Solutions: Chronic Wounds

Program Objectives

- Wound healing physiology and complications related to diabetes
- Ideal health maintenance for diabetic patients with wounds
- Describe the etiology of a diabetic neuropathic ulcer
- Understand evidenced-based protocols of care for diabetic wound care patients
- Review wound care case studies

Outline

- Skin Structure
- Wound Classification
- Wound healing physiology
- Diabetes and wound healing
- Health Maintenance
- Neuropathic ulcers
The Structure of the Skin and Underlying Tissue

Comparison of Superficial, Partial, and Full-thickness Wounds

Stage I Pressure Ulcer, Suspected Deep Tissue Injury, perineal dermatitis, burn
Stage II Pressure Ulcer, Suspected Deep Tissue Injury, perineal dermatitis, venous ulcer, diabetic ulcer, surgical wound, skin tear, burn
Stage III Pressure Ulcer, Suspected Deep Tissue Injury, Unstageable Pressure Ulcer, lower-extremity ulcers (mixed etiology, arterial, diabetic, venous), surgical wound, skin tear, burn
Stage IV Pressure Ulcer, Suspected Deep Tissue Injury, Unstageable Pressure Ulcer, lower-extremity ulcers (mixed etiology, arterial, diabetic, venous), surgical wound, burn

Wound Classification

Definitions

Acute Wound: “...typically traumatic or surgical in origin. These wounds occur suddenly, move rapidly and predictably through the repair process and result in durable closure (Brissett and Hom, 2003; Clark, 2002).”

Chronic Wound: “...wounds that fail to proceed normally through the repair process. Chronic wounds are frequently caused by vascular compromise, chronic inflammation, or repetitive insult to the tissue, and either fail to close in a timely manner or fail to result in durable closure.”
Classification Methods

**Etiology**
- Surgical/non-surgical
- Acute and chronic

**Depth**
- Superficial, partial-thickness, and full-thickness
- Pressure ulcer staging

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Phases of Wound Healing

- Vasoconstriction
- Inflammation
- Proliferation
- Remodeling

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Vasoconstriction

- Period: seconds to minutes
- Triggered by ruptured vessels
- Platelet aggregation, degranulation, release of cytokines and growth factors
- Initiate healing cascade
Inflammation

- Period: 0 - 3 days
- Recruit platelets, neutrophils, lymphocytes, macrophages, and epithelial cells to wound site
- Fibrin clot formation
- Release potent chemical mediators: cytokines, growth factors
- Stimulate epithelialization, connective tissue contraction, angiogenesis

The Wound Healing Process

**Inflammatory Phase**
- Vasoconstriction
- Fibrin Blood Clots
- Vasodilation
- Neutrophils
- Macrophages
- Removal of Bacteria and Debris

Proliferation

- Period: 3 - 21 days
- Formation of granulation tissue
- Fibroblast migration, proliferation, collagen synthesis
- Epithelialization at wound edges
- Wound contraction by myofibroblasts
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The Wound Healing Process

**Proliferative Phase**
- Macrophages
- Growth Factors
- Endothelial Cells
- Fibroblasts
- Collagen
- New Blood Vessel Growth
- Granulation Tissue

**Re-epithelialization**
- Macrophages
- Growth Factors
- Endothelial Cells
- Fibroblasts
- Keratinocytes (Epithelial Cells)
- Collagen
- New Blood Vessel Growth
- Granulation Tissue

Remodeling
- Up to 2 years to achieve 80% of structure and function
- Balance of collagen deposition and degradation
- A surgical incision closed by primary intention regenerates 65% of tensile strength after 28 days from closure.
The Wound Healing Process

**Maturation Phase**

- Collagen Deposition
- Remodeling
- Increase Tensile Strength
- Scar Reduction

Factors that Delay Wound Healing

- Infection
- Diabetes
- Poor circulation, perfusion
- Venous stasis
- Trauma/repetitive forces
- Pressure
- Immunosuppression
- Malnutrition
- Age
- Medications
- Wound desiccation

Wound Assessment and Management
Wound Care Assessment

Important Assessments:
- Location
- Etiology
- Classification (Thickness)
- Measurements – Length, width, depth
- Tissue Types – (Red, Yellow, Black)
- Exudate – Amount and qualities
- Surrounding skin
- Wound Edges
- Signs & Symptoms of Infection
- Pain

Type/Etiology

Skin Tear  Incontinence Associated Dermatitis  Pressure Ulcer  Venous Ulcer
Diabetic Ulcer  Arterial Ulcer  Surgical Wound  Burn

Wound Classification Algorithm

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Practice Principles
1. Consistent, accurate wound measurements are essential to gauge progress.
2. Selecting the appropriate size dressing to cover the wound is key.

DuoDERM is a registered trademark of ConvaTec Inc.

Wound Bed Tissue Types
- % Granulation
- % Clean but non-granulating
- % Slough
- % Eschar

Tissue Type
- Granulation
- Slough/Fibrin
- Epithelium
- Eschar

Wound Size

= 100%
**Wound Exudate**

- **Amount**
  - Minimal or no exudate
  - Light
  - Moderate
  - Heavy

- **Type**
  - Serous – clear or light yellow. Thin and watery
  - Sanguineous – red (with fresh blood). Thin
  - Serosanguineous – pink to light red. Thin. Watery
  - Purulent – creamy yellow, green, white, or tan. Thick and opaque

**Practice Principles**
- Document amount and type. Consider absorptive dressing capacity for amount of exudate.
- Certain dressings interact with wound fluid and leave a gel or residue in wound that may resemble purulence.
- Exudate amount guides product choice.

**Wound Margins/Edges**

- Rolled under (epibole) – “thickened—soft to firm and flexible to touch”
- Well defined, fibrotic, scarred, or hyperkeratotic – “callus-like tissue formation around wound and at edges”

**Practice Principles**
- Rolled edges occur when the wound is allowed to dry out.
- Wounds with epibole will not heal unless the edges are removed.
- Calluses will lead to delayed healing.
- Wound edges/margins guide product selection.

**The Physiological Difference**

- Undermining
- Sinus Tract
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Epithelial Tissue vs. Maceration

Principles of Wound and Management

Wound Management Highlights Include:

- Cleanse wound with a noncytotoxic wound cleanser or normal saline.\(^\text{19}\)
- Debride nonviable tissue.\(^\text{19}\)
- Manage or eliminate the cause.\(^\text{21}\)
- Provide a moist wound environment.\(^\text{19}\)
- Fill dead space.\(^\text{19}\)
- Protect periwound skin from maceration.\(^\text{19}\)
- Prevent and manage infection.\(^\text{19}\)
- Provide a thermal environment
- Control odor.\(^\text{19}\)
Wound Cleansing

**Product Options**

- **SAF-Clens® AF Dermal Wound Cleanser**
- **Shur-Clens® Wound Cleanser**

SAF-Clens and Shur-Clens are registered trademarks of ConvaTec Inc. Refer to product insert for complete information on indications and use of each product.

Debridement

Wound Debridement is removal of devitalized tissue from the wound bed. 5

- Autolytic debridement: The removal of devitalized tissue using moisture-retentive dressings
- Biodebridement: The use of maggots/larval therapy to remove necrotic tissue
- Enzymatic (chemical) debridement: The removal of devitalized tissue by applying proteolytic enzymes
- Sharp (surgical) debridement: The removal of devitalized tissue by a sharp instrument, e.g., scalpel, scissors, curette.
- Mechanical Debridement: The removal of necrotic tissue through external mechanical forces.

Would you debride?

The determination of an ulcer’s stability may not be made based on its appearance alone, but through a comprehensive assessment. The ulcers presented are from cases where a multidisciplinary team managed the ulcers as suggested. As with any ulcer, periodic reassessment is needed.
Manage or Eliminate the Cause

- If pressure, remove pressure
  - Specialty beds
  - Seating cushions
- If venous stasis, compression
- If diabetic, offload and manage disease
- If no blood flow, vascular surgery consult
- If malnourished, supplement
  - Pre-Albumin 16 (Formerly,Albumin >3.0)
- Consult specialists
  - Dietician
  - PT, OT, DPM, Vascular Surgery

Moist Wound Healing

- Gauze has no cause
- George Winter 1962 Reference
- Dryness causes cell death
- Bolton 2000, > occlusion = > healing rates

Fill Dead Space

- Wound size
  - Adhesive dressings such as DuoDERM, Versiva®, Composite Foam Dressing, or CombiDERM ACD must be at least 1-inch larger than the wound on all sides.
- Wound depth
  - Must be filled
    - Prevent premature closure
    - Primary dressing
    - Secondary dressing
Protect Surrounding Skin

- Excess moisture on the surrounding tissues is damaging to the surrounding skin.
- Macerated skin is more likely to ulcerate than dry skin, due to macerated epidermis and softened connective tissue.
- Prevent maceration with appropriate product selection, frequency of dressing changes.
  - Consider AQUACEL dressings.
  - AllKare® Protective Barrier Wipe.
  - Aloe Vesta® Protective Ointment.
  - Versiva, CombiDERM dressings.

Visual Assessment

- Maceration – softening of the tissues; is due to excess moisture and is considered an abnormal finding. It presents as white tissue at the edges of the wound.
- Erythema – redness around the wound edges.
- Hyperpigmentation, or hemosiderin staining – may be present around the wound edges and should be documented when observed. It is a darkening or staining of the periwound tissues.

Clinical Signs of Infection

Acute Wounds – demonstrate local signs of inflammation

- Erythema
- Heat
- Edema
- Pain
- Purulent exudate
**Wound Contamination versus Infection**

- **Contamination**
  - "Open skin wounds or wounds healing by secondary intention all are colonized with microbial organisms"\(^{22}\)

- **Infection**
  - "The presence of microorganisms with signs and symptoms of disease"\(^{23}\)
  - Determination of infection should be based on clinical signs and microbiological observations. Restrict cultures to clinically infected wounds or non-healing wounds (consider critical colonization)\(^{24}\)

**Microbial Progression in Wounds**

- **Topical Antiseptic Agents**
  - Microorganism (load x virulence)
- **Systemic Antibiotics & Topical Antiseptic Agents**
  - Critical Colonization (established microbial population, wound not progressing, microbial imbalance, no signs of infection)
  - Infection (microbial control)

**Host Resistance**

**Microbial Continuum Model**

*Reassessing its Clinical Relevance in Wound Healing.*

**Wound Odor**

- Evaluate odor
  - Document presence or absence
  - Autolytic and enzymatic debridement may result in odor\(^{14}\)
  - Odor is a natural result of semi-exclusive or exclusive dressings
  - Odor should not be noticeable after a thorough cleansing
  - If odor remains, consider infection if consistent with other signs and symptoms
  - Charcoal dressings may decrease odor in palliative care, silver dressings may reduce odor if secondary to bacteria

*Practice Principles*
Solutions: Chronic Wounds

Diabetes, Wound Healing, and Neuropathic Ulcers

Neuropathic Diabetic Foot Ulcers

Prevention and Treatment Guidelines

1-888-224-WOCN  www.wocn.org
Diabetic Neuropathic Foot Ulcers

Definition
Ulcers occurring due to the complications of diabetes, which may: make the foot insensitive to forces of friction, shear, and pressure (sensory neuropathy); may lead to dryness, cracking callus formation and fissuring of the extremities with resulting ulcerations (autonomic neuropathy); or may result in foot deformities such as hammer toes, claw feet, or Charcot Foot (motor neuropathy), and also may result in calluses, friction (blisters), or pressure. Diabetic foot ulcers also have a greater risk of infection, gangrene and possible amputation.

Neuropathic Foot Ulcers
- Annual incidence for foot ulcers in patients with diabetes is 1%-6.84%.
- Infection and ischemia complicate management.
- Cause “… 50-70% of all non-traumatic amputation in the US”.
- “At least 50% of all amputations due to diabetic neuropathy are preventable with early intervention.”

Etiology
- Peripheral vascular disease
  - Incidence of peripheral artery disease 4 x greater in patients with diabetes.
  - Inadequate blood flow caused by occlusion in the peripheral artery circulation.
- Peripheral neuropathy
  - Sensory
  - Motor neuropathy
  - Autonomic neuropathy
Solutions: Chronic Wounds

Diabetic Neuropathic Foot Ulcers

**Sensory neuropathy**
- Alters sensation
- Loss of protective sensation, numbness, impaired temperature sensation
- Paresthesia, pain
- Loss of vibration and position, sensation, sensory ataxia
- Results in increased susceptibility to injury

**Motor neuropathy**
- Alters biomechanics and muscles
- Motor loss
- Muscle weakness, atrophy
- Anatomical manifestation
  - Foot drop
  - Claw toes
  - Charcot foot
- Results in increased shear and pressure on the sole

**Autonomic neuropathy**
- Alters the sympathetic nervous system
- Decreased vasomotor activity with decreased sweating of the feet
- Vasodilatation, arteriovenous shunting, edema
- Increased atherosclerotic plaque formation
- Possible disturbed microvascular circulation to the cutaneous tissue
- Resulting dry skin can precipitate fissures, cracks, callous, and finally ulceration
Comprehensive Foot and Ulcer Evaluation

- Multidisciplinary team approach is most advantageous for the treatment of neuropathic ulcers.
- Components:
  - Health history
  - Physical examination
  - Laboratory screening
  - Nutritional evaluation
  - Lifestyle/Psychosocial
  - Neurologic, musculoskeletal, vascular assessment
  - Wound history

Foot and lower extremity examination

- Assess for callus development.
- Palpate for local inflammation
  - Edema or swelling
  - Redness
  - Pain or tenderness
  - Heat
- Assess perfusion status:
  - Skin temperature
  - Capillary and venous refill
  - Color changes
  - Parathesias
- Assess musculoskeletal/biomechanical status:
  - Foot deformities – Claw toe, Charcot deformity
  - Muscle weakness
  - Gait abnormalities
- Assess for loss of protective sensation – Semmes Weinstein Monofilament testing
- Diminished tendon reflexes
- Assess footwear
  - Sizing and design
  - State of insoles

Diabetic Ulcer
**Diabetic Neuropathic Foot Ulcers**

**Wagner System Ulcer Grades – Classification**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Preulcerative lesion</td>
</tr>
<tr>
<td></td>
<td>Healed ulcers</td>
</tr>
<tr>
<td></td>
<td>Presence of bony deformity</td>
</tr>
<tr>
<td>1</td>
<td>Superficial ulcer without subcutaneous tissue involvement</td>
</tr>
<tr>
<td>2</td>
<td>Penetration though the subcutaneous tissue. May expose bone, tendon, ligament, or joint capsule</td>
</tr>
<tr>
<td>3</td>
<td>Osteitis, abscess, or osteomyelitis</td>
</tr>
<tr>
<td>4</td>
<td>Gangrene of digit</td>
</tr>
<tr>
<td>5</td>
<td>Gangrene of the foot requiring disarticulation</td>
</tr>
</tbody>
</table>

**Diabetic Neuropathic Foot Ulcers**

**University of Texas Treatment Base Diabetic Foot Classification System**

<table>
<thead>
<tr>
<th>Stage</th>
<th>Grade 0</th>
<th>Grade I</th>
<th>Grade II</th>
<th>Grade III</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Pre- or preulcerative lesion with complete epithelialization</td>
<td>Superficial wound, not involving tendon, capsule or bone</td>
<td>Wound penetrates to tendon or joint capsule</td>
<td>Wound penetrates to bone or joint</td>
</tr>
<tr>
<td>B</td>
<td>Infection present</td>
<td>Infection present</td>
<td>Infection present</td>
<td>Infection present</td>
</tr>
<tr>
<td>C</td>
<td>Ischemia present</td>
<td>Ischemia present</td>
<td>Ischemia present</td>
<td>Ischemia present</td>
</tr>
<tr>
<td>D</td>
<td>Infection and ischemia present</td>
<td>Infection and ischemia present</td>
<td>Infection and ischemia present</td>
<td>Infection and ischemia present</td>
</tr>
</tbody>
</table>

**Diabetic Neuropathic Foot Ulcers**

**Prevention Highlights Include:**

- Multidisciplinary approach in managing patients with diabetes, insensate feet and peripheral neuropathy.
- Identify patients at risk
- "Refer high-risk patients to foot care specialists for ongoing preventive care and life long surveillance”.
- "Initiate a lower extremity amputation prevention program, that includes: annual foot screening, patient education, appropriate footwear selection, daily self-inspection of the foot by the patient, management of simple foot problems”.
- Seek professional assistance in selecting foot wear.
- Patient/caregiver/family education
**Diabetic Neuropathic Foot Ulcers**

**Wound Management Highlights Include:**
- Recommend referral to wound experts
- Multidisciplinary approach
- Offload ulcer
  - Ensure adequate offloading of pressure though wound closure
  - Use aggressive offloading techniques such as cast walkers and total contact cast
- Rule out or diagnose osteomyelitis
- Utilize basic principles of nutritional management
- Manage edema if present
- Initiate a customized exercise program based on patient limitations and/or wound complications

**Wound Hydration**

- Cleanse wound with a noncytotoxic wound cleanser or normal saline
- “Choose dressings that promote a moist wound environment”
- Debride calluses, devitalized tissue, and ulcers with extensive cellulitis and/or osteomyelitis
- “Maintain dry stable eschar on noninfected, ischemic, neuropathic wounds”
- Culture (ie, tissue biopsy or quantitative swabs to identify infection)
- Aggressive treatment for wound infection including immediate physician/surgical referral

**Product Options**

- DuoDerm® Hydroactive® Sterile Gel
- AQUACEL® Hydrating Dermal Wound Dressing Gel with Alginate

The above primary dressings need to be covered by an appropriate secondary dressing that maintains a moist environment.

*Note to product insert for complete information on indications and use of each product.*
Diabetic Neuropathic Foot Ulcers

**Primary and/or Secondary Dressings**

- **Product Options**
  - DuoDERM Extra Thin Dressing
  - DuoDERM Signal Dressing
  - CombiDERM Non-adhesive Dressing & CombiDERM ACD® Dressing
  - Versiva® XC® Gelling Foam Dressing with Hydrofiber® Technology

**Diabetic Neuropathic Foot Ulcers**

**Exudate Management**

- **Product Options**
  - AQUACEL Hydrofiber Wound Dressing
  - CombiDERM Non-adhesive Dressing & CombiDERM ACD Dressing
  - Versiva XC Gelling Foam Dressing with Hydrofiber Technology
  - KALTOSTAT® Alginate Wound Dressing

**Diabetic Neuropathic Foot Ulcers**

**Antimicrobial Dressing**

- **Product Options**
  - AQUACEL® Ag Hydrofiber® Wound Dressing with ionic silver
  - Hydrated Dressing

Refer to product inserts for complete information on indications and use of each product.
Adjunctive Wound Care

- Negative Pressure Wound Therapy (NPWT)
  - See next slide
- Enzymatic debridement
  - Collagenase is the only commercially available product
- Skin Substitutes — Dermagraft, Apligraf, Graft Jacket
  - Be aware of reimbursement and indications
- Collagen based dressings
  - Clean, recalcitrant wounds only
- Hyperbaric Oxygen – Limb salvage
- PDGF and Autologous PRP and PDGF
  - Black box warning for Regranex, marginal results vs. cost
  - Reimbursement lacking for Autologel and PRP
- Ultrasound, Electrical stimulation, UVC, Cold Laser Therapy

Diabetic Neuropathic Foot Ulcers

Negative Pressure Wound Therapy

Wound Classification and Interventions

SUMMARY

- Wounds can not be appropriately managed until the etiology has been determined
- Accurate wound classification and assessment will help to determine appropriate management and treatment options
- Understanding evidenced-based protocols of care for the prevention and management of diabetic neuropathic foot ulcers may improve outcomes
References