ABSTRACT

According to the American Diabetes Association, approximately 82,000 nontraumatic lower-limb amputations were performed among people with diabetes in the United States in 2002. Guidelines on managing the patient with diabetes with suspected or evident foot infection, prepared by members of the Infectious Diseases Society of America, were published recently. This article reviews the information from those guidelines focusing on the workup and treatment of a patient with diabetic foot infection. Optimal management of diabetic foot infections requires appropriate culture (ie, after the wound has been cleaned, and from the deepest site possible) and appropriate antibiotic (ie, empirically covering for Staphylococcus and Streptococcus for mild infections and covering aerobic and anaerobic organisms in patients with moderate to severe infections). If hospitalization is required, timely surgical consultation and intervention is critical. Surgical consultation should involve surgeons experienced with diabetic foot complications.

Foot infections in persons with diabetes are common and costly. They account for the largest number of diabetes-related hospital bed days. They are also the most common cause of nontraumatic leg amputations. According to the American Diabetes Association, approximately 82,000 nontraumatic lower-limb amputations were performed among people with diabetes in the United States in 2002. The risk of a leg amputation—the most severe and permanent local morbidity of diabetic foot infection—is 15 to 40 times greater for a person with diabetes than the general population.

THE GUIDELINES

Lipsky et al published guidelines on managing the patient with diabetes with suspected or evident foot infection, prepared by members of the Infectious Diseases Society of America. The information focusing on the management of a patient with diabetic foot infection is summarized in Figure 1.

For patients with clinically infected wounds, the most important initial task is to recognize those patients who require immediate hospitalization, parenteral and broad-spectrum empirical antibiotic therapy, and urgent consideration of diagnostic testing and surgical consultation. Hospitalization should be considered in patients who present with any of the following: systemic toxicity (eg, fever and leukocytosis), metabolic instability (eg, severe hypoglycemia or acidosis), rapidly progressive deep-tissue infection, substantial necrosis or gangrene, the presence of critical ischemia, requirement of urgent diagnostic or therapeutic intervention, and inability to care for self or inadequate home support.

The guidelines classify diabetic foot infections using 4 categories: uninfected, mild, moderate, and severe (Table 1). For patients with an infected foot wound, it is important to assess the severity of infec-
tion: the depth and the tissue involved, evidence of systemic infection, presence of metabolic instability, and critical limb ischemia. Although it is not usually necessary to perform a magnetic resonance imaging (MRI), a plain X ray should be obtained. The patient’s comorbid conditions and psychosocial status should also be reviewed.

If hospitalization is not required, the wound should be debrided and probed. If bone is felt with a metal probe, there is a high probability of osteomyelitis. Obtaining the appropriate wound culture is also important. We recommend cleaning the wound first, and taking a deep-tissue specimen for culturing. Swabs taken directly from the ulcer can be misleading. After a wound care regimen is prescribed, empiric therapy can be initiated. Mild infections can be treated on an outpatient basis with oral therapy with antistaphylococcal and antistreptococcal activities. However, if the patient has gastroparesis, oral agents may not be well absorbed. In any case, the patient should be re-evaluated in 3 to 5 days (prefer-

**CASE STUDY**

**A 56-YEAR-OLD MAN WITH DIABETIC FOOT INFECTION**

DS is a 56-year-old man who presents with a 5-day history of a rapidly swelling and foul-smelling left foot (Figure 1). DS has insulin-dependent diabetes, with a known history of a chronic foot ulcer. As shown in Figure 1, the surrounding tissue had color indicating generally good vascularity.

**Evaluation**

His temperature was 38.2°C, with mild hypertension (130/85 mm Hg) and normal heart rate (90 beats per minute). His blood glucose was 350 mg/dL with an elevated white blood cell count (15,200 cells/mm³). Plain radiograph of the foot showed no osteomyelitis. The ulcer dimensions are 2.5 cm × 0.8 cm with a depth of 1 cm. A probe to the bone is negative.

DS was hospitalized and antibiotic therapy covering both aerobes and anaerobes was initiated. The wound was debrided on admission, on day 3 of his hospitalization, and again during surgery. The culture grew mixed aerobic/anaerobic bacteria, including methicillin-resistant *Staphylococcus aureus* (MRSA), thus an anti-MRSA agent was added. DS was clinically stable, and on day 7 of the hospitalization, DS showed continued improvement. Parenteral therapy was continued for 2 weeks, and DS was sent home on 2 weeks of oral therapy.

**DISCUSSION**

Hospitalization was the appropriate choice for DS. He had 2 criteria for hospital admission: presence of (Continued on page S551)
fever and leukocytosis and a rapidly progressive or deep-tissue infection. Although his blood sugar was high, it is not a criterion for hospitalization and could be managed as an outpatient; however, high blood sugar can be an indication of the severity of his illness. Figure 2 is an algorithm of DS’s case.1 It follows the guidelines for managing patients with evidence of a diabetic foot infection.

Table 1. Clinical Classification of Diabetic Foot Infections Based on Severity

<table>
<thead>
<tr>
<th>Severity</th>
<th>Description</th>
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<tbody>
<tr>
<td>Uninfected</td>
<td>Wound lacking purulence or any manifestation of infection</td>
</tr>
<tr>
<td>Mild</td>
<td>Presence of 2 or more manifestations of inflammation (purulence, erythema, pain, tenderness, warmth, or induration), but any cellulitis/erythema extends &lt;2 cm around the ulcer; and infection is limited to the skin or superficial subcutaneous tissues; no other local complications or systemic illness</td>
</tr>
<tr>
<td>Moderate</td>
<td>Infection (as above) in a patient who is well and metabolically stable but has ≥1 of the following characteristics:</td>
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<tr>
<td></td>
<td>• Cellulitis extending ≥2 cm</td>
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<tr>
<td></td>
<td>• Lymphangitis streaking</td>
</tr>
<tr>
<td></td>
<td>• Spread beneath the superficial fascia, deep-tissue abscess, gangrene, and involvement of muscle, tendon, joint, or bone</td>
</tr>
<tr>
<td>Severe</td>
<td>Infection in a patient with systemic toxicity or metabolic instability</td>
</tr>
<tr>
<td></td>
<td>• Fever, chills, tachycardia, hypotension, confusion, and vomiting</td>
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<tr>
<td></td>
<td>• Leukocytosis, acidosis, azotemia, and severe hyperglycemia</td>
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Data from Lipsky et al.1

The importance of timely surgical consultation and intervention cannot be overstated. The key to reducing above-ankle amputation rates and hospital length of stay is to obtain early surgical debridement and removal of dead bone. The rate of above-ankle amputation can be reduced by 50% by obtaining debridement of the infected area in the first 3 days and initiating appropriate surgical consultation (Continued from page S550)}
tation was compared in 164 patients with diabetic infection, who were divided into 2 groups: those patients who did not undergo surgical intervention during the first 3 days of hospitalization but received intravenous empiric antimicrobial therapy (87 patients) and those who underwent surgical intervention promptly and received intravenous antimicrobial therapy (77 patients). As shown in Figure 2, those patients who received surgical intervention had significantly fewer above-ankle amputations during the same hospitalization or subsequent admission after a 12-month follow-up. The early surgical intervention group was also associated with a reduced length of stay by at least 6 days.7

As discussed earlier in this article, specimens should be obtained from as deep in the wound as possible. As shown in Figure 3, wound depth affects the type of organisms that are likely to be cultured, thus it affects treatment choices. The guidelines also note that needle aspiration may be useful for obtaining purulent collections or, perhaps, a specimen from an area of cellulitis.6

Sapico et al obtained quantitative deep-tissue aerobic and anaerobic cultures from amputated infected lower limbs of 13 patients with diabetes immediately after surgery.8 The results were compared to those obtained from ulcer swabs, (before and after amputation), curettage of the ulcer base, and needle aspiration. They found poor concordance between deep-tissue culture results and the other types of specimen collection methods, such as ulcer swabs (Table 2).8

In another study, Sapico et al demonstrated that Bacteroides species bacteremia can be present even when the anaerobic wound culture yields no growth (Table 3).9 Therefore, it is advisable to cover anaerobes in all patients with deep diabetic foot infections.9

**TREATMENT**

Table 4 summarizes the recommended treatments for diabetic foot infection based on severity.6,7 Mild infection can be treated on an outpatient basis with oral therapy for 1 to 2 weeks (4 weeks maximum). For
moderate infections, begin intravenous antibiotics and switch to oral agents; some patients can receive oral therapy if their adherence is expected to be good. Severe infections require parenteral therapy for 2 to 4 weeks. Rarely, some patients may need longer treatment, but that should be a clinical judgment. The suggested empiric antibiotic regimens are also outlined in Table 4. Note that trimethoprim/sulfamethoxazole may not be effective against some *Streptococci* spp.

Lipsky et al performed a head-to-head comparison of ertapenem (1 g daily; \( n = 295 \)) to piperacillin/tazobactam (3.375 g every 6 hours; \( n = 291 \)) for moderate to severe diabetic foot infections.\(^2\) Of the 445 patients who were treated and assessed, favorable clinical response rates occurred in 94% of the ertapenem-
treated group and 92% of the piperacillin/tazobactam-treated group.2

Also, as noted in the guidelines, aerobic gram-positive cocci (especially *Staphylococcus aureus*) are the predominant pathogens in diabetic foot infections, and methicillin-resistant *Staphylococcus aureus* (MRSA) incidence is an ever-increasing concern, especially with associated worse outcomes. Therefore, adding an anti-S aureus (and anti-MRSA, depending on local epidemiology and clinical judgment) antimicrobial agent should be considered.5

CONTINUING TREATMENT

If the patient improves, the antimicrobial regimen should reassessed, thus a therapy with narrower spectrum, lower cost, or greater convenience can be considered (Figure 1). The wound care regimen should also be reviewed, and the patient can be prepared for discharge if hospitalized. Follow-up should occur within 1 to 2 weeks, preferably by 1 week.5

If the patient is not improving after empiric therapy, the physician needs to consider whether the surgical intervention was adequate; the infection was adequately treated regarding the cultured organism(s), susceptibility, and antimicrobial agent; the patient’s vascular status needs augmentation; or if the wound care regimen needs to be adjusted (Figure 4).5

CONCLUSIONS

Optimal management of diabetic foot infections requires appropriate culture (ie, after the wound has been cleaned, and from the deepest site possible) and appropriate antibiotic (ie, empiric coverage for aerobic and anaerobic organisms). If hospitalization is required, timely surgical consultation and intervention is critical. Surgical consultation should involve surgeons experienced with diabetic foot complications.

REFERENCES


