CASE STUDY APPROACH TO CHRONIC WOUND CARE

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OBJECTIVES

- Discuss principles of Wound Bed Preparation in treating chronic wounds
- Differentiate between the various types of chronic wounds
  - Pressure ulcers
  - VLU/VSU
  - DFU
  - Burn
- Formulate appropriate evaluation and management for the different types of chronic wounds

NORMAL WOUND HEALING

**Hemostasis** (coagulation)
- Vasoconstriction
- Formation of fibrin clot

**Inflammation** (24-48 h)
- Removal of debris
- Release of cytokines/growth factors by platelets and immune cells from the disrupted matrix
- Invasion of inflammatory cells, neutrophils, monocytes-macrophages

**Proliferation** (3d – 3 weeks) (fill and cover)
- Release of growth factors
- Fibroblast migration and proliferation
- Synthesis of collagen (matrix proteins)
- Angiogenesis (blood vessel development), granulation tissue formation
- Keratinocyte migration, proliferation, differentiation
- Wound edge contraction, and re-epithelialization

**Remodeling/Maturation** (21 d – 2 years) (remodel and increase tensile strength)
Remodeling of the ECM, final result is a scar

THE MICROENVIRONMENT OF THE CHRONIC WOUND

HEALING WOUNDS
- Low inflammatory cytokines
- Low proteases, ROS*
- Functional ECM† and growth factors
- Mitotically competent cells
- Apoptotic clearing (without necrosis)

CHRONIC WOUNDS
- High inflammatory cytokines, bacteria
- High proteases, ROS*
- Degraded ECM† and growth factors
- Quiescent and senescent cells
- Necrosis (without regulation of apoptosis)

WOUND BED PREPARATION

T Tissue Management
Defective matrix and cell debris impair healing

I Inflammation and Infection Control
Bacterial burden and prolonged inflammation cause increase inflammatory cytokines, increase protease activity and decrease in GF activity

M Moisture Balance
Desiccation slows epithelial cell migration. Excessive fluid causes maceration

E Epithelial Edge Advancement
Non-migrating keratinocytes, abnormalities in ECM


WOUND BED PREPARATION DEBRIDEMENT

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical</td>
<td>Removal of necrotic tissue by mechanical means</td>
<td>W-D dressing, hydrotherapy</td>
</tr>
<tr>
<td>Autolytic</td>
<td>Use of the patient’s own endogenous enzymes to liquefy, dissolve necrotic tissue</td>
<td>Films, hydrogels, hydrocolloids, honey</td>
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<tr>
<td>Enzymatic</td>
<td>Use of an exogenous enzyme (Collagenase) to selectively liquefy, dissolve necrotic tissue (only attacks denatured collagen)</td>
<td>Collagenase/Santyl</td>
</tr>
<tr>
<td>Biosurgical</td>
<td>Use of sterile larva to selectively digest necrotic tissue and bacteria</td>
<td>Horsefly larvae</td>
</tr>
<tr>
<td>Selective Debridement</td>
<td>Remove necrotic tissue only, no living/viable tissue is removed</td>
<td>CPT codes 97937-97938</td>
</tr>
<tr>
<td>Surgical/Excisional Debridement</td>
<td>Sharp removal of tissue at the wound edge and at the base of the wound to viable tissue. Code to the level of tissue removed and the size of the wound debrided</td>
<td>CPT codes 11342-11347; code to the deepest layer of viable tissue removed</td>
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Contamination is the presence of non-replicating organisms. Most chronic wounds are contaminated.

Colonization is the presence of replicating organisms without injury to the host (patient), without tissue invasion.

Infection is the presence of replicating organisms that may cause host injury.

<table>
<thead>
<tr>
<th>Early Infection/Critically colonized</th>
<th>Deep infection (10⁵)</th>
<th>Systemic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-healing</td>
<td>Pain</td>
<td>Fever</td>
</tr>
<tr>
<td>Bright red granulation tissue/friable</td>
<td>Swelling/edema</td>
<td>Chills</td>
</tr>
<tr>
<td>New areas of breakdown/increased</td>
<td>Erythema</td>
<td>Hypotension</td>
</tr>
<tr>
<td>slough/necrosis</td>
<td>Wound breakdown</td>
<td>WBCs</td>
</tr>
<tr>
<td>Increased wound exudate</td>
<td>Undermining</td>
<td>Lymphangitis</td>
</tr>
<tr>
<td>Foul odor</td>
<td>Probe to bone</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Foul odor</td>
<td></td>
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</tbody>
</table>

Biofilm
- Bacteria is encapsulated with an extracellular polymeric substance that serves as a barrier to antibacterial agents.
- MRSA and PSAE are biofilm producers.
- 500 more times resistant to antimicrobials.
- Treatment consists of sharp debridement.
WOUND BED PREPARATION

EPITHELIAL EDGE ADVANCEMENT

- avoid rolled edges (Epibole), undermining
- Debride undermined edge
- If you pack a wound, DO NOT over pack

DRESSING DECISIONS

Dry or Wet wound?
Necrotic tissue/slough/stalled wound?
Does it appear colonized, infected?
How many weeks into treatment?

CATEGORIES OF WOUND DRESSINGS

- Gauze
- Films
- Hydrogels
- Hydrocolloid
- Foams
- Alginates
- Anti-infective
- Enzymatic Debrider
- Biologics
CATEGORIES OF WOUND DRESSINGS

**Gauze**
- readily available, highly permeable, non-occlusive
- primary or secondary dressing
  - 2x2s, 4x4s, kerlix, kling, ABD pads

**Films**
- made of flexible, clear polyurethane, easily contours to the skin, and semi-permeable
- primary or secondary dressing
- cover IV sites, superficial partial thickness wounds, dry or scant exudate
  - permeable to water vapor, O2, and CO2
  - impermeable to bacteria and water
  - tegaderm, op-site

**Hydrogels**
- 80-99% water or glycerin based gels, sheets, impregnated gauzes
- add moisture to a dry or minimally draining wound
- maintain moist wound environment, facilitating autolytic debridement
- indicated in partial thickness burn/wound, eschar
  - Safe Gel®, SkinIntegrity®, Solosite®

**Hydrogels with Silver**
- same as hydrogel plus antimicrobial action of silver
  - Elta Ag®, Silver Sorb®, Silver Sept®
CATEGORIES OF WOUND DRESSINGS

- Hydrocolloids
  - Gelatin or pectin bonded together as a film or sheet to produce an occlusive, flat, adhesive dressing that forms a gel on the wound surface and promotes moist wound healing.

- Foams
  - Made of polymer material to absorb drainage from partial and full thickness wounds
  - Suitable for moderate to highly exudating wounds
  - Permeable to gas with high moisture vapor transmission rate and act as barrier to bacteria
  - Maintain moist wound environment
  - Maintain core temperature of the wound
  - Provide protection and cushioning
  - Can be adhesive or non-adhesive backing
  - Can be bordered or non-bordered edge
    - Mepilex®, Biatain®, Allevyn®
CATEGORIES OF WOUND DRESSINGS

- Foam with Silver
  - Mepilex Ag®, Optifoam Ag®, Biatain Ag®

- Alginates/Carboxymethylcellulose (CMC)
  (with and without silver)
  - hydrophilic, non-woven fiber dressings made from seawood or sodium carboxymethylcellulose (CMC)
  - Hydrofiber®
  - indicated for partial and full-thickness wounds with moderate to heavy exudate
  - fill cavities, tunnels, undermining wounds
    - Aquacel/Aquacel Ag®, Mepilex Ag®, ReliaMed®

ENZYMATIC DEBRIDER

Santyl/Collagenase
- Only FDA approved enzymatic debrider on the market
- Made from Clostridium Histolyticum
- Selectively attacks only denatured collagen
  (slough, eschar, necrotic tissue)
- Indicated for all chronic ulcers and burns
Anti-Infective Dressings

- Topical antiseptics
  - Betadine, Dakin’s/Clorpactin, Acetic Acid 0.25% (vinegar)
- Topical antibiotics
  - Sulfadiazine
  - Mafenide
  - Mupirocin
  - Bacitracin
  - Cadexomer Iodine
  - Medical Grade Honey
  - Silver
- ABX (oral and parenteral)

Dynamic Dressings

Granulated, static wound?

Failure to heal?
- Biologic support
  - Apligraf/Dermagraft/Oasis/Tegranex
- MMP inhibitors
  - Collagen/ORC
VENOUS STASIS ULCERATIONS (VSUs, VLUs)

Mechanism of Action
- Result of peripheral edema secondary to incompetent venous valve
  - tissue inflammation
  - increase in MMPs and Reactive Oxidative
  - causes leakage of blood and fibrinogen, RBC extravasation
  - hemosiderin staining
  - damage to the micro-vessels, cell death, tissue damage and ulceration

CHARACTERISTICS
Location
- Medial lower leg, ankle, above the medial ankle

Edema and skin changes
- dermatitis
- varicosities
- hemosiderin staining-hyperpigmentation
- fibrous dermal tissue
- Atrophic Blanche-ivory white scar
- Lipodermatosclerosis- woody induration, inverted champagne bottle

Ulcer characteristics
- shallow, superficial, irregular margins
- Weepy, moderate to heavy exudate
- Ruddy granulation tissue and slough
CASE STUDY #1

54 yo male, hx CVI, who presented with chronic ulcerations of bilateral lower extremities for > 6 months duration

Pt underwent right short SVG ablation and Left saphenous tributary stab avulsion approximately two months prior to his OBWCC clinic visit.

PMH: morbid obesity, CVI, sleep apnea
LOWER EXREMITY EXAM

Vascular Assessment
• Assess Pulses: DP/PT/Peroneal (Palpable, Non-Palpable)
• If Non-palpable-hand-held doppler

ABI/TBI
• Simple
• Use as a screening for PVD
• Use to determine if it’s safe to compress
• Results: ABI and TBI
  • Normal > 0.9 >0.7
  • Borderline 0.6-0.8 0.64-0.7
  • Ischemia 0.4-0.6 <0.64
  • Critical limb ischemia <0.4

LOWER EXREMITY EXAM

Assess Color
• Capillary refill
• Dependent rubor
• Engorged varicosities
• Hemosiderin staining

Assess Edema
(L) 11.5cm x (W) 6.0cm x (D) 0.3cm
Santyl/Sulfamylon
Query insurance for Apligraf

Epidermal side
Dermal side

(L) 11.4cm x (W) 7.4cm x (D) 0.3cm
Apligraf placed. Topical dressing: Sulfamylon and Drawtex. Unna Boot. Returned to clinic every 3 days.
Still not a sig reduction in wound area but there is epithelialization Occurring on the medial border of the wound
Gentamicin cream, Drawtex, Unna boot
s/p 4 Apligraf applications

(L) 4.5cm x (W) 4.1cm x (D) 0.1cm

Healed at week 25. After the 5th application of Apligraf.
MANGEMENT of VLU/VSU

- Perform a lower extremity vascular assessment
- Compression
  - Do not want to compress if ABI <0.8 without vascular consultation
- Exercise
- Leg elevation
- No prolonged standing
- Weight reduction
- Refer to vascular or vein specialist for vein mapping or reflux evaluation to assess for valvular incompetence, reflux, or perforators

DIABETIC FOOT ULCER (DFU)

Causes and Risk Factors:
- Previous History of Foot Ulcers
- Neuropathy, lack of protective sensation
- Peripheral Arterial Disease
- Excessive Plantar Pressure
  secondary to joint immobility at ankle, subtalar and 1st MTH
- Foot Deformity, structural and biomechanical abnormalities
- Trauma
  secondary to ill-fitting footwear, foreign body, infection (tinea), improper toenail cutting
- Self-care Behavior and Knowledge

Wagner Scale/Classification
Based on depth, degree of infection, +/- gangrene

Grade 0  Preulcer, intact skin/healed ulcer/bony deformity

Grade 1  Superficial, without subcutaneous involvement

Grade 2  Penetration through SC, may visualize structure

Grade 3  Osteitis, osteomyelitis, abscess

Grade 4  Gangrene digit/forefoot

Grade 5  Gangrene of entire foot

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DFU ASSESSMENT

LOWER EXREMITY EXAM

Macro Circulation
- Assess Pulses: DP/PT/Peroneal (Palpable, Non-Palpable)
  - Grading of Pulses
    - 0 = absent
    - 1+ = barely palpable
    - 2+ = palpable but diminished
    - 3+ = normal
    - 4+ = bounding, suspect aneurysm
- If Non-palpable--hand-held doppler
- Assess Color
  - Capillary refill
  - Dependent rubor
  - Engorged varicosities
  - Hemosiderin staining

LOWER EXREMITY EXAM

Macrocirculation: ABI/TBI
- Simple
- Use as a screening for PVD
- Use to determine if it’s safe to compress
- Results:  
  - ABI
  - TBI
  - Normal > 0.9 > 0.7
  - Borderline 0.6-0.8 > 0.64-0.7
  - Ischemia 0.4-0.6 < 0.64
  - Critical limb ischemia < 0.4
Micro Circulation
• TCOM (Trans-Cutaneous Oxygen Measurement)
  • Measures oxygen perfusion of the skin
  • Determines if there is adequate blood flow/circulation
    for the wound to heal
  • Determines response to HBOT
  • Determines level of amputation
• Results
  • TcPO2 > 40 suggests wound will heal
  • TcPO2 <40 suggests impaired wound healing
  • After 100% NRB, expect a 3-fold increase in TcPO2
  • Consider HBOT TCOM challenge
DFU CHARACTERISTICS

Location
• Plantar aspect of foot
• MTH
• Heal
• Toes

Characteristics
• Painless
• Even wound margins
• Rounded/oblong shape over bony prominences
• Callus
• Cellulitis
• Osteomyelitis

DIABETIC FOOT ULCERS

[Image of diabetic foot ulcer]

[Image of diabetic foot with toes]

[Image of diabetic foot with callus]
Case Study # 2: Pressure/DFU

- 53 yo male with hx ESRD/renal transplant, DM, PE (on coumadin), who has chronic non-healing right foot wounds
- Duration: Chronic for several months
- Context: Pt suffered a anterior tibia fracture. Developed pressure areas on the foot secondary to cast.
WOUND HEALING GOALS

- Goal to heal ulcers in 12 weeks
- At 4 weeks, 50% reduction in wound volume
- The % change in ulcer size at 4 weeks is a robust predictor of wound healing and may assist identifying patients who would not respond to conservative care

Multi-disciplined DFU Management

Thorough Medical/Surgical History, FH, SH, Medication, Allergy

Lower Extremity Exam

- Examination Foot/Skin
- Palpation Pedal Pulses
- AB/TTI, TCOM
- Vascular Referral

Debridement

Evaluation Osteomyelitis

- Plain radiographic studies, MRI, WBC tagged scan
- CBC/diff, ESR, CRP
- Bone debridement

Prevention Infection

- Swab/tissue culture
- Consult ID

Multi-disciplined DFU Management

Glycemic Control

Wound Management

- Appropriate dressing selection
- Consider Biologic Dressings

Proper Off-loading

Routine F/U Care

- No Neuropathy/Ulceration/Amputation yearly
- Peripheral Neuropathy Only every 6 months
- Peripheral Neuropathy/foot abnormality every 3 months
- Peripheral Neuropathy/foot abnormality, Charcot, previous ulceration every 1-3 months


PRESSURE ULCERS (PUs)

Pressure Ulcer Staging

Stage 1: Intact skin, non-blanchable erythema
Stage 2: Partial thickness, loss of dermis, shallow, no slough
Stage 3: Full thickness, may have subc fat visible but no structure (no bone, tendon, muscle exposed), may have slough
Stage 4: Full thickness, visible structure

DTI: Purple/maroon localized area, blood-filled blister, tissue may be indurated, boggy
US: Ulcer is covered by slough or eschar and unable to visualize depth

*No reverse staging
CASE STUDY # 3 PRESSURE ULCER

- 48 yo male, new paraplegic, presents for management of buttock PU

- Injured during an attempted robbery, he is a driver for a company and suffered a T8-T10 SCI
  - Pt does a ISC every 2-3 hrs for bladder management, neurogenic bowel and does a bowel program.
  - Has some muscle spasticity, left leg > right leg, Uses flexeril.
  - Has some depression/anxiety, followed by psychiatry and is taking lexapro and Ativan
  - Chews tobacco

CASE STUDY # 3 PRESSURE ULCER

Wound Care:
Wash buttock wound with soap and water, apply enzymatic debrider, foam and change daily
To both heels, apply foam for protection and change daily

Off-Loading
Wheelchair Cushion.
Seat lifts or shift position in chair every 15 minutes.
Turn every 2 hours. Avoid position directing pressure to Wound site. Limit side lying to 30 degree tilt. Limit HOB elevation to 30 degrees in bed.
Other: - Order sent for low air loss bed, and a trapeze

Misc/Additional Orders
Stop Smoking. - Encouraged to stop chewing
2.5cm x 0.5cm x 0.2

Having diarrhea.
Scheduled for colonoscopy.
Rec Venex or Flander's for the buttock area, cover with Aquacel Ag and change daily
PRESSURE ULCER: MANAGEMENT

Positioning/Repositioning
- Q2H
- Rule of 30
- Use Trapeze, slide board
- Seat lift Q15min

Support Surfaces
- Wheelchair cushions
- Mattress
  - overlay (static) – pt can assume variety of positions, reimbursed for Stage 1 and Stage 2 PU
  - low air loss (dynamic) – pt unable to assume variety of positions, reimbursed for multiple Stage 3 or 4 PU
  - Clinitron (air fluidized) – flap, grafts

PRESSURE ULCER MANAGEMENT

- NUTRITION
- MINIMIZE RISK OF INFECTION
- CONTINUE APPROPRIATE WOUND CARE
- CONSULT WITH PLASTICS TEAM, ID
- IF NO SURGICAL INTERVENTIONS, PALLIATIVE WOUND CARE

CASE STUDY #4 FULL THICKNESS BURN

- 58 yo male suffered a work-related burn injury
- 15% TBSA of LE
- Works at metal foundary, suffered a scald burn with liquid salt 500 degree F
- Started on Augmentin this week and Sulfamylon soln dressing changes
TWO WEEKS POST-OPERATIVE
Right Lateral Lower Leg
Using Sulfamylon Solution

TWO WEEKS POST-OPERATIVE
Right Medial Lower Leg

TWO WEEKS POST-OPERATIVE
Left Lower Leg
THREE WEEKS POST-OP

Started on Augmentin, wound cultures obtained, Santyl and Sulfamylon Solution
Wound cx: +enterobacter and light growth Staph A.

FOUR WEEKS POST-OP

Green drainage on dressing. Wound cx obtained and Started on Levaquin.
Continue Santyl

Treatment: Oasis, compression.
Oasis. 100% porcine collagen made from small intestinal submucosa (SIS) of pig. OASIS contains 4 different types of collagens, responsible for cell migration, structure, and support; GAGs (glycosaminoglycans: heparin, hyaluronic acid, and chondroitin); heparin assists in binding growth factors, act as an anticoagulant, hyaluronic acid maintains moisture and decreases inflammation, chondroitin also assists in binding growth factors and cell proliferation; Proteoglycans and Glycoproteins also assist in binding growth factors and cell migration; Indicated for chronic wounds and second degree burns.

Place the product on the wound, moisten with normal saline, cover with a secondary dressing (eg. Xeroform if the wound bed dry to minimally exuding, or Aquacel Ag/Duoderm/Loan if the wound has moderate exudate), and leave the dressing intact over the next 5-7 days.
REFERENCES


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