WOUND CARE:
Basics and updates in the management of chronic wounds

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OBJECTIVES

- Understand the differences between acute and chronic wounds
- Understand the stages of wound healing
- Understand the topical agents available and their usage
DISCLOSURES

- Speaker’s Bureau Organogenesis
WHAT IS A WOUND?

wound

n.

1. An injury, especially one in which the skin or another external surface is torn, pierced, cut, or otherwise broken.

2. An injury to the feelings.
WOUND HEALING

- Patient factors
- Macroscopic and microscopic environment
- Highly orchestrated process
- Involves different cell types which have different functions
- Results in restoration of anatomic continuity, function and cosmesis
TYPES OF WOUND HEALING

- **Primary**
  - Surgical incision
  - Minimal scar tissue

- **Delayed primary**
  - Wounds left open for 3-5 days due to edema or infection and then closed

- **Secondary healing**
  - Not approximated.
  - More granulation tissue
  - Scar tissue
NORMAL RESPONSE

- Extracellular matrix forms (collagen, fibrin, fibronectin)
- Formation of collagen by fibroblasts
- Angiogenesis begins
- Wound fills in with granulation tissue
- Epithelial cells migrate in from the margin
- Skin coverage achieved
STAGES OF WOUND HEALING

- **Coagulation**
  - Platelets are primary cell line
  - PDGF-attracts fibroblasts
  - TGFβ-attracts fibroblasts and smooth muscle cells-stimulates collagen production

- **Inflammatory**
  - 4-6 days
  - Neutrophils and macrophages

- **Proliferative**
  - Begins day 6 and lasts several weeks
  - Fibroblast

- **Remodeling**
Normal Wound Healing Requires Cells, Signals, and a Matrix

Keratinocytes and fibroblasts: 2 of the essential cell types

Extracellular matrix (ECM) formation and maintenance

Growth factors and cytokines; provide cell-to-cell communication

### Essential Cellular Processes in the Wound

<table>
<thead>
<tr>
<th>PROCESS</th>
<th>Keratinocyte</th>
<th>Fibroblasts</th>
<th>Both</th>
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</thead>
<tbody>
<tr>
<td>MIGRATION</td>
<td>X</td>
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<tr>
<td>PROLIFERATION</td>
<td>X</td>
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<td>BASEMENT MEMBRANE</td>
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<td>Epidermal Differentiation</td>
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<td>ECM Production</td>
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FIBROBLASTS

- Critical role in collagen synthesis
- Synthesize glycosaminoglycans (maintains hydration of the ECM)
- Myofibroblasts—wound contraction
Cross-talk Between Keratinocytes and Fibroblasts in Wound Healing

The Extracellular Matrix Plays an Essential Role in Wound Healing

- The ECM consists of noncellular proteins produced by cells
  - Structural proteins (e.g., collagen, elastin)
  - Adhesion proteins (e.g., fibronectin, laminin)
  - Proteoglycans (e.g., core protein + GAGs)

- Synthesis and deposition of the ECM are critical
  - Provides structural/functional integrity
  - Plays a major role in determining tissue function
  - Serves as a reservoir for growth factors and other proteins

Disruption of Cellular Function

Noncycling (senescent) cells

- Impaired migration and proliferation
- Decreased response to signaling molecules

Cells
Matrix
Signaling Molecules

References:
Imbalance of Signaling Molecules

Abnormal levels of cytokines and growth factors

## Imbalance of Cytokines and Growth Factors

<table>
<thead>
<tr>
<th>Levels in Chronic Wounds</th>
<th>Growth Factors/ Cytokines Function</th>
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<tbody>
<tr>
<td>![Down Arrow]</td>
<td>EGF</td>
</tr>
<tr>
<td>![Down Arrow]</td>
<td>FGF-2</td>
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<td>![Down Arrow]</td>
<td>TGF-β</td>
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<td>![Down Arrow]</td>
<td>PDGF</td>
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<td>![Down Arrow]</td>
<td>VEGF</td>
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<td>![Up Arrow]</td>
<td>IL-1</td>
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<td>![Up Arrow]</td>
<td>IL-2</td>
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<tr>
<td>![Up Arrow]</td>
<td>TGF-α</td>
</tr>
</tbody>
</table>

- **EGF**: Re-epithelialization
- **FGF-2**: Granulation tissue formation; re-epithelialization; matrix formation and remodeling
- **TGF-β**: Inflammation; granulation tissue formation; re-epithelialization; matrix formation and remodeling
- **PDGF**: Inflammation; granulation tissue formation; re-epithelialization; matrix formation and remodeling
- **VEGF**: Angiogenesis; granulation tissue formation
- **IL-1**: Inflammation; re-epithelialization
- **IL-2**: Inflammation; re-epithelialization
- **TGF-α**: Inflammation; re-epithelialization

Matrix Impairment in Chronic Wounds

Impaired ECM production and maintenance

Imbalance of ECM in Chronic Wounds

Deficiency of TIMPs creates MMP imbalance

CHRONIC WOUNDS

- Remain in the inflammatory phase
- High concentration of matrix metalloprotenases
- Abnormal fibroblast morphology and activity
  - Abnormal growth rates
  - Impaired response to growth factors
ACUTE VS CHRONIC

- Orderly & timely
- Closed wound
- Viable tissue
- Single injury
- Controlled inflammation
- Controlled bacteria

- Complex & delayed
- Open ulcer
- Compromised tissue
- Repeated injury
- Uncontrolled inflammation
- Uncontrolled bacteria
TREATMENT OF WOUNDS

- Address underlying etiology
- Address underlying patient related factors that led to the wound and that negatively effect wound healing
- Debride devitalized tissue if wound is not ischemic
- Create a wound environment which facilitates cellular proliferation and healing
ISCHEMIC ULCERS

- Physical Examination
- Measurement of foot perfusion
  - ABIs
  - SPP
- Revascularization if necessary
VENOUS ULCERS

- Physical examination
- **Compression**
  - Multilayer wraps
  - Hose
- Venous duplex
- Venous intervention if necessary
- Advanced products
DIABETIC FOOT ULCER

- Glucose control
- **Offloading**
- Assure adequate vascularity
- Evaluate for osteomyelitis
- Hyperbaric oxygen if appropriate
DRESSINGS
IDEAL DRESSING

- Wound moist and the peri-wound skin dry
- Remove the exudate but does not dessicate
- Provide a bacterial barrier yet allow gaseous exchange
- One your patient can afford and get changed at the appropriate frequency
WET TO DRY DRESSINGS

- Cotton fibers left in wound with the dressings result in foreign body reaction and chronic inflammatory state.
- Tissue dries and becomes a perfect medium to grow bacteria.
- Epithelial cells grow into gauze.
- Appropriate for some freshly debrided wounds.
TOPICALS

- Hydrogels
  - Safegel, hydrogel, amerigel
- Enzymatic debriders
  - Santyl
  - Honey
- Silver products
  - Aqua-cel AG, acticoat, silvergel
TOPICALS

- Foams
  - Poly-mem
  - Mepilex
  - AMD
- Growth factors
  - Regranex
    - Recombinant PDGF
    - FDA approved for diabetic foot ulcers with healthy tissue and adequate perfusion
    - EXPENSIVE
CYTOTOXIC MATERIALS

- Dakin’s solution*
- Iodine
- Peroxide
- Acetic acid

TOXIC TO FIBROBLASTS

*-May be indicated for wounds colonized with pseudomonas
COLLAGENS

- Oxidized regenerated cellulose and collagen
- Reduces proteolytic enzyme activity in wound by binding to the MMPs
- Protects biological activity of growth factors
- May also have a component of silver
- Promogran, Biostep, prisma
What about honey?
HONEY

- Natural hydrogen peroxide property which is released after activation of glucose oxidase after the honey contacts body moisture.
- This peroxide is bactericidal but does not injure tissues.
- Used in diabetic ulcers, venous ulcers, burns, decubitus ulcers, MRSA infections.
UMF (unique manuka factor)

- Non-peroxide antibacterial activity which is a phytochemical property and strain specific
- Flowers of the manuka bush (*Leptospermum scoparium*)
- This particular antibacterial activity diffuses deeply into skin tissues
- UMF of 10 or greater
MANUKA HONEY

- Filtered and sterilized by gamma radiation
- Acidic - changes wound pH
- Debriding effect by osmotic effect of the honey
- Stimulates angiogenesis, stimulates fibroblast growth (H2O2), stimulates epithelial cell growth
HONEY

- No large randomized controlled trials
- Case series
- Small trials
NEGATIVE PRESSURE THERAPY
KCI WOUND VAC

- Introduced in 1996 as negative pressure wound therapy (NWPT)
- Granufoam
- Sensitrac (controls suction)
- Pump
GRANUFOAM

- Open pore polyurethane ether foam
- 400-600 microns
- Increases metabolic activity and stimulates granulation
- Evenly distributes the vacuum pressure at the wound surface
KCI WOUND VAC

- Vacuum induces mechanical stress at the wound surface
- Black sponge
  - Reticulated, porous
  - Most effective at stimulating granulation
- White sponge
  - Polyvinyl alcohol
  - Dense, hydrophilic
  - Non-adherent
  - Can control granulation
- Decreases maceration, decreases bacterial load, increases tissue perfusion by decreasing interstitial fluid
NEGATIVE PRESSURE THERAPY

- Other companies with negative pressure devices
- Gauze under suction
- Similar foams under suction
- Variable costs
  - SNFs
  - Hospitals
MAGGOT THERAPY
MAGGOT THERAPY

- Used throughout history
- 1st known application in the northern hemisphere 1920’s
- Used in the 1920’s and 1930’s then fell out of favor with the development of antibiotics
MAGGOT THERAPY

- Reintroduced secondary to antibiotic resistance
- Disinfected fly larvae from the blowfly
- Secrete a proteolytic enzyme
MAGGOT THERAPY

- Applied to wound and covered with a dressing to prevent migration
- In place 2-3 days
- Debrides and disinfects wounds
MIST

- Mist of saline and ultrasound transducer
- Low frequency, non-contact ultrasound
- Stimulates cell growth
- Debrides
- Removes bacteria
- Not painful
ADVANCED BIOLOGICS

- **Apligraf**
  - Keratinocytes and fibroblasts
  - FDA approved for diabetic foot ulcers and venous leg ulcers

- **Dermagraft**
  - FDA approved for diabetic ulcers

- **Oasis**
  - Porcine small intestine
  - Acts as a scaffolding

- **Integra**
  - Dermal filler/substitute
HYPERBARIC OXYGEN

- Diabetic foot ulcers
  - Wagner 3
  - Wagner 4
- Non-healing wounds in radiated fields
- Chronic refractory osteomyelitis
WOUND SURVIVAL KIT
SUPPLIES

- Skin tears
  - Tegaderm
  - Mepilex borders
- Foot ulcers
  - Medihoney
  - Hydrogel
- Exudative wounds
  - AMD foam
SUPPLIES

- Venous ulcers
  - Medihoney
  - Compression hose
  - Multilayer wrap
    - UNNA boot
    - 3M product
SUPPLIES

- **Burns**
  - silvadene

- **Necrotic/sloughy wounds**
  - Enzymatic debriders
  - Honey
SUMMARY

- Wound healing is a complex process and often does not proceed in an orderly fashion.
- Treatment plans should be tailored as best as possible to manage the underlying etiology.
- Chronic wounds often require advanced modalities.
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QUESTIONS
All of the following are stages of wound healing except:  

A: Inflammatory phase  
B: Proliferative phase  
C: Remodeling  
D: Fibroblast phase
All of the following are stages of wound healing except:

D: Fibroblast phase
Which of the following cell types is most important for wound healing?

A: Fibroblast
B: Keratinocyte
C: Both
D: Neither
Which of the following cell types is most important for wound healing?

C: Both
The picture below is a patient with a history of prior DVT, a history of diabetes, and a history of rheumatoid arthritis. The ulcer has been present for 6 weeks with no previous therapy. The patient’s hemoglobin A-1C is 6. The patient has an ABI that shows no arterial insufficiency and the rheumatoid arthritis is mild and well controlled. The initial management of this patient included all of the following except:
A: Enzymatic debridement
B: Biopsy
C: Compression therapy
D: Apligraf
E: Nutritional assessment
F: Evaluate for infection
D: Apligraf

Apligraf is an advanced modality, FDA approved for venous leg ulcers that have failed conservative therapy.