

Assessing the clinician's role in diabetic foot ulcers: from pre-ulceration through post-healing

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Key words

- Diabetic foot ulcers
- Pre-ulceration
- Post-healing

Article points

1. Regular foot care is considered standard of care for patients with diabetes mellitus.
2. Algorithmic approaches to wound care will result in improved outcomes for patients.
3. Patients should be empowered and educated on the importance of self-care of their feet between care visits.

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Diabetic foot ulcers (DFU) are a devastating complication of diabetes mellitus. The importance of appropriate management of diabetic foot ulcers cannot be understated and this includes prevention of future complications. Understanding the role of the provider at each stage of diabetic foot complications is essential to limit the moribund complications associated with this condition. Too often, patients are treated for a wound and then are lost to follow up and true longitudinal care is lacking. The result can be reulceration, re-amputation and potentially unnecessary hospitalisations. The hallmarks of each stage (pre-ulcerative, ulcerative and post-ulcerative) are highlighted. The authors provide a framework to develop and implement comprehensive diabetic foot care, no matter the stage of presentation for an individual patient. In doing so, this systematic approach aids providers in optimal management and will mitigate the risk of diabetic foot ulceration.

From each unique perspective, the impact of diabetic foot ulcers (DFUs) is significant. Patients experience high rates of morbidity and mortality, while quality of life impairment can be devastating. Caregivers of those living with diabetic foot complications exhibit higher rates of depressive symptoms, may require excessive time off work and often are placed in supportive roles that they never anticipated. Overburdened hospital systems experience further burden from the excess of complications, while payer sources (i.e. private insurance company Medicare/Medicaid) are spending disproportionate percentages of healthcare dollars on DFU management. DFU outcomes are more favourable when utilising a multidisciplinary approach (Lavery et al, 2004).

The incidence rates for foot ulceration over the course of a lifetime of living with diabetes are reported to be between 19–34% (Armstrong et al, 2017). A larger problem with DFU is the extremely high recidivism rates. Upon successful healing of a DFU, it can be expected that 40% of patients will

experience DFU recurrence within 1 year, while up to 65% recurrence rates are reported within 3 years (Armstrong et al, 2017). Wound healing is achievable in many cases but keeping wounds healed remains a challenge. Bus and colleagues reported that up to 75% of DFU are preventable (Bus and van Netten, 2016). It is incumbent upon all clinicians to emphasise the preventative strategies in an effort to reduce the clinical and financial burden of this condition.

Clinicians are in the unique role of providing pre-ulceration foot care and education, wound management for those with active DFU and also coordinate strategies to prevent re-ulceration. Paisey and colleagues showed that improved diabetic foot services has the potential to meaningfully reduce incidence of foot ulceration, particularly for those without history of previous wounds (Paisey et al, 2019). The purpose of this review article is to assess the clinician's role in diabetic foot disease.

Clinician's role in pre-ulceration

The American Diabetes Association and the

International Working Group on the Diabetic Foot (IWGDF) have established clear recommendations for foot screening and risk stratification for all patients with diabetes (Bus et al, 2019). At a minimum, every person with diabetes should be screened annually. It is the primary responsibility of footcare specialists to risk stratify patients upon completion of a comprehensive foot examination. A systematic evaluation of the diabetic foot will include the neurologic, vascular, dermatologic and musculoskeletal systems, as well as shoe gear evaluation. Loss of protective sensation, peripheral arterial disease (PAD), history of ulceration or amputation and rigid foot deformities are the most common risk factors predisposing patients to lower-extremity complications, including ulceration, infection and amputation (Monteiro-Soares et al, 2012; Crawford et al, 2015; Armstrong et al, 2017a). A comprehensive assessment of risk factors allows the provider to determine appropriate frequency of visits.

Generally, patients are stratified into low, moderate, or high risk for development of foot complications. Low-risk patients may be seen annually while higher-risk patients are usually seen at more frequent intervals.

Key elements for primary ulcer prevention in low- and moderate-risk patients include diabetic foot education, accommodative shoe and insert recommendations, as well as routine foot care, such as paring of pre-ulcerative calluses (Bus et al, 2019). Structured diabetic foot education can be delivered in many different forms by different specialists but the current authors have found that at minimum, patients should be reminded that avoiding foot complications can be accomplished by consistent targeted glucose control, checking feet daily and avoiding barefoot walking. However, the recommendation of daily visual inspection may be an impractical expectation for self-care behaviour. Many patients with diabetes will have concomitant eye disease and obesity, making a visual inspection of the feet of little value or impossible (Killeen et al, 2020). A caregiver who can perform a visual inspection of the patient's feet can be helpful but a patient may benefit more from touching his or her feet instead of relying on visual cues. If a potential problem is encountered, patients should also have access to providers for urgent issues requiring prompt attention.



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Inappropriate shoes and trauma while barefoot are significant aetiologies of foot ulceration. Accommodative shoe and insert recommendations are an important part of prevention of incident ulcerations (Bus et al, 2009; van Netten et al, 2016). Diabetic shoes are generally deeper and wider to accommodate a custom-molded insert. The custom insert will assist in reducing peak plantar pressures, especially important in patients with pre-ulcerative calluses. Custom-molded shoes are generally reserved for patients with severe foot deformity, such as Charcot neuroarthropathy, when the deformity cannot be accommodated with usual depth inlay shoes. Education regarding appropriate shoes and inserts is not limited to obtaining therapeutic footwear but must include education on wearing those shoes at all times, inside and outside of the home. Adherence in continuous use of appropriate footwear has been found to be as low as 15%, and Bus and colleagues reported that incidence of complications, including ulceration, can vary significantly between those who wear appropriate footwear for greater than 80% of steps ambulated and those who do not (Armstrong et al, 2001; Bus et al, 2013).

“Routine foot care” is the term that has been associated with regularly scheduled interval appointments with podiatrists or other footcare specialists. Some commonly encountered pathologies during these visits include calluses, fungal infections, ingrown toenails and skin fissures, all of which may result in significant foot complications. While the intent of routine footcare visits is to treat the mentioned pathologies, it is also an opportunity to evaluate the foot and reinforce diabetic foot education. Current evidence-based literature does not support a causal link between a reduction of diabetes-related foot complications and routine care, but the importance of regular surveillance cannot be understated. For example, the removal of callus tissue, especially in the presence of subdermal hemorrhage, is clearly supported in the literature as peak plantar pressures are reduced (Bus et al, 2019).

According to the IWGDF meta-analysis, routine foot care overall shows weak evidence but remains a strong recommendation. As such, routine foot care is considered standard of care and furthermore, conducting randomised controlled trials withholding this type of treatment would be considered unethical (Bus and van Netten, 2016).

Clinician role in ulceration

The role of the clinician once a DFU develops is to promote wound healing through the least morbid means. To do so, providers can follow a general algorithm and escalate care accordingly. To that end, it is paramount to proceed with advanced wound-care products only after the patient has been fully assessed for common non-healing confounders, including infection, PAD and poor nutrition. Once assessed, the clinician can proceed with wound bed preparation, appropriate offloading, and finally surgical closure if conservative attempts are unsuccessful.

If infection is present, it needs to be eradicated promptly. Surgical incision and drainage followed by tailored parenterally delivered antibiotic therapy is required (Lipsky et al, 2016). Judicious use of antibiotics is imperative as patients who have been previously treated for a diabetic foot infection have an independent risk factor to develop multi-drug resistance organisms (Henig et al, 2018). Serial radiographs and advanced imaging are to be used early to identify deeper infections when suspicion arises. Tracking laboratory values and inflammatory markers are helpful and may predict regression of condition (Hadavand et al, 2019), but alone they do not predict healing (Tardáguila-García et al, 2020). Taken together, swift and aggressive infection resolution must occur prior to DFU healing.

Patients with diabetes mellitus (DM) are at-risk of developing PAD, which can lead to chronic limb-threatening ischaemia (CLTI), delayed wound healing and lower-extremity amputation. The prevalence of PAD worldwide has been estimated between 10% and 49% (Armstrong et al, 1998; Prompers et al, 2008), though reports vary depending on geographic location (Prompers et al, 2008). Every DM patient should be assessed for PAD through peripheral vascular examination (Mills et al, 2014) at least annually. When pedal pulses are weak or absent, baseline non-invasive vascular testing, which includes ankle/toe brachial index (ABI/TBI), is recommended (Mills et al, 2014). Both should be performed as false elevation of ABIs may occur secondary to arterial calcifications which is common in patients with DM (Moon et al, 2011) and those with advancing age (Hayden et al, 2005). Both indexes have high sensitivity and specificity compared to angiogram (American Diabetes Association,

2003) and are predictive of healing (Castronuovo Jr et al, 1997; Brownrigg et al, 2016). If abnormality exists, immediate referral to a vascular surgeon or interventional radiologist is needed.

Wound-bed preparation prior to use of advanced biomaterials (bioengineered tissues, split-thickness skin grafting, etc.) is important. A short interval between regular debridement correlates with a higher healing rate as does more frequent wound debridement (Cardinal et al, 2009; Wilcox et al, 2013). The quality of wound debridement must remain high as poorly performed wound debridement results in delayed healing (Saap and Falanga, 2002). Various debridement methods (sharp, surgical, autolytic, enzymatic) exist and should be implemented based on wound presentation at time of evaluation.

Several biomarkers can assist the provider in regularly assessing DFU. The first relates to wound surface area as wound trajectory informs the physician to escalate care to more morbid methods. Wound surface is classically and easily used to monitor progress. If DFU fail to have a reduction in surface area by 50% over the course of 4 weeks, treatment plan needs to be altered (Sheehan et al, 2003). Other biomarkers include ratios of matrix metalloproteinases (MMP) to tissue inhibitors of MMPs (Liu et al, 2009) and IL-6 (Liu et al, 2014; Korkmaz et al, 2018), but these are largely bench oriented.

Nevertheless, assessment should evaluate for changes in infection and peripheral vascularity along with nutrition. If the aforementioned remain unchanged and wound improvement is not demonstrated, then escalation to skin grafting or flaps. Additional soft tissue reconstruction techniques include muscle-, pedicle-, or free flaps, as needed. Utilising a standard approach once a DFU has developed will assist in reproduction of results.

Clinician's role in post-ulceration care

As important as it is to follow pre-ulceration care to prevent the development of an initial DFU, it is imperative to follow post-ulceration care in order to prevent ulceration recurrence, which can ultimately increase the risk for lower-extremity amputation. Evaluation and management of patients in the "post-ulceration state" include provider based patient education, therapeutic footwear and insoles,

patient adherence with footcare provider prevention recommendations and patient at-home care.

Provider-based patient education during treatment and once the ulcer heals is essential to preventing development of an ulceration recurrence by empowering the patient with information and knowledge (Dorresteijn et al, 2014; Bonner et al, 2016; Bus et al, 2016; Armstrong et al, 2017; American Diabetes, 2020; van Netten et al, 2020). This information needs to be emphasised and repeated numerous times for patients to understand and grasp the significance of the information, as it has been shown that when the information is provided in only one or two sessions the education was insufficient to reduce ulcer recurrence rates (Lincoln et al, 2008). The IWGDF has delineated several key points and recommendations on specific 'action items' that should be implemented to prevent DFU recurrence in the 'at-risk' patient population (Bus et al, 2016). A large portion of their recommendations describe provider-based education for patients to learn and subsequently implement in their daily life to protect their feet and help reduce risk of recurrence. Armstrong et al estimate that approximately 40% of patients have an ulceration recurrence within 1 year after healing, 60% within 3 years, and 65% within 5 years (Armstrong et al, 2017). They describe this phenomenon as "ulceration remission", rather than "ulceration healing". "Ulceration metastasis" has also been described since DFU can recur at anatomical locations different from the primary occurrence site (Petersen et al, 2020).

It has been well established that there is a strong link between ulceration recurrence and having had an ulceration previously (Monteiro-Soares et al, 2012, Crawford et al, 2015b; Armstrong et al, 2017). Clinician evaluation and management of this high-risk population includes consideration of both conservative and surgical treatment options to prevent reulceration. Assessment of prior ulceration sites, pre-ulcerative calluses, and blisters urgently is important to preventing deterioration and recurrence. Prescribing and recommending therapeutic footwear and insoles to offload deformities, reduce plantar pressures, and address biomechanical factors should be considered for at-risk patients, and certainly for patients who have a history of ulceration; adherence to using these

devices is important as well (Maciejewski et al, 2004; Paton et al, 2011; Rizzo et al, 2012; Lavery et al, 2012; Ulbrecht et al, 2014; Waaijman et al, 2014; Bus et al, 2016; Armstrong et al, 2017; American Diabetes, 2020; van Netten et al, 2020).

Last, there has been some evidence describing at-home care that the patient should implement in between formal clinician visits. Self-management includes maintaining good diabetes control, adherence to foot protection behaviours (i.e. not walking barefoot or with socks only), performing frequent foot inspections, wearing properly fitting shoe gear (with or without insoles as needed), in addition to monitoring foot temperatures (Lavery et al, 2004; Armstrong et al, 2007; Lavery et al, 2007; Bus et al, 2016; Armstrong et al, 2017). It has been shown that those patients who follow these recommendations have superior outcomes (Armstrong et al, 2017).

Conclusion

The multidisciplinary team approach to management of the diabetic foot is well documented as advantageous and effective in complication prevention (Hicks et al, 2014). The patient must be in the centre of the team and is expected to be an active participant in the process of complication prevention. The foot care specialist is often the 'team captain' and in the unique position of not only providing services and recommendations towards DFU prevention but additionally, are directly responsible for empowering patients to have the education and tools for best practices of effective self-management behaviours. Non-adherence to recommendations is often reported as a part of the causal pathway leading to foot complications among people with diabetes (Crews et al, 2016). In these circumstances, the authors encourage screening and evaluation for mental health issues such as depression. Additionally, understanding that many patients with diabetes have multiple comorbidities, most notably peripheral neuropathy resulting in the absence of pain, make adherence to recommendations oftentimes difficult.

The importance of the clinician's role in examination, risk stratification and coordination of care for the diabetic foot cannot be overstated. Unfortunately, data suggests that only 2–20% of the time, the diabetic foot is adequately evaluated

by primary care physicians (Bus et al, 2019). Given this information, education to health care providers is an area for improvement with a focus on following established referrals to foot care specialists as delays in referral to specialist providers result in much poorer outcomes (Health and Excellence, 2015). Podiatrists are especially well positioned to lead a team of multidisciplinary specialists to improve diabetic foot outcomes. Following evidence-based prevention strategies is the best option to reduce the significant clinical and financial crisis of DFU. ■

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