Advanced Wound Management

MU Advanced Practice & Skills Workshop
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Objectives
Upon completion of this session, the participant will be able to:

1. Differentiate assessment and treatment of chronic wounds - pressure injuries, diabetic foot ulcers, and lower extremity wounds related to venous and arterial disease.

2. Identify appropriate topical and adjunctive treatment options for chronic wounds.

Outline
Wound assessment
Diagnostics
Classification Systems
Wound healing/treatment
Topical therapy
Adjunctive therapy

Wound Types

Acute
- Traumatic
- Abrasion
- Laceration
- Surgical
- Incision
- Infection
- Skin/soft tissue
- Abscess
- Necrotizing

Chronic
- Pressure Injury
- LE Arterial Disease (LEAD)
- LE Venous Disease (LEVD)
- LE Neuropathic Disease (LEND)/Diabetic Foot Ulcer (DFU)

Assessment
Assessment

**Complete health/medical & social history**
- History of prior wound & previous treatment
- Pain assessment
- Nutritional assessment
- Functional capacity
- Values & goals of care - individual and/or significant others
- Psychological health, behavior, & cognition
- Social & financial support systems, resources
- Knowledge & belief about prevention & treatment
- Ability to adhere to a prevention & management plan

(Doughty & McNichol, 2014; NPUAP, 2014; WOCN, 2016)

**Focused Physical Exam**

**Vital signs**

**Wound assessment**

**Factors that may affect healing**
- Impaired perfusion
- Impaired sensation
- Systemic infection

(NPUAP, 2014; WOCN, 2016)

**Wound Assessment**

Location
Dimensions
Wound bed
Exudate
Surrounding skin

**Wound Bed**

**Assessment-PI**

**Prior surgical interventions**
- Flaps
- Amputations
**Functional capacity**
- Positioning
- Posture
- Assistive equipment

(NPUAP, 2014; WOCN, 2016)
Differential Diagnosis- PI

Differentiate pressure injuries from other types of wounds:
- Skin tear or abrasion
- Herpes lesions
- Incontinence-associated dermatitis (IAD)/candidiasis
- Medical-adhesive related skin injury (MARSII)
- Arterial insufficiency ulcer/venous stasis ulcer
- Skin failure
- Kennedy Terminal Ulcer

(AAWC, 2010; Delmore, et al. 2015; NPUAP, 2014)

Assessment- LEAD

Health history- risk factors
- Tobacco use
- Diabetes
- Hypertension
- Dyslipidemia
- Renal insufficiency

Assessment- LEAD

Bilateral lower-extremity examination:
- Functional ability & physical activity
- Ischemic skin changes
  - Purpura
  - Atrophy of the skin, subcutaneous tissue & muscle
  - Shiny, taut, hairless skin
  - Dystrophic nails
- Pedal pulses
- Calculate ABI for each leg- using the higher of the ankle pressures (dorsalis pedis or posterior tibial) divided by the higher of the brachial pressures from the R or L arm

(WOCN, 2014)

Differential Diagnosis-LEAD

Differentiate wounds associated with LEAD from:
- Pressure injuries
- Wounds associated with LEVD
- Diabetic Foot Ulcer
- Scabbed abrasions
- Malignant skin lesions

Assessment- LEVD

Health history- risk factors
- Family history
- Pregnancy
- Advanced age
- Thrombophilia
- Systemic inflammation
- Obesity
- Venous thromboembolism [VTE]
- Lack of adherence with compression therapy

(AAWC, 2010; Delmore, et al. 2015; WOCN, 2011b)
Assessment-LEVD

Skin changes
- Edema
- Hemosiderin staining
- Venous dermatitis
- Atrophie blanche
- Venous dermatitis
- Ankle flaring
- Scarring from previous ulcers
- Lipodermatosclerosis
- Elevated temperature


Ulc er complications
- Cellulitis
- Gangrene
- Osteomyelitis


Differential Diagnosis-LEVD

Differentiate wound associated with LEVD from:
- Pressure injuries
- Wounds associated with LEAD
- Diabetic foot ulcers
- Traumatic wounds
- Malignant skin lesions
- Morbid obesity
- Lymphedema
- Lipidema

(AAWC, 2010; Gloviczki, et al, 2011; WOCN, 2011b)

Assessment-LEND/DFU

Health history – risk factors
- Diabetes mellitus
- Hypothyroidism
- Alcoholism
- Vitamin deficiencies
- Obesity
- Collagen & metabolic diseases
- Pernicious anemia
- Advanced age
- Neuromuscular diseases

(WOCN, 2012)

Assessment-LEND/DFU

- Comprehensive foot assessment
  - Inspect skin, including between toes
  - Hygiene and footwear
  - Loss of Protective Sensation (LOPS) - Monofilament testing

- Ulcer complications
  - Cellulitis
  - Gangrene
  - Osteomyelitis

(WOCN, 2012)

Differential Diagnosis-LEND

Differentiate LEND/DFU from:
- Pressure injury
- LEAD
- LEVD
- Skin malignancy
- Tinea pedis

(WOCN, 2012)
Diagnostics

Evaluate status of co-morbid conditions affecting wound healing

- Complete blood count with differential (CBC)
- Metabolic profile (BMP)
- Coagulation studies (prothrombin time [PT] and partial thromboplastin time [PPT])
- Lipid profile
- HbA1c
- Hepatic function profile
- Pre-albumin
- Thyroid function (TSH)

(AAWC, 2010; NPUAP, 2014)

Diagnostics

Suspected infection/non-healing wound

- Wound culture
- Complete blood count with differential (CBC)
- C-reactive protein (CRP)
- Erythrocyte sedimentation rate (ESR)
- Blood cultures (if bacteremia or osteomyelitis is suspected)
- Imaging – Xray, Magnetic Resonance Imaging (MRI), Bone Scan

Suspected peripheral arterial disease

- Bedside – Doppler, Ankle-Brachial Index (ABI)
- Non-invasive arterial studies – Ankle-Brachial Index (ABI), Transcutaneous Oxygen Measurement (TCOM)

Suspected malignancy/non-response to optimal care for 12 weeks

- Biopsy

(AAWC, 2010; NPUAP, 2014)

Wound Culture Technique

- Use sterile technique & sterile supplies
- Debride & cleanse wound prior to obtaining culture
- Swab only viable tissue that is clean, express fluid from wound bed
- Swab 1 cm² area of viable tissue for 5 seconds
  - Sufficient pressure to cause minimal bleeding & express fluid from the underlying tissue
  - If the wound bed is dry, moisten swab with sterile saline
- Do NOT culture eschar, necrotic debris, drainage or from the dressing

Pressure Ulcer Injury:

“A pressure injury is localized damage to the skin and/or underlying soft tissue usually over a bony prominence or related to a medical or other device.”

- Can present as intact skin or an open ulcer
- May be painful
- Occurs as a result of intense and/or prolonged pressure or pressure in combination with shear
- Tolerance of soft tissue for pressure & shear may also be affected by microclimate, nutrition, perfusion, co-morbidities & condition of the soft tissue

(Edsberg, 2016; NPUAP, 2016)

(AAWC, 2010; NPUAP, 2014)
**Stage 1 Pressure Injury:**

Non-blanchable erythema of intact skin

- Intact skin with localized area of non-blanchable erythema
- May appear differently in darkly pigmented skin
- Blanchable erythema or changes in sensation, temperature, or firmness may precede visual changes
- Color changes do not include purple or maroon discoloration

(NPUAP, 2016)

**Stage 2 Pressure Injury:**

Partial-thickness skin loss with exposed dermis

- Partial-thickness loss of skin with exposed dermis
- Wound bed - viable, pink or red, moist
- May present as an intact or ruptured serum-filled blister
- Adipose & deeper tissues not visible
- Granulation tissue, slough & eschar are not present.

These injuries commonly result from adverse microclimate & shear in the skin over the pelvis & shear in the heel.

(NPUAP, 2016)
**Stage 3 Pressure Injury:**

Full-thickness skin loss

- Full-thickness loss of skin, in which adipose tissue is visible in the ulcer
- Granulation tissue & epibole (rolled wound edges) often present
- Slough and/or eschar may be visible
- Undermining & tunneling may occur

The depth of tissue damage varies by anatomical location; areas of significant adiposity can develop deep wounds.

*(NPUAP, 2016)*

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**Stage 4 Pressure Injury:**

Full-thickness skin and tissue loss

- Full-thickness skin & tissue loss with exposed or directly palpable fascia, muscle, tendon, ligament, cartilage or bone in the ulcer
- Slough and/or eschar may be visible
- Epibole (rolled edges), undermining and/or tunneling often occur
- Depth varies by anatomical location

*(NPUAP, 2016)*
Unstageable Pressure Injury:
Obscured full-thickness skin and tissue loss

- Full-thickness skin & tissue loss- the extent of tissue damage within the ulcer cannot be confirmed because it is obscured by slough or eschar
- If slough or eschar is removed, a Stage 3 or Stage 4 pressure injury will be revealed

(NPUAP, 2016)

Deep Tissue Pressure Injury:
Persistent non-blanchable deep red, maroon or purple discoloration

- Intact or non-intact skin with localized area of persistent non-blanchable deep red, maroon, purple discoloration or epidermal separation revealing a dark wound bed or blood filled blister
- Pain & temperature change often precede skin color changes
- Discoloration may appear differently in darkly pigmented skin
- This injury results from intense and/or prolonged pressure & shear forces at the bone-muscle interface
- The wound may evolve rapidly to reveal the actual extent of tissue injury, or may resolve without tissue loss

(NPUAP, 2016)
Additional PI definitions

**Medical Device Related Pressure Injury**
(Describes an etiology)
- Result from the use of devices designed & applied for diagnostic or therapeutic purposes
- Resultant pressure injury generally conforms to the pattern or shape of the device
- Should be staged using the staging system

**Mucosal Membrane Pressure Injury:**
- Found on mucous membranes with a history of a medical device in use at the location of the injury
- Due to the anatomy of the tissue these injuries cannot be staged

Avoidable vs Unavoidable?

**Unavoidable pressure ulcer**
- Provider evaluated the individual's clinical condition & pressure ulcer risk factors
- Defined & implemented interventions consistent with individual needs, goals, & standards of practice
- Monitored & evaluated the impact of the interventions
- Revised the approaches as appropriate (Bruck, et al, 2011)

**Documentation**
- Preventative measures targeted at reducing risk
- Clinical reasons why preventative measures are not appropriate (WOCN, 2017)

**Possible risk factors**
- Vasopressors – particularly vasopressin & norepinephrine (Cox, 2016)

Skin Failure

“An event in which the skin & underlying tissue die due to the hypoperfusion that occurs concurrent with severe dysfunction or failure of other organ systems”

- Kennedy Terminal Ulcer (Kennedy, 1999)
- SCALE – Skin Changes at Life’s End (Sibbald, Krasner, & Lutz, 2010)

Predictors - PAD, mechanical ventilation for more than 72 hours, respiratory failure, liver failure, severe sepsis/septic shock (DeShano, et al, 2013)

Classification-LEAD

**Fontaine Clinical Classification of Arterial Disease**

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Asymptomatic</td>
</tr>
<tr>
<td>II</td>
<td>Intermittent claudication</td>
</tr>
<tr>
<td>IIa</td>
<td>Mild claudication, pain with walking more than 200m</td>
</tr>
<tr>
<td>IIb</td>
<td>Moderate/severe claudication, pain with walking less than 200 m</td>
</tr>
<tr>
<td>III</td>
<td>Ischemic rest pain/nocturnal pain</td>
</tr>
<tr>
<td>IV</td>
<td>Ulceration, necrosis and/or gangrene</td>
</tr>
</tbody>
</table>

**Rutherford Categories of Arterial Disease**

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Asymptomatic</td>
</tr>
<tr>
<td>1</td>
<td>Mild claudication</td>
</tr>
<tr>
<td>2</td>
<td>Moderate claudication</td>
</tr>
<tr>
<td>3</td>
<td>Severe claudication</td>
</tr>
<tr>
<td>4</td>
<td>Rest pain</td>
</tr>
<tr>
<td>5</td>
<td>Ischemic ulceration not exceeding ulcer of the digits of the foot</td>
</tr>
<tr>
<td>6</td>
<td>Severe ischemic ulcers or frank gangrene</td>
</tr>
</tbody>
</table>
LEAD Wounds

Classification-LEVD
Clinical Epidemiological Anatomical & Pathophysiological (CEAP) Classification of Venous Disorders

<table>
<thead>
<tr>
<th>CEAP Classification</th>
<th>Clinical Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>C0</td>
<td>No visible or palpable signs of venous disease</td>
</tr>
<tr>
<td>C1</td>
<td>Telangiectasies or reticular veins</td>
</tr>
<tr>
<td>C2</td>
<td>Varicose veins</td>
</tr>
<tr>
<td>C3</td>
<td>Edema</td>
</tr>
<tr>
<td>C4a</td>
<td>Pigmentation or eczema</td>
</tr>
<tr>
<td>C4b</td>
<td>Lipodermatosclerosis or atrophie blanche</td>
</tr>
<tr>
<td>C5</td>
<td>Healed venous ulcer</td>
</tr>
<tr>
<td>C6</td>
<td>Active venous ulcer</td>
</tr>
</tbody>
</table>

Etiological classification
- Ec: congenital
- As: superficial veins
- Pr: reflux

Anatomical classification
- Ep: primary
- Ap: perforating veins
- Po: obstruction

Pathophysiology
- Es: secondary
- Ad: deep veins
- Pr,o: reflux and obstruction

Classification-DFU
Wagner Classification System (Diabetic Foot Ulcers)
- 0 – At risk foot, pre-ulcer, no open lesions, skin intact: may have deformities, callus or cellulitis.
- 1- Superficial ulcer with partial or full thickness tissue loss.
- 2- Probing to ligament, tendon or joint capsule with soft tissue infection.
- 3- Deep ulcer with abscess, osteomyelitis, or joint sepsis.
- 4- Ulcer localized to forefoot or heel gangrene.
- 5- Ulcer with gangrene involving entire foot, beyond salvage.

LEVD Wounds

Classification-DFU
Wagner Classification System (Diabetic Foot Ulcers)
- 0 – At risk foot, pre-ulcer, no open lesions, skin intact: may have deformities, callus or cellulitis.
- 1- Superficial ulcer with partial or full thickness tissue loss.
- 2- Probing to ligament, tendon or joint capsule with soft tissue infection.
- 3- Deep ulcer with abscess, osteomyelitis, or joint sepsis.
- 4- Ulcer localized to forefoot or heel gangrene.
- 5- Ulcer with gangrene involving entire foot, beyond salvage.

LEND/DFU Wounds
Treatment

- Establish realistic goals of care
- Address underlying etiology
- Optimize host response
- Appropriate topical therapy

PI-Alleviate Pressure

- Pressure redistribution products
- Positioning aids
- Avoid positioning directly on pressure ulcer
- Wheelchair-seated individuals
  - Allow limited sitting if capable of performing weight shifts every 1.5 minutes
  - Powered weight-shifting wheelchair system: individuals who are unable to independently perform effective weight shifts
  - Reposition at least every hour; if not able, return individual to bed

PI-Support Surface

- One component of treatment—along with repositioning, nutrition, moisture management, etc.
- Ensure proper functioning & appropriate use for maximum benefit
- Be aware of limitations & contraindications—weight limits, unstable spine, agitated patient
- Consider support surface that facilitates getting in & out of bed
- Use minimal layers of linen for maximum benefit

LEAD-Maximize perfusion

- Maintain dry, stable eschar/blisters in non-infected ischemic wounds
- Closely monitor autolytic or enzymatic debridement
- Choose dressings that permit frequent visualization & inspection of the wound
- Monitor closely for s/s of infection—can be subtle with ↓ blood flow
- Use compression very cautiously
- Claudication exercise program
- Pain control
- Smoking cessation!

LEAD-Medications

- Statin therapy - lipid control, reduce cardiovascular mortality & morbidity
- Antiplatelet therapy (aspirin, clopidogrel, dipyridamole) for patients with symptomatic LEAD—decrease mortality & CV events
- Cilostazol (100 mg oral 2 times per day) - increases HDL cholesterol, decreases triglycerides & LDL cholesterol, improves the walking distances of patients with intermittent claudication
- Consider:
  - prostanoids—some benefit in pain relief & wound healing for patients with critical limb ischemia
  - pentoxifylline—second-line therapy for patients with intermittent claudication
  - angiotensin-converting enzyme inhibitors (e.g., Ramipril 10 mg oral per day) - reduce cardiovascular risks and improve pain-free walking time in patients with claudication
LEVD-Edema & Dermatitis

Composition, Composition, Composition

- Multi-layer wraps
- Graduated compression stockings
- Intermittent pneumatic pump sleeves

- Elevation
- Minimize irritants & allergens on the skin
- Manage exudate

(Glovic, et al., 2011; WOCN, 2011b)

LEVD-Medications

- **Pentoxifylline**: 400 mg 3 times per day as an adjunct to compression therapy
- **Granulocyte-macrophage colony stimulating factor**: given as a peri-ulcer injection to improve ulcer healing
- **Horse chestnut seed extract**: controlling pain & reducing edema
- **Sulodexide**: administered orally or intramuscularly combined with compression (not widely available in the U.S.)

(Glovic, et al., 2011; WOCN, 2011b)

LEND/DFU

Offloading, Offloading, Offloading

- Foot care/Footwear
- Maintain dry, stable eschar on noninfected, ischemic, neuropathic ulcers
- Debride devitalized tissue AFTER perfusion has been evaluated
- Treat infection, evaluate for osteomyelitis
- Monitor for Vitamin D deficiency
- Consider Vitamin B12 supplements – neuropathy

(Lipsky, et al., 2012; WOCN, 2012)

LEND-Medications

Becaplarmin (Regranex)[Rx]

- Platelet derived growth factor
- Treatment of DFU that extend into subQ tissue or deeper, with adequate perfusion
- Formula to calculate length of gel to be applied daily – ulcer length (cm) x ulcer width (cm) ÷ 4
- Increased rate of mortality related to malignancy in patients treated with more than 3 tubes

(Becaplarmin, 2010; WOCN, 2012)

Optimize the host response

- Evaluating nutritional status & addressing deficits
- Stabilizing glycemic control
- Improving arterial blood flow
- Reducing immunosuppressant therapy, if possible

(NPUAP, 2014)

Wound Cleansing

Cleanse the wound at the time of each dressing change

Potable water (i.e., water suitable for drinking), normal saline or non-cytotoxic wound cleanser

Consider surfactants and/or antimicrobials to clean wounds with

Debris, confirmed infection
Suspected infection
Suspected high levels of bacterial colonization

Aseptic technique- the individual, the wound or the wound healing environment is compromised

Cleanse wounds with sinus tracts/tunneling/undermining with caution

(AAWC, 2010; NPUAP, 2014; Barth & Bryant, 2010)
Manage peri-wound skin

- Moisturize skin if dry
- Protect skin from moisture, chemical or physical trauma
- Manage peri-wound skin infection, inflammation, edema & circulation
- Be alert to sensitization reactions

Debridement

Debride devitalized tissue within the wound bed when appropriate to the individual's condition & consistent with overall goals of care

- Thorough vascular assessment prior to debridement of extremity ulcers

Contraindications:
- compromised vascular circulation at ulcer site
- stable heel eschar
- gravely palliative or critically unstable patients

Debridement

**Autolytic debridement**
- As effective (or more so) than enzymatic debridement
- Use when there is no urgent clinical need for drainage or removal of necrotic tissue

Debridement

**Enzymatic debridement**
- Collagenase (Santyl) [Rx]
  - Efficacy has been shown better than placebo, similar to autolytic debridement
  - Use when there is no urgent clinical need for removal of necrotic tissue

Debridement

**Collagenase (Santyl) (Rx)**
- Use saline only to cleanse wound
- Requires moist environment – cover with saline moistened gauze or impregnated gauze
- Dry eschar should be softened or cross-hatched prior to application
- Apply nickel thickness to wound bed daily; does not harm surrounding skin
- Inactivated by heavy metals (mercury, silver), antiseptics, some commercial wound cleansers
- No allergy sensitivity or toxic reactions noted

Debridement

**Conservative Sharp Debridement/Surgical debridement**
- To achieve rapid removal of necrotic tissue, in the presence of extensive necrosis, advancing cellulitis, crepitus, fluctuance, and/or sepsis secondary to wound-related infection
- Must be performed by specially trained, competent, qualified, licensed healthcare professionals credentialed to perform the procedure
- Use sterile instruments
- Caution in the presence of:
  - Immune incompetence
  - Compromised vascular supply
  - Lack of antibacterial coverage in systemic sepsis
Debridement

Mechanical debridement
- Wet-to-dry gauze is considered substandard practice

High flow irrigation

Biological debridement (maggots)
- Use when there is no urgent clinical need for removal of necrotic tissue

Treatment of infection

Topical antibiotic
- Consider a 2-week course of topical antibiotics for ulcers with delayed wound healing despite 2-4 weeks of optimal care.

Systemic antibiotics
- Clinical evidence of systemic infection, such as positive blood cultures, cellulitis, fasciitis, osteomyelitis, systemic inflammatory response syndrome (SIRS), or sepsis.

Drain local abscesses

Evaluate for osteomyelitis
- Exposed bone is present
- The bone feels rough or soft
- Ulcer has failed to heal with prior therapy
- If osteomyelitis is suspected, obtain a tissue and/or a bone biopsy

Topical Therapy

Select a wound dressing based on the:
- Ability to keep the wound bed moist
- Need to address bacterial bioburden
- Nature & volume of wound exudate
- Condition of the tissue in the ulcer bed
- Condition of periwound skin
- Ulcer size, depth & location
- Presence of tunneling and/or undermining
- Goals of the individual with the ulcer – including comfort, cost, ease of application & availability

Dressing Principles

- Manage excess wound drainage with absorptive dressings
- Maintain moist wound environment
- Hydrate dry ulcers, e.g., with hydrogel dressings, except in case of a stable ischemic heel eschar
- Fill ulcer cavities to reduce dead space
- Provide thermal insulation and ulcer temperature stability
- Protect periwound skin

Dressing Changes

- Monitor dressing site at least daily
- Assess wounds at every wound dressing change & confirm the appropriateness of the current dressing regimen
- Determine whether modifications are needed as the wound heals or deteriorates
- Change frequency based on assessment of patient, ulcer status, dressing condition, & manufacturer recommendations

Topical Antimicrobials

cadexomer iodine (Iodosorb/Iodoflex)
- Iodine contained in a cadexomer starch bead; wound exudate triggers slow release of iodine
- Broad spectrum antimicrobial
- Reduces biofilm
- Contraindications – allergy to iodine or shellfish, dry wound without exudate, with collagenase (inactivates the collagenase)
Topical Antimicrobials

**Medical-grade honey**
- Gamma radiation sterilization retains biologic activity
- Broad-spectrum - 50 species of bacteria, virus, fungi, protozoa
- Anti-inflammatory
- Osmotic effect dehydrates bacteria
- Promotes moist wound healing and autolytic debridement
- May produce mild, transient stinging
- Contraindications – honey allergy (no reported anaphylaxis with bee-sting allergy)

(Bernard, 2015; NPUAP, 2014; Weir & Schultz, 2016)

**Silver sulfadiazine - Silvadene [Rx]**
- Broad-spectrum antimicrobial
- Disadvantages – short period of action, poor eschar penetration, difficult removal
- Apply twice a day
- Contraindications – allergy [sulf], with collagenase (inactivates the collagenase)

(NPUAP, 2014; Weir & Schultz, 2016)

**Double antibiotic (Polysporin)**
- Polymyxin B sulfate
  - Gram-negative organisms
- Bacitracin
  - Gram-positive organisms

**Triple antibiotic (Neosporin, Gold Bond First Aid)**
- Polymyxin B sulfate, bacitracin, neomycin
- Sensitivity reactions – up to 6% of population
- Application to large open areas – systemic toxicity

(Bernard, 2015)

Topical Medications

**Balsam of Peru, Trypsin, Castor Oil Ointment (BIC ointment)(Venelex)(Rx)**
- Balsam Peru - capillary bed stimulant, mildly bactericidal action
- Castor Oil - improves epithelialization, protective covering, aids in the reduction of pain
- Trypsin removed due to unsubstantiated claim of enzymatic debriding agent
- Apply thin film at least twice a day
- Locations difficult to apply dressing, DTI, extravasation injuries
- Precaution – do not apply to a fresh arterial clot

Adjunctive Therapy-PI

**Negative pressure wound therapy**
- Electrical stimulation

- Recombinant Platelet-Derived Growth Factor
- Pulsed electromagnetic field (PEMF) treatment
- Pulsed radio frequency energy (PRFE)
- Pulsed lavage with suction

- Biological dressings
  - Other growth factors
  - Phototherapy: Laser, Infrared and Ultraviolet
  - Acoustic Energy (Ultrasound)
  - Whirlpool
  - Vibration therapy
  - Hyperbaric oxygen
  - Topical oxygen therapy

(AAPC, 2015; NPUAP, 2014; Queen, et al, 2015; WOCN, 2014)

Complementary Therapies

**Aloe vera**
- Contains Vitamins A, B, C, E

**Datura metel**

**Calendula officinalis**
- Reported anti-inflammatory & antibacterial properties
- May enhance anti-oxidant defense mechanisms

**Garcinia morella**

**Tea tree oil**
- Safe topically, should not be ingested
- Anti-inflammatory
Adjunctive Therapy - LEAD

Level of Evidence – B
- Low frequency ultrasound
- Hyperbaric Oxygen (HBO)
- Arterial flow augmentation (intermittent pneumatic compression)

Level of Evidence – C
- Electrotherapy
- Topical Negative Pressure – wounds with infected vascular grafts

Adjunctive Therapy - LEVD

Biophysical interventions
- Electrical stimulation
- Vacuum (negative pressure wound therapy) has limited evidence for preparing VU for autologous pinch grafting or in VU graft management
- Warming
- Electromagnetic/radiofrequency (RF) stimulation
- Laser, including infrared (IR) stimulation & monochromatic light stimulation
- Hyperbaric oxygen
- Ultrasound stimulation

Vein procedures
- Endovenous Thermal Ablation - recommended over surgery for incompetent saphenous vein
- Sclerotherapy of Varicose Veins [per AAWC, requires more evidence].
- Treatment of Perforating Veins
- Minimally invasive subfascial endoscopic perforating vein surgery (SEPS)
- Selective treatment of incompetent perforating veins in patients with simple varicose veins (CEAP class C2) is not recommended.
- Open venous surgery

Adjunctive Therapy - DFU

- Negative Pressure Wound Therapy*
- Hyperbaric oxygen*
  - patients with Wagner Grade 3 or DFUs that have not shown significant improvement after 30 days of treatment (UMHS)
  - In patients with Wagner Grade 3 or higher DFUs who have just had a surgical debridement of an infected foot

Consider
- Bioengineered skin equivalents
- Growth factors*
- Granulocyte colony-stimulating factors*

*not supported by IDSA

Patient/Caregiver Engagement

- Etiology of wound
- Risk factors, risk reduction, disease management (including glycemic control)
- Principles of wound healing
- Nutritional support
- Appropriate skin & wound care - inspection, cleansing, dressing application & frequency
- Complications to observe for & report to provider
References