Wound Care
Jenna E. Clowers, PA-C, MPAS
Portland Adventist Medical Center
Wound Healing & Hyperbaric Medicine

Objectives
1) Review Chronic Wounds
   • Acute vs Chronic Wounds
   • Most Common Chronic Wounds and Workups
2) Wound Dressings
3) Advanced Wound Care Principles
   • Wound Bed Preparation
   • Offloading
   • Compression therapy
   • HBOT
4) When to Refer to Wound Care Center

Acute vs Chronic Wounds
The Acute Wound

- Hemostasis/coagulation → Seconds to hours
  - Vasoconstriction, platelet release, clot formation
- Inflammatory phase → Hours to days
  - Vasodilation, neutrophils and macrophages clean the wound and produce growth factors
- Proliferation/Migration → Days to weeks
  - Angiogenesis
  - Collagen fiber synthesis by fibroblasts
- Remodeling → Months to 1-2 years
  - Shrinking and strengthening of the scar

The Chronic Wound

Chronic wounds stall in the inflammatory phase and fail to progress through normal phases of wound healing

- Infection/Biofilm
- Hyperproliferation epidermis/stalled re-epithelialization
- Persistent inflammation
- Fibroblast senescence
- Impaired angiogenesis
- Fibrin cuffs (barrier to oxygenation)
- Elevated MMPs

Common Chronic Wounds and Workups

- Categorizations
- Diagnostic factors
- Workups
- Management
Major Chronic Wound Categories

- ~90% of all chronic wounds fall within 4 categories
- ~2.4-4.5M people in the US suffer from chronic lower extremity wounds

<table>
<thead>
<tr>
<th>Category</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other</td>
<td>Surgical: Delayed surgical healing, tertiary intention wound healing, compromised flap graft</td>
</tr>
<tr>
<td>Pressure</td>
<td>Radiation induced: Soft tissue radionecrosis, osteoradionecrosis, radiation cystitis</td>
</tr>
<tr>
<td>Diabetic</td>
<td>Trauma: Skin tears, burns</td>
</tr>
<tr>
<td>Venous</td>
<td>Derm: Skin cancer, pyodermagangrenosum, calciphylaxis</td>
</tr>
</tbody>
</table>

Venous Stasis Ulcers (VSUs)

- Most common chronic wound
- 60-80% of all ulcers

<table>
<thead>
<tr>
<th>Risk Factors</th>
<th>Typical Locations</th>
<th>Wound Bed</th>
<th>Periwound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic venous insufficiency, lymphedema,</td>
<td>Lower leg and ankle</td>
<td>Often shallow with irregular borders. Mix of red granulation and white/yellow fibrous tissue covered with yellow slough. Heavy drainage.</td>
<td>Stasis dermatitis, hemosiderin staining, lipodermatosclerosis, edema, varicosities, atrophie blanche</td>
</tr>
<tr>
<td>swelling, fx DVT, CHF, varicosities, family hx, age, smoking, DM, high BMI</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

VSU Examples
**Risk Factors:**
- Venous insufficiency, lymphedema, DVT, CHF

**Workup:**
- Vascular assessment: venous and arterial
- Evaluate for infection, +/- culture
- Evaluate: compression, nutrition, other comorbidities, smoking
- +/- Imaging

**Management:**
- COMPRESSION THERAPY
- Debridement
- Dressing management to optimize wound environment
- Infection control
- Treat underlying venous disease
- +/- use of skin substitutes
- Patient education

---

**Diabetic Foot Ulcers (DFUs)**

- CDC/ADA: US >30.3 million people (9.4%) have DM, ¼ are undiagnosed.
- Ulcer precedes 85% of non-traumatic amputations in people with DM.
- Relative 5-year mortality rate after limb amputation is 68%.
- DFUs double mortality and MI risk, increase stroke risk by 40%.
- Seconds count: Every 7 seconds someone dies from diabetes. Every 20 seconds someone undergoes an amputation.

---

**Diabetic Foot Ulcer**

<table>
<thead>
<tr>
<th>DFU Type</th>
<th>Risk factors</th>
<th>Typical location</th>
<th>Wound bed</th>
<th>Periwound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neuropathic</td>
<td>Hyperglycemia, neuropathy, deformity, obesity, PVD, trauma, CAD, HTN, Other DM co-morbidities, smoking, prior DFU</td>
<td>Weight-bearing areas (MTH, heel, toes)</td>
<td>Pink and granulating, undermacerated, yellow slough</td>
<td>Callus typically present, macerated</td>
</tr>
<tr>
<td>Ischemic</td>
<td>Tips of toes, nail edges, between toes, lateral foot</td>
<td>Sparse, pale granulation tissue, adherent yellow slough</td>
<td>Hair loss on foot, pallor w/ elevation, dependent rubor</td>
<td></td>
</tr>
<tr>
<td>Neuroischemic</td>
<td>Margins of foot and toes, post heel</td>
<td>Poor granulation</td>
<td>Thin, shiny skin, no hair</td>
<td></td>
</tr>
</tbody>
</table>

---

*Armstrong, et al, Diabetes Care 2013*


*Armstrong, et al, Diabetes Care 2013*
DFU Examples

DFU Wagner Grading System

<table>
<thead>
<tr>
<th>Grade</th>
<th>Lesion</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Intact skin but foot is at risk</td>
</tr>
<tr>
<td>1</td>
<td>Superficial diabetic ulcer, superficial or full thickness</td>
</tr>
<tr>
<td>2</td>
<td>Ulcer extends to ligament, tendon, joint capsule, or fascia without abscess or osteomyelitis</td>
</tr>
<tr>
<td>3</td>
<td>Deep ulcer with abscess or osteomyelitis</td>
</tr>
<tr>
<td>4</td>
<td>Gangrene to portion of forefoot or heel</td>
</tr>
<tr>
<td>5</td>
<td>Extensive gangrene of foot</td>
</tr>
</tbody>
</table>

DFU Basic Workup

Risk Factors:
- LOPS, PVD, DM, infection, pressure, smoking

Workup:
- Monofilament testing
- Evaluate vascular status, perfusion
- Evaluate for infection, +/- culture, consider HBOT if Wag 3+
- Labs: consider CBC, CBG, HgbA1c, CRP, ESR
- Consider Imaging: Xray, MRI, angiography
- Evaluate nutrition, glycemic control, habits, other comorbidities.

Management:
- +/- revascularization to improve perfusion
- Debridement
- Infection control
- Offloading
- Dressing management to optimize wound environment
- +/- use of biologics
- Patient education and referral for foot care follow up
Pressure Injuries

- 2.5M people develop pressure injuries in the US each year

<table>
<thead>
<tr>
<th>Risk Factors</th>
<th>Typical Locations</th>
<th>Wound Bed</th>
<th>Periwound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immobility, loss of sensation, use of vasopressors, stroke, age, low BMI (&lt;20), traumas, prolonged pressure from devices, MSK disorders/fractures, GI bleed, concurrent chronic disease (DM, COPD, CA, CHF), hx prior wound, moisture.</td>
<td>Skin overlying bony prominences such as malleoli, trochanters, heels, or sacrum.</td>
<td>Base color varies by stage from red, pink, yellow, grey, black, +/- slough, eschar, undermining, tunneling, rolled edges.</td>
<td>+/- induration, erythema, maceration, may be normal periwound skin.</td>
</tr>
</tbody>
</table>

Risk Factors:
- Chronic pressure, immobility

Workup:
- Evaluate positioning, habits, equipment, available assistance
- Evaluate use of appropriate offloading devices
- Evaluate for infection, +/- culture
- Evaluate: nutrition, other comorbidities, habits

Management:
- REMOVE PRESSURE via offloading
  - frequent position changes, low air-loss mattress, cushions, heel lift
- Debridement
- Infection control
- Dressing management to optimize wound environment
- +/- use of biologics
- Patient education
Arterial Ulcer Examples

Arterial Ulcer Basic Workup

Risk Factors:
- PAD, trauma, pressure

Workup
- Evaluate vascular status, perfusion
- Evaluate for infection, +/- culture
- Evaluate pressure offloading
- Evaluate: nutrition, other comorbidities, habits

Management:
- Conservative management until revascularization
- Revascularization, especially with critical limb ischemia
- Offload wound to reduce pressure
- Debridement
- Infection control
- Dressing management to optimize wound environment
- +/- use of biologics
- Patient education
Key Points:

- Addressing the underlying etiology and contributing factors is crucial for wound healing.
- Is there adequate perfusion?
- Is there infection?
- Is pressure an issue?
- Is swelling an issue?
- Has nutrition been optimized?
- Is smoking a factor?
- Is patient’s diabetes controlled?
- Are comorbidities a complicating factor?

Wound Dressings

- Categories
- Advantages/Disadvantages
- Examples

Dressing Categories

- Skin protectants
- Contact layer dressings
- Gauze
- Impregnated gauze
- Films
- Hydrogels
- Hydrocolloids
- Foams
- Alginites
- Antimicrobial dressings
- Biologics
- Absorbent cover layers
Skin Protectants

**Advantages**
- Protects the skin from the effects of mechanical injury due to tape and adhesive
- Available in foam applicators, wipes and sprays

**Disadvantages**
- Not an actual wound dressing
- Meant for periwound skin

**Examples**
- Wands
- Wipes
- Pads
- Sprays
- Creams
- Swabs

Contact Layer

**Advantages**
- Typically non-adherent
- Maintains contact of topical dressing against wound bed, maximizing effect.
- Barrier between wound surface and secondary dressing.
- Protect wound bed from trauma while allowing exudate through.
- Prevents ingrowth of granulation tissue into the foam of a NPWT system

**Disadvantages**
- May leave ‘dead spaces’ if good contact is not achieved, thereby allowing exudate to collect on the wound surface.
- Not for wounds that need extra moisture

**Examples**
- Gauze

Gauze

**Advantages**
- Mechanically debride
- Permeable to gases
- Fills dead space
- Economical and available
- Absorpive

**Disadvantages**
- Can damage granulation tissue on removal
- May dehydrate the wound
- Permeable to fluid and bacteria
- May require more frequent dressing changes

**Examples**
### Impregnated Gauze

**Advantages**
- Less adherent to wound bed
- May keep wound moist

**Disadvantages**
- Requires secondary dressing
- Less absorptive than plain gauze
- May lead to maceration

**Examples**
- Oil-emulsion
- Petrolatum
- Hydrogel
- Vaseline

### Films

**Advantages**
- Allows wound visualization
- Conforms to body contours
- Facilitates autolytic debridement
- Cost-effective
- Impermeable to fluids and bacteria
- Retain moisture

**Disadvantages**
- Does not absorb exudate
- May tear fragile skin upon removal
- May macerate skin with fluid accumulation
- May dislodge in high friction areas

**Examples**
- Hydrocolloids

### Hydrocolloids

**Advantages**
- Absorbs minimal to moderate exudate
- Impermeable to bacteria
- Facilitates autolytic debridement
- Stays in place up to 7 days
- Conformable
- Water resistant
- Can be self-adhering
- Various shapes, sizes, thicknesses

**Disadvantages**
- Does not absorb heavy exudate
- Not recommended on exposed structures
- Contraindicated with infection
- Difficult to remove from fragile skin
- Can cause maceration

**Examples**
- Oil-emulsion
- Petrolatum
- Hydrogel
- Vaseline
Hydrogels

**Advantages**
- Water/glycerin based
- Hydrates dry wounds
- Can be a delivery system for other agents (silver, collagen, lidocaine)
- Soothing, can reduce pain
- Available in gels, sheets, saturated pads

**Examples**

**Disadvantages**
- Can cause periwound maceration
- Does not absorb exudate
- Requires secondary dressing

Foams

**Advantages**
- +/- border, film
- Absorbs light to heavy exudate, variety of options.
- Creates/maintains moist wound environment
- Easy to apply, comfortable
- Available with antimicrobial agents
- Protects against mechanical trauma
- Conforms well

**Examples**

**Disadvantages**
- May require secondary dressing if non-bordered
- May macerate wound edge if dressing becomes saturated

Alginates

**Advantages**
- Moderate/heavy exudate, absorbent
- Forms a gel when moist and provides a moist wound environment
- Facilitates autolytic debridement
- Many forms: sheets, ribbons, ropes
- +/- silver or honey for bioburden mgmt.

**Examples**

**Disadvantages**
- Adheres to wound bed if there isn’t enough moisture to create the gel effect
- Not for dry wounds
- Requires a secondary dressing
Antimicrobial

**Advantages**
- Topical vs oral vs IV
- Localized therapy
- Variety of dressing forms/agents
- Reduces wound burden
- Decreases pain
- Reduces odor
- Intermittent bacteria biofilms

**Disadvantages**
- Allergies
- Dressing compatibility

**Examples**
- Silver
- Manuka Honey
- Oxirins
- Cadexomer Iodine
- Povidone-iodine (betadine)
- Polyhexamethylene biguanide (PHMB)
- Dialkylcarbamoyl chloride (DACC)
- MBGV-PVA (methylene blue/gentian violet-PVA foam)

Absorbent Cover Dressings

**Advantages**
- Often multilayered with the ability to absorb large drainage
- Non-occlusive
- Provides extra protective layer against trauma
- Cost-effective
- Can cover any non-occlusive dressing

**Disadvantages**
- Need primary contact dressing underneath

**Examples**

Negative Pressure Wound Therapy

**Advantages**
- Moist environment reduces edema/interstitial fluid
- Increases local perfusion
- Approximation of wound edges
- Stimulates granulation tissue
- Reduces bioburden
- Decreases frequency of dressing changes
- Wide variety of machines, foams, sizes.

**Disadvantages/contraindications**
- Malignancy (unless palliative)
- Gross infection/pus
- Untreated osteomyelitis
- Lack of hemostasis
- Not for use over exposed vessels, bypass grafts, organs
- Can cause periwound maceration
- Requires training to apply

**Examples**
- Variety of brands and types of granulofarm
Collagen

**Advantages**
- Variety of forms
- Binds MMPs
- Provides temporary scaffolding
- Promotes epithelialization
- Easy to apply
- Cost-effective advanced wound care

**Disadvantages**
- Requires secondary dressing
- Not for 3rd degree burns or necrotic tissue
- Requires a clean wound bed
- Often bovine or porcine derived. Not to use with sensitivity or cultural restrictions.

**Examples**
- Derived from bovine, porcine or avian sources
- Forms: Sheets, powders, gels, +/- Ag

Biologics

**Advantages**
- Cellular or acellular
- Wide variety of options
- Induces tissue to granulate and close in a more normal healing process
- +/- growth factors, cytokines, fibroblasts, keratinocytes.

**Disadvantages**
- Expensive
- Used primarily in wound care centers due to high cost, CMS regulations and specific guidelines that must be followed.

**Examples**
- Advanced Wound Care Principles
  - Wound bed preparation
    - Debridement
    - Dressing management goals
  - Use of tissue products/grafting
  - Offloading
  - Compression therapy
  - Hyperbaric Oxygen Therapy
Wound Bed Preparation

Debridement

Key goals: Remove non-viable tissue, reduce bioburden, remove impediments to epithelialization

- Autolytic
- Enzymatic
- Biotherapy or maggot therapy
- Mechanical
- Surgical
- Chemical

Wound Bed Preparation

Dressing Management Goals

Simultaneous with Debridement

- Moisture balance:
  - Ideal = moist wound environment
- Slough control:
  - Mechanical, autolytic, enzymatic
- Tissue promotion:
  - NPWT, collagen, skin subs
- Address infection / bioburden:
  - Antimicrobial dressings
  - Topical/oral/IV antibiotics

Dressing Management Goals

Location, Size, Tissue type, Exudate, Periwound

- Moisture balance
- Slough control
- Tissue promotion
- Infection / bioburden

Maintain a moist wound environment
Dressing Management Goals

- Moisture balance
- Slough control
- Tissue promotion
- Infection / bioburden

Remove the yellow/grey, gelatinous covering made of fibrin, protein, exudate, bacteria and other non-viable tissue

<table>
<thead>
<tr>
<th>Autolytic</th>
<th>Enzymatic</th>
<th>Mechanical</th>
<th>NPWT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Honey</td>
<td>Collagenase</td>
<td>Wet-to-dry (Gauze)</td>
<td>Wound VAC</td>
</tr>
<tr>
<td>Hydrogel</td>
<td>Silver nitrate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saline-moistened gauze</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydrocolloid</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Dressing Management Goals

- Moisture balance
- Slough control
- Tissue promotion
- Infection / bioburden

Promote growth of new red granulation tissue and epithelialization

NPWT    Biologics  Collagen
Dressing Management Goals

- Moisture balance
- Slough control
- Tissue promotion
- Infection / bioburden

Reduce bioburden and formation of biofilm

<table>
<thead>
<tr>
<th>Silver</th>
<th>DACC</th>
<th>PHMB</th>
<th>Honey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topical</td>
<td>Iodine</td>
<td>Hydrofera blue</td>
<td></td>
</tr>
</tbody>
</table>

Use of Tissue Products/Grafts

Biologics
- Primarily used in wound care centers or by surgeons in the operating room.
- Expensive, strict guidelines for insurance coverage, CMS regulated.

Grafts
- Wide variety of options.
- Most performed by surgeons in the operating room.
- Some forms of split thickness grafts available for outpatient environment.

Offloading

Diabetic Foot Ulcers: methods to assist with healing and for use once healed
- Total Contact Cast (TCCs) "GOLD STANDARD"
- Felt/foam
- Football dressing
- Custom diabetic shoes
- Shoes (orthowedge, rocker-bottom, heel-wedge, segmented insoles)
- Specialized diabetic shoes
- Removable cast walkers/walking boots/limb load braces/crow boot

Pressure Injuries
- Foam
- Low air-loss mattress
- Cushions
- Heel lift AFO boots
**Compression Therapy**

- Clinic applied
- Patient applied
- Stockings (OTC and Rx)
  - Class 1: 15-20 mmHg
  - Class 2: 20-30 mmHg
  - Class 3: 30-40 mmHg
- Compression pumps
- Elastic tubular bandage
- Manual lymphatic massage

---

**Hyperbaric Oxygen Therapy: Medicare Approved Indications**

15 Medicare approved indications

### Common Inpatient Applications
- Acute carbon monoxide intoxication
- Decompression illness
- Gas embolism
- Gas gangrene
- Acute traumatic peripheral ischemia
- Crush injuries and suturing of severed limbs
- Progressive necrotizing infections
- Actinomycosis
- Cyanide poisoning

### Common Outpatient Applications
- Diabetic wounds of the lower extremity (specific guidelines)
- Soft tissue radionecrosis
- Osteoradionecrosis
- Chronic refractory osteomyelitis
- Compromised skin graft
- Acute peripheral arterial insufficiency

---

**When to Refer to a Chronic Wound Care Center**

- Wound has stalled and has not improved in 3-4 weeks
- When advanced wound care principles are needed
- For assistance when multidisciplinary approach is needed for wound healing.
- Clinic has limited access to materials
  - Dressings, compression, offloading, biologics
- HBOT is warranted
Recall…

- Physiology differences between acute and chronic wounds
- Address underlying cause
- Debridement to remove non-viable tissue
- Dressings to optimize wound environment
- Seek advanced wound care options when appropriate/available

Email: clowerje@ah.org

Thank You