Diabetic Foot Wound

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“Diabetic foot” variety of pathological conditions that might affect the feet in patients with diabetes (Boulton 2002)

Team Approach

• Expedited referral and care
• Madagin program proven to decrease amputations 82%
  • Driver et al. Diabetes Care 2005
• Swedish study decreased amputations 71% over 11 years
  • Wennberg et al Diabetes research 2019
• UK study 40% reduction and 62% reduction in major amputations
Prevalence
- 29.1 Million people 9.3% of the US 2012
  - CDC
- 2.8% Worldwide 2000 (171 million)
  - WHO

Amputations
- 73,000 non-traumatic amputations in diabetics 2010
  - CDC

Cost
- $4,595 per ulcer and $28,000 >2 years
- $5 billion per year annually
  - Clin Ther 1998
- $30-50k amputation according to president

Foot Infections
- Any infra-malleolar infection in a person with diabetes
- Common and costly problem
  - DM related amputation cost 38 per year
    - Diabetes Care 2003
- Most common reason for a diabetic to be admitted
  - National Hospital Discharge Data
- Most common non-traumatic cause of amputation
  - 60% of LEA
  - Most common cause of nontraumatic lower extremity amputation
    - Lancet 2005
Importance of Diabetic Wound care

• Diabetic foot ulcers present >4 weeks have a 5 fold higher risk of infection

• Infection in a foot ulcer increases the risk for hospitalization 55.7 times and risk for amputation 155 times

• 5 year mortality after limb amputation is 68%
  • NIH publication 1995

Clinical Practice Guidelines

• Management of etiologic factors
  – Adequate perfusion
    • PAD (Twice as common in DM)
    • Gregg et al 2004
    Rarely lead to ulcer directly
    Contributes to 50% of ulcers
    Diabetes Metab 2008
  – Debridement
    • Sharp debridement of infection
    • Urgent for gas/necrotizing infection
  – Infection Control
    • IDSA guidelines
  – Pressure Mitigation
    • Offloading
    • Total contact cast

The FDA defines a healed wound as reepithelialized skin without drainage or dressing requirements confirmed at 2 consecutive visits 2 weeks apart.

Guidance for Industry
Chronic Cutaneous Ulcer and Burn Wounds — Developing Products for Treatment
**Vascular work up**

- **ADA recommendations:**
  - ABI >50 y DM
  - <50 y with risk factors
  - Smoking
  - HTN
  - Hyperlipidemia
  - >10yrs 2DM
  - Anyone with PAD symptoms
- **Dependent rubor**
- **Pallor on elevation**
- **Absence of hair growth**
- **Dystrophic nails**
- **Cool/Dry/Fissured skin**
- **Diabetes Care 2003**

**Deformity**

- Pathophysiologic mechanism complex
  - Neuropathy
  - Repetitive trauma
  - Focal tissue ischemia
  - Tissue Destruction
- **Foot deformities**
  - Charcot
  - Neuroarthropathy
- **Limited joint mobility**
  - Glycosylation of soft tissue

**Wound Evaluation**

- **Size**
  - % reduction early predictor of outcome
- **Location**
  - WB surface
  - Digits
  - Heel
  - Legs
- **Shape**
  - Margolis
- **Depth**
  - Deep tissue involvement
  - Base
  - Necrotic/Fibrotic/Granular
  - Border
  - Abnormal
- **Probe**
  - 89% Probe to bone
- **Xrays**
  - Free air/foreign body
- **Infection**
  - Advanced imaging work up
Orthopaedic Wound Care
Management of osteomyelitis and bone infection
Anne Sullivan, MD
Assistant Professor - Clinical
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Why Orthopaedic Wound care?
• Things may not be as they appear…..
• Bone Expertise provides a margin for safety
• Bone Debridement without Expertise
  • May Compromise Structural integrity
  • May Fail to Eradicate infection
  • Bone Debridement without Coverage
  • Exposes previously Protected area to Environment
  • May Promote Deeper infection
• Biopsy techniques Must Avoid Contaminating deeper bone – Metaphyseal or Medullary bone.
• Red flag: Persistent Draining Wound despite Meticulous care
• What Lies Beneath……
• As many as 64% Diabetic Foot infections involve Bone
• Foreign material and Necrotic bone harbor Biofilm
• Granulation tissue Obscures, does Not Protect underlying structures from Environment
• Proper use of Imaging/X-rays is Essential

Osteomyelitis
= Infection involving bone
• Timing: acute or chronic
• Organisms: Staphylococcus aureus
  • Most common, can be any organism
• Causes/ examples: (may be acute or chronic)
  • Direct contamination – bone contacts environment—
    • Open Fracture
    • Penetrating Trauma
    • Stage 4 ulcer
  • Animal or Human bite
  • Contiguous spread –from Local wound or abscess.
  • Diabetic Foot wound, Pressure ulcer, Paronychia, Injection Related abscess
  • Infected Fixation Hardware or Prosthetic Joint Infection (PJII)
• Hematogenous seeding from Remote source
• Endocarditis, Pyelonephritis,
• Infections related to Injected Drug use

Osteomyelitis
Cierny- Mader Classification/ Factors (1980’s)
• Location of infection in Bone:
  • 1. Medullary
  • 2. Superficial
  • 3. Localized
  • 4. Diffuse
• Type of Host:
  • “A”: Healthy Host normal healing potential
  • “B”: Compromised Host Systemic or Local Factors +/- Correctable ??
  • “C”: Debilitated host: Treatment is worse than Disease


Systemic (s):
• Organ failure (renal, hepatic)
• Malnutrition
• Diabetes Mellitus
• Chronic Hypoxia
• Extremes of Age
• Immune disease
• Immune compromise
• Malignancy

Local (l):
• Vascular disease, stasis, lymphedema
• Scarring, radiation fibrosis
• Neuropathy
• Small vessel disease
• Tobacco abuse

2021 Substance Abuse, Noncompliance
Treatment Strategies: Wound Closure efforts may require any or all to succeed
• Recognize Source and remove Bioburden
  • Assessment, Imaging, Irrigation, Debridement, Bone Resection
• Protect bone
  • Avoid Further and Repeat contamination
  • Maintain or Restore Structural integrity of bone, joint, tendon, ligament
• May Require Advanced Orthopaedic Reconstruction
• Antibiotics: IV, Oral, Local delivery (beads), Antimicrobial dressings
• Avoid spread: Coverage / closure, Blood supply, Dressings, Control pathogens
• Optimize healing potential – Improve host
  • Oxygen, Nutritional resources for Healing,
  • Decrease Size of wound – Negative pressure, Bone resection, Flap/Graft

Control Medical Factors (optimization)
No Tobacco

General Surgery and Wound Care

Typically, General Surgery deals with the abdomen, so this is what we deal with in Wound Care as well.
Most of what I am seeing in wound care is chronic abdominal wounds.
This often has to do with infected prosthetics such as hernia mesh that are involved in patient care in the past.
Also help with colostomy creation for help in healing sacral wounds.

General Surgery and Wound Care
David Renton, MD, MPH, FACS
Associate Professor
Associate Chief Quality Officer for Perioperative Services
Department of Surgery
The Ohio State University Wexner Medical Center

Plain x-ray, 2 stage reconstruction
Bone proximal tibia showing metal artifact = wrong study!
Laparoscopic Loop Colostomy

- Diverts stool to the abdominal wall through a stoma
- Helps clean up perineum, allows for complex wound closure of sacral wounds
- Can be temporary, or permanent, depending on patient preference

Wound Care

- With a team approach, we can offer our patients a full breadth of options for wound care
- Having Plastic Surgery, Orthopedics, and General Surgery gives patients the best chance of healing their wounds
- Our nursing staff is very experienced, and helps get patients ready for surgery if it is indicated.

Case Presentations on Various Wound Etiologies

Nancy Hale, APRN, CNP
Comprehensive Wound Center
The Ohio State University Wexner Medical Center
Wound Center Provider

Pyoderma

Stage 4 Pressure Injury

Arterial Wound
Disclosures

I have no disclosures
Referral to Wound Center

Wound Care Documentation

Color Coding Wounds

New OSU wound care center
Principles of Advanced Wound Care
- Differentiate between acute wounds and the development of chronic wounds.
- Identify risk factors for chronic wound development.
- Identify the four most common type of chronic wounds: pressure injury and venous, arterial, and diabetic ulcers.
- Discuss the development of biofilm and the role it plays in wound chronicity.
- Apply the concepts of DIME+S
  - Debridement, Inflammation Control, Moisture management, Edge effect AND Surgery (when indicated)
Wound Preparation Model

New OSU wound care center

Chronic Wound

Rx
Cause

Local Wound Care

Debridement

Infective Inflammation

Moisture Balance

Edge Effect

Surgery when indicated

DEBRIDEMENT

Why is it necessary?

Necessary to convert a chronic wound into an acute wound

Keeps the wound in the active phases of healing

Removes nonviable/injected tissue and bioburden

Types of debridement: autolytic, enzymatic, sharp, mechanical

Inflammation and Infection Control

What Does it Do?

<table>
<thead>
<tr>
<th>Critically colonized</th>
<th>Deep wound infection</th>
<th>Systemic infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Necrosis</td>
<td>Biofilm formation</td>
<td>Septicemia</td>
</tr>
<tr>
<td>Ulceration</td>
<td>Temperature increase</td>
<td>Septic shock</td>
</tr>
<tr>
<td>Mild and bleeding</td>
<td>Protein type exposed base</td>
<td>Cellulitis</td>
</tr>
<tr>
<td>Infected</td>
<td>Necrosis of breakdown</td>
<td>Septicemia</td>
</tr>
<tr>
<td>Wound</td>
<td>Wound, dermatitis, ect.</td>
<td>Multiple organ failure</td>
</tr>
<tr>
<td>Sequestrum</td>
<td>Septicemia</td>
<td>Acute</td>
</tr>
<tr>
<td>Adj.</td>
<td></td>
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</tr>
</tbody>
</table>

Topical

Systemic

Systemic
Infection – shades of grey

Management of Moisture Tips and Tricks

Edge Effect: The Benefits of a Contact Layer

Edge Effect: Choosing the Right Dressings
Overall Cost-Awareness

Complicated by many factors:
- Insurance coverage
- Quality of life
- Economic constraints
- Rising health care costs - labor and materials

Cheaper wound management does not necessarily = cost savings
For example, if the dressing costs more but reduces time to wound healing, decreases length of stay, reduces the frequency of dressing changes, and/or decreases the need for analgesia with dressing changes, then it may actually mean overall cost savings.

Surgical Closure

Pre-op Evaluation

- **History:**
  - Cardiac, pulmonary, endocrine, oncologic
- **Location:**
  - Depth, volume
  - Involvement of adjacent structures
    - Bone, Joint, sinus
- **Quality:**
  - Vascularity
  - Presence of scarring
  - Extent of infection
    - Cellulitis, Heavy bacterial count, C/S

Pre-op Evaluation

- **Nutritional status**
  - Cachexia, anemia
- **Musculoskeletal status**
  - Spasms, fixed contractures
- **Distant infection**
  - Urinary, pulmonary, other
- **General status**
  - Neurologic/psychiatric
    - Coma, disorientation
    - Schizophrenia, depression
    - Social support system
Methods of Surgical Closure

- Primary closure
- Skin graft
- Pedicle flap: muscle, musculocutaneous, fasciocutaneous
- Free tissue transfer

Sacral Ulcer Closure

- Primary closure
- Superior gluteus muscle
- Gluteal fasciocutaneous
- Gluteal turnover
- Reverse dermal graft
- V-Y advancement
- Paraspinous based perforator flap
Ischial Ulcer Closure

- primary closure
- posterior thigh
- inf. gluteal muscle
- gracilis
- biceps femoris & skin
  - hamstring
  - tensor fascia lata & vastus lateralis
  - lateral thigh
  - rectus abdominus
Ischial Ulcer

Ischial Ulcer

Ischial Ulcer

Ischial Ulcer
Trochanteric Ulcer Closure

- random fasciocutaneous
- TFL
- TFL V-Y
- sensate TFL
- TFL w/ skin island

- gluteus medius & TFL
- vastus lateralis
- gluteus maximus, distally based
- gluteal thigh flap
- expansive gluteus max.

Tensor Fascia Lata (TFL)
Trochanteric Ulcer

Posterior thigh flap

Fillet (Leg Amputation) Flap

- Hip disarticulation & fillet flap
- High complication rate - OR blood loss, infection, sinus tract, dehiscence, femoral stump rotation
- Hemicorporectomy: For extensive infection, very morbid
What does ‘FUNCTIONAL RESTORATION’ mean?

Functional Restoration
The FIVE CARDINAL QUESTIONS
Can the patient ambulate easily?
Can she/he resume their original work? If not can they find new work suitable to their ‘NEW’ limb function?
Is the reconstruction robust enough for continued wear and tear?
Are recurrence rates of diabetic foot wounds lowered?
Is the patient able to manage his diabetic target organ disease?

Functional Restoration
The FIVE ESSENTIAL TOOLS
Accurate functional preoperative assessment
Diabetic (and other comorbid) control

System Structures: The Iceberg Metaphor
Well-defined Surgical Plan
Acute Postoperative Management

SURGICAL PLAN: Reconstructive Choices Are A Plenty
11 muscles, abundant adipofascia, three blood vessels, multiple perforators, superficial, deep and venae comitantes, one expendable bone.
Coupled with great orthotics, and the ability to supercharge
Functionalized Reverse Sural Fasciocutaneous Flap

Reverse Sural Fasciocutaneous Flap
Sural And Saphenous Vessels
Vasanervosum and Vasovasorum may play a role (controversial)
Deep fascia is included
Great for Achilles Repair

Funtionalized Reverse Sural Fasciocutaneous Flap

Funtionalized Reverse Sural Fasciocutaneous Flap
Currently, this patient walks without support, drives, and has resumed her job as a school teacher.
Calcaneal reconstruction with microvascular double/single barrel fibula osteocutaneus flap

Background
Calcaneal destruction commonly occurs in diabetics - usually necessitates a below-knee amputation since the central weight-bearing mechanism is lost and reconstructive choices are limited. Here we present two cases of calcaneal reconstruction, using double/single-barreled fibular osteocutaneous free flaps.
Currently, this patient walks without support and has resumed his job as a supervisor in a tree-cutting agency.
Currently, this patient walks without support and has resumed his job as a short-distance truck driver. He even takes his Harley out, once in a while!

Reverse Peroneus Brevis Flap

Reverse Peroneus Brevis Flap
### New OSU wound care center

- Strong commitment by the members of the multidisciplinary team
- Physical space and financial support from the sponsoring institution
- Performance metrics, Quality measures
- Data Management and Support
- Technology
- Partnership with an OutPatient Community
- Actionable Knowledge
- CoMarket Expansion
- Defined Drivers of Care and Patient Volumes