Objectives

1. Summarize pathophysiologic mechanisms that lead to foot ulcerations in patient with diabetes.
2. Using foot risk classification scale, list key assessment parameters and prevention interventions for patient with diabetes.

Magnitude of DFU problem

- 15% will develop DFU during lifetime
- 1 in 4 patients with diabetes have a DFU at any one time
- Leads to as many as 80% of nontraumatic amputations
- Increased risk of: Premature death, MI, Fatal stroke
- Reflective of serious disease and comorbidities: Neuropathy, PAD, Altered neutrophil function, Diminished tissue perfusion, Defective protein synthesis

Relative Risk 5 Year Mortality (%) DFU Compared to Cancer

Pathologic Mechanism: Neuropathy
- Sensory: loss of protective sensation, insensate (LOPS)
- Motor: foot deformities (hammer toes)
- Autonomic: dry skin, fissures, cracks, callus, bounding pulse

Typical Ulcer Features:
- Insensate
- Callus
- Pink wound bed surrounded by callus
- Warm foot with bounding pulses
- Plantar surface and dorsum of clawed toes

Pathologic Mechanism: Ischemia
- PAD 2-4 times as prevalent with diabetes than without diabetes
- Ischemia contributory factor to DFU in up to 50% of patients.
- Macrovascular disease
- Microvascular disease

Typical Ulcer features:
- Painful
- Necrosis or Pale wound bed
- Tips of toes, nail edges, lateral borders of foot
- Only 15% of DFU purely ischemic

Pathologic Mechanism: Neuroischemia
- +/- Intact arterial supply
- +/- small vessel dysfunction
- +/- neuropathy / foot deformity
- +/- external trauma

Typical features:
- Some degree of sensory loss
- Minimal callus
- Poor granulation
- Cool foot/absent pulses
- Ulcers on margins of foot and toes
- HIGH risk of infection
- 50% of DFU

Foot Care: 5 steps of Prevention
1. Regular inspection and examination of at risk foot.
2. Identify and classify at risk foot.
3. Education: patient, family, providers
4. Offloading and callous management (appropriate footwear).
5. Treatment of non-ulcerative pathology.

1. Regular Inspection and Examination
At least once per year by provider
1. History and Exam:
   - Feet lying and standing
   - Inspect shoes/socks
   - Bare foot walking?
   - Tingling or pain in lower leg especially at night?
   - Skin color, temperature, edema
   - Deformities in feet/toes or boney prominence?
2. Sensory Exam:
   - Plantar surface: Semmes-Weinstein 10 g monofilament
   - Dorsal surface: Vibration (tuning fork) or Discrimination (pin prick) or Tactile sensation (cotton ball)

Sensory Exam
- Close eyes
- Sitting position
- Apply to arm first so know what to expect
  - "Tell me when you feel that pressure (yes/no) and where (right/left foot)."
- Not over callous or ulcer
- Test each site 3 times:
  - LOPS = 2 out of 3 incorrect answers at any one site
2. Identify and classify at risk foot

<table>
<thead>
<tr>
<th>Risk Group</th>
<th>Definition (ADA; Boulton et al, 2008)</th>
<th>Clinical Screening</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No risk of foot ulcer</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Diabetic Neuropathy and/or Foot Deformity</td>
<td>Callus Undetected monofilament, tuning fork or cotton ball Deformity or bony prominence</td>
</tr>
<tr>
<td>2</td>
<td>Peripheral Vascular Disease and/or Diabetic Neuropathy</td>
<td>Skin discolored on dependency DP or PT pulse absent</td>
</tr>
<tr>
<td>3</td>
<td>History of Foot Ulcer or Lower Extremity Amputation</td>
<td>Ulcer present Previous ulcer</td>
</tr>
</tbody>
</table>

Other Risk Classification Schemes:
- SIGN**: Scottish Intercollegiate Guideline Network (low, medium, high)
- IWGDF: International Working Group on Diabetic Foot (0-3)
- UTRFS: University of Texas Foot Risk Stratification (0-3)

3. Education: patient, family, providers

- Structured, organized, several sessions
- Goal: To enhance motivation & skills of individual for self care
- Goal: Recognize potential foot problems and steps to take in response

Examples of Foot Care Instructions:
- Bakker, Apelqvist & Schaper (2012)
- Driver et al (2012)

4. Appropriate footwear

- Off-the shelf shoes OK when sensation intact
- Modified footwear
  - Inside of shoe 1-2 cm longer than foot
  - Internal width & depth
  - Abnormal loading (hyperemia or callus formation)
- Pedorthist or orthotist

Footwear

American Board for Certification in Orthotics and Prosthetics, Inc. has been credentialing practitioners and organizations since 1948

Ankle Foot Orthosis (AFO)

5. Treatment of non-ulcerative pathology

<table>
<thead>
<tr>
<th>Pathology</th>
<th>E.g.</th>
<th>Cause</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyperkeratosis</td>
<td>Corns and Callous</td>
<td>Repetitive pressure &amp; friction</td>
<td>Regular sharp debridement by provider. Modify footwear. Do NOT use chemical callous removers. No &quot;self surgery&quot;</td>
</tr>
<tr>
<td>Fungal infections (Tinea)</td>
<td>Onychomycosis, Interdigital fissure</td>
<td>Moisture entrapment &amp; callus</td>
<td>Topical &amp; systemic anti-fungal. Change socks more often. Dry feet thoroughly</td>
</tr>
<tr>
<td>Nail conditions</td>
<td>Ingrown, Thickened, Deformity</td>
<td>Nail cutting technique Vascular changes</td>
<td>Regular nail care with foot care specialist</td>
</tr>
</tbody>
</table>

5. Treatment of non-ulcerative pathology
DFU Classification Systems

PEDIS Classification System

<table>
<thead>
<tr>
<th>Grade</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wound</td>
<td>Normal</td>
<td>Non-vital</td>
<td>Critical limb ischemia</td>
<td></td>
</tr>
<tr>
<td>Extent/size (cm²)</td>
<td>Full thickness</td>
<td>Deep</td>
<td>Bone and/or joint</td>
<td></td>
</tr>
<tr>
<td>Depth of tissue loss</td>
<td>Intact</td>
<td>Intact</td>
<td>Moderate/ severe</td>
<td></td>
</tr>
<tr>
<td>Infection</td>
<td>None</td>
<td>Mild</td>
<td>Moderate</td>
<td></td>
</tr>
<tr>
<td>Sensation</td>
<td>Intact</td>
<td>LOPS</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Systems inflammatory response syndrome

Additional Systems:
- Wagner Scale
- UT ulcer class.

Principles Wound Management

1. Relieve Underlying Etiology
   - Mechanical factors
   - Enhance/restore arterial perfusion

   ABI

   Severely impaired healing:
   (Revascularization Indicated)
   - ABI <0.6
   - Toe pressure <50mmHg
   - TcPo2 <30mmHg

2. Address cofactors
   - Glucose management (<140 mg/dL)
   - Reduce/control edema
   - Nutrition
     - Protein (~1.5 grams/kg/24 hours)
     - Vitamins and Minerals
   - Emotional/Psychosocial support

3. Create optimum healing environment
   - Tissue debridement
   - Inflammation and infection control
   - Manage topical dressings:
     - Control exudate
     - Maintain moist wound environment
     - Fill deadspace
     - Deliver topical antimicrobial if indicated
     - Protect surrounding skin to maintain integrity
   - Epithelial edge advancement

Debridement

- Initially
- Regularly via sharp debridement with scalpel, scissors, forceps

Infection in the Diabetic Foot

- 40-80% DFU infection present
- Risks for infection:
  - PMN function altered
  - Muted inflammatory response
  - Majority limited to soft tissue
  - 20% develop culture positive osteomyelitis
  - Multiple organisms (5-8 species)
- MRSA common when:
  - Previous ATB therapy
  - Prolonged healing time

International Best Practice Guidelines: Wound Management in Diabetic Foot Ulcers.
Available from: www.woundsinternational.com

Debridement

International Best Practice Guidelines: Wound Management in Diabetic Foot Ulcers.
Available from: www.woundsinternational.com

Infection in the Diabetic Foot

International Best Practice Guidelines: Wound Management in Diabetic Foot Ulcers.
Available from: www.woundsinternational.com
### IDSA Guidelines: Clinical Classification of Diabetic Foot Infections, 2012

<table>
<thead>
<tr>
<th>Clinical Manifestation of Infection</th>
<th>IDSA Infection Severity</th>
<th>PEDIS Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>No symptoms or signs of infection</td>
<td>Uninfected</td>
<td>1</td>
</tr>
<tr>
<td>Infection present as shown by presence of at least 2 of following: local swelling or induration; erythema; local tenderness or pain local warmth; purulent discharge</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Local infection involving only skin &amp; subcut. tissue; erythema &gt;0.5 cm to &lt;2cm periwound skin</td>
<td>Mid</td>
<td>2</td>
</tr>
<tr>
<td>Local infection with erythema &gt; 2 cm or involving deeper structures (eg., abscess, osteomyelitis, septic arthritis, fasciitis) and NO systemic inflammatory response signs (SIRS)</td>
<td>Moderate</td>
<td>3</td>
</tr>
<tr>
<td>Local infection with signs of SIRS (more than two: temp&lt;36 or &gt; 38° (C); Heart Rate &gt;90; RespRate &gt;20 or PaCO2 &lt;32mmHg; WBC&gt;12,000 or &lt;4,000 or &gt;/=10% immature (band) forms</td>
<td>Severe</td>
<td>4</td>
</tr>
</tbody>
</table>

### Superficial Infection: MILD

**Non Limb Threatening**
- Superficial ulcer
- <2cm periwound erythema (cellulitis)
- No systemic signs

**Treatment**
- Empiric oral antibiotics
  - Staph aureus and
  - β-hemolytic Strep
- Change antibiotic as needed with culture results
- Topical antimicrobial
  - Silver, Cadexomer Iodine, medical grade honey, hydrofera blue
  - 2 weeks

**Life/Limb Threatening**
- Deeper ulceration or undrained abscess
- Gangrene
- >2cm periwound erythema
- Plus edema lower leg
- Systemic symptoms (fever, ↑ WBC, hyperglycemia
- MRSA common pathogen

**Moderate to Severe Infection: Treatment**

1. **Systemic antibiotics**
   - Parenteral for severe infection & some moderate
   - Duration of ATB based on severity and wound response (1-3 weeks)
2. **Topical Care**
   - Aggressive surgical debridement
   - Monitor closely to assess response to therapy
3. **Hospitalization for severe infection**

### Topical Therapy: Dressings

**Priority Considerations:**
- Absorb exudate
- Alginates and hydrofibers
- Sodium impregnated gauze
- Fill wound bed and tunnels
  - Same as above
- Donate moisture
  - Hydrogel impregnated gauze
- Cover (secondary) dressing
  - Foam
  - Seldom hydrocolloids or transparent dressings
  - Adhesive or nonadhesive with roll gauze/Coban
- Antimicrobial topical product x 2 weeks
- Frequency of Change: initially daily then 2-3x/week

### Diabetic Foot Ulcer: Closure of the Wound

- Autograft (split thickness skin graft)
- Skin equivalents (apligraft, dermagraft)
- Negative Pressure Wound Therapy (NPWT)
Negative Pressure Wound Therapy

- Reduce edema/interstitial fluid
- Remove toxic cytokines, bacteria, MMP's
- Symmetrical contraction of wound edges
- Mechanical stretch stimulates cellular proliferation, angiogenesis and granulation tissue formation

Algorithm: Management of DFU

Diabetic Foot Service: An Interdisciplinary Team

- Podiatrist
- PCP
- Vascular Surgeon
- Infectious Disease
- Diabetologist
- Diabetes Educator
- Wound Care Nurse
- Pharmacy
- Orthotist/Pedorthist

Conclusion

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References


