Care of the Diabetic Foot: Assessment and Prevention

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Diabetes mellitus is a major risk factor that impairs wound healing, making foot wounds one of the major problems of diabetes.

- Over 60% of lower limb amputations in the US are due to diabetes, most started out as a foot ulcer
- Affects 42 per 10,000 patients with diabetes
- The cost of an amputation starts at $40,000!
- Estimated that 1 in 3 people will have diabetes by 2050
Diabetes

- Directly and indirectly impacts wound healing
- The good news is amputations are on the decline in the past 20 years, but diabetic foot ulcers still have a major impact on quality of life
- The bad news is that neuropathic ulcers carry a 45% 5 year mortality
Reported 5-year mortality rates

Common pathway for ulceration
- 50% of diabetics have NEUROPATHY
- Insensate
  - Minor trauma
- Deformed foot
- Abnormal gait
- Callous formation
  - Subcutaneous hemorrhage

Concommitant vascular disease complicates the healing
- Macrovascular
- Microvascular

Bakker et al., Diabetes/Metabolism Research and Reviews pages 225–231, 23 JAN 2012 DOI: 10.1002/dmrr.2253
Neuropathy vs Vasculopathy

Common foot deformities resulting from diabetes complications: A) claw toe deformity (increased pressure is placed on the dorsal and plantar aspects of the deformity as indicated by the triple arrows); and B) Charcot arthropathy (the rocker-bottom deformity leads to increased pressure on the plantar midfoot).
Trifecta of neuropathy, vasculopathy and pressure
Figure 1: An illustration of the causal chain for developing a diabetic foot ulcer, as well as the related events that lead to lower-extremity amputation. Adapted from Reiber et al.
If they have a wound, offload...offload...offload...offload

Figure 1. Peak plantar pressures on first metatarsal head.

Figure 3. Diabetic foot ulcer healing rates of various modalities.

Shah, 2012 WOUNDS Clinical and Economic Benefits of Healing Diabetic Foot Ulcers With a Rigid Total Contact Cast
Offloading—height matters

Figure 2. The knee–high, ankle–high, and shoe–high RCWs and a standard athletic shoe and the resultant walking peak plantar pressures on the right foot of the same patient in 3D graphs (the heel is presented at the top of the 3D graphs and the toes at the bottom).

http://lermagazine.com/article/rethinking-device-design-to-improve-compliance
But if they don’t have a wound (yet), prevention is the key...but nothing matters if you don’t look at the feet.
What your feet can tell you about your health..what do you look for?

- Gross inspection
  - Corns, callouses, deformities
  - Dry scaly skin
  - Thickened yellow toenails
  - Absence of hair
  - Missing parts
Cornerstones of foot management

There are five key elements that underpin foot management:
1. Regular inspection and examination of the at-risk foot
2. Identification of the at-risk foot (loss of protective function key)
3. Education of patient, family, and healthcare providers
4. Appropriate footwear
5. Treatment of nonulcerative pathology
3 part Program

1 – Medical visit and examination with diagnosis and detailed explanation of the disease, risk of ulcer progression, risk of amputation and footwear prescription (when indicated)

2 – Individual visit with a nursing professional directed towards general preventive care and review of the medical prescriptions (15 minutes long in average)

3 – Educational group, set up by the nursing team, directed to patients and family members and/or caregivers (with the objective of reinforcing self-examination instructions and in average 45 minutes long).
Items that should be covered when instructing the high-risk patient are as follows:

- Daily feet inspection, including areas between the toes
- The need for another person with skills to inspect feet, should the people with diabetes be unable to do so. (If vision is impaired, people with diabetes should not attempt their own foot care.)
- Regular washing of feet with careful drying, especially between the toes
- Water temperature, which should always be below 37°C
- Not using a heater or a hot-water bottle to warm one's feet
- Avoidance of barefoot walking indoors or outdoors and of wearing of shoes without socks
- Chemical agents or plasters to remove corns and calluses, which should not be used
- Daily inspection and palpation of the inside of the shoes
- Not wearing tight shoes or shoes with rough edges and uneven seams
- Use of lubricating oils or creams for dry skin, but not between the toes
- Daily change of socks
- Wearing of stocking with seams inside out or preferably without any seams
- Never wearing tight or knee-high socks.
- Cutting nails straight across (Figure 3)
- Corns and calluses, which should be cut by a healthcare provider
- Patient awareness of the need to ensure that feet are examined regularly by a healthcare provider
- Notifying the healthcare provider at once if a blister, cut, scratch, or sore has developed
90% of patients were found to do
- Adequate moisturizing
- Proper washing and drying
- Proper toe nail cutting, no cuticle trimming
- Routine shoe inspection
- No pumice stone use
- No barefoot walking

Only 10% wore appropriate footwear!!!
In a survey of diabetics
- 34.9% wore ill-fitting shoes
  - At least one size too large or small
- 11.9% had a discrepancy of at least 1.5 shoe sizes
- 90% of patients did not know their shoe width
- Right and left shoe sizes are different in 60% of patients

Three Key Interventions

- Hemoglobin A<sub>1c</sub> < 7% (<9% in older patients; micro/macrovascular disease)
- BP less 130/80 mm Hg
- Foot care for at high risk patients
- Diabetics:
  - Never barefoot even at home
  - Shoes with extra depth
  - Buy shoes later in day
  - Seamless socks
  - Have two pairs to change out
60 second Tool Screening for the High Risk Diabetic Foot
### Screening for the high risk diabetic foot: A 60-Second Tool (2012) © Sibbald

**Name:**

**ID#:** 

**DOB (dd/mm/yy):** 

**Gender:** M □ F □  Years with diabetes: 

**Ethnicity:** Black □ Asian □ Caucasian □ Mixed □ Other □  

**Date of Exam (dd/mm/yyyy):** 

**CHECK BOTH FEET**  

(Circle correct response) 

"YES" on either foot = HIGH RISK  

**HISTORY**  

1. Previous ulcer:
   - NO
   - YES
   - No response

2. Previous amputation:
   - NO
   - YES
   - No response

**PHYSICAL EXAM**  

3. Deformity:
   - NO
   - YES
   - No response

4. Absent pedal pulses (Dorsalis Pedis and/or Posterior Tibial):
   - NO
   - YES
   - No response

5. Active ulcer:
   - NO
   - YES
   - No response

6. Ingrown toenail:
   - NO
   - YES
   - No response

7. Callus (thick plantar skin):
   - NO
   - YES
   - No response

8. Blister:
   - NO
   - YES
   - No response

9. Fissure (linear crack):
   - NO
   - YES
   - No response

10. More than 4 sites lacking feeling = "YES"  

**NEUROPATHY**  

- **Monofilament Exam (record negative reaction):**
  - Right:
    - ≥ 4 negatives = "YES"  

- **Left:**
  - ≥ 4 negatives = "YES"  

**PLAN**  

a) **POSITIVE SCREEN:** Results when there are one or more "YES" responses. **Refer to a foot specialist or team for prevention, treatment and follow up.** (Bony deformity, current ulcer, absent pulse are most urgent).

These individuals are at increased risk of a foot ulcer and/or infection. Patients should be educated on what changes to observe and report, while waiting for the specialist appointment.

**Appointment time:** 

b) **NEGATIVE SCREEN:** Results when there are all "NO" responses. **No referral required.**  

Educate patient to report any new change to their healthcare provider and re-examine in 1 year.

**One Year Date for Re-Examination (dd/mm/yyyy):** 

**Completed By:** 

**Date:**

**Additional Note:** 


Local referral patterns may vary depending on expertise and available resources.

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### Screening for the high risk diabetic foot: A 60-Second Tool (2012) © Sibbald

**General Instructions:**  

This diabetic foot screening tool is designed to identify individuals with high-risk diabetic feet. This screening tool is a simplified 60-second assessment for each foot to be implemented by any healthcare provider. Preparation involves having a 5.0/7.0 monofilament available and asking patients to remove their shoes and socks.

**Normal screening findings are indicated as "NO" (not requiring referral) and abnormal screening findings are indicated as "YES" (requiring referral).** Generation of a list of local reputable foot specialists and/or teams for referring is recommended.

**Screening involves:**  

- Inform patient about the simplified 60-second screening and explain the reason for the examination.  
- Fill in patient’s demographic data in top left section of screening tool.  
- Assess both feet. Circle either a "Yes" or "No" response for questions 1–10.  
- Any "Yes" response requires follow up or a referral to a foot specialist and/ or team.

**Question**  

**"Yes" Response**

<table>
<thead>
<tr>
<th>Question</th>
<th>&quot;Yes&quot; Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. &quot;Yes&quot;, if previous ulcer from history is observed. Ask the patient and assess both lower legs and feet for the presence of a healed ulcer or an evidence by x-ray.</td>
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<td>2. &quot;Yes&quot;, if previous amputation of digit(s), foot or limb is observed.</td>
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<tr>
<td>3. &quot;Yes&quot;, if deformity or abnormality in shape or structure of either foot is observed (bony prominences/hammer toes).</td>
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<tr>
<td>4. &quot;Yes&quot;, if absent pedal pulses (palpate Dorsalis Pedis and if absent check Posterior Tibial). A yes answer requires absence of both pulses.</td>
<td></td>
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<tr>
<td>5. &quot;Yes&quot;, if active ulcer(s) present. Openings in the skin with a dermal or deeper base.</td>
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<tr>
<td>6. &quot;Yes&quot;, if ingrown toenail present. Inspect dorsal corners for embedded nail and/or thinned nail fold skins.</td>
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<tr>
<td>7. &quot;Yes&quot;, if callus present (thick plantar skin). Assess and inspect for presence of small areas of keratin on the bottom or sides of foot and toes.</td>
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<tr>
<td>8. &quot;Yes&quot;, if blister(s) present. Observe for fluid (serum, blood or pus) under intact skin surface.</td>
<td></td>
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<tr>
<td>9. &quot;Yes&quot;, if fissure (linear crack). Observe for a linear break with dermal base or deeper base.</td>
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<tr>
<td>10. &quot;Yes&quot;, if Monofilament Exam identified 4 or more negative reactions (lack of feeling). Follow the monofilament exam instructions below. Each foot is examined separately.</td>
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**Steps for Monofilament Test for Neuropathy:**  

- Show and touch monofilament to patient’s arm or upper leg.  
- Ask the patient to close their eyes and say yes when they feel the monofilament.  
- Touch monofilament until filament bends in a letter “V” shape, assessing all 10 areas on diagram (Do not test over calluses, scars or ulcers).  
- "Lack of feeling (4 or more out of 10) - indicates a negative reaction = Neuropathy = "YES" on screening tool.

<table>
<thead>
<tr>
<th>Foot Risk Classification and Follow-up Guide</th>
<th>Risk</th>
<th>Follow-Up</th>
<th>Nail Care</th>
<th>Orthotics</th>
<th>Activity</th>
</tr>
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<tbody>
<tr>
<td>Neuropathy</td>
<td>1</td>
<td>6</td>
<td>3</td>
<td>2</td>
<td>Ulcer</td>
</tr>
<tr>
<td>Deformity</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>Amputation</td>
</tr>
<tr>
<td>Peripheral Vascular Disease</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>Amputation</td>
</tr>
<tr>
<td>Ulcer Hx or Active Ulcer</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>Amputation</td>
</tr>
<tr>
<td>Amputation</td>
<td>6</td>
<td>2</td>
<td>1</td>
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</tr>
</tbody>
</table>

Fig. 2 Demonstration of the assessment of peripheral neuropathy using the Semmes–Weinstein monofilament: (A) depicts application of the monofilament, (B) demonstrates the bend in the filament when assessing for neuropathy.

Semmes–Weinstein monofilament

- Sensory examination should be carried out in a quiet and relaxed setting. First, apply the monofilament on the patient's hands (or elbow or forehead) so that he or she knows what to expect.
- The patient must not be able to see whether or where the examiner applies the filament. The three sites to be tested on both feet are indicated in Figure 6.
- Apply the monofilament perpendicular to the skin surface (Figure 7(A)).
- Apply sufficient force to cause the filament to bend or buckle (Figure 7(B)).
- The total duration of the approach – skin contact and removal of the filament – should be approximately 2s.
- Apply the filament along the perimeter of, not on, an ulcer site, callus, scar, or necrotic tissue.
- Do not allow the filament to slide across the skin or make repetitive contact at the test site.
- Press the filament to the skin and ask the patient whether they feel the pressure applied ('yes'/'no') and, next, where they feel the pressure ('left foot'/'right foot').
- Repeat this application twice at the same site, but alternate this with at least one 'mock' application in which no filament is applied (total three questions per site).
- Protective sensation is present at each site if the patient correctly answers two out of three applications. Protective sensation is absent with two out of three incorrect answers – the patient is then considered to be at risk of ulceration.
- Encourage the patients during testing by giving positive feedback.
- The healthcare provider should be aware of the possible loss of buckling force of the monofilament if used for too long.
Tuning fork

• The sensory examination should be carried out in a quiet and relaxed setting. First, apply the tuning fork on the patient's wrists (or elbow or clavicle) so that he or she knows what to expect.
• The patient must not be able to see whether or where the examiner applies the tuning fork. The tuning fork is applied on a bony part on the dorsal side of the distal phalanx of the first toe.
• The tuning fork should be applied perpendicularly with constant pressure (Figure 8).
• Repeat this application twice, but alternate this with at least one ‘mock’ application in which the tuning fork is not vibrating.
• The test is positive if the patient correctly answers at least two of three applications and negative (‘at risk for ulceration’) with two of three incorrect answers.
• If the patient is unable to sense the vibrations on the big toe, the test is repeated more proximally (malleolus, tibial tuberositas).
• Encourage the patient during testing by giving positive feedback.
The Future

The Smart Diabetic Socks

Fig. 4 Screen shots of the smart-phone application. The pressure values collected for the eight sock sensors are displayed during gait.

Blue Heels Society: More than Just a Diabetes Fashion Statement

Bad idea......

Raising Diabetes Awareness
The Foot Book

By Dr. Seuss
Care of the Diabetic Foot: Assessment and Prevention

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