

## PATIENT EDUCATION: PREVENTING DIABETIC FOOT INFECTIONS

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### ABSTRACT

Diabetic foot infections are a common complication in people with diabetes. This article will discuss the foot-related complications that can happen in people with diabetes, as well as guidelines for good foot care. Patient education is a central component in the self management of diabetes infections in both prevention and treatment. Poor knowledge of foot care practices is an important risk factor for foot problems among diabetics. Studies have demonstrated deficiencies in knowledge and practices regarding foot care, particularly among rural populations with diabetes. Patients should be informed about the risk factors and their complications that could lead to amputation. The mainstay therapy for intervention of diabetic lower limb complications is prevention.

**Keywords:** diabetic foot, infections, foot care, prevention

### INTRODUCTION

Diabetic foot infections are associated with substantial morbidity and mortality. Over time, diabetes can lead to various complications, many of which can be serious if they are not identified and addressed promptly (1). Important risk factors in the development of diabetic foot infections include neuropathy, peripheral vascular disease, and poor glycemic control. Educating patients about proper foot care and periodic foot examinations are effective interventions to prevent ulceration. Regular foot exams to check for problems or changes are a critical part of managing diabetes (2). Trauma in patients with one or more of these risk factors precipitates development of wounds that can be slow to heal and predispose to secondary infection.

It may help to make the self foot exams a part of daily routine. This should include looking carefully at all parts of the feet, especially the area between the toes (3). Look for excessive skin dryness, scaling, broken skin, ulcers, blisters, areas of increased

warmth or redness, or changes in callus formation. Nerve damage may lead to unusual sensations in the feet and legs, including pain, burning, tingling, or numbness (4). A weak pulse, cold feet, thin skin, and lack of hair in the area suggest that there is reduced blood flow.

### DIABETIC FOOT INFECTIONS

All patients with diabetes should be examined to identify risk for foot ulceration. The feet should be visually inspected at each routine visit to identify problems with nail care, poorly fitting footwear resulting in barotrauma, fungal infections, and callus formation that may result in more severe foot problems. A comprehensive foot examination should be performed annually on patients with diabetes to identify risk factors predictive of ulcers and amputation; and should include inspection, assessment of pedal pulses, and testing for loss of protective sensation.

Diabetic foot infections can develop as a result of neuropathic or ischemic ulcers, traumatic wounds, skin cracks or fissures, or other defects in the skin of the foot or nail beds (paronychia). Thus, infection can present as localized superficial skin involvement at the site of a preexisting lesion or as an infection of the skin or deeper skin structures that has spread beyond the site of local trauma. Such infections can subsequently extend to joints, bones, and the systemic circulation.

The microbiology of diabetic foot wounds is variable depending on the extent of involvement. Superficial diabetic foot infections (including cellulitis and infected ulcers) are likely due to aerobic gram-positive cocci including *Staphylococcus aureus*, *Streptococcus pyogenes* (5). It is also important to note that diabetic patients with chronic foot wounds who receive repeated and prolonged courses of antibiotics represent an important risk group for development of vancomycin-intermediate *S. aureus* infections. Ulcers that are deep, chronically infected, are more likely to be polymicrobial. Such wounds may involve enterococci, *Enterobacteriaceae*, *Pseudomonas aeruginosa*, and anaerobes. Wounds with extensive local inflammation, cutaneous bullae, severe ischemia, necrosis, malodorous drainage, or gangrene with signs of systemic toxicity should be presumed to have anaerobic organisms in addition to the above pathogens and may denote the presence of a limb-threatening infection. Potential pathogens include anaerobic streptococci, *Bacteroides* species, and *Clostridium* species. Systemic signs such as fever, chills, hypotension, and tachycardia may accompany local signs of infection, and their presence indicates an increased severity of infection. The possibility of osteomyelitis should be considered in diabetic patients with foot wounds associated with signs of infection in the deeper soft tissues and in patients with chronic ulcers, particularly those overlying bony prominences that do not heal after several weeks of wound care (6). Clinical features associated with underlying osteomyelitis in patients with diabetic foot ulcers include ulcer size > 2 cm<sup>2</sup> and depth allowing visibly exposed bone or ability to probe to bone (7).

## DIAGNOSIS OF DIABETIC FOOT INFECTIONS

The diagnosis of a diabetic foot infection is primarily based on suggestive clinical manifestations. Systemic signs such as fever, chills, hypotension, and tachycardia may accompany local signs of infection, and their presence indicates an increased severity of infection. The presence of two or more

features of inflammation (erythema, warmth, tenderness, swelling, induration and purulent secretions) can establish the diagnosis. As many diabetic foot wounds are colonized by bacteria, the presence of microbial growth from a wound culture in the absence of supportive clinical findings is not sufficient to make the diagnosis of infection. Clinical examination should also include a neurologic evaluation that documents the extent of sensory loss as well as a vascular evaluation of the presence and severity of arterial and/or venous insufficiency (8). Infection may coexist with other inflammatory processes, and empiric antimicrobial therapy may be warranted in some cases when the diagnosis is unclear. These include trauma, crystal-associated arthritis, acute Charcot arthropathy, fracture, thrombosis, and venous stasis.

Laboratory evaluation should include complete blood count as well as measurement of blood glucose, electrolytes, renal function and subsequent inflammatory markers such as erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP). Some studies, but not all, have suggested that procalcitonin (PCT), a novel inflammatory marker, may also be useful if laboratory facilities that test this substance are locally available; further investigation is needed to determine the clinical utility of this assay (9).

Physical examination findings such as diminished pulses, decrease in skin temperature, thin skin, lack of skin hair, and bluish skin color are not specific enough to guide further management in an individual patient (10). Patients with clinical evidence of peripheral artery disease should have ankle-brachial index testing. A low ankle-brachial index in the presence of a foot ulcer suggests that the prognosis will be improved with reconstructive vascular surgery (11).

Sweating is diminished or absent; as a result, the skin of the feet remains dry and has a tendency to become scaly and cracked, thereby allowing infection to penetrate below the skin. Lack of autonomic tone in the capillary circulation causes shunting of blood from arteries directly into veins, bypassing the tissues that need nutrition (12). This results in a foot that feels warm and has distended veins and bounding pulses (13). Despite these apparent signs of adequate perfusion, the foot is vulnerable to local „microvascular” gangrene, will heal very poorly and slowly, and will be less able to resist infection (4).

Neuropathy, promotes ulcer formation by decreasing pain sensation and perception of pressure, by causing anatomic deformities, and by impairing

the microcirculation and the integrity of the skin. Once ulcers form, healing may be delayed or difficult to achieve, particularly if infection penetrates to deep tissues and bone and/or there is diminished local blood flow. Bony deformities, joint mobility, and gait and balance should also be assessed. This leads to subluxation of the proximal interphalangeal-metatarsal joints, resulting in a claw toe appearance. One consequence of this abnormality is increased pressure on the metatarsal heads, which are a common site of ulcer development.

A later complication is Charcot arthropathy, which is characterized by collapse of the arch of the midfoot and abnormal bony prominences (14). These changes are often triggered by injury, inflammation, and hyperperfusion, accompanied by the triad of small muscle wasting, decreased sensation, and abnormal distribution of weight when standing, leading to repetitive microtrauma due to the absence of protective pain sensation.

### GENERAL MEASURES

There are several things that patients can do to reduce foot complications. Careful management of blood sugar levels can reduce the risk of circulation problems and nerve damage that often lead to diabetic foot complications. Smoking can worsen heart and vascular problems and reduce circulation to the feet. They need to avoid activities that can injure the feet and use care when trimming their nails. Weight control/dietary modification, reduction in alcohol, exercise are other things that modification lifestyle changes (10).

Several risk factors are predictive of ulcers and amputation. Early recognition and management of risk factors is important for reducing morbidity of foot ulceration. Most are readily identifiable from the history or physical examination. The most important risk factors are: previous foot ulceration, neuropathy (loss of protective sensation), foot deformity, vascular disease.

The skin should be assessed for integrity, especially between the toes and under the metatarsal heads. Findings that may herald a developing foot ulcer include the following: lesions between adjacent toes due to pressure from tight shoes cramming them together, macerated areas between the toes („athlete’s foot”); these lesions are often painless and may go unnoticed until bacterial infection supervenes, callused areas. The presence of erythema, warmth, or fissures may indicate areas of tissue damage.

### BASIC PRINCIPLES OF WOUND MANAGEMENT

Management of diabetic foot infections requires attentive wound management, good nutrition, appropriate antimicrobial therapy, glycemic control, and fluid and electrolyte balance. Local wound care for diabetic foot infections typically includes debridement of callus and necrotic tissue, wound cleansing, and relief of pressure on the ulcer. Topical agents such as antiseptics and antimicrobial agents can be used to control locally heavy contamination. Applying a suitable dressing to a wound, can arguably have a significant impact on the speed of wound healing, wound strength and function of the repaired skin, and cosmetic appearance of the resulting scar. The purpose of wound dressing is to absorb exudate and create a moist environment to promote healing. A wide array of dressing and wound healing products for ulcer management has been developed. These products include enzymes, gels, hydrocolloids and antiseptics containing iodine or silver salts.

Empiric antibiotic therapy should be selected based on the severity of infection and the likelihood of involvement of resistant organisms. Patients with mild infection should receive oral antibiotic therapy in conjunction with attentive wound care. The antibiotics chosen and duration of therapy depend upon the depth and severity of infection. For severe infections, patients require surgical debridement after receiving intravenous antibiotic therapy perioperatively (15). Surgical debridement is required for cure of infections complicated by abscess, extensive bone or joint involvement, crepitus, necrosis, gangrene or necrotizing fasciitis and is important for source control in patients with severe sepsis. In addition to surgical debridement, revascularization (via angioplasty or bypass grafting) and/or amputation may be necessary (3).

### RECOMMENDATIONS FOR PATIENTS

In conjunction with the comprehensive foot exam, advice for prophylactic foot care should be given to all patients (16). These recommendations are particularly important in patients with existing neuropathy: avoid smoking, avoid going barefoot, even at home, and especially on hot decks and hot sand, trim toenails to shape of the toe, and remove sharp edges with a nail file; do not cut cuticles (17), wash in lukewarm water, dry thoroughly (including between the toes), and check feet daily, test water temperature before stepping into a bath, socks

should fit and be changed daily, shoes should be snug, but not tight, and customized if feet are misshapen or have ulcers.

Patient education must also emphasize the need to reduce the risk of avoidable damage to the skin. Integrity of the skin is essential because it forms a protective barrier (18). Once breached, it allows ingress by pathogenic bacteria, with consequent risk of spreading infection, inflammation, thrombotic occlusion of small and medium-sized vessels and gangrene (19). Lifestyle modification should be discussed: weight control/dietary modification, reduction in alcohol intake, cessation of smoking, proper exercises.

Patient education is a central component in the self management of diabetes complications in both prevention and treatment. It is one of the major management strategies for prevention and treatment of diabetic foot ulcer (20). Patient involvement is vital for the successful care of diabetic foot ulcers. The primary task of the health care team is to boost patient's self confidence, improve patient

awareness and provide support. Poor knowledge of foot care practices is an important risk factor for foot problems among diabetics. Patients should be informed about the risk factors and their complications that lead to amputation. The mainstay therapy for intervention of diabetic lower limb complications is prevention.

The advice of a psychologist may help to deal with problems of denial of the condition, particularly in the later stages of neuropathy (21).

## CONCLUSIONS

Patients should be informed about the risk factors and their complications that could lead to amputation. The mainstay therapy for intervention of diabetic lower limb complications is prevention.

### Acknowledgement

All authors equally contributed to the present paper.

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