Learning Objectives
• To understand the role of each of the 9 essentials in wound healing:
  - Perfusion
  - Non-Viable Tissue
  - Inflammation/Infection
  - Edema
  - Wound Microenvironment
  - Tissue Growth
  - Off-loading
  - Pain Control
  - Host Factors

Pre-test
1. Infection/Inflammation have little to do with ultimate wound healing.  T  F
2. In the wounded patient, pain control usually means improved compliance.  T  F
3. Knowing the patient’s current medications can be key to remediating delayed healing.  T  F
4. Removal of dead tissue from the wound every once in awhile is an important essential of early wound closure.  T  F
5. The invasive Vascular Surgeon/Cardiologist/Radiologist is a wound care physician’s best friend.  T  F
The Nine Essentials of Wound Healing

If you can’t get water to the garden......the garden won’t grow!!!!

It has been suggested that decreased oxygen down regulates or diminishes certain critical cellular functions.

Epidemiology and Impact of PAD

• PAD is a manifestation of atherosclerosis characterized by progressive lower extremity arterial occlusive disease
• PAD serves as a marker of atherothrombotic disease in other vascular beds
• Estimated to affect over 10 million people in the US

Epidemiology and Impact of PAD

• Framingham Heart Study suggested that 20% of symptomatic patients with PAD also had diabetes
• Probably underestimates prevalence as more people with PAD are asymptomatic than symptomatic
  – Over half are probably asymptomatic
  – Only a third have claudication
  – Remainder have more severe forms of disease

Patterns of Peripheral Arterial Occlusive Disease in Diabetics

• Earlier age of onset
• Characteristic distribution pattern (Strandness, 1964)
  
<table>
<thead>
<tr>
<th></th>
<th>Aortoiliac</th>
<th>Tibial/Peroneal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nondiabetics</td>
<td>68%</td>
<td>57%</td>
</tr>
<tr>
<td>Diabetics</td>
<td>27%</td>
<td>81%</td>
</tr>
</tbody>
</table>

Angiographic Evaluation of PVD as a Prognostic Determinant for Major Amputation in Diabetics with Foot Ulcers

• Stenoses causing vessel lumen reduction 50% or greater detected in 99% of 104 consecutively admitted diabetic patients with foot ulcers, 1993-1995
• Stenoses were detected in patients with palpable foot pulses, ankle-brachial indexes greater than 1
• Stenoses were detected in patients with PtcO2 values greater than 50 mmHg
• Risk of amputation significantly increased when total occlusion present in popliteal and infrapopliteal arteries

### Epidemiology and Impact of PAD

- PAD risk factors include:
  - Diabetes
  - Smoking
  - Male
  - Advanced age
  - Hypertension
  - Hyperlipidemia
  - Obesity

- Other risk factors may include:
  - Elevated CRP, fibrinogen, homocysteine, apolipoprotein B, lipoprotein A
  - Plasma viscosity

### Pecoraro Diabetes Care 1990; 13(5):513-521

#### Major Pathophysiological Mechanisms

- Neuropathy
- Ischemia
- Infection
- Wound healing failure

#### Two Common Soft Tissue Complications

- Cutaneous ulcer
- Gangrene

#### Frequent Initiating Events

- Minor trauma
- Acute arterial insufficiency

### Microvascular Dysfunction

- Increased microvascular pressures lead to microvascular sclerosis
- Basement membrane thickening
- Increased extracellular matrix as diffusion barrier
- Increased capillary fragility
- Microvascular failure with loss of vasodilatory response
- Loss of flow reserve
- Delayed hyperemic response to pressure
- Impaired hyperemic response to injury

### Endothelial dysfunction leads to vascular functional abnormality in the absence of luminal obstruction

- Endothelial cells line the inner surface of all blood vessels
  - Arteries
  - Veins
  - Heart (endocardial cells)
  - Lymphatic vessels

- Normal functions include:
  - Mediation of coagulation
  - Platelet adhesion
  - Immune function
  - Control of volume and electrolyte content
Endothelial dysfunction is the loss of normal physiological and biochemical properties of the innermost lining of blood vessels

- Endothelial dysfunction can result from disease or environmental processes and can exist without atherosclerotic disease
  - Septic shock
  - Hypertension
  - Hypercholesterolemia
  - Diabetes
  - Inflammatory disease
  - Smoking tobacco products
- Arteries and arterioles can not vasodilate in response to stimuli- low levels of nitric oxide (NO)

Diagnosing Peripheral Arterial Occlusive Disease (PAOD): Comprehensive History

Remember Key Caveats:
- Endothelial dysfunction can be present and significant even in the absence of atherosclerotic disease
- Typical predispositions for “arterial disease” may not be positive in patients suffering from endothelial dysfunction

Bottom Line
- In the Diabetic Patient:
  - Far greater chance of PAD than non-diabetics
  - Far greater chance of concurrent venous disease
  - Far greater chance of ulceration leading to amputation
  - Far greater chance of mortality as a result of amputation
  - Far greater chance of requiring a 2nd amputation within a short period of time

Refer early.....the life you save may be your patient’s!!!

The Nine Essentials of Wound Healing

1. Adequate Perfusion
2. Non-Viable Tissue
3. Inflammation or Infection
4. Edema
5. Wound Microenvironment
6. Tissue Growth Optimized
7. Off-Loading
8. Pain Control
9. Host Factors

Please welcome

Glen R. Einspanier, DO, FACOS, CWSP
• Essential 2: Nonviable Tissue Debridement

Goal: Understand the principles of local and excisional wound debridement
Objectives:
1. Know the essentials of initial excisional wound debridement and why this should occur in the operating room environment
2. Review the principles of limited local wound debridement in the wound care center setting
3. Review anesthetic techniques for local wound debridement

Two Premises...
1. Wound healing is either delayed or prevented in the presence of devitalized or contaminated tissue.
And as a corollary...
2. Removal of necrotic tissue must be performed to allow normal healing.

Necrotic Tissue
• Provides growth medium for bacteria
• Causes prolonged elevation of pro-inflammatory mediators and cytokines
• Release of endotoxins inhibiting the migration of keratinocytes and fibroblast
• Covers cell receptors
  – Blocking chemical mediators and growth factors from facilitating the wound healing cascade

Necrotic tissue acts as a physical barrier

Wound Debridement
• The removal:
  – Necrotic tissue
  – Exudate
  – Metabolic waste
  – Residual dressing material
• To improve the healing process

Uncontrolled MMP’s in Wound Healing

Excessive MMP activity may result in:
- Degradation of newly deposited tissue components
- Destruction of GF’s, cell surface receptors
- Chronic, non-healing wounds

Debridement of Wounds

- Reduces bacterial load
- Decreases production of MMPs
- Increases the production and release of growth factors
- Exposes receptors on cells, for growth factor interface
- Removes senescent cells
- Facilitates angiogenesis
- Wound bed prep for advanced therapies
- Allows for determining depth and character of the wound bed

Cleansing vs Debridement

- Cleansing is the use of fluids to remove loosely adherent material
- Debridement is an enzymatic or sharp dissection process to remove tightly adherent or necrotic material.

Types of Debridement

- Autolytic
- Enzymatic
- Mechanical
- Sharp
- Surgical
- Biologic (Larva or Maggot therapy)
- Chemical

Debridement Principles

- Clean wound base of all devitalized tissue
- Remove “undermining”
Which Debridement Technique is NEEDED?

- All debridement techniques might be appropriate in the same patient, at different times, depending on:
  - Type and extent of devitalized tissue
  - Pain control
  - Infection or bleeding risk
  - Cost
  - Access to care
  - Underlying nutritional status
  - Many other complex factors

**Autolytic Debridement**

**Indications**

- All wounds with necrotic tissue

**Contraindications**

- Dry gangrene or dry ischemic wounds
- Must determine vascular status

**Advantages**

- Does not damage surrounding skin
- Fast—should see significant improvement within one week
- Painless
- Easy to perform
- Always occurs when using MOIST WOUND HEALING
  - Can and should be used in conjunction with other methods of debridement

**Disadvantages**

- Not as rapid as surgical, mechanical or enzymatic debridement
- Occlusive dressings may promote anaerobic growth
- Maceration of skin edge
- Sensitivity to adhesives

**Contraindications**

- Dry stable gangrene
- Dry ischemic wounds
- **Contraindicated for infected wounds**

**Relative Contraindications**

- Diabetic wounds
### Autolytic Debridement

<table>
<thead>
<tr>
<th>Dressing</th>
<th>Absorb</th>
<th>Wound Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saline Gauze</td>
<td>Yes</td>
<td>All, undermined, cavernous</td>
</tr>
<tr>
<td>Hydrogel</td>
<td>Limited</td>
<td>All except heavily exudative</td>
</tr>
<tr>
<td>Alginate</td>
<td>Yes</td>
<td>All except dry eschar</td>
</tr>
<tr>
<td>Hydrocolloid</td>
<td>Yes</td>
<td>All. Use filler for dead space</td>
</tr>
<tr>
<td>Foam</td>
<td>Yes</td>
<td>All. Use filler for dead space</td>
</tr>
<tr>
<td>Film</td>
<td>No</td>
<td>Avoid heavily exudative</td>
</tr>
</tbody>
</table>

- Necrotic tissue is liquified using the body’s natural enzymes
  - phagocytic cells
  - proteolytic enzymes.
- Accomplished by keeping the wound moist with occlusive or semiocclusive dressings.
- Only works if wound stays moist

#### Mechanical
- Application of outside force or energy to dislodge necrotic tissue
- Does not discriminate between viable and nonviable tissue
- Examples:
  - Wet to dry
  - Pulse Lavage
  - Whirlpool

#### Wet to Dry
- Non-selective
- Cost of dressing is not a factor although labor costs may be significant
- Various interpretations of what wet to dry means
- Various gauze types used, most common open weave, woven,
- Issues of linting and pain
- Traumatic to wound bed

#### Wound Irrigation Systems:
- Maximum safe irrigation pressure is 15 psi
- Bulb syringe: 2 psi
- #19 needle on syringe: 8-10 psi
- Tume syringe: 4 psi
- Water pik:
  - low setting: 6 psi
  - med setting: 35 psi
  - high setting: 70 psi
- Stryker system: 8-15 psi

---

80 y.o. woman with COPD and active lung cancer on prednisone. Multiple skin tears treated with saline wet to dry for 16 weeks with no improvement. Debrided and healing wound after 14 weeks of moist wound care using a hydrocolloid.
Pulsatile Lavage

- Provides cleansing and debridement with pulsed irrigation combined with suction
- Negative pressure removes irrigation and debris to reduce infection and encourage granulation tissue formation

Pulse Lavage

- Quick removal of necrotic tissue, bacterial load, foreign debris
- Controlled pressure >15 psi
- Site specific
- Less risk of maceration
- Less risk of cross contamination
- Can be done at bedside

Pulse Lavage

- Used in...
  - Pressure ulcers
  - Diabetic ulcer
  - Venous stasis ulcers
  - Cavernous wounds
  - Tunnelled or undermined wounds
  - Infected wounds
  - Multiple wound sites

Enzymatic Debridement

- Application of topical agents that disrupt or digest extracellular proteins.
- Collagenase: derived from the fermentation of Clostridium histolyticum.
  - It possesses the unique ability to digest collagen in necrotic tissue.
- Papain: proteolytic enzyme from the fruit of carica papaya, a potent digestant of nonviable protein matter but harmless to viable tissue.
  - Relatively ineffective when used alone
  - Usually combined with urea, a substance which denatures proteins.
  - Urea makes the proteins more susceptible to enzymatic digestion.

Chemical Debridement

- Silver Nitrate
  - Skin, wound cauterization following sharp debridement
  - Debridement of hypergranulated tissue
  - Educate the patient regarding black or gray staining

54 y.o. man with painful mixed arterial and venous disease ulcer. The patient applied collagenase daily for 5 weeks.
Medicinal Maggots
Maggot Debridement Therapy (MDT)

- FDA approved Medical Device as of 2005
- Monarchlabs.com

Medicinal Maggot Therapy

- Facultative Myiasis: Infestation that is not harmful to the host
- Action of Maggots:
  - Debride the wound by dissolving necrotic tissue
  - Kill bacteria
  - Stimulate wound healing

Medicinal Maggots

COST:
- 1 Vial (250-500) $80
- 4x4 dressing $4
- 8x8 dressing $8
- FEDEX $35

Indications for Sharp Debridement

- Wound Bed Preparation: As an adjunct to allow other methods to be more effective
- Presence of deep eschar such that autolytic or enzymatic debridement will not be effective
- Should be first consideration in an infected wound

When Not to Debride

- If the wound is dry ischemia, and vascular status is not yet determined
- If a clear demarcation line is not established
- If you are not prepared to follow through on wound care
- If you are unsure of what you will find and how deep it will be

Debridement…Critical Principles

1. Necrotic tissue must be debrided to facilitate healing and management of microbial burden.
2. Debridement of lower extremity wounds/ulcers, especially those associated with arterial insufficiency or diabetes mellitus should undergo sharp, surgical, excisional debridement only after evaluation of perfusion status.
Debridement...Critical Principles

3. Do not debride stable, dry, black, non tender, non fluctuant, non erythematous and non suppurative eschars until perfusion status is determined.
4. Debridement of nonviable and non infected tissue should be performed ONLY AFTER the revascularization procedure. Pre revascularization debridement should be indicated only in a septic foot with and without ischemic signs.
5. Soft, fluctuant eschar should be unroofed when identified.

Debridement...Critical Principles

6. For diabetic neuropathic foot ulcers, the following are always indications for debridement:
   - Presence of callus
   - Presence of skin undermining at the ulcer edges or margination of epithelium
   - Wound bed necrotic tissue

7. These indications are probably appropriate for other wounds/ulcers as well.

Debridement...Critical Principles

8. There is no evidence for the effectiveness of hydrotherapy/whirlpool in chronic wound/ulcer patients (see DCS white paper).

Excisional Debridement CPT Codes

- The removal of tissue by surgical means by cutting outside or beyond the wound margin in whole or in part (CPT 2007 AMA).
- 11040: debridement skin, partial thickness
- 11041: debridement skin, full thickness
- 11042: debridement of skin, subcutaneous tissue
- 11043: debridement of skin, subcutaneous tissue, and muscle (would also include fascia, tendon, joint capsule; 10 day global)
- 11044: debridement of skin, subcutaneous tissue, muscle, and bone (bone is the discriminator; 10 day global)

Selective “Debridement CPT Codes

- The removal of devitalized tissue including slough, fibrin, exudates, crusts, and other non-tissue materials from wounds
- 97597 total wound(s) surface area ≤ 20 cm2;
- 97598 total wound(s) surface area > 20 cm2 and is billed once per patient per event

When and how often should chronic wounds be debrided?

- When there is necrotic tissue present
- When there is tunneling or undermining detected
- When the wound edges need sculpting in order to favor epithelial migration
Maintenance Debridement

Repeated removal of necrotic tissue throughout the lifespan of the chronic wound
- Required for chronic wounds
  - Fibrotic and necrotic tissue continue to accumulate in the wound
  - Continually prepares the wound bed for healing


CONCLUSION

- A key to wound healing is a clean wound
- Autolysis always occurs in a moist wound environment
- Mechanical debridement should be discontinued as soon as possible
- Enzymatic and Autolytic debridement may be used in conjunction with each other and with Sharp Debridement

Essential 3: Wounds with bugs don’t heal!!

Katherine A. Lincoln, DO, FAAFP

The Nine Essentials of Wound Healing

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Please welcome

Katherine A. Lincoln, DO, FAAFP
Essential 3: Signs and Symptoms of Infection and/or Inflammation

• AKA Wounds with Bugs don’t Heal

• AKA Dear ER, please stop putting everyone on Clindamycin

“To cure, sometimes;
To help, often,
To care, always.”

-Hippocrates

Essential 3: Signs and Symptoms of Infection and/or Inflammation

• Hallmarks of Infection:
  • Calor
  • Dolor
  • Rubor
  • Tumor

Evaluation is subjective and objective

• Culture +/- biopsy

• Labs

Getting to the Truth

• Culture vs Biopsy
• “gold standard” is biopsy of deep tissue within wound
• Often practiced: punch biopsy with punch biotome, swab of wound, needle-aspiration of fluid
• Don’t start IV or po Abx before wound culture

Biopsy of Lesions

• Biopsy ANY atypical wound

• Biopsy ANY wound that has been unresponsive to 2-4 wk of appropriate therapy

• (we usually use 3-4mm punch biotome, 2 punches, one to pathology and one to histology)
Biopsy Technique

Biopsy Technique

Culture technique

- Culture POST-debrided wound bed
- Use 20 # pressure to wound bed
- Levine’s technique

Culture Techniques

Culture Techniques

Labs of Assessment

- CBC
- ESR
- CRP
- trends are helpful

Bacterial Balance

Bacterial Balance

Labs of Assessment

- CBC
- ESR
- CRP
- trends are helpful

Bacterial Balance

Bacterial Balance

Labs of Assessment

- CBC
- ESR
- CRP
- trends are helpful

Bacterial Balance

Bacterial Balance

Labs of Assessment

- CBC
- ESR
- CRP
- trends are helpful
**Treatment of Inflammation vs. Infection**

- Topical antimicrobials
- Topical Antibiotics
- Systemic Antibiotics
  - Bacteremia
  - Sepsis
  - Advancing Cellulitis
  - Osteomyelitis

---

**Use Evidence Based Medicine**

---

**Essential 3: Signs and Symptoms of Infection and/or Inflammation**

**Pearls:**
- If Osteo is suspected in DFU
  - serial x-ray
  - MRI
  - CT
  - Tagged WBC radionuclide study

**Pearls:**
- Surgical closure
- Direct wound approximation
- Free flap
- Bioengineered tissue graft

**Essential 3: Signs and Symptoms of Infection and/or Inflammation**

**Pearls:**
- EARLY closure is the MOST important intervention to prevent wound infection
Essential 3: Signs and Symptoms of Infection and/or Inflammation

- **Pearls:**
  - S/s of disease may be subtle due to decreased blood flow +/- immune compromised state

Please welcome back

Dr. Sprague Taveau

The Nine Essentials of Wound Healing

1. Adequate Perfusion
2. Non-Viable Tissue
3. Inflammation or Infection
4. **Edema**
5. Wound Microenvironment
6. Tissue Growth Optimized
7. Off-Loading
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Anatomic Layers of the Venous system

Deep
Superficial

Deep Veins

- Inferior Vena Cava
- Iliac Vein
- Femoral Vein
- Popliteal Vein
- Posterior Tibialis
- Anterior Tibialis
**Superficial Veins**

- Superficial venous system - tremendously complicated and extremely variable network of interconnecting veins
- Most veins are unnamed
- A few larger superficial veins are fairly constant in location

**Perforating Veins**

Perforators pass through anatomic defects in the deep fascia to connect the superficial “collecting web” and the larger superficial veins with the deep veins of the calf or thigh

---

**Main superficial veins of the leg**

- Long saphenous vein
- Short saphenous vein

---

**At Rest - Legs Elevated**

- 0 - 10 mmHg

---

**Walking**

- 30 - 40 mmHg

---

**Standing**

- 90 mmHg ±
**The Battle Against Gravity**

Calf Muscle Pump

- The deep veins
- The superficial veins
- The venous valves
- The calf muscles inside the inelastic fascia

Four components working together against the force of gravity

Venous Valves - normal competent valves allow blood flow in only one direction

- Deep vein
- Superficial vein

Muscle Systole

Every time the calf muscles contract, veins are compressed and blood is pushed upwards.

Muscle Diastole

Every time the calf muscles are relaxed, blood is sucked in from the peripheral regions.
Injection of radiographic contrast dye in the femoral vein shows a competent valve, which is preventing backward flow down the vein.

Leaky Valves allow deep to superficial flow during muscle systole and bidirectional during muscle diastole.

Normal Vascular Fluid Balance

Edema
- Natural secondary response
- Often temporary
- Normal lymphatic system
- Primarily water

Etiology of Edema
- Passive Hyperemia
  - Venous insufficiency
  - Cardiac
  - Pulmonary
  - Pregnancy
  - Inactivity
  - Dependency
  - Travel
- Active Hyperemia
  - Inflammation
  - Allergy

Hypoproteinemia
- Malabsorption
- Malnutrition
- Renal disease
- Cyclic idiopathic edema syndromes
- Drugs
- Age

Lymphedema
- High protein edema consisting of both
  - Lymph
  - Water
- Results from
  - Damage to lymphatic vasculature
  - Absence of the normal lymphatic anatomy

Normal Vascular Fluid Balance

Blood Capillary

Resorption

Filtration

\[ P_a = 35 \text{ mmHg} \]

\[ P_v = 25 \text{ mmHg} \]

\[ P_L = 15 \text{ mmHg} \]

~27 liters/day

~30 liters/day

~3 liters/day

(10% of filtered)

Lymphatic Capillary

Protein
**Etiology of Lymphedema**

**Primary**
- Congenital (Birth)
- Praecox (adolescent)
- Tarda (age 35+)

**Secondary**
- Surgery
- Infection
- Tumor
- Radiation
- Wounds
- Venous
- Trauma
- Neurological
- Filariasis

**If Net Filtration Exceeds Lymphatic Transport Capacity**

- Overload = Edema
  - Lymphatic Transport Malfunction + Edema + Protein = Lymphedema

**Therapy Options**
- Reduce Filtration
- Compression
- Increase Transport Capacity
- Massage

**Etiology of an Edema Related Ulcer**

- Calf Pump Failure
- Venous Hypertension
- WBC Adhesion
- Cell Wall Damage
- Increased Permeability

**EDEMA**
- Proteins
- Impaired Nutrition

**LYMPHEDEMA**
- Activated Cells
- Inflammation

**Tissue Death**
- Ulceration

**Bottom Line**

Wounds won’t heal in a swamp!!

**The Nine Essentials of Wound Healing**

1. Adequate Perfusion
2. Non-Viable Tissue
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4. Edema
5. **Wound Microenvironment**
6. Tissue Growth Optimized
7. Off-Loading
8. Pain Control
9. Host Factors

Please welcome back

Dr. Glen Einspanier
Goals: Understand the key factors in wound examination, documentation and classification and a general approach to selecting products for topical wound care.

Objectives:
1. Outline the Essentials in wound examination
2. Know the technology useful in wound examination and documentation.
3. Know the important wound classification systems
4. Know a topical wound care product

Wound Assessment
- Good complete History and Physical
  - We treat the whole patient not just the hole in the patient

Purposes of Assessment
- Initial definition/diagnosis
- Monitoring the effect of treatment
- Failure to progress
- Monitoring for occurrence of infection
- Prediction of outcome
- Reimbursement qualification

Partial vs Full Thickness wounds
- Partial
  - Loss of epidermis into but not through the dermis
    - Abrasions, Skin tears, Blisters
- Full
  - Through the dermis into subcutaneous tissue, muscle, and may exposes deep structures

Skin Assessment
- Temperature
  - Normally warm to the touch
    - Warmer could indicate inflammation
    - Coolness could indicate vascular issues
  - Color
    - Intensity
      - P aller
      - Rubor
- Hyper – or Hypopigmentation
- Moisture
  - Dry (xerosis) or moist
  - Hyperkeratosis (flaking, scales)
  - Eczema
  - Dermatitis, psoriasis, rash
- Turgor
  - Dehydration vs effects of aging
**Location**

- Document in reference to Commonly used terms
  - Proximal, distal
  - Superior, inferior
  - Medial, lateral
  - Anterior, posterior
  - Dorsal, plantar

**Location**

- Pressure Ulcers
  - Identify the location by the boney prominence beneath the wound
    - Left iliac crest
    - Left trochanter
    - Thoracic spine

**MEASURE**

- M = Measure
- E = Exudate
- A = Appearance
- S = Suffering
- U = Undermining
- R = Reevaluation
- E = Edge

**Measure: Length, Width, Depth**

- Document in centimeters
- Length (measurement head to toe or longest dimension)
- Width (perpendicular to length)
- Depth (at deepest point)
- Calculations of area and volume
- Tools:
  - linear measuring ruler
  - acetate wound tracings
  - computerized planimetry
  - digital photography
- Issue of inter-rater reliability

**Key Point**

The percentage of decrease in wound area in first 2-4 weeks has been found to be predictive of healing at 12-24 weeks.
**Measure: Length, Width, Depth**

**Wound Size: Depth**
- Insert tip of probe to greatest depth and measure perpendicular distance to wound edge
- 15% variability

**Measure: Length, Width, Depth**

**Wound Depth**
- Foam Tip Measuring Device with centimeter calibrations

**Measure: Exudate**

**Exudate Descriptions**
- Character
  - Serous, Serosanguineous, Sanguineous, Purulent
  - Opaque, clear, cloudy
  - Liquefying necrotic tissue (slough)
  - Dressing residue

**Measure: Exudate**

**Exudate Descriptions**
- Too little exudate results in a desiccated wound
- Excessive exudate complicates wound management

**Look at the dressing upon removal...**

**Exudate**

- Character: Liquid, Greasy, Dry, Clear
**Measure: Exudate**

*Exudate Descriptions*

- **LARGE**
- **MODERATE**

**Measure: Exudate Moisture Balance**

- Exudate

**Measure: Appearance**

*Condition Of The Wound Bed*

- Necrosis
- Granulation tissue
- Exposed structures
- Fibrin
- Exudate
- Eschar
- Foreign body
- Inflammation, infection
- Tunneling, sinuses

**Measure: Appearance**

<table>
<thead>
<tr>
<th>Tissue type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Granulation</td>
<td>Red, firm, and pebbled. Friability may indicate infection.</td>
</tr>
<tr>
<td>Fibrin</td>
<td>Yellow and firm. Represents collagen or other proteinaceous material in the wound bed.</td>
</tr>
<tr>
<td>Slough</td>
<td>Yellow to gray-green and loose. Soft, loose necrotic tissue.</td>
</tr>
<tr>
<td>Eschar</td>
<td>Black, soft and wet or hard and dry. Necrotic tissue</td>
</tr>
</tbody>
</table>

**Measure: Suffering (pain, disability)**

*Essential 8*

- **Evaluation**... By standard grading scale in every patient at every visit
- **Consider**... Monitor and reevaluate pain level, adjust intervention strategy and continue reevaluation and treatment adjustment
- A change in pain (worsening) should prompt reevaluation for infection, ischemia...

**Measure: Undermining**

*Space between the surrounding skin and the wound bed*

- Usually involves significant proportion of wound edges
- May extend entirely around wound
- Subcutaneous fat necrosis
- **Result of:**
  1. Necrotizing infection
  2. Primary inflammatory etiology
  3. Friction, shearing


*Krasner D. in Chronic Wound Care 2nd ed, 1997;336-403.*
measUre: Undermining

Tunneling

• Extends into tissue in any direction
• May be more than one present in any wound
• Document number if more than one present
• Document direction of each using face of clock
• Document depth of each if more than one is present

measUre: Undermining

Tunneling

Condition Of The Surrounding Skin

• Color
• Pigmentation
• Inflammation, induration
• Dermatologic abnormalities
• Satellite lesions
• Suppleness
• Edema
• Maceration

NPUAP Pressure Ulcer Classification System

• Stage I: Non-blanchable erythema of intact skin
• Stage II: Partial thickness skin loss involving epidermis or dermis
• Stage III: Full thickness involving subcutaneous tissue that may extend down to, but not through, the underlying fascia
• Stage IV: Full thickness with extensive tissue necrosis involving muscle, bone, or supporting structures

Stage I (New from NPUAP)
– An observable pressure related alteration of intact skin whose indicators as compared to an adjacent or opposite area on the body may include changes in one or more of the following:
  • Skin temperature (warmth or coolness)
  • Tissue Consistency (Firm or boggy feel)
  • Sensation (pain or itching)
– Non-blanchable erythema of intact skin (press 15 seconds)
– In darker skin tones, the ulcer may appear with persistent red, blue or purple hues

Deep Tissue Injury (DTI)
• Often skin is still intact
• Deep purple or deep bruising present
• Obvious deeper muscle damage
• Unfortunately, staged as a Stage I
• Typically will demonstrate that it is actually Stage III or IV in days to follow
• “… Stage I pressure wound with DTI…”

Stage II – Partial thickness skin loss involving epidermis and or dermis. The ulcer is superficial and presents clinically as an abrasion, blister or shallow crater.

Stage III – Full thickness skin loss involving damage/necrosis of subq tissue. Presents as a deep crater, possible undermining.

Stage IV – Full thickness skin loss with extensive destruction, necrosis, damage to muscle, bone or tendon.
Deficiency of NPUAP Staging System

- Need to visualize the wound bed in order to apply correct stage.
- Wounds that are covered with eschar cannot be staged.

Wagner Classification of Diabetic Foot Ulcers

Grade 0
Intact skin

Grade I
Superficial without penetration deeper layers (no subcutaneous involvement)

Grade II
Deeper reaching tendon, bone, or joint capsule (full thickness)

Grade III
Deeper with abscess, osteomyelitis, or tendonitis extending to those structures
Wagner Grade IV
Gangrene of some portion of the toe, toes, and/or forefoot

Wagner Grade V
Gangrene involving the whole foot or enough of the foot that no local procedures are possible

UTHSCSA Diabetic Wound Classification

<table>
<thead>
<tr>
<th>GRADE / DEPTH</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Pre- or post-excisional lesion, completely epithelialized</td>
<td>Wound perforating to tendon or capsule</td>
<td>Wound perforating to bone or joint</td>
</tr>
<tr>
<td>B</td>
<td>Superficial wound, not involving tendon, capsule, or bone, with infection</td>
<td>Wound perforating to tendon or capsule</td>
<td>Wound perforating to bone</td>
</tr>
<tr>
<td>C</td>
<td>Superficial wound, not involving tendon, capsule, or bone, with infection and ischemia</td>
<td>Wound perforating to tendon or capsule</td>
<td>Wound perforating to bone or joint with ischemia</td>
</tr>
<tr>
<td>D</td>
<td>Pre- or post-excisional lesion, completely epithelialized with infection and ischemia</td>
<td>Wound perforating to tendon or capsule, with infection and ischemia</td>
<td>Wound perforating to bone or joint, with infection and ischemia</td>
</tr>
</tbody>
</table>

MEASURE

- M = Measure
- E = Exudate
- A = Appearance
- S = Suffering
- U = Undermining
- R = Reevaluation
- E = Edge

Bottom Line
Wounds won’t heal unless the environment is conducive to healing.....

Please welcome back
Dr. Katie Lincoln
The Nine Essentials of Wound Healing

1. Adequate Perfusion
2. Non-Viable Tissue
3. Inflammation or Infection
4. Edema
5. Wound Microenvironment
6. Tissue Growth Optimized
7. Off-Loading
8. Pain Control
9. Host Factors

Focus: Essential 6
Enhance Tissue Growth
Options to stimulate tissue growth
AFTER:
• Proper debridement
• Control of microbial burden
• Optimized wound bed moisture balance
• Optimization of Host Factors

Enhance Tissue Growth
Options:
- Growth factors/cytokine replacement
- Dermal substrate replacements
- Bioengineered tissue grafts
- Surgical closure/reconstruction
- Negative pressure wound therapy
- Correction of local hypoxia (stimulate angiogenesis)
- Misc “other”: laser, US
- Soft tissue splinting
- Hyperbaric oxygen therapy (HBO)

Enhance Tissue Growth: 4 different methods
- 1-Bioengineered tissue
- 2-Negative Pressure Wound Therapy
- 3-Hyperbaric oxygen therapy
- 4-Suction bubble epidermal grafting
Bioengineered tissues
• 3 main types: Dermagraft, Apligraf, Epifix
  • Dermagraft- human derived dermal substitute; only FDA approved for chronic diabetic foot ulcers (DFU)
  • Apligraf- 2 layered living cell based product; Only FDA approved for DFU and chronic venous insufficiency ulcers
  • Epifix is dehydrated Human Amnion/Chorion Membrane dHACM
    • Available to place on any wound anywhere
    • Uses the PURION Process for tissue safety
    • Multiple layers including a single layer of epithelial cells, a basement membrane, and an avascular connective tissue matrix

Epifix

Enhance Tissue Growth: 4 different methods
• 1-Bioengineered tissue
• 2-Negative Pressure Wound Therapy
• 3-Hyperbaric oxygen therapy
• 4-Suction bubble epidermal grafting

Negative Pressure Wound Therapy (V.A.C. devices)
• The V.A.C. Therapy System is comprised of three essential components that actively work together to help promote wound healing through granulation tissue formation:
  – VAC Therapy Unit: Provides intermittent and continuous therapy with integrated patient safety features
  – SensaTRAC Technology: Regulates pressure at the wound site to provide accurate delivery of prescribed therapy settings
  – VAC GranuFoam™ Dressings: Help provide the necessary mechanisms to promote granulation tissue formation
Negative Pressure Wound Therapy (V.A.C. devices)
FDA approved indications of VAC
• Cavitary wounds (acute trauma, post surgical, chronic-diabetic wounds, pressure wounds)
• Heavily exudative if infection is treated
• Surgical wound dehiscence
• Wounds requiring soft tissue mechanical stabilization
• Split thickness grafts/support of flaps
• Thermal partial thickness burns
• Management of certain fistulas

Enhance Tissue Growth: 4 different methods
• 1-Bioengineered tissue
• 2-Negative Pressure Wound Therapy
• 3-Hyperbaric oxygen therapy
• 4-Suction bubble epidermal grafting

Hyperbaric oxygen therapy
• “HBO”
• Defined as “breathing 100% oxygen at a pressure greater than 1.5 ATA for the purpose of elevating the PtO2 and thereby tissue PO2 values improve oxygen delivery and diffusion to malperfused tissue”
• Used as adjunctive therapy in wound care

Hyperbaric oxygen therapy

HBO CMS indications
• Acute carbon monoxide intoxication
• Cyanide poisoning
• Decompression illness
• Gas embolism
• Gas gangrene
• Acute traumatic peripheral ischemia
• Crush injuries/suturing of severed limbs
• Necrotizing fasciitis
• Acute peripheral arterial insufficiency
• Prep/preservation of compromised grafts
• Chronic refractory osteomyelitis
• Osteonecrosis
• Soft tissue radionecrosis
• Actinomycosis, ref to Abx
• Diabetic Wound of the LE, Wagner Grade 3 or more

Enhance Tissue Growth: 4 different methods
• 1-Bioengineered tissue
• 2-Negative Pressure Wound Therapy
• 3-Hyperbaric oxygen therapy
• 4-Suction bubble epidermal grafting
Suction Bubble Epidermal Grafting (SBEG)

- Commercially called “CelluTome”, which is an epidermal harvesting system
- Epidermal harvesting system in out patient setting
- No “down time” or OR complications
- Uses heat and suction for auto-donation of Microdomes, transfer to chronic wound site

Questions, additions, subtractions, and edifications
Katherine Lincoln, DO, FAAFP
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Please welcome back
Dr. Sprague Taveau

The Nine Essentials of Wound Healing

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Positioning and Off-Loading

- Sustained pressure causes most ulcerations
- Factors for unrelieved pressure:
  - Inactivity, immobility, decreased sensation
- Use pillows, bolsters, pads, support surfaces
- Turning schedules:
  - Every two hours, more often in higher risk patients
  - Typically supine to sidelying, opposite sidelying, then back to supine (3/4 position)
  - Protective boots or pillow bridging for heels
Positioning and Off-Loading

• Pressure relief techniques
  – Volitional off-loading at periodic intervals
    Capillary refill and tissue reperfusion
  – Wheelchair pushups
  – Passive repositioning by care provider
  – Greater risk: support surface modification

Positioning and Off-Loading

• Support surfaces – 2 groups
  – Pressure reducing – low risk patient
    • Tend to lower tissue interface pressure
    • Don’t provide full relief
    • Pads, cushions, overlays, foam mattresses
  – Pressure relieving
    • Consistent reduction of tissue interface pressure
    • Low air, high air, dynamic air devices

Positioning and Off-Loading

• Mattress overlays
  – Pressure reducing surface
  – Inexpensive, easy to clean and transport
  – Bottoming out phenomenon
  – Leaks and moisture build up
  – Less forgiving
  – Intended for the patient of < minimal risk

Positioning and Off-Loading

• Specialized pads – dense foams & gels
• Foam pads
  – Low cost, ease of application
  – Increase body temperature, retain moisture
  – “bottoming out “ phenomenon
• High quality gel pads
  – None of the above disadvantages
  – Higher cost, heavy

Positioning and Off-Loading

• Low air loss beds
  – Pressure relieving surface
  – Patients with high risk for breakdown
  – Immobile patients or those with ulcerations
  – Bed frame, air filled cushions, low friction/shear surface material
  – Low noise pump, continuous air flow, multiple areas or zones
  – High cost

Positioning and Off-Loading

• High air loss beds
  – “air-fluidized” glass beads
  – Dry environment, heat controlled
  – Highest risk patient
  – Patients with recalcitrant wounds
  – Total bed rest patient
  – Highest cost range
  – Large and heavy (2000 lbs)
Treatment...Pressure Relief for Mobility Impaired Patients and PU Treatment

- Use support surfaces for bed-bound patients...stage III or IV or multiple ulcers need low-air-loss mattress or air-fluidized bead
- Air-fluidized support and low-air-loss beds are reported as effective treatments and support healing
- Use adequate pressure reducing surfaces for chair bound patients

Specialized beds are effective in reducing pressure ulcers... A study of alternating pressure supports compared with standard foam mattresses did demonstrate lower pressure ulcer development in the intervention group (RR 0.32; 95% CI 0.14-0.74).

Comparing pressure-reducing devices among themselves (versus against a standard mattress) yields no significant differences.

Treatment...Offloading the DFU

- Offloading essential for optimal treatment
- Total contact casting considered "gold standard"
  - TCC not applicable to all DFUs...those with ischemia, infection, limits frequency of dressing changes
  - TCC reviewed by Cochrane Foundation who found little evidence of effectiveness due to limited amount and poor quality research

Common Methods to “Off-Load” the Foot

- Bed Rest
- Wheel Chair
- Crutch Assisted Gait
- Total Contact Casts
- Felted Foam
- “Half Shoes”
- Therapeutic Shoes
- Custom Splints
- Removable Cast Walkers

Felt-foam Offloading

- Accommodates ulcer
- Applied to plantar surface
- Distributes weight away from ulcer
- Cost effective

- The variability in off-loading efforts skews results.
- Removable off-loading devices may be encouraging non-compliance.
- The authors suggest that there are several options for non-removable off-loading devices to help eliminate this variable for future studies.

DH Walker Boot

Completed Total Contact Cast

Offloading Sub 1st Metatarsal Head DM Ulcers
Peak Plantar Pressures in (N/cm²)

Armstrong, David et al. Activity patterns of patients with diabetic foot ulceration: patients with active ulceration may not adhere to a standard pressure off-loading regimen. Diabetes Care 2003 26(9): 2575-2580

- 20 subjects treated for neuropathic diabetic foot ulcer, treated with removable cast walker (RCW).
- Total activity measured with waist monitor.
- Mean Essentials per day was 1219 +/- 821 and only 28% of these Essentials were done with the boot in place.
- Only 30% of the study group wore boot for more Essentials than not.
- Even this group only wore boot 60% of the time.
- Conclusion: Off loading regimen compliance is poor and may be worse than we originally thought.

Treatment...Pressure Relief

- “Instant total-contact-cast” using removable cast walker converted into non removable devise by wrapping with cohesive bandage or fiberglass

Positioning and Off-Loading

• Specialized footwear
  – Plantar ulcers
  – Diabetic patient with neuropathy (insensate)
  – Options:
    • Prefabricated lifts and ankle supports
    • Custom molded shoes
    • Orthoses
    • Wedges
    • Total walking casts
  – Shoe with removable insole sections (new)
  – Surgical options
    • Achilles lengthening

Positioning and Off-Loading

• Surgical options
  – Achilles tendon lengthening
  – Gastrocs recession
  – Tenotomy
  – Metatarsal head resection

Bottom Line

Wounds won’t heal under pressure......

Please welcome back

Dr. Glen Einspanier

The Nine Essentials of Wound Healing

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2. Non-Viable Tissue
3. Inflammation or Infection
4. Edema
5. Wound Microenvironment
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8. Pain Control
9. Host Factors
Factors influencing a painful experience
• Age
• Personality
• Perception
• Pain threshold
• Past experiences with pain

Assessment of Pain
Biopsychosocial History- the 5th Vital Sign

P - Provocation- inciting factor, onset, worsens
Q - Quality- describe: sharp, dull, burn, ache, cramp
R - Region- affected body part
S - Radiation- where does it “shoot to”
T - Severity- rating on analog scale 1-10
U - Special Characteristics - movements, diaphoresis
V - Timing- constant, variable, intermittent, duration

Wound Pain Assessment

Clinical Pain Management

Pain Management Guidelines

Pain and Wound Healing
• Clinicians must adopt a rational approach to pain management to help relieve pain and facilitate wound healing and minimize the risk of developing chronic wound pain.
Bottom Line

Good pain control increases patient compliance.....

Essential 9: Optimizing Host Factors

Dr. Katherine Lincoln, D.O.

Essential 9 Optimizing Host Factors

- Assess the status of nutrition, diabetes, renal, mobility, other systemic disease, and psychosocial issues and intervene

Essential 9 Optimizing Host Factors

- Smoking
- Diabetes
- Renal, dialysis
- Age
- Hemoglobinopathies
- Heart disease
- Chronic respiratory disease
- Malnutrition
- Systemic Inflammatory Disease
- Visual impairment
- Auditory impairment
- Cognitive impairment
- Malignancy
- Chemotherapy
- Chronic steroid therapy
- Addiction

Optimizing Host Factors
Host Factors

- Break it down into Manageable bits
- Nutrition
- Smoking
- DM/Renal
- Mobility
- Other systemic disease
- Psychosocial issues

Assess/Address What You Can

Nutrition Assessment (labs) in the Wound Care Patient

- Screening labs:
  - Albumin <3.5
  - Transferrin <200
  - Prealbumin <16
  - Total lymphocyte ct <1500

Assess/Address What You Can

Fix What You Can

- ?smoking meds?
- Nutritional support with teaching, food bank, supplements
- Mobility support with off loading mattresses, DME feeding assistive devices
- Diabetic education

- Work with other attendings in coordination of care
- Addiction related malnutrition and multiple adverse effects
- Work with local psych to encourage follow up
Essential 9 Host Factors

Necrotic Tissue is a Physical Barrier

In chronic wounds, dead tissue is unreceptive to growth factors or any bioactive treatment. Once the wound is debrided and bleeding, growth factors are stimulated and micro-healing can begin.

Purposes of Assessment

- Initial definition/diagnosis
- Monitoring the effect of treatment
- Failure to progress
- Monitoring for occurrence of infection
- Prediction of outcome
- Reimbursement qualification

Post-test

1. Infection/Inflammation have little to do with ultimate wound healing.  T  F
2. In the wounded patient, pain control usually means improved compliance.  T  F
3. Knowing the patient’s current medications can be key to remedying delayed healing.  T  F
4. Removal of dead tissue from the wound every once in awhile is an important essential of early wound closure.  T  F
5. The invasive Vascular Surgeon/Cardiologist/Radiologist is a wound care physician’s best friend.  T  F