

Preventing amputation in patients with diabetes

This article will explore the literature to identify why people with diabetes are at a high risk of lower-limb amputation. The significance of the problem, aetiology, evidence-based prevention and screening measures, as well as infection prevention will also be discussed. Many diabetes-related lower-limb amputations can be avoided or delayed by early detection of the problem. It is also important to maintain good glycaemic control, and encourage multidisciplinary involvement to ensure that the person takes responsibility for their own health and well-being.

Katy Dunn

KEY WORDS

Diabetes
Amputation prevention
Foot ulcers
Infection

The number of people diagnosed with diabetes is increasing. Wild et al (2004) undertook a prevalence study and found that the total number of people with diabetes is expected to rise from 171 million in 2000 (2.8% prevalence) to 366 million (4.4% prevalence) by 2030. Therefore, it is likely that the incidence of diabetic foot ulcers will also increase. In the UK every year 5,000 people with diabetes mellitus undergo lower-limb amputation (National Diabetes Support Team, 2006) making diabetic foot ulceration a major cause of morbidity and mortality. The roles of healthcare professionals are expanding to include the prevention, assessment, therapeutic intervention and critical evaluation of care relating to tissue viability. Therefore, to reduce the impact of diabetic foot ulcers, it is necessary to not only give optimal treatment to the person with diabetes

but to also prevent complications that arise from diabetes from occurring in the first place (Davies et al, 2004).

Background

Diabetes mellitus is considered to be one of the most costly and burdensome chronic diseases of our time and it is a condition that is gaining epidemic proportions in the US and throughout the world (King et al, 1998). In 2005, it was estimated that

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2.35 million people in England (4.7% of the total population) had diabetes, of which only 1.8 million were diagnosed. It is predicted that, by 2010, 5.05% of the population, or more than 2.5 million people, will be suffering from diabetes (DoH, 2006).

Diabetes mellitus is a complex metabolic, multifactorial disease, which affects both quality of life and life expectancy (DoH, 2006). Complications of diabetes include retinopathy, nephropathy, neuropathy, cardiovascular disease and foot ulcers.

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The financial burden of diabetes on the NHS' limited health resources has been well documented (Audit Commission, 2000; Gordois et al, 2003; DoH, 2005). However, this does not take account of the indirect costs to the individual living with diabetes, such as limited mobility, a reduced ability to work, lowered self-esteem and feelings of dependency on others (McIntosh and Newton, 2006). These many concerns led to the publication of the *National Service Framework for Diabetes (NSF)* (DoH, 2001) which set a deadline of 10 years to improve the services that are offered for the treatment and prevention of diabetes. The aim is to reduce the many complications of diabetes and to target foot care for people who are at high risk, therefore preventing hundreds of amputations each year.

Prevention and screening

The Audit Commission (2000) believes that up to two-thirds of diabetes-

related lower limb amputations can be avoided with effective foot care. NICE (2004) emphasises the need for preventive measures which include regular foot screening and health education. Due to the complexity of the aetiology of the diabetic foot ulcer, assessment and topical treatment is not straightforward (Bowker and Pfeifer, 2001). NICE (2006) reiterates that, due to the absence of reliable symptoms and the high prevalence of asymptomatic disease, foot screening is essential. Furthermore, studies demonstrate that with appropriate multidisciplinary team care, the incidence of complications and amputation can be significantly reduced (Edmonds et al, 1996; Armstrong et al, 1998).

The DoH (2005) suggests that people with diabetes have poor adherence to preventive measures. Pain is masked by poor peripheral sensory functions in the early stages of diabetic foot disease and so patients may only seek treatment in the advanced stages of the ulcer. At this point, healing is difficult due to the multi-systemic effects of diabetes, thus making the incidence of amputation greater (Abu-Qamar, 2006).

Early identification of risk factors for diabetic foot ulceration and initiation of proper treatment reduces the occurrence of complications, including the need for amputation (American Diabetes Association [ADA], 2006). This highlights the need for preventive action to be taken which should include educating the diabetic patient on the importance of foot care and metabolic control at the time diabetes mellitus is diagnosed.

Careful inspection of the diabetic foot on a regular basis is one of the easiest, least expensive and most effective measures for preventing foot complications (DoH, 2005). It is well documented in the literature that diabetes-related foot problems can be delayed or even prevented through proper control of glucose levels (Diabetes Control and Complications Trial [DCCT], 1993;

United Kingdom Prospective Diabetes Study [UKPDS], 1998) and foot care (NICE, 2004). However, foot screening is not performed for a substantial percentage of people with diabetes (ADA, 2006). Appropriate care of the diabetic foot requires recognition of the most common risk factors for limb loss. Many of these risk factors can be identified based on specific aspects of the history and a brief but systematic

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examination of the foot (Armstrong and Lavery, 1998). The key risk factors for diabetic foot ulceration include neuropathy, deformity and repetitive stress (trauma). Therefore any underlying physical cause of the wound must be identified and, if possible, eliminated or corrected (Shilling, 2003). A multidisciplinary team approach enables the identification of factors prolonging ulceration to be eliminated or their impact to be minimised (Bielby, 2006). However, Abu-Qamar (2006) states that there is no consistency in the advice given to professionals about who should carry out the inspections. The risk classification posed by the International consensus on the Diabetic Foot (1999) is adopted by NICE (2004), the International Diabetes Federation (2005) and Frykberg et al (2006). It categorises patients into low, medium or high risk and suggests annual, 6-monthly or 1–3 monthly review depending on risk status.

NICE (2004) also recommends that podiatrists and orthotists should be involved in the care of patients with diabetes. Diabetic disease processes, notably neuropathy, may lead to changes in foot posture and abnormal weight bearing. Plantar callus, a risk factor for ulceration, indicates abnormal

pressure on the foot and occurs most frequently under the metatarsal heads (Day and Harkless, 1997). Regular foot examinations, including debridement of calluses and ingrown toenails, provide an opportunity to reinforce appropriate self-care behaviours and allow for early detection of new or impending foot problems (NICE, 2004). Ulceration develops because patients lack protective sensations to warn them of injury to the foot. Once sensation is lost, patients are less able to sense irritants such as shoes rubbing or temperature changes, so are more prone to injury (Day and Harkness, 1997). As a result, puncture wounds may go unnoticed, foreign bodies may remain in subcutaneous tissues, or poorly fitting shoes may continue to be worn until pressure necrosis develops (Culleton, 1999).

Infection and diabetic foot ulceration

One of the most common complications of diabetic foot ulceration is infection (Bowker and Pfeifer, 2001). The DoH (2001) state that infection is the most common reason for patients with diabetic foot ulcers to have an emergency admission to hospital. European Wound Management Association (EWMA) (2005) said that identifying infection in diabetic foot ulcers is complicated by the fact that at least 50% of patients with a limb-threatening infection do not manifest systemic signs or symptoms. Diabetic patients often do not realise the extent of their foot ulceration until they notice a discharge from the wound soiling their footwear or when the odour becomes extreme. Diabetic foot ulceration does not occur spontaneously (Beilby, 2006) and teaching people with diabetes the importance of assessing their own feet regularly is a key recommendation put forward by the DoH (2001).

Patient/carer education

The NSF for diabetes (DoH, 2001) recommends structured education to improve patients' knowledge and understanding of their condition, enabling them to undertake effective self-care. There is a lack of patient

education relating to diabetes-induced foot problems. A study by Stern et al (2005) looked at the impact of diabetes education when directed simultaneously to both diabetes care providers and patients. This study concluded that a well-structured educational programme targeted at both practitioners and people with diabetes can lead to better monitoring of diabetes-related conditions and improved metabolic control. However, it could be argued that many patients are unable to perform self-monitoring because of poor eyesight and reduced mobility, making it difficult for them to inspect their feet. Thus regular contact with healthcare professionals is important for people with diabetes (Edmonds et al, 1996).

Diagnosis

Beilby (2006) states that the underlying pathophysiology must be established to identify whether there is evidence of peripheral neuropathy and/or peripheral vascular disease when managing ulceration in the diabetic foot. EWMA (2004) cites metabolic control as one of the basic elements that needs to be managed effectively to ensure successful wound care and management. Optimal glucose control is needed to help prevent complications. Longstanding hyperglycaemia can damage blood vessels, decreasing blood flow to the foot (UKPDS, 1998). This poor circulation can weaken the skin, contribute to the formation of ulcers, and impair wound healing. In addition, high blood sugar can damage the nerves of the foot, decreasing a patient's ability to notice pain and pressure (ADA, 2006). Hyperglycaemia also affects the body's defence mechanism resulting in impaired wound healing.

Risk factors

Patients with poorly controlled diabetes are more susceptible to both bacterial and fungal infections (UKPDS, 1998). In a large, randomised, controlled trial performed in patients with type I diabetes, the DCCT (1993) demonstrated that improving glycaemic control substantially reduces the

development and progression of early microvascular complications. Wound infections in patients with diabetes are particularly serious because not only do they delay healing, but the response to infection is also impaired due to hyperglycaemia inhibiting the normal immune response (Shilling, 2003). Hyperglycaemia impairs neutrophil functions including chemotaxis, phagocytosis and bactericidal activity allowing usually non-pathogenic organisms to establish an infection in traumatised skin. This can lead to infection spreading rapidly throughout the foot in a person with diabetes particularly in the presence of sensory neuropathy when pain sensation is absent (Foster, 2000). Furthermore,

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infection in the neuropathic foot with microvascular disease and poor capillary perfusion of the skin may further reduce the normal responses to infection (Page and Hall, 1999). Wound infection is associated with delayed wound healing and in the neuroischaemic foot can rapidly give rise to spreading infection such as cellulitis that can progress to tissue necrosis requiring surgical intervention and possible amputation (McIntosh and Newton, 2006).

The main problem remains that frequently the infection will be well established and undetected before the signs appear or the patient reports any symptoms. Therefore, once a patient presents with a wound, prompt recognition of infection is vital so that amputation can be prevented. Patients should be urgently seen in a

multidisciplinary diabetic foot clinic where there is close working between physicians, podiatrists and surgeons (Fowler and Rayman, 2006). It is imperative to try to obtain accurate microbiological information on the nature of the infection in order to tailor treatment (McIntosh, 2006). Fowler and Rayman (2006) consider that although the classic signs of infection (including redness, warmth, purulent exudate, odour, pain, systemic symptoms and elevated plasma inflammatory markers) make diagnosis straightforward, in the diabetic foot these symptoms and signs can be diminished or absent. Factors such as ischaemia can diminish the localised vascular response to infection, as can neuropathy by reducing the localised hyperaemic flare reaction to infection (McIntosh, 2006). Furthermore, neuropathy may significantly reduce the feeling of pain (Fowler and Rayman, 2006). This would appear to suggest that a culture should always be taken to rule out infection.

Identifying infection

Tissue is constantly in contact with pathogens which, under the proper conditions, are able to proliferate to create pathological conditions. Infection of a wound with a large number of bacteria (colonisation) will slow the healing process (Bowler et al, 2001). However, all wounds contain some bacteria which do not usually affect healing (Donovan, 1998). The difference between contamination, colonisation and infection is the concentration of bacteria (Kelly, 2003). Where bacteria are present but are not multiplying they are described as contaminating the wound bed. Colonisation occurs where the bacteria are present and the numbers are increasing, but there is no host reaction. Critical colonisation is the point in time when the body's local host response starts to be initiated, but there are no systemic signs of infection. Infection is where bacteria are multiplying, healing is impaired and a systemic host reaction is present (Fletcher, 2005). The development of a wound infection is dependent on the pathogenicity of the organism,

the bacterial load, the toxin produced and the host response (Harker, 2002). Diagnosing infection in a foot ulcer involves using clinical judgement and/or laboratory analysis of microbiological specimens (O'Meara et al, 2006).

Sampling

Fowler and Rayman (2006) considered that the best samples to send are those of tissue obtained from the wound by debridement or deep swabs because superficial swabs are likely to reveal superficial skin organisms that are not necessarily responsible for the infection and can lead to unnecessary use of broad spectrum antibiotics. The ADA (1998) states that most diabetic foot infections are polymicrobial, so both aerobic and anaerobic cultures specimens should be collected. Anaerobic bacteria such as bacteroides, clostridium and streptococcus may be active at deeper levels of the dermis, insulated from the healing influence of oxygen and are responsible for many devastating infections resulting in gangrene and amputation (O'Meara and Nelson, 2003). Therefore, cultures from superficial tissue may be of little value and cultures from tissue deep in the ulcer base are more reliable for identifying true pathogens (ADA, 1998). However, a study by Slater et al (2004) reported reliable bacterial identification from superficial swabs as long as the ulcer was not down to bone. Therefore, if deep swabs or tissue cannot be taken, superficial swabs are a second best alternative.

Although the wound swab remains the most common method of sampling (Bowler et al, 2001), Donovan (1998) showed that few nurses are taught how to swab a wound correctly. This is supported by Gilchrist (1996) who stated that there is no consensus on swabbing methodology. However, the literature tends to give conflicting advice on the various procedures for obtaining a specimen using a swab. For example, there is ongoing debate about whether wounds should be cleaned before taking the specimen. Some nurses clean the wound before

taking a swab, whereas others take the swab before the wound is cleaned (Miller, 2001). Cooper and Lawrence (1996) said that wounds must be cleaned first to remove surface contamination, however, Wilson (1995) maintained that the swabs need to be taken before cleansing so that the maximum number of bacteria are present. Some practitioners swab only the pus and some nurses wipe the swab all over the wound, yet others take the sample from just one place on the wound bed (Miller, 2001). This inconsistency could possibly lead to unreliable results. Therefore, there is a need for a standard criterion on the technique of wound swabbing to be devised that can be used nationwide.

Patients with diabetes have impaired wound healing which is often delayed because of the interruption of the inflammatory and proliferative phases resulting from uncontrolled blood glucose levels (Edwards and Foster, 1999).

Wound assessment and management

Wound bed preparation (WBP) is widely accepted as a valuable strategy for implementing appropriate care planning for the patient with a complex wound (Watret, 2005). Wound bed preparation is the management of a wound in order to accelerate endogenous healing or to facilitate the effectiveness of other therapeutic measures (Schultz et al, 2003). Wound healing is a complex series of events that begins at the moment of injury (Fletcher, 2005). All wounds heal following a specific sequence of phases: inflammatory phase, proliferative phase and remodelling or maturation phase. Patients with diabetes have impaired wound healing which is often delayed because of the interruption of the inflammatory and proliferative phases resulting from uncontrolled blood glucose levels (Edwards and Foster, 1999). Neutrophils and macrophages

are responsible for initiating the wound cleansing process; they phagocytose bacteria and devitalised tissue (Fletcher, 2005). Without this stage the bacterial load of the wound becomes out of control and infection occurs which further prolongs the inflammatory phase (Watret, 2005).

This suggests that proper insulin control is paramount and a multi-disciplinary approach is needed in order to treat people with diabetic foot ulcers holistically, rather than just treating the wound (Gottrup, 2003). Wound care has evolved greatly over the past decade and evidence-based practice has led to changes in wound management. Therefore professionals need to ensure that they are using current evidence-based strategies to be able to justify their management choices.

Classifying diabetic foot lesions

The key factors associated with non-healing in diabetic foot wounds (and therefore the risk of amputation) include wound depth and the presence of infection and ischaemia (Wu and Armstrong, 2005). Various classification systems for diabetic foot ulcers are available. The Wagner ulcer classification system (1981) and the University of Texas diabetic wound classification system (adapted from Armstrong et al, 1998) appear to be the most commonly used. A review of the literature comparing these two classification systems reveals that although the Wagner system is the most widely accepted classification system for a number of types of wounds, it is not specific to diabetic foot ulcers and does not address two critically important parameters which are particularly relevant to diabetic foot ulcers: ischaemia and infection (McIntosh, 2006). The University of Texas diabetic wound classification system assesses the depth of ulcer penetration, the presence of wound infection, and the presence of clinical signs of lower-extremity ischaemia. This system uses four grades of ulcer depth (0 to 3) and four stages (A to D), based on ischemia or infection, or both (Frykberg, 2002). Therefore, the University of Texas system,

which combines grade and stage, is more objective and shows a greater association with increased risk of amputation and prediction of ulcer healing when compared with the Wagner system (Oyibo et al, 2001).

Dressing selection

Following classification of the ulcer and a comprehensive wound assessment, an appropriate dressing should be applied to the wound. Appropriate dressing selection is an important factor in the holistic management of diabetic foot ulcers (Edwards and Foster, 1999). Ideally, dressings should alleviate symptoms, provide wound protection, and encourage healing (Jones, 1998). Selecting the most appropriate dressing in order to create the ideal wound healing environment should not be underestimated (Cullum et al, 2000). There is no single ideal wound dressing for the diabetic foot, and no evidence exists to suggest that any particular wound dressing is more effective for diabetic ulceration (McIntosh, 2006). Foster et al (1994) highlighted desirable properties of the dressing of choice for diabetic feet. The dressing needs to be adapted to cope with the position of the foot in the shoe, taking account of the extreme pressure the foot will bear and ensuring that it does not cause further damage that will go undetected. It should also be able to be changed frequently, be low adherent and be able to withstand the pressures and shear stresses of walking.

Conclusion

Foot ulcers and amputation are common complications of diabetes mellitus (DoH, 2005). However, as this paper has shown, foot ulceration and amputation does not have to be an inevitable consequence of diabetes. Improving glucose control and educating patients in the routine care of their feet can reduce the incidence of diabetic foot complications. The development of an assessment leaflet for distribution to all people with a new diagnosis of diabetes on the importance of foot care and inspection is one possible step forward. Ensuring that

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everyone with diabetes receives an annual foot inspection, thorough and comprehensive assessment, and that foot ulcers are classified and staged are vital steps in identifying the management requirements of the patient (Bielby, 2006).

Prompt recognition of infection once a wound has been recognised is paramount to the prevention of amputation. A multidisciplinary healthcare team including physicians, podiatrists, diabetes educators, and tissue viability nurses will provide an effective comprehensive approach to care of patients with diabetes. This will ensure prompt recognition of any infection and prevent the need for amputation (EWMA, 2004). **WUK**

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Key Points

- ▶▶ Foot ulcers and amputation are common complications of diabetes mellitus.
- ▶▶ It has been estimated that up to two-thirds of diabetes-related lower-limb amputations can be avoided with effective foot care.
- ▶▶ The initial pain of diabetic foot disease is masked by poor peripheral sensory functions. This means that people often only seek treatment in the advanced stages of the ulcer when it is difficult to heal.
- ▶▶ Improving glucose control and educating patients in the routine care of their feet can reduce the incidence of diabetic foot complications.
- ▶▶ Prompt recognition of infection once a wound has been recognised is paramount to the prevention of amputation.
- ▶▶ Careful inspection of the diabetic foot on a regular basis is one of the easiest, least expensive and most effective measures for preventing foot complications.

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