Peripheral vascular disease is a complication of diabetes and is characterized by inadequate perfusion of tissues resulting in ischaemic changes and ulceration. The triad of neuropathy, foot deformities and minor foot trauma was reported in about two-thirds of DFU in Iran while peripheral vascular disease occurred in about a third of the same population.<sup>[7]</sup>

Nevertheless, the most dreaded end-result of DFU is lower extremity amputation. The hyperglycaemic state is associated with immunoparesis and poor wound healing. Therefore, the compounding effect of high rate of bacterial infection on poorly healing wound provokes an inflammatory cascade resulting ultimately in tissue necrosis and gangrene. Often, lower extremity amputation is inevitably offered when DFU becomes gangrenous and life-threatening. In addition, the mortality in DFU in Netherlands was 10%,<sup>[4]</sup> but may also be as high as 53% as reported in a Nigerian population<sup>[5]</sup> and 51.7% reported in a French population.<sup>[14]</sup>

### PRE-ULCERATION CARE

The most important initial step in the prevention of DFU is frequent and consistent foot assessment. Every health care provider who cares for patients with diabetics must be skilled in the art of foot assessment. Patients also need to be trained in self-centered foot care which may be carried out at

least six days per week.<sup>[15]</sup> Preventive strategies have been shown to be cost-effective<sup>[16]</sup> and reduce amputation rates in DFU.<sup>[17]</sup> In a study of the regularity of preventive care for persons with diabetes in Norway, 85% reported receiving regular clinical diabetes examination, 31.7% reported regular foot inspection by health care personnel and 63.3% reported regular foot self-inspection.<sup>[18]</sup> Obviously, a cogent need exists to emphasize the need for regular foot inspection as part of hospital care of individuals with diabetes.

The three most important components of foot assessment include the search for neuropathy, peripheral vascular disease and plantar pressure points especially calluses. Neurologic assessment should aim at detecting abnormal sensations like “pins and needles”, burning and numbness. These features usually co-exist with loss of pain, vibration and touch sensations in the foot particularly, the plantar surfaces of the toes and the heel. The assessment of the sensory functions is achieved in most centres in the developed world with the use of 10g Semmes Weinstein monofilament and biothesiometer<sup>[19] [20]</sup> but most providers in the developing world still use basic clinical methods which are less precise like tuning fork and sharps to test for vibration and pain respectively. The use of biothesiometer and the 10g monofilament have been reported to be reliable in predicting patients at risk of ulceration and to detect who might benefit from podiatry care at the primary care level. Some of the criteria for podiatric referral include inability to feel the monofilament and previous history of ulceration or amputation.<sup>[19]</sup>

Contact thermography system is also used in the technologically-advanced countries to test temperature sensations. Poor responses from both cold and warm immersion recovery tests have been shown to be reliable predictors of loss of sensation in people at risk of ulceration.<sup>[21] [22]</sup> More sophisticated methods like the use of imaging technologies in infra-red or liquid crystal thermography and thermometry<sup>[23]</sup> in the assessment of responses to thermal stimuli are increasingly applied in the developed world. Indeed, these sophisticated methods are not routinely available in most centres in the developing world.

Vascular assessment is necessary to detect peripheral vascular disease.<sup>[24]</sup> Symptoms that are directly related to this condition are unusual until the disease is advanced and the patient may then present with pains in the affected limb (claudication) which initially occurs only on exertion and later occurs even at rest. Clinical assessment is done by

palpating the major arterial pulses in the lower extremities particularly the dorsalis pedis and the posterior tibial artery. The former is reached in between the first and second metatarsal bones on the arch of the foot while the latter is located behind the medial malleolus. The absence of these arterial pulses is strongly suggestive of partial occlusion of the vessels by endothelial thickening caused by depositions made on the vascular wall from dyslipidaemia in diabetes.<sup>[3]</sup> The practice in the resource-poor parts of the developing world is still grossly limited to this clinical method of assessment wherever improved facilities in the developed world and the technologically-advanced parts of the developing world now include the Doppler ultrasound techniques as well as the ankle-brachial blood pressure indices (ABI).<sup>[20]</sup> Ankle-brachial blood pressure index less than 0.9 is diagnostic of peripheral vascular diseases.<sup>[11]</sup> The non-availability of such sophisticated vascular assessment techniques implies that health care providers in the developing world must be skilled in the use of the basic clinical methods of foot assessment to facilitate early detection of peripheral vascular disease and prevent the development of DFU. Similarly, health care providers in the resource-poor settings need to improve the quality of diagnostic facilities available for the care of diabetics.

Physical inspection of the diabetic feet for the presence of hard skin, callused areas and areas of abnormal bony prominences which could create unusual pressures in the erect and walking postures is important. Skin discolouration over such pressure areas may be an early sign of imminent ulceration. Thus, the patient should be referred to a podiatrist for safe removal of callus if detected.<sup>[25] [26]</sup> Patients should be discouraged from attempting to remove calluses because of the risk of causing extensive tissue damage and precipitating ulceration. Surgical intervention may also be necessary for early correction of bony abnormalities which create pressure areas in the feet.

The knowledge of appropriate foot care had been suggested to be positively influenced by patient education which in turn reduces the risk of foot ulceration and amputation in high-risk diabetics.<sup>[20]</sup> Thus, patient education on the prevention of foot ulceration needs to be incorporated into the routine care of patients with diabetes both in the hospital and in the community. Time must be allotted to communication, information and education during clinic sessions.<sup>[27]</sup> Self care has been shown to improve the quality of care in diabetes.<sup>[15]</sup> Patients must understand the need for foot care which must include frequent checks for pressure

areas and cracks especially in the interdigital clefts. Patients must also be taught to recognize the signs of infections because fungal and bacterial infections like tinea pedis, tinea corporis and carbunculosis are common in diabetes and commonly predispose to more severe and spreading bacterial infections if untreated. Trauma to the feet must be avoided as up to 54% of DFU may be due to trauma caused by foot wears.<sup>[19]</sup> The need to avoid trauma is most relevant with reference to farmers and miners. Therefore, protective foot wear like boots may be necessary for such group of patients. In addition, toe nail care must be done with mechanical nail cutting devices rather than with razor blades since the latter may cut both the nails and the surrounding soft tissues.

Excessive skin dryness must be avoided hence the recommendation is to use light, inert and moisturizing preparations. Feet must not be soaked in the absence of infections and ulcers.<sup>[15]</sup> Foot wear should be light and loose to minimize pressures on the feet. Prescriptions are made for special foot wear in some places but the use of such devices has not been conclusively shown to be highly effective in the prevention of DFU.<sup>[28]</sup> For practical purposes, foot wear must not expose the toes to trauma, shoes must always go with light socks, shoes must be well padded and high-heeled shoes, and shoes with pointed front should be avoided to prevent creating pressures on the heels and toes.

### POST-ULCERATION CARE

The most significant challenge in the management of DFU in most resource-poor settings in the developing world is delay in presentation at the health facility. On average, most patients with DFU take two to four weeks to seek specialized care. The delay is usually multi-factorial; ignorance about the cause of the ulcer results in inappropriate health care-seeking behaviours especially from traditional healers and alternative practitioners. Poverty is another cogent reason for delay in presentation since the services are expensive. The resultant effect of the delay is poorer condition of the ulcers with increased risk of complications, especially tetanus infection. Therefore, health care providers caring for patients with diabetics are confronted with the dual challenge of cleaning the wound and the use of potent systemic antibiotic therapy. Infections must be aggressively treated to minimize the risk of complications like osteomyelitis and mortality from septicaemia. The medications recommended for empirical treatment of DFU vary in different places based on the local experience about the predominant bacterial agents in DFU. A recent Nigerian study reported that most of the isolates cultured from DFU are aerobes, particularly

*Staphylococcus aureus* and these organisms are sensitive to the quinolones, the cephalosporins and metronidazole.<sup>[12]</sup> Interestingly, most of these antibiotics are expensive for the level of economical development which subsists in such parts of the developing world.

Many staging methods for DFU are known but the Wagner method and The University of Texas method are commonly used.<sup>[29],[30]</sup> Table 1 describes the Wagner and The University of Texas staging methods. Staging of DFU guides therapy and harmonizes communicating with other health professionals with respect to the condition of DFU. The Wagner staging method is simple to use and based on the location and depth of ulceration. On the other hand, The University of Texas classification of diabetic foot wounds is becoming increasingly popular for easy of clinical use. The stagings in DFU are directly related to the prognosis in the disease and the care should be tailored to the stage of the disease.

**Figure 1**

Table 1: The Wagner Method and The University of Texas Method\* of Classification of Diabetic Foot Wounds

Wagner Method <sup>[29]</sup>		The University of Texas Method <sup>[30]</sup>	
Grade	Details	Grade	Details
0	No open foot lesion	0	Presence of pre-ulcer or post-ulcer epithelization
1	Presence of superficial ulcer, partial or full-thickness	1	Superficial ulcer not penetrating tendon, bone or joint
2	Ulcer extends to ligaments, tendon, joint capsule or deep fascia without abscess or osteomyelitis	2	Ulcer penetrating through to tendon or capsule
3	Presence of deep ulcer with abscess, osteomyelitis or joint sepsis	3	Ulcer penetrating to bone or joint
4	Gangrene localized to the forefoot or heel	A	Non-infected and non-ischaemic ulcer
5	Extensive gangrene	B	Infection present
		C	Ischaemia present
		D	Both infection and ischaemia are present

KEY: \* Grades 0 to 3 are further sub-classified as A, B, C or D.

The goals of wound care include the prevention of contamination of wound, good drainage of exudates, and minimal pressure on the wounds.<sup>[31]</sup> Efforts should be made at every session of wound care to deslough and remove necrotic tissues from within and around the ulcers until fresh bleeding occurs. In advanced settings, tissue viability experts are involved in diabetic wound care but such experts are scarce in the developing world. In the developing world, diabetic wounds are jointly cared for by nurses and the physicians.

Depending on the state of the wound in terms of sloughs, the wound dressings may be done once or twice daily. In the developed world, various biosynthetic agents have been used to manage DFU like Apligraf.<sup>[32]</sup> Although, suggestions abound that such agents are more cost-effective in the care of DFU than general wound care, such products are almost non-existent in the resource-poor parts of the developing world thus limiting experience with their use. Therefore, these wounds are dressed with initial soaking in saline or 10% chlorhexidine solution for an hour prior to dressing with either natural honey or EUSOL. The initial saline or chlorhexidine treatment reduces the bacterial load on the wounds and contributes to improved healing.<sup>[33]</sup> Occlusive dressing with sterile gauze is routinely used after topical application or packing with either natural honey or EUSOL. Natural honey has been repeatedly shown to be an effective desloughing and antiseptic agent.<sup>[34][35]</sup> Other dressing options include self-adherent absorbent materials, charcoal dressing, calcium alginate hydrofibre and soft silicone dressings. The sophisticated dressing options have various advantages ranging from ability to stay in place for up to seven days, minimize maceration, absorb odour, remove sloughs and interact with exudates to form a gel that is easily removable from wounds. Similarly, the use of hyperbaric oxygen had been shown to significantly reduce the risk of amputation and improve healing after one year of treatment of DFU. Unfortunately, hyperbaric oxygen is expensive and not widely available.<sup>[36]</sup> Special foam casts may also be used for wound dressing since foams apply minimal pressure on wounds and also facilitates drainage of exudates.

Poor glycaemic control is associated with poor leucocyte activity, resulting in delayed wound healing. Thus, good glycaemic control with diet and hypoglycaemic agents is imperative for wound healing. During wound dressings, attention must be focused on signs suggestive of wound infection like sudden change in colour, swelling of the affected limb and increased exudates or hyperviscosity of exudates. Pressure relief is achieved, particularly in neuropathic ulcers by removing calluses using scapel techniques; this procedure is best done by podiatrists. Special foot wear such as extra-depth shoes available in developed countries, and casts may also be used to relieve pressure.<sup>[25]</sup>

Pain relief is also important in the care of DFU. Simple analgesics like acetaminophen may be adequate, but in a few cases, more potent analgesics like the non-steroidal anti-inflammatory drugs (i.e., diclofenac [100 mg 12-hourly],

ibuprofen [400 mg 12-hourly], piroxicam [20 mg 12-hourly] may be required. Caution needs to be applied with these medications due to their potentials to cause gastric irritation and ulceration, and must be used cautiously in patients with renal conditions. Such unwanted effects of the medications may be avoided by administering the drugs after meal or with milk drinks. Usually, the need for analgesic therapy reduces drastically when adequate psychological supports are provided.

DFU, like other chronic ulcers, tend to heal by secondary intention in more than three- quarter of cases.<sup>[14]</sup> In a few cases, particularly in the presence of severe infections, healing with granulation may fail thus necessitating skin grafting or use of biosynthetic materials for wound closure.<sup>[16]</sup> In the other extreme, amputation is carried out when the ulcer is not healing well, is gangrenous or becomes life-threatening to the patient. Heel ulcers are mostly associated with the need for limb amputation.<sup>[37]</sup> Early presentation of DFU coupled with aggressive wound care, control of infections, and adequate glycaemic control can minimize the risk of lower extremity amputation.

The endocrinologist, clinical psychologist, health educator, physiotherapist, plastic and orthopaedic surgeons, orthopaedic nurse, advanced practice nurse, and occupational therapist must be involved in the management of patients with DFU. The chronic nature of the wound may result in despair and eventually depressive illness. Therefore, patients need to be adequately counseled and psychologically prepared for the long course of treatment as well as the eventualities like ablative surgery. Counseling is necessary to minimize the emotional trauma that may result from the procedures and improve the patients' coping abilities. Similarly, physiotherapy is required for graded ambulation using crutches, braces, and prosthetics depending on availability. Indeed, prosthetics are expensive and thus, not within the reach of the average patient who may need them in most parts of the developing world. The dearth of such materials hinders to a large extent the scope of rehabilitation that could be carried out.

Apart from providing psychological relief, early ambulation also reduces the risk of deep vein thrombosis and thrombo-embolism which may precipitate severe morbidities or mortality. The relatives of the patients must be involved in the care. They are required to provide emotional support for the patient. Specifically, studies have been shown that provision of more than three sessions of education programme are required to lead to good performance of

adequate self-care in diabetes.<sup>[38]</sup> The education programme may be adapted to include the patients and their relatives for better outcome.

### MEDICO-SOCIAL IMPLICATIONS

Close to one out of every five cases of DFU results in amputation<sup>[39]</sup> and is associated with remarkable medico-social burden. The condition casts a heavy shadow of despair on a disease that is often presented to the newly-diagnosed patient as amenable to control. Apart from the expensive cost of surgery, the post-operative complications of ablative surgery and prolonged hospital stay are important.<sup>[39]</sup> Similarly, lower limb amputation is associated with remarkable emotional disturbances, insomnia, erosion of self-esteem, physical handicap, pain and immobility.<sup>[40]</sup> The anticipated physical and emotional effects of ablative surgery should form the pivot of a perfect nursing care plan for amputees. Significant derangements in social life must also be considered in amputees.<sup>[41]</sup> Loss of job and financial handicap are also important aftermaths of limb amputation and may have severe spill-over effects on the family institution. Often, patients are confronted with all these issues and as part of the grief reaction to a seemingly inevitable limb loss they withhold consent for ablative surgery.<sup>[8]</sup> Denial of consent constitutes another stage of delay in the treatment of DFU. Clinical psychologists are most useful at this stage, but these professionals are not always readily available. Thus, the physician and the advanced practice nurse managing the patient must be able to provide the counseling that the patient needs to overcome this delay.

Available rehabilitation services may provide physiotherapy to reduce pain and immobility but occupational therapy may not be available in resource-poor parts of the world. Therefore, limb amputation has significant adverse effects on the overall prognosis in diabetics. In the absence of comprehensive rehabilitation programmes and severe loss of finances, the sustenance of the basic management of this condition (medication procurement, home-based blood or urine sugar monitoring and nutritional changes) become extremely difficult without a strong social security system which could provide financial relief. The risk of more morbidities and ultimately premature mortality become inevitably accentuated.<sup>[42]</sup> Therefore, health promotion and health education are vital tools for the reduction of the risk of ulceration and ultimately prevention of amputation in individuals with diabetes. Mass media campaigns as well as community-based education programmes may be useful in

providing information on the risk factors and causes of foot ulceration and infection in diabetes. The people should be educated on the dangers of delaying appropriate health care-seeking with respect to the risk of limb amputation.

### CONCLUSION

The prevention of lower limb amputation is the ultimate goal in the management of DFU hence is imperative to aggressively manage DFU. Frequent foot examination both at home and in the clinic, prevention of trauma to the foot and prompt treatment of foot infections would be useful. To achieve this, emphasis should be placed on communication, information and education right from the point of diagnosis of diabetes. Diabetic amputation rates had been shown to decline progressively from 40.5% (1979 to 1981), through 33.3% (1986 to 1989) to 23.5% (1990 to 1993).<sup>[43]</sup> This progressive decline was attributed to the use of a comprehensive protocol and a multi-disciplinary treatment approach in dedicated health facilities. More importantly, standard practice guidelines for the prevention and treatment of DFU must be developed and be integrated into the existing health practices. In addition to that, basic education on diabetes should be incorporated into the curricula of the training institutions for the various health professionals.<sup>[44]</sup> The quality of care provided for patients with diabetes in the developing world should be improved to facilitate early detection and treatment of neuropathy and DFU. The introduction of a vibrant social security system where none presently exists and improved accessibility of comprehensive specialized care in the developing world are highly desired.

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