

# Approach to managing diabetic foot ulcers

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## ABSTRACT

**INTRODUCTION** Of an estimated 1.7 to 2 million Canadians with diabetes, approximately 10% will present each year to their family doctors with plantar ulcers. Nearly 3500 will require major lower extremity amputations.

**SOURCES OF INFORMATION** Most of the recommendations outlined in this paper are based on level I evidence from excellent bench research and epidemiologic studies.

**MAIN MESSAGE** Both insulin-dependent and non-insulin-dependent diabetics develop foot infections. These patients are on average 60 years old and have had diabetes for more than 10 years. Physicians who insist on excellent blood sugar control, provide ongoing patient education on diabetic foot care, prescribe appropriate shoes, and practise an aggressive multidisciplinary approach to wound care can reduce the rate of lower extremity amputations by more than 50%.

**CONCLUSION** Foot problems remain one of the main challenges associated with diabetes, but family physicians can manage them successfully.

## RÉSUMÉ

**INTRODUCTION** Chaque année au Canada, environ 10% des 1,7 à 2 millions de diabétiques consultent leur médecin de famille pour des ulcères plantaires. Près de 3 500 d'entre eux nécessiteront des amputations majeures des membres inférieurs.

**SOURCE DE L'INFORMATION** La plupart des recommandations dans cet article sont fondées sur des preuves de niveau I provenant d'études pilotes et épidémiologiques d'excellente qualité.

**PRINCIPAL MESSAGE** Les diabétiques, qu'ils soient insulino-dépendants ou non, risquent des infections aux pieds. Ils ont en moyenne 60 ans et souffrent de diabète depuis plus de 10 ans. En insistant pour un excellent contrôle de la glycémie, renseignant régulièrement le patient sur les soins des pieds des diabétiques, prescrivant des chaussures adéquates, et en utilisant une approche multidisciplinaire agressive pour le traitement des blessures, le médecin peut réduire de plus de 50% le taux d'amputation des membres inférieurs.

**CONCLUSION** Les lésions des pieds demeurent l'un des principaux défis associés au diabète, mais le médecin de famille peut s'en occuper adéquatement.

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Cet article a fait l'objet d'une évaluation externe.

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## Case

Mr H.S., a 47-year-old construction worker who has type 2 diabetes, has had a plantar ulcer under his right big toe for 6 weeks. Approximately 2 months ago, Mr H.S. purchased a new pair of steel-toed work boots and shortly thereafter developed blisters on the medial aspect of both big toes. The blister on the left big toe quickly resolved when he acquired a new extra-wide pair of boots with an over-the-counter cushioned insert, but the lesion on the right big toe continued to grow.

This prompted him to visit his family doctor who removed the loose skin surrounding the small, full-thickness lesion, and prescribed cephalexin (250 mg four times daily for 10 days), daily sodium fucidate dressings, and evening foot soaks. Mr H.S. reported that this treatment appeared beneficial for the first 5 days, but slowly over the subsequent 7 days, his right big toe became inflamed and swollen again. He returned to his family doctor who prescribed ciprofloxacin (500 mg twice daily) and called my office for an urgent diabetic foot ulcer assessment. I saw Mr H.S. the following day.

A review of Mr H.S.'s medical history revealed that, despite being a type 2 diabetic for 4 years, he had not been checking his blood sugar because the chemical strips were too expensive. He said he had had no emergency hospital visits for glycemic complications, previous foot injuries, plantar ulcers, or lower extremity infections. He was not aware of any cardiac (including hypertension and dyslipidemia), renal, gastrointestinal, or neurologic problems, and he did not smoke. His medications included metformin (850 mg three times daily), gliclazide (80 mg twice daily), and ciprofloxacin (500 mg twice daily). He was still applying sodium fucidate dressings each day to his toe ulcer and soaking his feet each evening for 10 to 15 minutes in warm water. He had no known medical allergies.

On examination, Mr H.S. was normotensive and afebrile. A 1.8 x 1.0 cm full-thickness lesion was on the plantar aspect of his right big toe; the

**Figure 1. Lesion on right big toe**



lesion's base extended to bone (**Figure 1**). The toe was markedly swollen, and a purulent, foul-smelling discharge seeped from the ulcer. There was no associated forefoot swelling, erythema, fluctuation, or articular crepitus, and no groin lymphadenopathy. No foot or ankle deformities were observed. Mr H.S.'s posterior pulses were easily palpable, but neurologic assessment found he had no sensation on monofilament testing in a symmetrical stocking distribution (**Figure 2**), and both ankle reflexes were absent.

Results of screening blood tests are shown in **Table 1**. A culture of the debrided wound base grew *Staphylococcus aureus* and Gram-negative bacilli. Plain x-ray film of his right big toe showed a cortical break involving the head of the proximal phalanx and a surrounding periosteal reaction (**Figure 3**). A three-phase bone scan showed marked isotope uptake in this area confirming the clinical and radiologic picture of osteomyelitis. Formal vascular testing was not done because Mr H.S.'s peripheral pulses were easily palpable, and there was no evidence of an ischemic foot (ie, absence of posterior tibial or dorsalis pedis pulses, dependent rubor, delayed capillary filling, shiny skin over the dorsal aspect of the foot with loss of hair, or thickened brittle nails).

Of an estimated 1.7 to 2 million Canadians with diabetes, approximately 10% will present

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**Figure 2. Monofilament testing:** A Semmes–Weinstein 5.07 monofilament is pressed against the skin in several locations on the plantar surface and dorsal aspect of the foot until the filament buckles. If patients cannot perceive this pressure, which is equal to 10 g of linear strength, they have a permanent loss of protective sensation.



**Figure 3. X-ray image of the right big toe showing osteomyelitis of the head of the proximal phalanx**



**Table 1. Mr H.S.'s blood test results**

White blood cell count	7500
Hemoglobin A <sub>1c</sub>	0.092
C-reactive protein	4.6 mg/L
Sedimentation rate	14 mm/h
Thyroid-stimulating hormone level	1.31 mU/L
<ul style="list-style-type: none"> <li>• Complete and white blood cell counts are frequently normal.</li> <li>• Low hemoglobin levels could indicate anemia or chronic disease.</li> <li>• Glucose levels are usually elevated because glycemic control is almost impossible when patients have severe infection.</li> <li>• Creatinine levels are frequently elevated and are important in determining antimicrobial medication and dose.</li> <li>• C-reactive protein is often elevated in the presence of osteomyelitis but, as can be seen in this case, can still be within the normal range of 0-8 mg/L.</li> <li>• Erythrocyte sedimentation rates might be elevated in the presence of acute infection without osteomyelitis. The rate will return to normal within 2 to 3 weeks as the infection is controlled.</li> <li>• A lipid profile and a thyroid-stimulating hormone test should also be done.</li> </ul>	

each year to their family doctors with a clinical picture similar to that of Mr H.S. Of those patients, nearly 3500 will require a major lower extremity amputation in order to salvage the involved limb.<sup>1</sup> A major amputation is required because untreated ulcers can develop gangrene

or compromise local blood flow sufficiently to cause digital or forefoot necrosis.

Unfortunately, the downward spiral of diabetic lower extremity complications often leads to further amputations. Approximately 20% of people who require below-knee amputations have surgical wounds that fail to heal without further wound revision or above-knee amputations.<sup>2</sup> The 5-year rate of contralateral amputation among patients with below-knee amputations is 50%,<sup>3</sup> and 5-year survival rate after the first amputation is only 40%. The main cause of death is cardiovascular events (eg, strokes, heart attacks, or complications associated with a diabetic foot).<sup>4-6</sup>

### Sources of information

Diabetic tissue repair and infection research laid the groundwork for such programs as the American Long-Range Plan to Combat Diabetes (1987) and the Canadian Diabetic Association Clinical Practice Guidelines.<sup>3,7-9</sup> There are few controversies in the management of diabetic foot ulcers. Some practitioners manage their patients with a variety of topical

ointments, antibiotics, and off-loading devices. The recommendations outlined in this paper are based on level I evidence from excellent bench research and epidemiologic studies.<sup>2-4,7,8</sup>

## Diabetes and foot ulcers

Both insulin-dependent and non-insulin-dependent diabetics develop foot infections. Most are about 60 years old and have had diabetes for more than 10 years. Research has shown a direct correlation between number of diabetic complications (retinopathy, cardiovascular disease, nephropathy, gastroparesis, peripheral neuropathy, vasculopathy, and previous foot infections) and incidence of foot ulcers.<sup>2</sup>

Patients are usually acutely ill and have erythema and drainage from the ulcers. They do not usually have fever or rigours. Occasionally, they present in ketoacidosis and are unaware of the infection.

## Treatment

Physicians who provide ongoing diabetic foot care education (Table 2), prescribe appropriate shoes, and take an aggressive multidisciplinary approach to wound care (Figure 4<sup>3,10</sup>) can reduce the lower extremity amputation rate in their patient populations by more than 50%.<sup>2,3</sup>

In assessing patients with diabetic foot ulcers, the most important initial decision is whether patients have neuropathic or neuro-ischemic foot lesions. They must be treated accordingly. If Mr H.S.'s lower extremity vascular status was deemed compromised (ie, he had signs of an ischemic lesion) an urgent peripheral vascular surgical consultation would have been imperative.

## Mr H.S.'s treatment regimen

Three-times-a-day blood-sugar monitoring was initiated with subsequent oral hypoglycemic agent adjustment. Good diabetic control improves fibroblast activity, capillary blood flow, and leukocyte function, thereby enhancing wound healing. He received parenteral clindamycin and systemic ciprofloxacin combined therapy for 12 weeks. It is essential to treat diabetic

infections aggressively since they are deceptively subtle and polymicrobial, tend to spread quickly, and are often associated with underlying osteomyelitis.

He began to use an Air Cast™ walking brace with total contact inserts (Figure 5). Pressure relief

### Table 2. General principles of diabetic foot-care education:

*Target the level of information at the specific needs of patients. Those not at risk require only general advice about foot hygiene and footwear. Use "do" rather than "don't" in your teaching approach to convey foot care in a positive light that might be more acceptable to patients.*

**DO** inspect feet daily.

**DO** report any problems immediately (ie, all skin lesions, including fissures, abrasions, calluses, hot or red spots, and web-space maceration).

**DO** buy shoes with extra-depth toe boxes and molded rocker soles.

**DO** inspect the inside of shoes for foreign objects every day before putting them on.

**DO** visit a skilled skin and nail specialist on a regular basis.

**DO** cut your nails straight across, not rounded.

**DO** keep your feet away from heat (fires, radiators, hot water bottles) and check the bath water with a thermometer or your elbow before stepping into it.

**DO** wear something on your feet at all times to protect them, and never walk barefoot.

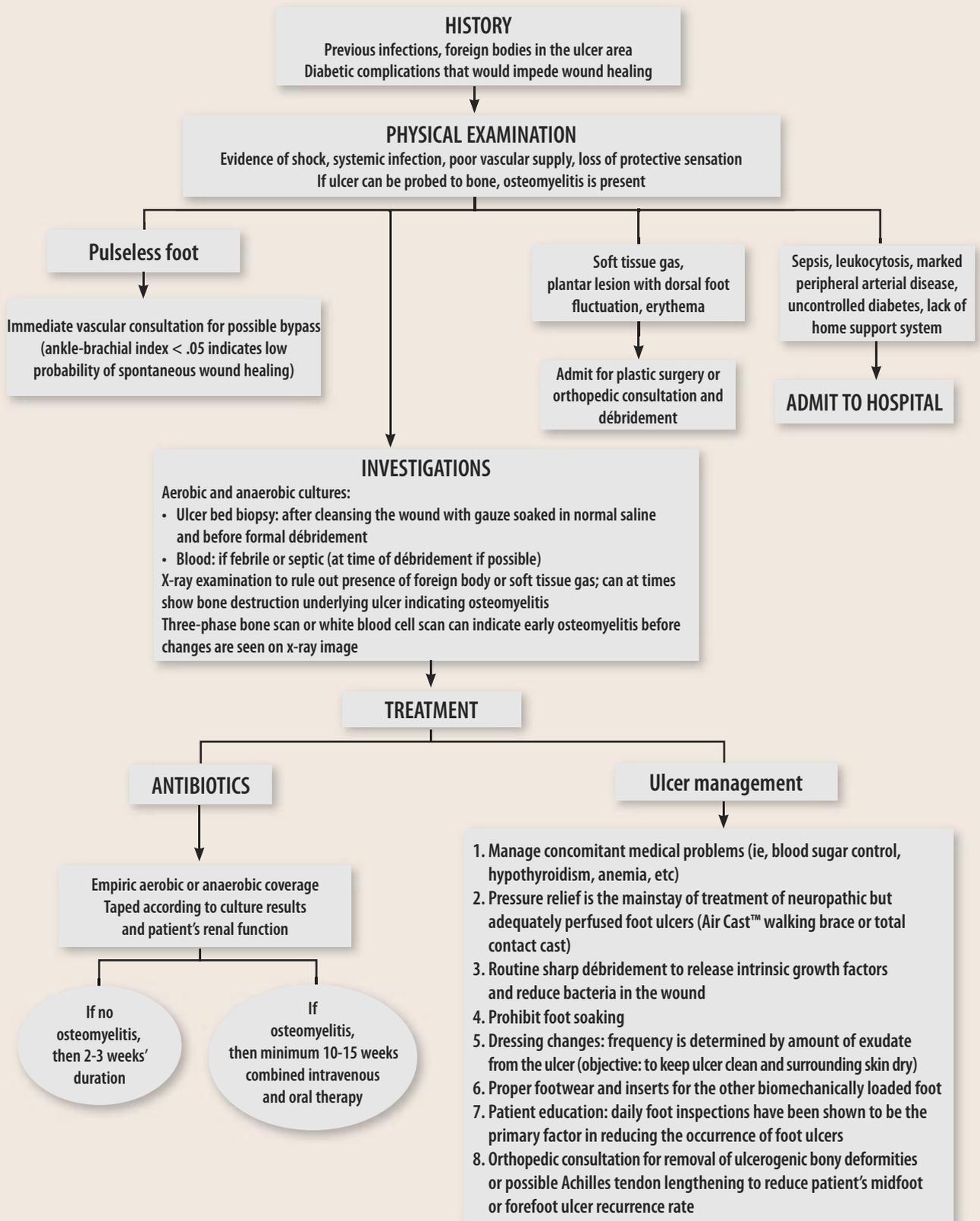
**Repeat this advice at regular intervals. You or your nurse should check that it is being followed at each office visit.**

Disseminate advice to other family members and health care professionals involved in the care of your patient.

Figure 5. Air Cast™ walking splint with total contact insert



**Figure 4.** Approach to treatment of a patient with an infected diabetic ulcer: Decision tree adapted from Levin<sup>3</sup> and Thompson.<sup>10</sup>



is the mainstay of treatment for neuropathic but adequately perfused foot lesions. Mr H.S. was told he must use the walking brace every step of the day and night because any biomechanical friction on the ulcer would markedly impede healing. He was also fitted with an extra-depth *left* walking shoe with total contact inserts because his left foot was at risk of developing a plantar ulcer as a result of the off-loading device on the right foot. Mr H.S. was placed on short-term disability, as he could not continue his construction job (and did not qualify for a desk job) until the wound healed.

At each follow-up visit, sharp débridement of the wound was done since complete removal of callus, fibrin, and necrotic tissue activates wound healing by releasing intrinsic growth factors. Debriding ulcers to the point where they are bleeding freely is not necessary, but thorough removal of necrotic tissue is essential. Small areas of active bleeding should be cauterized.

Daily sodium fucidate dressings (Telfa™ top- per held in place with Mefix™ tape) were continued after the ulcer had been cleaned with normal saline and dried with sterile gauze. The evening foot soaks were discontinued immediately because, with lower extremity infection, soaking can promote maceration of the skin surrounding the ulcers, facilitate spread of soft-tissue infection, and lead to abscess formation.

Mr H.S.'s lesion resolved within 4 weeks with outpatient therapy. Some conditions require hospitalization and treatment with parenteral antibiotics. Criteria for hospitalization are sepsis, leukocytosis, marked peripheral arterial disease, uncontrolled diabetes, a minor plantar infection with erythema and edema on the dorsal aspect of the foot (high probability of a deep-space infection requiring immediate aggressive surgical débridement), and inadequate home support.

### Recent substantive changes in treatment

Increased knowledge of foot biomechanics has led to improved ulcer off-loading materials and devices.

#### EDITOR'S KEY POINTS

- Foot ulcers are an important source of morbidity, and occasionally mortality, in patients with diabetes. Each year, about 10% of diabetic patients have some form of foot lesion.
- Prevention is a key element for patients and includes daily foot inspection, regular visits to a nail care specialist, wearing appropriate shoes with proper weight off-loading devices, and reporting early signs of infection.
- It is important to check peripheral circulation at the outset of treatment and consider vascular surgery consultation early in the process.
- Managing foot ulcers requires excellent blood sugar control, pressure relief with an Air Cast™ walking brace, sharp débridement of the wound, dressings that keep the wound clean and the surrounding skin dry, and treatment of underlying osteomyelitis.

#### POINTS DE REPÈRE DU RÉDACTEUR

- Les ulcères aux pieds sont une importante source de morbidité et, parfois, de mortalité chez les diabétiques. Chaque année, environ 10% d'entre eux développent une forme de lésion aux pieds.
- La prévention est la clé du problème. Elle inclut une inspection quotidienne des pieds, des visites régulières chez un spécialiste des ongles, le port de chaussures dotés d'orthèses de délestage appropriées et le signalement de tout signe d'infection débutante.
- Il importe de vérifier la circulation périphérique dès le début du traitement et d'envisager une consultation en chirurgie vasculaire sans retard.
- Le traitement des ulcères aux pieds exige un excellent contrôle de la glycémie, l'utilisation d'une orthèse de marche «Air Cast» pour diminuer la pression, un débridement intensif de la plaie, des pansements qui maintiennent la plaie propre et la peau environnante sèche et le traitement d'une ostéomyélite sous-jacente.

Referral to a certified orthotist or pedorthist is highly recommended so that patients can be properly fitted with these devices.

The increased availability of magnetic resonance angiography allows peripheral vascular surgeons to plan bypass procedures without risk of inducing further renal impairment, which sometimes happened with use of traditional angiography dyes. These surgeons are attempting more distal bypass procedures with grafts extending into the small vessels of the foot. Incidence of postoperative wound dehiscence appears to be slightly higher with this procedure, but improved blood flow to the foot and subsequent wound healing can be dramatic. Magnetic resonance images are now indicated to rule out osteomyelitis when clinical suspicion of osteomyelitis is high but patients' nuclear studies are equivocal.

The advent of home parenteral therapy programs directed by infectious disease consultants has greatly increased outpatients' access to intravenous antibiotic therapy. Patients with severe infections can be monitored by program nurses who visit patients in their homes.

Hyperbaric oxygen therapy delivered at an accredited clinic can benefit patients with diabetic plantar neuro-ischemic lesions on limbs that peripheral vascular surgeons have deemed not bypassable. Bypass surgery is the treatment of choice for ischemic lesions. Local tissue transcutaneous oxygen readings must show a favourable response to breathing 100% oxygen before this treatment is initiated.

Growth factor delivery systems for enhancing the rate of wound healing have not lived up to expectations, but promising research in this field continues.<sup>11</sup>

## Conclusion

Foot problems remain one of the main challenges associated with management of diabetic patients. Physicians who provide ongoing diabetic foot care education, prescribe appropriate shoes, and practise an aggressive multidisciplinary approach

to wound care can reduce the lower extremity amputation rate in their patient populations by more than 50%.<sup>2,3</sup>



## Competing interests

None declared

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