Prevention and Management of Acute and Chronic Wounds

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Clinical Practice Guidelines

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PURPOSE AND USE OF THESE GUIDELINES

The Bureau of Prisons (BOP) Clinical Practice Guidelines for the *Prevention and Management of Acute and Chronic Wounds* reflect the collaborative work of a multidisciplinary taskforce including dietitians, midlevel providers, nurses, pharmacists, physical therapists, and physicians, as well as health care professionals with advanced certification in wound care.

- **This document provides guidance on the prevention and treatment of common types of wounds,** including pressure ulcers, diabetic foot ulcers, venous insufficiency ulcers, and arterial insufficiency ulcers.
  - ***It is not intended to provide guidance about all types of wounds or skin ulcerations.*** Instead, guidance regarding timely consultation is provided.
  - ***It is also not intended for the management of acute traumatic wounds***, such as crush injuries, or skin lesions that are primarily dermatologic in nature, e.g., rashes, MRSA lesions, and hidradenitis suppurativa (HS).
- **The focus of these guidelines is to optimize treatment outcomes in the correctional environment**. The algorithm that is provided to help practitioners meet these goals is organized around the concept of "basic supportive wound care"—a phrase coined by the group to encompass the principles that best support the body to heal itself. *The algorithm is not intended to replace a thorough evaluation of the patient's health care history and needs.*
- **Guidance regarding durable medical equipment (DME)**, consultation, and referral is included.
- **Terminology:**
  - Although the term *antimicrobial* is used in wound care to identify topical agents that are not antibiotics, for the sake of clarity, these guidelines use the term *antiseptic*.
  - *Eschar* is a term normally used for dry necrotic tissue of various colors. In these guidelines, however, the phrase *dry necrotic tissue* is used in lieu of this term. *Slough* is a term normally used for moist yellow necrotic tissue, which is more amenable than *dry necrotic tissue* to various forms of debridement.

BASIC SUPPORTIVE WOUND CARE ALGORITHM

Patient Presents with Wound

STEP 1

A. Perform a *Basic Initial Wound Assessment*:

- Wound History
- Wound Assessment
- Basic Vascular Exam for Wounds on Lower Extremities

➜ ***See TABLES 1.1 –1.3***

B. Identify type of wound:

For common wound types, see Table 2 and the specific sections on:

- *Pressure Ulcerations*
- *Arterial Insufficiency*
- *Venous Insufficiency*
- *Neuropathic Disease* (*diabetic foot ulcers*)

STEP 2

A. Alleviate the mechanism of injury for identified wound type.

➜ ***See TABLE 2***

B. Establish treatment plan and healing goal based on the wound bed color(s).

➜ ***See TABLE 3***

Meets 2-wk goal

STEP 3

Evaluate 2-week healing goal:

- Re-assess wound.

  ➜***See TABLE 1.2***

- 25% slough or size reduction goal met?

  ➜ ***See TABLE 4***

Does NOT meet 2-wk goal

STEP 4

Review wounds not meeting healing goals:

- Wound type/mechanism of injury and basic interventions
- Patient adherence to basic interventions
- Consider empiric treatment with topical antiseptics with low cytotoxic profiles for critical colonization

  ➜ ***See TABLE 5***

- Consider additional diagnostic studies:
  - Biopsy for tissue culture and/or pathology
  - Serum ESR/CRP & imaging if suspect osteomyelitis
  - Vascular study/consult if suspect arterial disease
- Consider consultation with wound care specialist and Registered Dietitian if healing goals not met after 4 weeks.

IMPORTANT NOTE:

➜ ***Consider prompt referral for pressure ulcers that present with cellulitis.***

➜ ***Consider immediate referral for any foot or toe wound that presents with cellulitis, abscess, gangrene, or deep ulceration.***

TABLES FOR BASIC WOUND CARE ALGORITHM

TABLE 1.1: WOUND HISTORY	
Onset	When did it first occur? Is it recurrent? What is the patient's description of the cause of the wound?
Prior Treatment and Diagnostic Work	Dressings? Antibiotic use? Offloading or prevention strategies to alleviate mechanism of injury? Diagnostic tests? Previous consultations/referrals?
Past Pain	Past pain and pain level related to the wound(s)? Interventions tried for relief? Effectiveness of interventions?

TABLE 1.2: WOUND ASSESSMENT	
Parameters	**Descriptors**
Location	Anatomical site

Size/Volume	***L x W x D (cm)*** (L x W for wounds without depth)
	Always measure in centimeters (cm) the longest measure for each axis:
	• ***Length:*** 12–6 o'clock measure in cm
	• ***Width:*** 9–3 o'clock measure in cm
	• ***Depth:*** deepest point in cm
	  • If no depth, document "no appreciable depth."
	  • If wound covered with slough/dry necrotic tissue, document as "indeterminate."
	  • Note any tunneling or undermining.

Wound Bed	Estimate percentage of colors (e.g., black, brown, yellow, grey, red, green).
Drainage	• Amount (none, scant, moderate, or copious) • Color • Odor (none, mild, moderate, or strong). • Moisture balance (surrounding skin is not wet; dressing is not adhered to wound bed). Is the drainage well contained by the dressing?
Surrounding Skin	• Intact or not intact? Color? Is there a palpable temperature change? • How does it feel to palpation: supple (normal), soft (fluctuant), or hard (indurated)? Does it blanch?
Current Pain	Location, scale, quality, qualities, onset, duration, exacerbating/relieving factors, comments

Barriers to Healing	***Intrinsic:***
	  • Ability to comprehend and understand instructions
	  • Any physical limitations or mobility issues that may affect healing
	  • Willingness to be an active participant in care and treatment
	Extrinsic:
	  • Equipment not available
	  • Institution specific limitations: building, housing, terrain challenges
	  • Correctional/security challenges

***For more details**, see discussion of Wound Assessment under Step 1A.*	

TABLE 1.3: BASIC VASCULAR EXAM FOR WOUNDS ON THE LOWER EXTREMITIES		
Appearance of Skin	• Color/discoloration • Edema	• Distribution of hair
Vascular Assessment	• Skin temperature • Capillary refill (in seconds) • Palpation of dorsalis pedis and post-tibial pulses	• Presence of dependent rubor • Pallor elevation test
***For more details**, see discussion of Basic Vascular Exam under Step 1A.*		

TABLE 2: WOUND TYPE AND MECHANISM OF INJURY		
Wound Type	**Mechanism of Injury**	**Basic Interventions**
Pressure Ulcerations	Pressure over ulceration	Offload or limit pressure over the area around the ulcer (sitting and/or lying). Sleep surface and wheelchair cushion must be in accordance with CMS criteria. Provide a shower cushion, when needed. ★ If cellulitis present, consider prompt referral for treatment. ★ If ulcer tunnels near the bone, review *STEP 4* of algorithm: Suspect osteomyelitis.
Arterial Insufficiency	Decreased arterial blood flow in limb	Limit constriction and elevation of affected area. Keep warm and protect from injury (e.g., thick socks, extra layer of clothing). External heating devices are not recommended due to potential for burns. Provide padding over the ulcer (e.g., extra layers of gauze). ★ If ulcers are on toes or heels, may need a wheelchair and wound shoe to offload wounds. ➔ *If cellulitis, abscess, gangrene, or deep ulceration is present, consider immediate referral for treatment and amputation prevention.*
Venous Insufficiency	Venous congestion/edema	*Short term*, consider elasticated tubular bandage size F (e.g., Medigrip™ or Tubigrip™); use ACE wraps and TED hose if no other alternatives are available or acceptable to the patient. Ambulate to tolerance. ★ Consider consultation (e.g., with physical therapist; wound or vascular specialist) for safe, *long-term* compression.
Neuropathic Disease (*diabetic foot ulcers*)	Change in foot sensation and/or structure (poor fitting footwear)	Maintain good glycemic control. Recommend limited weight bearing on affected foot; may need a wheelchair and wound-healing shoe (not the same as a diabetic shoe) to offload wounds. Callous debridement by qualified provider may be needed. Once resolved, recommend medical footwear and foot care for life. ➔ *If cellulitis, abscess, gangrene, or deep ulceration is present, consider immediate referral for treatment and amputation prevention.*
Skin Infection	MRSA or other infections	See the BOP Clinical Practice Guidelines for *Management of MRSA Infections* and for *Antimicrobial Stewardship Guidance*. If there is a residual wound after treatment of the infection, then follow the *Basic Supportive Wound Care Algorithm* in conjunction with these guidelines.
KEY: ★ = critical decision points; ➔ = potential life or limb threatening issue		
For more in-depth review of interventions *to alleviate specific mechanisms of injury, see the sections under Common Wound Types which provide more detailed discussions.*		

TABLE 3: WOUND COLOR, GOALS, AND TREATMENT FOR HEALING A WOUND

Wound Bed Color*	2-Week Healing Goal	Treatment**
Mostly black tissue	Discuss therapy goal with provider: *healing* vs. *stabilization*	***Healing*** = see "mostly mixed colors" in next row below ***Stabilization*** = Povidone-Iodine and gauze 1–2 times/day. ★ See *General Therapy Goals: Healing, Stabilization, and Palliation* in Section 2 under *General Concepts*. ★ If black tissue on heels or toes, see *caution with black heels and toes* under STEP 2B discussion. ★ For alternatives to iodine, see section on *Use of Topical Antiseptics*. ➔ *If signs of cellulitis on foot or toes, consider immediate referral.*
Mostly mixed colors: red/pink/yellow/brown/ black	25% reduction in yellow slough	Rinse with normal saline (NS), and apply NS-moistened gauze to wound. Cover with gauze and/or ABD, secure with tape OR consider collagenase (Santyl®) 1–2 times a day, nickel thickness to entire wound. ★ If yellow/ brown/black tissue is dry, consider removing the dry roof or cross-hatching—by qualified provider—to optimize therapy. See the description of *conservative sharp debridement*. ★ Healing goals are not calculated until most of the dry yellow/brown/black tissue is removed.
Mostly red or pink	25% reduction in size	Rinse with normal saline (NS), and apply NS-moistened, gauze to wound. Cover with gauze and/or ABD, secure with tape
Healed/intact skin	Remains healed x 2 weeks	Protect the wound bed and apply OTC topical moisturizer if dry. ★ Continue interventions used to alleviate mechanism of injury and consider long-term interventions for mechanism of injury.

KEY: ★ = critical decision points; ➔ = potential life or limb threatening issue

* ***For a more in-depth review and examples****, see discussion under STEP 2B: Establish Treatment Plan and Healing Goal, Based on the Wound Bed Color(s).*

** ***Unless otherwise indicated, dressings are to be changed daily or less often.*** *At each dressing change, the wound is assessed for moisture balance and containment of drainage. Moisture balance is adjusted by adding or subtracting the amount of saline used when applying the dressing. If moisture balance is difficult to establish with normal saline and gauze, consider using an alternative dressing type listed in Appendix 2, Basic Dressing Types. Notify the provider if unable to establish good moisture balance. For a more thorough discussion, see Key Principles of Topical Therapy under STEP 2B.*

TABLE 4: ASSESSMENT OF 2-WEEK HEALING GOAL
Wound Re-assessment Criteria
See *Table 1.2* for criteria.
Percentage of Slough Reduction
Only for yellow slough: = 1 – (current % wound slough/previous % wound slough) = % slough reduction = %
Percentage Size Reduction Calculation
1 – (new size/previous size) = % size reduction *Note that there are some minor differences for the following:* • Wound without depth • Wound with depth • Comparing a wound which previously had measurable depth and now does not
***For examples** of slough reduction and size reduction calculations, see Step 3: Evaluate 2-Week Healing Goal.*

TABLE 5: TOPICAL ANTISEPTICS WITH LOW CYTOTOXIC PROFILES FOR EMPIRIC TREATMENT OF CRITICAL COLONIZATION		
Agent	**Frequency**	**Special Instructions**
Silvadene® 1% cream (silver sulfadiazine)	2–3 times a day	Nickel thickness to entire wound; avoid letting cream dry out. ➜ *Caution if patient has sulfa allergy.*
Iodasorb® gel 0.9% ointment (cadexomer iodine)	daily to every 3 days	Nickel thickness to entire wound; changes color as it absorbs drainage. Light yellow signals time to change. *Caution: Color change should not be confused for pus.* ***Dose limit:*** 50g per application or 150 g per week. ➜ *Caution if patient has iodine allergy.* ➜ *Contraindicated for patients with thyroid disorders, and for pregnant or breastfeeding patients*
0.25% acetic acid solution (1/4 strength acetic acid)	1–2 times a day	Deliver on moistened gauze and adjust dressing for moisture balance (not too wet, not too dry). ➜ *Undiluted solution can cause serious acid-related injury to tissue and bone.*
KEY: ➜ = potential life or limb threatening issue		
Treat with one of the above antiseptics for two weeks. *If healing goals are met, then return to basic treatment listed in Table 3. If no improvement, consider a different agent listed above in this table.* ***For more in-depth review**, see Use of Antibiotics for Wound Care: Topical and Systemic and Use of Topical Antiseptics.*		

STEPS 1–4 OF BASIC WOUND CARE ALGORITHM

STEP 1A: PERFORM A BASIC INITIAL WOUND ASSESSMENT.

When performing the initial evaluation of a wound, conduct (1) a wound history and (2) a wound assessment. If the wound is located on the lower extremity, also perform a (3) basic vascular exam for wounds on lower extremities.

WOUND HISTORY

Determine from the patient the onset, prior treatments and diagnostic studies, and a review of past pain related to the wound.

➜ *See TABLE 1.1 for more details.*

WOUND ASSESSMENT

➜ *The following discussion is summarized in TABLE 1.2.*

1. **Location**: Describe the portion of the body affected. Be clear and concise.

2. **Size/Volume:** Determine the *length* x *width* x *depth* (L x W x D) in centimeters.

   There are a variety of methods to measure the size or volume of a wound. The key is to use the same pattern of measurement to evaluate wound size so that comparisons over time are valid.

   - ***The ruler method*** is simple and available in almost all health care settings. The wound is visualized as a clock, with 12 o'clock oriented towards the patient's head and 6 o'clock oriented towards the patient's feet. *Length* is measured first, from 12 to 6 o'clock. *Width* is measured next, from 9 to 3 o'clock. *Depth* is then measured from the deepest point of the wound upward to the wound edge. The gentle use of a cotton-tipped applicator can be helpful in measuring depth.

     ➜ If the wound bed contains yellow, brown, or black tissue, then depth cannot be determined and should be labeled as "indeterminate."

   - ***A tunnel or area of undermining*** is also measured using the clock method:

     ► A *tunnel* is a narrow channel that extends from the edge of the wound into the tissue laterally. For instance, picturing the wound as a clock with 12 o'clock oriented towards the patient's head, a tunnel at 2 o'clock that extends 3 cm would be documented as "tunneling, 3 cm at 2 o'clock." A wound can have multiple tunnels.

     ► *Undermining*, when a section of tissue is missing under the edge of the wound, is identified by the starting and ending points, and measured where the undermining extends the farthest. For example, a section of missing tissue that starts at 4 o'clock and ends at 8 o'clock, and is 2.3 cm at its furthest measurement, would be documented as "undermining from 4 to 8 o'clock, 2.3 cm. A wound can have multiple areas of undermining.

3. **Wound Bed:** Describe the wound bed colors in percentages. Estimation is acceptable. For instance, a wound that is all red would be documented as "100% red." A wound with multiple colors might be documented, for example, as "50% red, 30% yellow, and 20% brown."

4. **Drainage:** Describe the *amount* of drainage (none, scant, moderate, or copious), *color*, and the presence of *odor* (none, mild, moderate, or strong). Also document if there is good *moisture balance*; in other words, determine if the wound is not too dry or too wet. A wound is too dry when the dressing adheres to the wound bed. A wound is too wet when drainage makes the surrounding skin wet and fragile, otherwise known as *maceration*. If moisture balance is difficult to establish with normal saline and gauze, consider using an alternative dressing type listed in *Appendix 2*, *Basic Dressing Types*.

   Note: *The drainage amount, color, and odor can indicate increased numbers of microorganisms living on the wound bed (referred to as critical colonization), but these parameters alone are not diagnostic.* ***The failure to meet healing goals should be the primary reason to select topical antiseptic treatment for critical colonization.*** *Initial antiseptic treatment options are listed in TABLE 5. Additional antiseptic treatment options are listed in Use of Topical Antiseptics.*

5. **Surrounding Skin:** The condition of the surrounding skin up to 5 cm from the edge of the wound is important to evaluate. Assessment features include whether or not the skin is *intact*, the *color*, palpable *temperature change*, and *palpable feel* such as normal (supple), soft (fluctuant), or hard (indurated).

   It is normal to find a 1 cm or less band of discolored, warmer, indurated tissue around the wound. It often indicates increased blood flow to support the body's efforts to autolytically debride any black tissue or yellow slough, and to support granulation tissue formation. A band wider than 1 cm may indicate cellulitis. A white blood count is helpful to differentiate between cellulitis and an appropriate, localized inflammatory response.

   Note: *In wounds caused by venous insufficiency, the band of erythema is often much wider than 1 cm. Most often, this is associated with the exaggerated cutaneous inflammatory response common to these types of wounds. A white blood count is especially helpful in differentiating this condition from cellulitis.*

6. **Current Pain:** It is important to evaluate and document a snapshot of the patient's pain associated with the wound over the last 2 weeks. Assessment characteristics are aligned with those found in the Bureau Electronic Medical Record (BEMR), and summarized in *TABLE 1.2*. Proper assessment and subsequent interventions to control pain is an integral part of wound care.

   - ***Consequences of Uncontrolled Pain:*** Pain can significantly affect a patient's quality of life, sleep cycle, and psychosocial status. In addition, inadequately treated acute pain can lead to the development of chronic disabling neuropathic pain.

     Inadequate treatment of pain can also lead to poor wound healing and increased infection rates. Acute pain increases catecholamine release, and leads to peripheral vasoconstriction and decreased perfusion of blood to the affected area. The decrease

in available oxygen inhibits the oxidative bactericidal effectiveness of white blood cells to maintain a clean wound bed, as well as disrupting the activity of fibroblasts in producing tissue and new blood vessels.

- ***Recommendations:*** The patient's experience of pain and management strategies should be reviewed at each 2-week re-assessment, and on an as-needed basis. This review should include the patient's day-to-day experience of pain from the wound, as well as the patient's episodic pain related to treatments and any chronic neuropathic pain. Reasonable attempts should be made to minimize these different types of pain.

7. **Barriers to Healing:** Barriers can be *real* or *perceived*, as well as *intrinsic* (related to the patient) or *extrinsic* (related to the patient's environment). In developing a plan of care for the patient, the goals are to ensure the feasibility of the plan and to secure a reasonable expectation of compliance from the patient. A review of both intrinsic and extrinsic barriers helps to helps to clarify the expectations that the staff has for the patient, and vice versa. For example, a staff person's goal for a patient may be to keep the dressing dry during showers by having the patient securely wrap a plastic bag around the affected leg. Conversely, the patient's expectation may be that the staff person is able to find plastic bags large enough to fit over that portion of his or her leg. This review and negotiation process is critical to the success of the plan of care.

   In some cases, patients are unwilling or unable to negotiate ways to overcome barriers to healing. Ultimately, if a patient's actions are repeatedly negligent of the plan of care, then the expectation to heal is negated by their own actions. In such cases—which require thorough documentation of the circumstances—it is often more realistic to consider stabilization, not healing, as an appropriate therapy goal. For a more in-depth review of healing versus stabilization, see *General Therapy Goals: Healing, Stabilization, and Palliation*.

BASIC VASCULAR EXAM FOR WOUNDS ON THE LOWER EXTREMITIES

➔ *The following discussion is summarized in TABLE 1.3.*

A basic vascular exam should be performed for all wounds on the lower extremity, including:

1. **Appearance of the Skin:** Color of the limb and presence of any discoloration, the presence or absence of edema, and the distribution of hair on the limb.

2. **Vascular Assessment:** Palpation of skin temperature, capillary refill (in seconds), and the dorsalis pedis and post-tibial pulses. In addition, examination for the presence of *dependent rubor* and the *pallor (paleness) elevation test* can give additional indications of the presence of any compromised arterial blood.

   - ***Dependent rubor:*** The presence of a purplish-red discoloration in one or both legs is caused by the retention of deoxygenated blood in the dilated skin capillaries of a patient with arterial disease. To differentiate from cellulitis or other mechanisms, have the patient lie in a supine position and elevate the leg approximately 60 degrees. If the discoloration fades, the most likely mechanism is dependent rubor.

- ***Pallor elevation test:*** With the patient in the supine position, elevate the affected leg approximately 60 degrees. Note the color of the soles of the foot, as indicated in the table below.

Pallor developing within…	Indicates…
25 seconds	Severe arterial disease
25–40 seconds	Moderate arterial disease
40–60 seconds	Mild arterial disease
60 seconds	No arterial disease

STEP1B: IDENTIFY THE TYPE OF WOUND.

Identifying the underlying cause of the wound is the most crucial step in determining appropriate management.

➜ *TABLE 2 summarizes wound types and mechanisms of injury. For more in-depth information, see the following sections under Common Wound Types:*

- *Pressure ulcerations*
- *Arterial insufficiency wounds*
- *Venous insufficiency wounds*
- *Neuropathic disease (diabetic foot ulcers)*

For surgical wounds left open to heal by secondary intention, the surgeon will usually prescribe the desired therapy. If the surgeon does not prescribe therapy, then the *Basic Supportive Wound Care Algorithm* is appropriate for treatment. For MRSA soft tissue infections, initiate treatment using the BOP Clinical Practice Guidelines on *Management of Methicillin-Resistant Staphylococcus aureus (MRSA) Infections*. If there is a wound that is associated with the MRSA infection, then also consider using the *Basic Supportive Wound Care Algorithm* for topical treatment.

For other wound types not covered by the algorithm, it is helpful to compile a list of differential diagnoses to determine if there are specific mechanisms of injury that must be alleviated such as vasculitis or sickle cell anemia. Those more complex wounds are beyond the scope of these guidelines, and providers may need to consult specialists in wound care or other specialists to assist in diagnosis and management. In most cases, the algorithm can still be used to select treatment and healing goals.

STEP 2A: ALLEVIATE THE MECHANISM OF INJURY FOR THE WOUND TYPE.

Alleviation of the underlying mechanism of injury for the identified wound type(s) is the foundation for treatment. A plan which does not include this principle is likely to fail, no matter the level and expense of the therapy applied. The injuries causing most types of common wounds are often reversible within the clinic and housing unit settings—through selected interventions and/or the use of specialty durable medical equipment (DME) issued by health services.

➜ *See TABLE 2 for a summary of the most common wound types, their mechanisms of injury, and initial interventions (including DME).*

➜ *For additional strategies to alleviate mechanisms of injury, see the sections for each of the wound types under Common Wound Types.*

STEP 2B: ESTABLISH TREATMENT PLAN AND HEALING GOAL BASED ON THE WOUND BED COLOR(S).

The color of the wound bed is used to estimate the stage of healing, as well as to determine the appropriate treatment and healing goal.

➜ *TABLE 3 provides a summary of the information below.*

KEY PRINCIPLES OF TOPICAL THERAPY

- ***For most wounds, using saline-moistened gauze*** to provide moisture to the wound is appropriate for initial therapy. *This approach, commonly termed a moist saline dressing, is not the same as wet-to-dry dressings.*

- ***Establish good moisture balance.*** Specifically, this means *not too dry* (dressing adheres to the wound bed) and *not too wet* (moisture gets on the skin around the wound and causes maceration). Everything in between is good moisture balance.

  Good moisture balance allows the body to use the moist environment (1) to form granulation tissue and new skin in a pink/red wound, or (2) to remove the necrotic tissue, through a natural process called *autolytic debridement*, in a yellow/brown/black wound. A dry wound environment inhibits these natural processes. Adjusting for a wound that does not have good moisture balance (i.e., is too dry or too wet), involves modifying the number of layers of saline gauze, dry gauze, and cover dressings. Some moisture should always be added to a wound where healing is the therapy goal. If moisture balance is difficult to establish with normal saline and gauze, consider using an alternative dressing type listed in *Appendix 2, Basic Dressing Types.*

  ➜ ***It is recommended that the practitioner add the following to the dressing change order in NMOS (Non-Medication Order System):*** *"Moist saline dressing [desired frequency]. Assess moisture balance with each dressing change and add/subtract saline as needed. Notify practitioner if unable to establish good moisture balance."*

- ***Limit the interruption of the healing process.*** As noted in *TABLE 3*, daily or less frequent dressing changes are recommended if good moisture balance is established. *Frequent wound*

cleansing and dressing changes interrupt the body's natural healing processes and can delay healing. An inability to establish good moisture balance with daily or less frequent dressing changes is a strong indication that either the mechanism of injury is not adequately addressed or there is an additional problem. Delivery of topical antiseptics or pharmaceuticals such as Santyl® is one reason to increase the frequency of the dressing change.

- ***Limit exposure to potentially cytotoxic antiseptics.*** Although the application of strong antiseptic agents such as povidone-iodine, Hibiclens®, Dakin's solution, or hydrogen peroxide to try to "clean out" the wound is still common, it is most likely harmful. These agents are believed to be toxic to many of the cells involved in healing from the moment of injury. Therefore these agents should be reserved for patients with wounds where stabilization, not healing, is the goal of therapy. For a more complete review of this topic see *General Therapy Goals: Healing, Stabilization, and Palliation* and *Use of Topical Antiseptics*.

  If there is concern over the status of the patient's immune system, then effective antiseptics with lower cytotoxic profiles can be considered. For further guidance see *TABLE* 5. Additional topical antiseptics are listed in *Use of Topical Antiseptics*.

  ➜ Topical or systemic antibiotics should be limited to wounds with objective signs of cellulitis and on a case-by-case basis.

THERAPY AND HEALING GOALS BASED ON WOUND BED COLOR

The sections below provide guidance based on wound bed color—including a review of the critical decision points and life/limb threatening situations identified in the algorithm tables.

- ***Therapy goals:*** Although the therapy goal for most patients with wounds is healing, there are circumstances in which either stabilization or even palliation is the goal of the plan of care. For more detailed discussions, see *General Therapy Goals: Healing, Stabilization, and Palliation*.
- ***Healing goals:*** Just as a blood pressure is monitored when medications are changed, healing goals should be monitored to evaluate the effectiveness of therapy. Healing goals depend on a number of factors, including the age of the wound, the adherence of the patient to the plan of care, and the ability of the patient's body to heal the wound. Wound bed color is used to determine the appropriate 2-week healing goal. Two measures are used to assess healing goals: size or slough reduction by 25% in 2 weeks, as shown in *TABLE 3*.

BLACK WOUNDS

Black wounds are those where the wound bed is completely covered by black/brown necrotic tissue or foreign debris. The presence of necrotic tissue indicates that the wound is in the inflammatory stage of healing. Common causes include inadequate blood flow and injury from pressure where the blood supply was temporarily interrupted. Therefore, in the case of black wounds, the therapy goal may be any of the following: healing, stabilization, or palliation.

➜ *For a more complete discussion of healing vs. stabilization, see General Therapy Goals: Healing, Stabilization, and Palliation.*

- ***If there are signs of cellulitis around black wounds on the foot or toes***, consider an immediate referral, as prompt referral may decrease the risk for amputation. If the patient has limited blood flow, they will be unlikely to mount a normal inflammatory response. In addition, the limited blood flow makes it unlikely that oral antibiotics will be able to adequately manage any cellulitis. Therefore, if cellulitis develops, it may indicate a serious situation.
- ***If the provider believes that blood flow to the ulcerated area is adequate for healing***, then removal of the necrotic tissue is necessary before healing can occur. If healing is selected as the goal, then use the *Healing Goal for Mixed Color Wounds* in the next section.
- ***If the provider is uncertain that blood flow to the ulcerated area is adequate for healing***, then *stabilization* is the goal until an arterial blood flow study can be obtained. During stabilization, the concern over cytotoxicity of cells involved in healing is low, and antiseptics with higher cytotoxic profiles should be considered. The preferred treatment is for povidone-iodine to be applied to the black tissue 1–2 times a day, which will help to keep the bacterial presence low and the black tissue dry. If there is an allergy to povidone-iodine, select an alternative antiseptic with higher cytotoxic profiles used for stabilization, as listed in *Use of Topical Antiseptics*. If the arterial study confirms adequacy of arterial blood flow, then follow the recommendations in *Healing Goal for Mixed Color Wounds* in the next section. If the arterial study confirms that arterial blood flow is inadequate, and the ulcer is without signs of cellulitis, then a wound care consultation is recommended.
- ***Caution with black heels and toes:*** A wound that is mostly covered by a dry, black tissue on the heels or toes is likely to be related to severely compromised arterial blood flow. *Debridement is cautioned without consultation with a specialist.* In addition to the recommendations listed above, careful protection of these areas is necessary to stop further injury to this compromised tissue. If the black tissue on the toes is extensive, then consider using a foot cradle to keep sheets and blankets off the toes, as well as special footwear for use during the day such as vascular boots or wound-healing shoes. In addition, it is critical to provide materials and instruction to elevate the heels off the bed, whether or not black tissue is present on the heels.

MOSTLY MIXED COLOR WOUNDS: RED/PINK/YELLOW/BROWN/BLACK

HEALING GOAL FOR MIXED COLOR WOUNDS: Slough Reduction of 25% in 2 Weeks

Goals cannot be calculated until most of the dry yellow, brown, or black necrotic tissue is removed. Goals can be calculated once slough, which has a moist yellow appearance, is the predominant tissue. See STEP 3 for example calculations.

The presence of necrotic tissue indicates the wound is in the inflammatory or clean-up stage of healing. Here, the wound bed is partially or completely covered by, necrotic tissue. This tissue must be debrided to establish a clean wound bed for granulation tissue and new skin formation. The necrotic tissue may be dry or moist, and either yellow, brown, black, or a mixture of these colors.

Signs and symptoms of a localized inflammatory response are normal—including pain and redness, warmth, and induration up to 1 cm around the wound—and are often more exaggerated around wounds caused by venous insufficiency. This more localized response is part of the body's attempt to resolve the necrotic tissue through a process of autolytic debridement. A white blood count is helpful to differentiate cellulitis from a normal inflammatory response.

Following is a discussion of debridement methods:

- ***Autolytic debridement (self-debridement):*** The body will try to autolytically debride the slough by sending white blood cells (WBCs) to the wound bed to phagocytize (eat) the necrotic tissue. This occurs optimally in a moist wound environment (optimal moisture balance) where the dry yellow/brown/black tissue is removed or cross-hatched. When WBCs "bite off" pieces of necrotic tissue, the combination forms a pus-like drainage. Conservative sharp debridement by a qualified provider (see the box below) should be considered, especially if there is dry necrotic tissue.

  ➔ *Avoid antiseptics with higher cytotoxic profile—such as povidone-iodine, Dakin's solution, Hibiclens, and hydrogen peroxide—as they may also destroy the WBCs and fibroblasts on which autolytic debridement and healing depends. A moist wound environment is best.*

- ***Chemical debridement:*** Collagenase (Santyl)—a pharmaceutical enzymatic debridement ointment that selectively digests the collagen holding the necrotic tissue onto healthy tissue—can also be used. Collagenase is normally used 1–2 times a day. Solutions or dressings that contain acid (e.g., quarter-strength acetic acid) or metal ions (e.g., silver-containing compounds) adversely affect the enzymatic activity of collagenase and eliminate the debridement action. Conservative sharp debridement by a qualified provider (see the box below) should be considered, especially if there is dry necrotic tissue.

- ***Conservative sharp debridement:*** Serial conservative sharp debridement can also speed the removal of necrotic tissue. *Qualified providers* are encouraged to undertake this procedure during each 2-week evaluation, or more frequently. Care should be taken to remove only necrotic tissue and not to cut into underlying healthy tissue, as described in the box below:

CONSERVATIVE SHARP DEBRIDEMENT

If the necrotic tissue is dry (regardless of color), cross-hatching or removal of the "dry roof" by a qualified provider is strongly encouraged as soon as possible to allow for moisture or the collagenase to reach the moist soft underlying slough. For unroofing, a clear line of demarcation between viable and necrotic tissue should be evident to ensure that the provider is not inadvertently cutting into viable, healthy tissue. If a clear demarcation is not visible, then consider starting with cross-hatching. To do this, score the surface of the dry necrotic tissue with a blade. Start shallow and increase the depth of the cuts to expose moist necrotic tissue. Multiple scorings are helpful.

- ***Mechanical debridement:*** This form of debridement is discouraged in the clinic setting as it is non-selective in terms of the tissue removed and often painful. Its most common form is wet-to-dry dressings where the dressings are intended to stick to the wound bed

and pull off necrotic tissue and debris when removed. This is often confused with moist-to-moist saline dressings that support autolytic debridement, granulation tissue, and new skin formation.

RED OR PINK WOUNDS

HEALING GOAL FOR RED/PINK WOUNDS: Size Reduction of 25% in 2 Weeks

See STEP 3 for example calculations.

A wound bed which is mostly red or pink tissue indicates the end of the inflammatory or clean-up stage of healing. The body is already shifting into the "proliferative" phase of healing, where the wound edges will contract, the body will form new granulation tissue, and new skin will be formed. Signs and symptoms of a normal localized inflammatory response will start to resolve.

Treatment for Red/Pink Wounds

The goal of treatment continues to be to support the body's natural healing process. It cannot be stressed enough that this is extremely fragile tissue that can easily be damaged or destroyed. Alleviation of the mechanism of injury must be maintained. A moist wound environment best supports the growth of new tissue and skin. Dressing frequency should be minimized to allow time for the body to heal itself. The body has sent a large amount of very specific cells to the wound bed to heal itself, and dressing changes performed too frequently can slow this process. Drainage getting onto the surrounding skin and soaking through dressings, known as "strike through," indicates the appropriate time to change the dressing. Altering the amount of moisture applied to the wound and adjusting the amount of dry dressings used to cover the moist ones can decrease the need for dressing changes, but some moisture should always be applied to the wound bed. If moisture balance is difficult to establish with normal saline and gauze, consider using an alternative dressing type listed in *Appendix 2, Basic Dressing Types.*

Note: *Antiseptics with higher cytotoxic profiles, such as povidone-iodine, Hibiclens, Dakin's solution, and hydrogen peroxide should be avoided. If there is clinical evidence of critical colonization, antiseptics with low cytotoxic profiles may be considered. TABLE 5 lists antiseptics. See also the section on Colonized versus Infected Wounds.*

STEP 3: EVALUATE 2-WEEK HEALING GOAL.

A time frame of 2 weeks should be used for an evaluation of healing goals. Example calculations for two healing goals are shown below: *mixed color wounds* and *red or pink wounds*. If healing goals are met, then the provider should ensure ongoing alleviation of the mechanism of injury and select a new goal, based on the color of the wound bed (see *TABLE 3*). For wounds that do not meet healing goals, a re-evaluation of the plan of care is warranted (see *STEP 4* below).

HEALING GOAL FOR MIXED COLOR WOUNDS: SLOUGH REDUCTION OF 25% IN 2 WEEKS

Goals will not be able to be calculated until any dry yellow, brown, or black necrotic tissue is removed. *Goals can be calculated once slough, which has a moist yellow appearance, is the predominant tissue.*

HEALING GOAL = 1 – (current % of wound slough/previous % of wound slough) = % slough reduction

Example of a mixed pink/yellow wound:

If the previous wound bed assessment was 30% pink and 70% yellow, and after 2 weeks of therapy, the assessment was 50% pink and 50% yellow, the calculation is as follows:

STEP 1:
1 – (50% slough/70% slough) [divide 50 by 70]

STEP 2:
1 – (0.71) = 0.29 or 29% [remember that 1 is equal to 100%]

STEP 3:
Compare to healing goal. Healing goal of 25% slough reduction met.

HEALING GOAL FOR RED/PINK WOUNDS: SIZE REDUCTION OF 25% IN 2 WEEKS

➜ *The technique for measuring wound size/volume is reviewed under Wound Assessment (Step 1A).*

Since wounds rarely present as a perfect square or cube, using the ruler method, together with the equations for computing the area of a square or volume of a cube, does not reflect the absolute surface area or volume of a wound; however, it does provide a robust estimation and comparing these measurements over time does yield a sufficient calculation of the healing goal.

Several examples of comparing size reduction are reviewed below: ***(a)*** in a wound with no measurable depth, ***(b)*** in a wound with measurable depth, and ***(c)*** in a wound that previously had measurable depth and now does not.

HEALING GOAL = 1 – (current size/previous size) = % size reduction

(a) Example of a wound with no measurable depth:

If the previous wound bed measurement was 3 cm x 2 cm (no depth), and after 2 weeks of therapy the wound bed measurement is 2.5 cm x 1 cm, the calculation is as follows:

STEP 1: Calculate the surface area of the wound for previous and new measurements.

Equation for size (surface area): length x width = cm²

Example:
- Previous measurement was 3cm x 2 cm = 6 cm²
- New measurement is 2.5 x 1 cm = 2.5 cm²

STEP 2: Calculate percentage of size reduction.

Equation for size % reduction: 1 – (current surface area/previous surface area)

Example:
% size reduction = 1 – (2.5 cm^2/6cm^2) = 1 – (0.42) = 0.58 or 58% [remember: 1 = 100%]

STEP 3: Compare size reduction to healing goal.

Healing goal of 25% size reduction is met.

(b) Example of a wound with depth:

If the previous wound bed measurement was 4 cm x 3.5 cm x 3 cm, and after 2 weeks of therapy the wound bed measurement is 3 cm x 3 cm x 2.5 cm, the calculation is as follows:

STEP 1: Calculate the volume of the wound for previous and new measurements.

Equation for wound volume: length x width x depth = cm^3

Example:
- Previous measurement was 4 cm x 3.5 cm x 3 cm = 42 cm^3
- New measurement is 3 cm x 3 cm x 2.5 cm = 22.5 cm^3

STEP 2: Calculate percentage of size reduction.

Equation for size % reduction: 1 – (current wound volume/previous wound volume)

Example:
% size reduction = 1 – (22.5 cm^3/42 cm^3) = 1 – (0.54) = 0.46 or 46 %
[remember: 1 = 100%]

STEP 3: Compare size reduction to healing goal.

Healing goal of 25% size reduction is met.

(c) Example of a wound* that previously had measurable depth and now does not*:

The equations used above only work when dividing the same types of measurements—either cm^2 *or* cm^3—within the equation. If the wound had depth at the last visit (i.e., had a wound volume in cm^3), but no longer has depth at the current visit (i.e., has a surface area in cm^2), then you must adjust the equation in order to get an accurate assessment of wound size reduction.

For example: Two weeks ago, the wound measured 2 cm x 1 cm x 0.5 cm. Today, the wound is measures 1.5 cm x 0.5 cm, but has no depth (0 cm). You cannot multiply 1.5 x 0.5 x 0 for today's visit, because the resulting wound volume would be zero. Instead, you should use 0.1 cm if no measurable depth, as shown below. If the wound remains without depth, then the next 2 week healing goal would be a comparison of surface area shown in the first example above.

STEP 1: Calculate the volume of the wound for previous and new measurements.

Equation for wound volume: length x width x depth = cm^3

Example:
- Previous measurement was 2 cm x 1 cm x 0.5 cm = 1 cm^3
- New measurement is (1.5 cm x 0.5 cmx 0.1 cm) = 0.075 cm^3

STEP 2: Calculate percentage of size reduction.

Equation for size % reduction: 1 – (current wound volume/previous wound volume)

Example:
% size reduction = 1 – (0.075 cm^3 / 1cm^3) = 1 – (0.075) = 0.925 or 93%
[remember: 1 = 100%]

STEP 3: Compare size reduction to healing goal.

Healing goal of 25% size reduction is met.

STEP 4: REVIEW WOUNDS NOT MEETING HEALING GOALS.

1. **Review wound type, mechanism of injury, and basic interventions.** Assess the patient and re-evaluate possible causes of the wound. Include an assessment of the patient's history and environment for clues to alternative and/or additional causes of the wound.

2. **Review patient adherence to the plan of care.** Ask the patient about their perceived ability to adhere to the recommendations. Evaluate if the plan is "do-able" in the current environment. For further guidance see the following sections: *Barriers to Healing* and *General Therapy Goals: Healing, Stabilization, and Palliation*.

3. **Consider empiric treatment with topical antiseptics that have low cytotoxic profiles for critical colonization.** If healing goals are not met after 2–4 weeks, and the rest of the basic supportive wound care principles have been established, then it is time to consider that the wound bed is critically colonized with microorganisms, a common barrier to healing. For a definition of *critical colonization* see the section on *Colonized versus Infected Wounds*. Unless cellulitis is confirmed, antiseptics—not antibiotic therapy—are recommended at this point. A wound culture is not recommended prior to initiating therapy unless clinical signs of cellulitis are present.

   Antiseptic agents with low cytotoxic profiles are listed in *Table 5*. Traditionally used antiseptics (such as Dakin's solution, povidine-iodine, Hibiclens, and hydrogen peroxide) should be avoided, as their cytotoxicity to wound healing cells is believed to outweigh their bactericidal effectiveness.

   For additional guidance on this topic and a list of additional antiseptic agents see *Use of Topical Antiseptics*.

4. **Consider additional diagnostic studies.** Some key studies are listed for initial consideration. Additional diagnostic studies for each common wound type are listed in their respective sections. Some will need to be performed in a local clinic or hospital setting. A few key diagnostic studies are highlighted here.

   - ***Biopsy for tissue culture and pathology*:** If cellulitis is suspected or if after 2–4 weeks of empiric topical antiseptic therapy a wound is not meeting healing goals, then a tissue culture is recommended so that appropriate treatment can be selected. A tissue biopsy for culture is the preferred method. If a swab culture must be used, consider the Levine method. For further guidance, see *Wound Culture Techniques*.

   - ***Tissue biopsy:*** Additionally, wounds that are not meeting healing goals may require further evaluation with a tissue biopsy to exclude pathology as a mechanism of injury. In order to maximize the potential pathologic information, an 8mm punch biopsy is usually preferred (smaller wounds may require smaller biopsies). In most cases, the ideal biopsy site should be obtained from the wound border. Including a small portion of both the wound bed and the adjacent skin may be critical to the pathologic interpretation. If an 8mm punch biopsy is unable to encompass the above sites, an incisional biopsy should be considered. A small portion of the base can be removed for tissue culture, as well. Normal saline (not povidone-iodine or other antiseptics) should be used to prepare the site for biopsy. If anesthesia is required, a preservative-free lidocaine, preferably 1%, should be used.

- ***Serum ESR/CRP and imaging if osteomyelitis suspected:*** The serum ESR (sedimentation rate) and the CRP (C-reactive protein) are lab tests that can indicate inflammation in the body. They are commonly used to screen for acute and chronic bone infection. If these labs are elevated in the absence of an obvious alternative diagnosis—such as an acute soft tissue infection, rheumatoid arthritis, or inflammatory bowel disease—consider imaging studies. For imaging recommendations see the information on *imaging* under *Diagnostic Tests* for *Pressure Ulcers*.

  Note that the efficacy of antibiotics alone—whether topical, oral, or intravenous—is poor for chronic osteomyelitis. Creating substantial antibiotic resistance is a more likely outcome. *Therefore, the use of antibiotics is discouraged outside of an acute clinical infection.* Surgical debridement of the infected bone, along with antibiotics, is the gold standard of treatment; therefore, consultation and referral for confirmed osteomyelitis is critical.

- ***Vascular study or consult if arterial disease is suspected:*** Revascularization increases the likelihood that a wound will heal and decreases the risk of amputation. See the section on the characteristics of *Arterial Insufficiency Wounds*.

  ➜ *For a review of vascular studies, see the section on diagnostic tests.*

5. **Consider consultation with wound care specialist and Registered Dietitian if healing goals are not met after 4 weeks.** Once treatment is started, not meeting healing goals for the first 4 weeks is indicative of a wound which is unlikely to heal without additional assistance.

   Practitioners are encouraged to consider a wound care consultation and assessment by a Registered Dietitian (see the section on *Nutrition Recommendations for Wound Healing*) to evaluate barriers to healing and appropriate therapies that might establish a good healing trajectory. Continuing therapy and goals based on the color of the wound bed, as directed in the algorithm, is appropriate until consultation is secured.

COMMON WOUND TYPES

PRESSURE ULCERATIONS

RISK FACTORS

Patients at increased risk include those with altered sensation or limited mobility (e.g., in the case of spinal cord injury, stroke, or severe altered mental status). Any person hospitalized is at greater risk, especially inmates who are secured to the bed, limiting their mobility. Additional risk factors include those who are severely deconditioned, had a recent weight loss related to an illness, are advanced in age, have poor nutritional intake, have incontinence of either bowel or bladder, or have a medical reason to have the head of their bed elevated at or above 30 degrees for extended periods of time.

In inpatient settings, a validated risk assessment tool such as the Braden Scale is commonly used to stratify risk and select appropriate interventions to decrease the possibility of ulcerations.

MECHANISM OF INJURY

Pressure ulcerations are caused by pressure that is of sufficient force to occlude blood flow, causing tissue necrosis (tissue death). Shearing and friction are two additional mechanisms that contribute to pressure ulcers. *Shearing* is a deeper force where tissue is pulled away from deeper attachments. This also decreases blood flow through vessels around the area of injury. This causes *undermining* around wounds. *Friction* is the force of two surfaces moving across each other causing blistering or the removal of the top layers of the skin. This opens the tissue to invasion by microorganisms.

The amount of pressure or shear needed to cause damage depends on the patient. In general, high pressure over relatively short times to moderate amounts of direct pressure over longer time periods can cause tissue damage. High risk areas include any place where the bone is very close to the skin or the bone protrudes from the underlying weight bearing structures. The most common places include the lying surfaces of the pelvis (hips/greater trochanters and the coccyx-sacral area), the sitting surfaces of the pelvis (ischial tuberosities), and the posterior surface of the heels.

CHARACTERISTICS

Pressure ulcers predominantly develop over bony surfaces. Location is often the primary sign that a wound is due to pressure injury. As described below, pressure ulcers present in multiple stages of ulceration, ranging from non-blanchable, discolored skin to deep craters extending to the bone.

- **Pressure Ulcer Stages:** In 2007, the National Pressure Ulcer Advisor Panel (NPUAP) provided updated guidance on the stages of pressure ulcers. Detailed descriptions and illustrations are available at the NPUAP website (links are listed under *References*). The NPUAP scale, which is for pressure ulcers only, includes these categories: ***Stage I***, ***Stage II***, ***Stage III***, ***Stage IV***, ***Unstageable***, and ***Suspected Deep Tissue Injury***.

Appropriate staging should occur as soon as possible. Identifying that an ulcer is present upon admission decreases the potential for litigation in the future. Staging should be accomplished by the team only one time, unless the initial stage increases, or the ulcer is initially staged as either suspected deep tissue injury or unstageable. In the case of suspected deep tissue injury and unstageable ulcers, resolution of the necrotic tissue is necessary before definitive staging can be accomplished.

If there is no certainty regarding the stage—or whether this is, in fact, a pressure ulcer—it should just be described as outlined in *TABLE 1.2*.

- ***Reverse Staging/Healing Pressure Ulcers:*** Healing pressure ulcers are not progressively staged in reverse as they heal. For example, a healing *Stage III* ulcer does not become a *Stage II* as it gets shallower; it remains a healing *Stage III* ulcer until closed. Once closed, it is a healed Stage III ulcer.
- ***Blanchable Erythema:*** Erythema over bony prominences that blanches is not considered a pressure ulcer, but may be an early indication of increased risk. It should be considered as a warning that pressure ulcer development is likely.

- **Development of Cellulitis:** If the pressure ulcer develops cellulitis, consider referral if appropriate treatment cannot be established. The development of cellulitis can expose the underlying bony structure to microorganisms, increasing the likelihood of developing osteomyelitis. If cellulitis develops, please see the *Culture* recommendations under *Diagnostic Tests* in the next section. If referral is not initiated, closely monitor the patient.

- **Possibility of Osteomyelitis:** If the ulceration extends close to the bone, if the bone is palpable, if the patient develops cellulitis, or if the wound is not healing in a timely manner, osteomyelitis should be ruled out. The presentation of osteomyelitis may not be obvious. Wounds with an underlying chronic osteomyelitis often appear as a small opening that tracks toward the bone, and may even repeatedly close and re-open in the absence of ongoing pressure injury. See the section on *Imaging* below.

DIAGNOSTIC TESTS

- **Basic Testing**
  - ***Patient history*** of the ulceration, along with observation of location and characteristics, is the initial diagnostic tool for pressure ulcers.
  - ***Examining the patient in his/her environment***, including the bed and wheelchair, if applicable, may assist in providing clues. Looking for the location of drainage on clothing or medical equipment is also helpful.

- **Advanced Testing:**
  - ***Laboratory screening:*** Laboratory screening for osteomyelitis can be accomplished through the use of serum sedimentation rate and/or C-reactive protein. Elevation of these serum markers indicates an ongoing acute or chronic inflammatory process, and imaging is recommended.

- ***Culture:*** Cultures are recommended if cellulitis develops or when the wound fails to meet healing goals after the empirical use of topical antiseptics for 2–4 weeks. Results of the culture are used to guide antibiotic therapy in treating cellulitis, as well as by wound care consultants when selecting therapy for wounds that fail to heal. Routine swab cultures are usually discouraged, as they often reflect contaminants and only poorly reflect the organisms that are responsible for inhibiting healing. If a culture is needed, a biopsy is recommended. For further guidance, see *Wound Culture Techniques*. Routine wound cultures and antibiotic use (whether topical, oral, or intravenous) is discouraged in the absence of acute cellulitis. They will rarely provide for an effective treatment of osteomyelitis without surgical removal of the bone, and their use prior to surgical debridement can create significant resistance issues.
- ***Imaging:*** Plain radiographs can be taken in-house to assess for bony changes, but cannot definitively rule out early osteomyelitis. An MRI is the gold standard. If the patient has retained metal, then a CT or Indium Bone Scan is recommended, but are not as sensitive. Involvement of a surgeon is also strongly recommended; even intravenous (IV) antibiotics alone will most likely suppress, but not clear, the infection. Unless an acute cellulitis or sepsis is confirmed, antibiotic therapy is of little value and can be harmful for the patient, often creating resistance issues. If osteomyelitis is confirmed, the patient must be referred for surgical debridement and management, which usually includes a lengthy course of IV antibiotics. Until this can be accomplished, healing is unlikely and stabilization is the goal. Consider using Dakin's 0.125% solution, once or twice a day, to decrease the number of microorganisms living on the surface of the wound.

INTERVENTIONS TO ALLEVIATE MECHANISM OF INJURY

Stopping the injury process should be the initial focus of treatment efforts and are more important than the type of dressing changes. For redistribution of pressure, the affected area can functionally be divided into the parts of the body affected when sitting and lying. Those parts of the body that make contact while in bed require offloading in bed. Those on the sitting surface of the body require offloading when seated, often in a wheelchair. Ulcers on the heels can occur in bed and in the wheelchair.

The following interventions should be considered—based on the stage, location, and number of pressure ulcers present:

- ***A pressure redistribution mattress or overlay for the bed if the ulcer is on the lying surface of the body*** (e.g., the sacrum to the mid buttocks, the hips, or the posterior heel). At a minimum, this would be a Group 1 support surface specialty overlay or mattress for treatment. The Centers for Medicaid & Medicaid Services (CMS) has recommendations for multiple levels of surfaces depending on stage, location, and number of ulcers. (See the link for *Medicare Policy Regarding Pressure Reducing Support Surfaces – JA1014* under CMS in the *References* section.)
- ***A pressure-redistributing cushion for patients with a sitting ulcer who use a wheelchair***. CMS defines three levels of cushions. At a minimum, a CMS-defined "skin protection wheelchair seat cushion" that offers at least 4 centimeters of immersion should be issued. See *Appendix 3*, *Durable Medical Equipment (DME) Resources*, for examples of wheel chair seat cushions that meet CMS specifications.

- ***A specialty boot if a pressure ulcer is located on the heel or foot.*** There are a variety of specialty boots on the market for heel-offloading. Examples of specialty boots include Heelift® Suspension Boots, HEELMEDIX™ Heel Protectors, Waffle® Heel Protectors, or Rooke® Heel Float System™ Boots.
- ***Equipment to elevate heels off of the bed*** such as pillows, blankets, or specialty boots if there is an ulcer on the heel. (See above for examples of specialty boots.)
- ***A waterproof shower cushion*** to offload sitting ulcers during personal hygiene.
- ***Patient education:*** Please issue the patient a copy of the *Pressure Ulcers: Prevention and Treatment* patient education handout available in *Appendix 4*.
- ***Pressure mapping:*** If the patient has an ulcer on the sitting surface of the buttocks (especially over the ischial tuberosity) that is not meeting healing goals, then consideration of pressure mapping is appropriate. It is the gold standard to ensure appropriate pressure redistribution in a wheelchair. Pressure mapping is available at many hospitals and wound care clinics. Ultimately, the effectiveness of offloading is determined by healing. If the wound is meeting healing goals, then the strategies are deemed generally appropriate. If the wound is not meeting healing goals, pressure redistribution equipment and the patient's time spent in a wheelchair must be re-evaluated.

PREVENTION STRATEGIES FOR THE SPINAL CORD INJURY POPULATION:

In the correctional environment, any patient with a spinal cord injury should be considered at high risk for pressure ulcerations, and prevention strategies should be taken, even in the absence of a current pressure ulcer. Patient education and specialty equipment should be considered for all of these patients.

At a minimum, considerations should be made for the following durable medical equipment:

- ***A pressure redistribution mattress or overlay for the bed:*** This would be a Group 1 support surface specialty overlay or mattress. CMS has recommendations for multiple levels of surfaces depending on stage, location, and number of ulcers. (See the link for *Medicare Policy Regarding Pressure Reducing Support Surfaces – JA1014* under CMS in the *References* section.)
- ***A pressure redistributing cushion for wheelchair use:*** CMS defines three levels of cushions. At a minimum, a CMS-defined "skin protection wheelchair seat cushion" that offers at least 4 centimeters of immersion should be issued. See *Appendix 3*, *Durable Medical Equipment (DME) Resources*, for examples of wheel chair seat cushions that meet CMS specifications.
- ***Equipment to elevate heels off of the bed*** (pillows, blankets, or specialty boots) if there is an ulcer on the heel. There are a variety of specialty boots on the market for heel offloading. Examples of specialty offloading boots include Heelift® Suspension Boots, HEELMEDIX™ Heel Protectors, Waffle® Heel Protectors, or Rooke® Heel Float System™ Boots.

- ***Firm-soled shoes for use in the wheelchair*** if the patient does not have an existing pressure ulcer on the foot that requires special equipment to offload foot ulcers.
- ***A waterproof shower cushion*** to prevent sitting ulcers during personal hygiene.
- ***Patient education:*** Please issue the patient a copy of the *Pressure Ulcers: Prevention and Treatment* patient education handout available in *Appendix 4*.

SPECIFIC TOPICAL TREATMENT RECOMMENDATIONS

Topical therapy should, in general, follow the recommendations discussed under the *Basic Supportive Wound Care Algorithm*. Avoid over-packing pressure ulcers as this can increase the amount of pressure on the wound bed over weight-bearing surfaces. In addition, if osteomyelitis is confirmed, the goal of therapy changes from healing to stabilization until surgical intervention is completed. Antibiotics are not warranted unless cellulitis develops. Antiseptics with a higher cytotoxic profile, such as Dakin's 0.125% solution, delivered on gauze once or twice a day, are recommended. This will decrease the number of microorganisms living on the surface of the wound and help prevent the development of an acute cellulitis until surgical intervention can be arranged.

ARTERIAL INSUFFICIENCY WOUNDS

Arterial insufficiency is also known as peripheral arterial disease (PAD) or Lower Extremity Arterial Disease (LEAD).

RISK FACTORS

In general, risk factors include those which cause atherosclerosis throughout the body, including tobacco use, diabetes, dyslipidemia, and hypertension. A history of any past cardiovascular event increases the likelihood of extremity arterial disease. Conditions exacerbating the degree of arterial insufficiency include those that affect cardiac output and oxygenation. Although arterial insufficiency is largely a disease of the lower extremities, some specific diseases also increase the risk for developing arterial ulcers on the upper extremities, as well, such as thromboangiitis obliterans, sickle cell disease, vasculitis, and renal disease. Patients with a recent history of arteriovenous (AV) graft placement for hemodialysis can develop arterial ulcers distal to the graft when the connection works too well, decreasing blood flow to that area.

MECHANISM OF INJURY

- **Arterial Blood Flow:** The exact pathologic mechanism producing arterial ulcers is not clearly defined, but a decrease in blood flow results in tissue necrosis (death).
- **Trauma and Pressure Injury:** These patients are also at an increased risk for trauma and pressure injury, especially over the lower extremities and feet. They have increased risk for pressure ulcer development over their heels. These injuries increase oxygen demand that the body is unable to meet, due to decreased arterial flow. Often these ulcerations seem to spontaneously appear.

CHARACTERISTICS

- **Characteristics of the Ischemic Limb**
  - ***Appearance:*** Trophic changes in the affected limb appearance include a thin and shiny skin, pale color, an absence of hair growth, and thickened and/or brittle nails.
  - ***Ischemic pain*:** Ischemic pain is common and can provide clues to the degree of arterial disease. This type of pain—divided into three categories of worsening severity: *intermittent claudication*, *nocturnal pain*, and *rest pain*—is related to ischemia and not to ulceration per say. The site of the pain can also give clues to the location of the occlusion. Thigh and buttock pain is related to the illiofemoral arteries; calf pain, to the superficial femoral artery; and foot pain, to the infrapopliteal artery.
    - ***Intermittent claudication pain*** occurs with activity. Patients will report that their calves or legs feel heavy or have cramping pain when they walk about the same distance each time. It is relieved with about 10 minutes of rest. This pain is present when the involved vessel is approximately 50% occluded.
    - ***Nocturnal pain*** occurs at night when the patient is in bed and is relieved by placing the legs in a dependent position to increase blood flow, often over the edge of the bed.
    - ***Rest pain*** occurs in the absence of activity with legs in a dependent position. This indicates advanced occlusive disease, typically greater than 90% of the affected vessel(s).
  - ***Dependent rubor:*** The presence of a purplish-red discoloration in one or both legs is caused by the retention of deoxygenated blood in the dilated skin capillaries of a patient with arterial disease. To differentiate from cellulitis or other mechanisms, have the patient lie in a supine position and elevate the leg approximately 60 degrees. If the discoloration fades, the most likely mechanism is dependent rubor.
- **Characteristics of the Wound:** Wound beds are usually covered with yellow, brown, or black dry necrotic tissue that is firmly adhered to the wound bed with minimal drainage. If the wounds are not covered with moist or dry necrotic tissue, they will often be small, punched-out appearing, with pale pink wound beds that have minimal drainage in the absence of infection. Arterial insufficiency wounds are often painful, unless the patient has concurrent neuropathic disease causing loss or alteration in sensation.
  - ***If ulcers present on the toes or heels, then additional offloading may be necessary to protect against additional injury.*** Consider issuing the patient a wound-healing shoe and a wheelchair. Examples of wound-healing shoes include: the DARCO Peg-Assist Insert placed into a DARCO type cloth shoe, and the DARCO Wound Shoe System.
  - ***Any sign of cellulitis, abscess, gangrene, or deep ulceration in an arterial ulcer is a serious condition.*** Because of the limited blood flow, these patients do not always have the ability to mount a normal inflammatory response. Any of these signs should prompt consideration for *immediate* referral for treatment and amputation prevention.

DIAGNOSTIC TESTS

- **Basic Testing**
  - ***Basic vascular exam:*** Assessment characteristics are summarized in *TABLE 1.3*.
  - ***Pallor elevation test:*** With the patient in the supine position, elevate the affected leg approximately 60 degrees. Note the color of the soles of the foot, as indicated in the table below.

Pallor developing within…	Indicates…
25 seconds	Severe arterial disease
25–40 seconds	Moderate arterial disease
40–60 seconds	Mild arterial disease
60 seconds	No arterial disease

  - ***Ankle-brachial index:*** Ankle-brachial index (ABI) is a comparison of blood pressures in the arms (brachial) and ankles (post-tibial) or feet (dorsalis pedis), using an appropriately sized blood pressure cuff and a simple Doppler. The highest systolic reading of the feet, indicated by the first audible Korotkoff sound, is divided by the highest systolic reading found in either arm. This gives a ratio, which can be interpreted as shown in then table below.

ABI Ratio	Indication
1.0 to 1.29	Normal ratio
0.8 to 0.99	Blood flow should be adequate for healing.
< 0.8	Patient may need to be referred for further diagnostic testing to evaluate whether blood flow is adequate for healing (see *Advanced Testing* below).
≥ 1.3	Indicates non-compressible vessels (i.e., an inaccurate test). This finding is common in diabetic patients, due to increased rates of arteriosclerosis. Further diagnostic testing may be needed to evaluate whether blood flow is adequate for healing (see *Advanced Testing* below).
For more information, see Aboyans V, et al., Measurement and interpretation of the ankle-brachial index: a scientific statement from the American Heart Association (see full citation in *References* section). Available at: http://circ.ahajournals.org/content/126/24/2890.long	

  - ***Imaging:*** Radiography has very limited use in diagnosing arterial insufficiency. It has some diagnostic value to evaluate for underlying osteomyelitis, but early bone infection can be missed using this test; an MRI is indicated as the gold standard for osteomyelitis diagnosis.

- **Advanced Testing**

  To evaluate the adequacy of arterial blood flow, the following tests are widely available via local referral to a health care center. If there are questions regarding which test is available or which test is most appropriate, a vascular consultation is recommended.

  - ***Non-invasive testing:***
    - Exercise stress test
    - Transcutaneous oxygen pressure (TCPO2)

- Skin perfusion pressure
- Pulse volume recorders (PVR)
- Doppler waveform studies
- Segmental limb pressure
- Magnetic resonance angiography
- Duplex angiography

► ***Invasive testing:***
- Arteriography
- Computed tomographic angiography

INTERVENTIONS TO ALLEVIATE MECHANISM OF INJURY

- Patient education is essential. Give patients a copy of the *Arterial Insufficiency* patient education handout available in *Appendix 4*.
- Interventions to treat the underlying atherosclerotic and other diseases.
- Appropriate offloading and protection of any wounds from further injury.
  - ► Extra padding over the wound and affected extremity with dressings or extra clothing
  - ► If the wounds are on the foot, consider footwear such as a wound-healing shoe to protect and offload the wounds. Examples of wound healing shoes include: the DARCO Peg-Assist Insert placed into a DARCO type cloth shoe and the DARCO Wound Shoe System.
- If moderate to severe arterial insufficiency, consider heel elevation off of the bed for the affected limb.
  - ► Use pillows, blankets, or specialty boots. Examples of specialty boots include the Heelift® Suspension Boot, HEELMEDIX™ Heel Protectors, Waffle® Heel Protectors, and the Rooke® Heel Float System™ Boot.
- Interventions to ensure optimal blood flow.
  - ► No restrictive bands or clothing around affected limb(s).
  - ► Limited elevation of affected extremities (even with lower extremity edema).
  - ► Keeping extremity warm with extra clothing (external heating devices are not recommended due to potential for burns).
  - ► Encouraging walking to tolerance unless contraindicated by location of wound or an unsafe gait pattern. Pain in the legs is a symptom indicating that they have reached tolerance.
- Referral to Vascular Center for evaluation and interventions for arterial blood flow, if appropriate.
- Appropriate pain control for wound related pain

SPECIFIC TOPICAL TREATMENT RECOMMENDATIONS

The *Basic Supportive Wound Care Algorithm* provides appropriate treatment recommendations, including the presence of critical decision points and life- or limb-threatening decisions. Debridement should be delayed until the adequacy of the blood flow to the affected limb can be. If there is black dry tissue on the toes or heels, debridement should be delayed until consultation with a specialist. Because of the poor condition of the skin around these types of wounds, great caution must be used in applying any type of tape to the skin. Rolled gauze is preferred to assist with securing any dressing in place.

VENOUS INSUFFICIENCY WOUNDS

Venous insufficiency is also known as Lower Extremity Venous Disease (LEVD).

RISK FACTORS

Risk factors include alterations and damage to the veins of the affected limb, especially a history of surgery or trauma affecting the large vessels, including hip or knee surgery and venous stripping. Conditions and lifestyle factors that increase pressure within the lower extremities include: obesity, pregnancy, thrombophlebitis, sedentary lifestyle, paralysis of the lower extremities, and any condition that induces inadequate calf muscle pump function, including walking with a shuffling gait. A history of lower extremity edema and/or varicosities is common.

MECHANISM OF INJURY

The valves of the veins that assist with return of blood to the heart are intended to be unidirectional. Due to either congenital or acquired disease, the one-way valves become incompetent and allow for bidirectional (retrograde) flow of blood, which increases the pressure within the venous system (venous hypertension). This process eventually leads to separation of the junctions of the vessels, allowing for leakage of proteins and red blood cells into the interstitial space of the tissue. Although the exact physiological mechanisms contributing to ulcerations are poorly understood, over time this causes changes to the tissue within the interstitial spaces and skin, resulting in the formation of ulcerations. Due to gravity, this disease process occurs mainly within the lower extremities.

Note: Venous insufficiency should not be confused with lymphedema, which often requires consultation for specialty care, including decongestive therapy.

CHARACTERISTICS

- **Skin and Tissue Abnormalities**
  - ***Hemosiderin staining:*** The presence of reddish-gray or brown discoloration of the skin, most commonly on the anterior portion of the lower leg and the ankle is a cardinal sign of venous insufficiency. It is caused by the breakdown of red blood cells that have leaked from veins into the interstitial spaces. With compression, the color will fade, but will always be present.

- ***Appearance of veins:*** The presence of distended veins in the lower extremity is only normal in the feet. The presence of distended veins elsewhere in the leg may imply venous insufficiency. Dilated veins are enlarged, palpable, and often bluish in color.
- ***Edema:*** Edema in the lower extremity can be cause by numerous conditions. It is often associated with venous insufficiency, but its presence is not necessary for diagnosis. Edema related to venous insufficiency is most often fairly uniform on both legs.
- ***Lipodermatosclerosis:*** In the setting of long-term, poorly controlled venous insufficiency, the soft tissue will harden and develop a woody texture. The shape of the leg will also change to resemble an inverted champagne bottle. Its development signals fairly advanced disease. It may be present in one or both legs.
- ***Dry skin:*** Dry skin related to venous insufficiency is common and can be mild to extreme. The exact mechanism is poorly understood, but it is part of the exaggerated cutaneous inflammation common to venous insufficiency. Response to treatment with lotions and creams will be variable. Appropriate compression is the primary treatment for this. For more information, see *Treatment of Dermatitis, Dry Skin, and Skin Sensitivities in Interventions to Alleviate Mechanism of Injury* below in this section.

- **Characteristics of Venous Insufficiency Wounds**

  These wounds are characteristically large, irregularly shaped wounds of the pretibial and ankle areas (gaiter area), which are shallow, red, and often draining heavily until appropriate compression is applied. The high level of drainage is directly related to the underlying physiology of sustained (chronic) venous hypertension. These wounds are often preceded by an area that is red, warm, and edematous, which is part of the exaggerated cutaneous inflammatory response common to venous insufficiency. This usually continues until the appropriate amount of compression is applied. Due to this characteristic presentation, practitioners often inadvertently diagnose and treat for cellulitis. A diagnosis of "chronic cellulitis of the leg" is common. The diagnosis of recurring cellulitis should be confirmed with additional diagnostics, including a fever and elevated white blood count.

- **Pain**

  Patients with venous insufficiency related wounds often experience dull aching pain deep within the tissue, which is worse when the affected limb is dependent and improves with appropriate compression therapy.

DIAGNOSTIC TESTS

There are very few tests that confirm the presence of venous insufficiency in the clinic setting. The presence of visible varicosities is helpful, but often not necessary. Diagnosis is largely made on the basis of history and characteristics of the affected limb.

➔ *Assessment of lower extremity for presence of concurrent arterial insufficiency is critical to selecting appropriate compression. Caution should be used for applying even introductory compression to patients with non-palpable dorsalis pedis and post-tibial*

pulses—especially if they have additional signs and symptoms of arterial insufficiency such as dependent rubor or a pallor elevation test of less than 25 seconds. In these cases, a wound care consultation is prudent prior to application of compression.

- **Basic Testing**
  - ***Basic Vascular Exam:*** Assessment characteristics are summarized in *TABLE 1.3*.
- **Advanced Testing**

  Although other tests are available, Duplex Ultrasound scanning is considered the gold standard for accurate evaluation of the retrograde venous flow in the affected limb. Often, compression therapy is initiated and if several attempts at providing an effective level of compression are unsuccessful, then venous testing is pursued to help evaluate the extent and level of disease. This can be done through a vascular consultation.

INTERVENTIONS TO ALLEVIATE MECHANISM OF INJURY

- **Patient Education**
  - Give patients a copy of the *Venous Insufficiency* patient education handout available in *Appendix 4*.
- **Compression Therapy**
  - ***Compression therapy is the cornerstone of treatment for venous insufficiency,*** in that it helps to correct the venous hypertension and assist with blood return to the heart. Compression therapy comes in multiple forms and levels of pressure for ambulatory and non-ambulatory patients.

    The patient need to understand that compression is necessary for the rest of their life, as it slows the progression of the disease and prevents further ulcerations to the leg. It needs to be worn whenever the patient is out of bed with their feet in a dependent position. It is best if patients apply their compression immediately upon rising from bed. Knee-high compression will be reviewed here. Longer garments, which need fitting by specialists, so will not be included.
  - ***Contraindications to compression therapy:***
    - Compression therapy is contraindicated in the presence of an acute venous thrombosis and should be used with caution in patients with an acute cellulitis.
    - Compression therapy should be used with caution for patients with uncompensated congestive heart failure. Pushing the fluid from the interstitial compartment back into the vascular system without close monitoring can initiate a congestive heart episode.
    - Compression is used with caution in patients with concurrent arterial disease. Assessment of the lower extremity for presence of concurrent arterial insufficiency is critical to selecting appropriate compression. Caution should be used for applying even introductory compression to patients with non-palpable dorsalis pedis and post-tibial pulses—especially if they have additional signs and symptoms of arterial insufficiency such as dependent rubor or a pallor elevation

test of less than 25 seconds. In these cases, a wound care consultation is prudent prior to application of compression.

- Compression should also be applied with caution in bed-bound and non-ambulatory patients.

- ***Patient adherence:*** Finding a compression therapy that is acceptable (in terms of comfort and ease of use) to the patient is more important than finding one which is theoretically the most optimal, since compression will be life-long and patient compliance is key.

- ***Determining the appropriate compression:*** In the outpatient setting, compression therapy is divided into a number of categories, but there are two key questions in determining the appropriate compression. *First*, does the patient have adequate blood flow? (See the earlier section on *contraindications to compression therapy*.) *Second*, does the patient ambulate with adequate calf muscle pump function? A shuffling gait does not provide adequate function. Such patients should be considered functionally non-ambulatory. Additional considerations include ease of use, need for assistance with application and removal, frequency of application and the changes this may bring to their ADL care (e.g., when they can shower), cost, and availability. If compression is not removed daily, patients may need to be issued a shower cast bag, or plastic bags and tape, in order to shower.

- ***Introductory compression:*** Elasticated tubular bandage size F (for example, Medigrip™ or Tubigrip™) provides a safe level of compression for patients with even weak palpable pulses. This type of compression is appropriate for ambulatory and non-ambulatory patients.

  - This compression comes on a roll, and "socks" are cut so that they are long enough to extend from an inch below the knee to the toes, with enough length to double the material back over the foot and ankle, thereby providing two layers of compression to the distal portion of the foot and leg. Patients may wear one or two layers.

  - Limiting factors include allergy to latex and proper shoe-fitting. The added bulk requires temporary consideration of shoe size, especially for patients with concurrent neuropathic disease.

  - Issue enough socks so that the patient has two sets. They will need to be hand-washed and air-dried by the patient. The socks need to be replaced monthly.

  ACE wraps and TED hose: These should be used only temporarily. It is difficult to apply uniform compression with ACE wraps, and they are usually poorly tolerated. TED hose provide only minimal compression. If nothing else is immediately available, they are acceptable as short-term solutions, but should be replaced with *introductory* (see above) or *long-term* (see below) compression solutions as soon as possible. They may be considered for patients who will not wear any other form of compression. They are appropriate for ambulatory and non-ambulatory patients.

- ***Long-term compression:*** Long-term compression solutions are divided into two types—those appropriate for ambulatory patients with adequate calf muscle pump function and those appropriate for individuals who are either non-ambulatory or lack adequate calf-muscle pump function, such patients with a shuffling gait. Some long-term compression measures such as CircAide® devices and Jobst® stockings may require measurement and fitting.

Ambulatory with Adequate Calf Function	Non-Ambulatory or Inadequate Calf Function
• Unna boots • Multi-layered wraps • CircAid device • Short-stretch wraps • Jobst stockings	• Long-stretch wraps • Jobst stockings • Multi-layered wraps

- **Walking and Exercise:** Exercise that adequately uses the calf muscle pump is very helpful to support venous return to the heart and decreased venous hypertension in the extremity. Exercise to tolerance should be strongly encouraged in patients with venous insufficiency.
- **Limb Elevation:** If the patient does not have moderate or severe arterial disease, the affected limb should be elevated above the level of the heart, at a minimum for 1–2 hours twice a day, as well as during the night. Many patients do not tolerate this therapy well and require special medical devices to assist with limb proper limb elevation. This intervention is rarely successful on its own.
- **Weight Control:** This is an essential long-term strategy to prevent further progression of the disease, as obesity increases the risk for venous hypertension.
- **Diuretic Therapy:** Consideration of diuretic therapy should be made on a case-by-case basis, especially in the presence of fluid volume overload promoted by conditions such as renal failure, congestive heart failure, and liver failure. Diuretics may be necessary, but their use should be guided by underlying medical conditions; they should not be used alone to control venous insufficiency.
- **Treatment of Dermatitis, Dry Skin, and Skin Sensitivities:** Moisturizers should be limited to emollients or lotions that do not contain lanolin or sterol alcohol. These ingredients will often exacerbate the cutaneous inflammation, which manifests as increased dry skin. *The primary treatment for this manifestation of cutaneous inflammation is compression therapy, not moisturizers alone.* Lac-Hydrin® lotion is preferred as second-line treatment in patients who fail emollient and compression therapy. Topical steroids are usually reserved for episodic dermatitis exacerbations.

  Due to chronic cutaneous inflammation, the skin is prone to developing sensitivities to tape, sealants, and topical antibiotics and antiseptics. Caution should be used when applying these agents, and the site should be monitored for allergic contact dermatitis.

SPECIFIC TOPICAL TREATMENT RECOMMENDATIONS

Topical dressing therapy for venous insufficiency ulcers is predicated on proper compression therapy. Until compression is in place, the wound will often have copious amounts of drainage, and moisture balance will be difficult to establish. Once drainage becomes minimal to moderate, the practitioner can be reasonably ascertain that some degree of appropriate compression has been attained. The treatment principles found in the *Basic Supportive Wound Care Algorithm* should be followed once compression is established.

➜ *Be cautious about treating for cellulitis. Venous insufficiency ulcers often present with an exaggerated inflammatory response that can precede ulceration. Overuse of antibiotics carries a high risk for creating resistance. Confirmation by evaluation of vital signs, including fever and a high WBC, is prudent prior to initiation of antibiotics.*

NEUROPATHIC DISEASE (DIABETIC FOOT ULCERS)

Neuropathic disease is also known as Lower Extremity Neuropathic Disease.

RISK FACTORS

- **Neuropathic Disease:** Patients at risk for neuropathic disease include those with chronic diabetes, HIV, neurologic or neuromuscular diseases, spinal cord injuries, and some forms of arthritis that affect the innervation of the lower extremities and result in changes in the structure of the feet. Persons of Native American and Alaskan Native ethnicity are at higher risk for neuropathy. However, diabetic patients who fail to monitor and manage their glycemic levels over extended periods present with the worse pathology among the diabetic population.
- **Neuropathic Ulcers:** Patients with a history of prior foot ulcers, amputations, peripheral neuropathy with loss of protective sensation, foot deformities, loss of ankle range of motion, visual impairment, and a history of tobacco use are at increased risk for developing a neuropathic ulceration of the foot.

MECHANISM OF INJURY

Peripheral neuropathy has a three-fold manifestation for patients, including *sensory*, *motor*, and *autonomic neuropathy* all related to the disturbance of the nerves in the legs and feet. This disturbance is often a result of the atherosclerotic changes of the small vessels that oxygenate the nerves. As oxygen delivery decreases, the nerves begin to atrophy. *Sensory neuropathy* involves loss of protective sensation. *Motor neuropathy* affects the strength of the small muscles that keep the structure of the foot intact. Progressive weakness of these muscles results in changes in the structure of the feet. The toes start to curl or claw, the fat pad covering the metatarsal heads/forefoot begins to atrophy, and due to the change in the soft tissue and bone structure, the forefoot becomes more prominent. *Autonomic neuropathy* involves damage to the secretory organs of the skin. This causes decreased sweating and oil production leading to dry skin prone to cracking, fissuring, and callousing.

These three manifestations of peripheral neuropathy combine to produce a foot at higher risk for neuropathic ulcerations. These ulcerations are largely caused by repetitive pressure, shearing, and friction over the deformities on the dorsal and distal surfaces of the toes and the

plantar surface of the feet. This occurs most often when not wearing appropriate footwear, because the patient with sensory neuropathy often cannot detect a poor fitting shoe and the resulting pain.

CHARACTERISTICS

- **Characteristics of the Neuropathic Foot:** Characteristics of the neuropathic foot include thin and/or dry skin, loss of hair on the feet and legs, and changes in the normal appearance and structure of the foot. These changes are often termed or classified as an *atrophic foot.* Visible structural changes include a pronounced foot pad (metatarsal head area) with loss of the normal amount of fat, "clawing" of the toes, and a sometimes a flattening of the foot. Callous formations over the prominent regions of the foot are common and indicative of areas at increased risk for ulceration. Limited joint mobility, complaints of numbness and tingling in the feet or loss of protective sensation are common. Decreased capillary refill, even with normal or bounding foot and ankle pulses, is also common.

- **Characteristics of the Neuropathic Ulcer:** Ulcers occur most commonly on the underside of the foot (plantar surface) and on the top of the toes or dorsal surface. They are secondary to repetitive stress. Those ulcers that present emergently and tunnel deep into the tissue are at higher risk for infection. The first indication of ulceration to the patient with neuropathy is usually blood or drainage on the sock. Drainage can be copious for these wounds. A strong odor is suspicious for underlying infection and requires further evaluation.

  Callous formation around any wound on the plantar surface of the foot is common. The development of this manifestation is a sign that the mechanism of injury continues. This can be due to issues of inadequate shoe fitting or non-compliance (i.e., the patient chooses not to wear the prescribed footwear).

  Note: *Neuropathic ulcers with signs of cellulitis, abscess, gangrene, or deep ulceration greatly increase the risk for amputation. Often neuropathic ulcers develop in the deeper tissue before showing on the surface. In addition, many patients with neuropathic foot disease also have concurrent arterial insufficiency. This can make it difficult for them to mount a normal inflammatory response.* ***Therefore, the development of any of these signs should prompt consideration for immediate referral to decrease the risk for amputation.***

- **Charcot Foot Deformity:** In chronic cases of neuropathy, the bones of the mid-foot can fracture repeatedly and completely collapse. This condition is termed *Charcot foot* or *Charcot deformity*. The foot often takes on a rocker-bottom shape in the presence of Charcot disease, and the arch of the foot flattens or becomes pronounced. This makes the walking surface of the foot more prone to ulceration, putting the patient into a particularly high-risk category. Patients with Charcot disease have broad neuropathic loss of sensation, including loss of proprioception. In turn, they suffer from gait deviations due to the limb length discrepancies associated with bone collapse and to the inability to feel their foot as they walk in the gait cycle. The Charcot foot deformity often requires close monitoring and specialty management.

DIAGNOSTIC TESTS

Diagnostic tests are generally divided into two categories. *Basic testing* can be used to evaluate a foot for risk of future ulceration. *Advanced testing* is used to evaluate the foot for infection. Based on the results of the basic tests, risk is categorized and preventative interventions (including appropriate footwear) are initiated to help prevent future complications. The National Hansen's Disease Program Lower Extremity Amputation Prevention (LEAP) program is widely used to evaluate risk and select appropriate interventions. Its use is recommended and described more fully below.

➜ The Health Resources and Services Administration LEAP website can be accessed at: *http://www.hrsa.gov/hansensdisease/leap/index.html*

- **Basic Testing**
  - ***Foot inspection:*** The foot is inspected for deformities, callous build-up, and the presence of any ulcerations or dry necrotic tissue. The spaces between the toes should also be examined for cleanliness, maceration, or lesions.
  - ***Semmes-Weinstein 5.07 (10 gram) monofilament test to detect the presence of protective sensation:*** The 10 grams of pressure that the monofilament applies has been shown to be the threshold for *protective sensation* (i.e., the level at which patients can tell if there is an object in the shoe or if their shoes are too tight).
    - *The inability of the patient to detect the pressure of the monofilament at any one of the examination sites is indicative of loss of protective sensation. Patients do not need to have complete loss of sensation to be at increased risk for ulceration.*
    - Patients with a loss of protective sensation may still be able to sense deep pressure and pain.
    - Examination of protective sensation of the feet by touching with a finger or the end of a reflex hammer is not sensitive enough to detect loss of protective sensation.
    - Directions on "How to Use the LEAP Monofilament" are available at the above-mentioned website (*http://www.hrsa.gov/hansensdisease/leap/index.html*). In addition, the 5.07 (10 gram) monofilaments can be ordered through the site, or through various health care vendors.
  - ***Vascular status:*** Concurrent arterial disease is common; it increases the risk for amputation and decreases the likelihood of reaching healing goals. See the section on *ischemic limbs*, both the *characteristics* and the *diagnostic tests*, for more detail regarding symptoms, signs, and diagnostic tests.
- **Advanced Testing**
  - **Biopsy for tissue culture and pathology**: If cellulitis is suspected or a wound is not meeting healing goals after 2–4 weeks of empiric topical antiseptic therapy, then a tissue culture is recommended. Results are used to guide antibiotic therapy for the treatment of cellulitis and are used by wound care consultants when selecting therapy. A *tissue biopsy* for culture is the preferred method. If a *swab culture* must be used,

consider the Levine method. For further guidance, see the section on *Wound Culture Techniques*.

- ***Serum ESR/CRP:*** Consider serum sedimentation rate (ESR) or C-reactive protein (CRP) to screen for osteomyelitis if the wound does not meet healing goals after 4 weeks of basic supportive wound care, especially if the ulceration is deep or is covered by necrotic tissue.
- ***Imaging:*** If either the serum ESR or CRP is elevated, or the wound probes close to the underlying bone, then consider imaging. Plain radiographs (X-rays) can assess for bony changes and help to establish baseline evaluation, but cannot definitively rule out early osteomyelitis. A repeat plain radiograph taken 2 weeks after the initial radiograph can evaluate for progressive bone destruction. An MRI is the gold standard for optimal examination when plain radiographic images are inconclusive. If the patient has retained metal, then a CT or Indium Bone Scan is recommended, although not as sensitive.

INTERVENTIONS TO ALLEVIATE MECHANISM OF INJURY

The interventions in this section are divided into those for prevention and those for treatment. Once a neuropathic foot ulcer is healed, then the prevention section should be used as a guide to ensure that they have proper footwear, education, and follow-up.

- **Prevention of Foot Ulcerations**

  Risk for complications should be evaluated using a risk assessment tool such as the LEAP monofilament test, described above under *Basic Testing*. LEAP is used to assess and categorize an individual's risk for foot complications into four categories (0–3), each of which is associated with specific recommendations for intervention. Provider discretion regarding these recommendations should be used on a case-by-case basis. The four LEAP categories are outlined in the table below.

  Note: *Loss of protective sensation is defined as an inability of a patient to detect a 5.07 (10 gram) monofilament test at one of the recommended test sites on the foot.*

LEAP Category	Patient Characteristics	Recommended Interventions*
0	• Risk for neuropathy, such as diabetes. • Intact protective sensation using a 5.07 (10 gm) monofilament test.	• Institutional safety shoe. • Neuropathic foot disease patient education at each visit. • Follow-up scheduled annually or as needed for foot evaluation and skin/callous/nail care.
1	• Loss of protective sensation using a 5.07 (10 gm) monofilament test.	• Alternate institutional shoes: Soft shoes, such as tennis shoes, that are not institutional safety shoes or medical shoes (HCPCS A5500). ***Note:*** *A medical shoe (A5500) may be issued at the clinician discretion.* • Neuropathic foot disease patient education at each visit. • Follow-up scheduled for 3–6 months for foot/shoe evaluation, and as needed for skin/callous/nail care.

LEAP Category	Patient Characteristics	Recommended Interventions*
2	• Loss of protective sensation using a 5.07 (10 gm) monofilament test. • Presenting with documented circulation compromise, or significant foot deformity. • Also consider patients who continue to have significant plantar surface callous formation requiring frequent debridement when using alternate institutional shoes.	• Medical shoe (HCPCS A5500): Medically prescribed footwear that meet specific CMS criteria, which include: **1)** has a full-length heal-to-toe filler which, when removed, provides a minimum of 3/16" of additional depth used to accommodate custom-molded or customized inserts; **2)** is made from leather or other suitable material of equal quality; **3)** has some form of shoe closure; and **4)** is available in full and half sizes with a minimum of three widths so that the sole is graded to the size and width of the upper portions of the shoe. • Neuropathic foot disease patient education at each visit. • Follow-up scheduled for 1–3 months for foot/shoe evaluation, and as needed for skin/callous/nail care.
3	• Loss of protective sensation using a 5.07 (10 gm) monofilament test. • History of plantar ulceration or neuropathic fracture (Charcot foot deformity). • Also consider patients who continue to have significant plantar surface callous formation requiring frequent debridement when using medical footwear (HCPCS A5500).	• Medical shoe (HCPCS A5500) as defined above. On a case-by-case basis, consider Custom Molded Medical Shoes (HCPCS code A5501) or specialty inserts. Custom molded medical shoes and inserts often require consultation with a specialist such as a Podiatrist or Pedorthist. • Neuropathic foot disease patient education at each visit. • Follow-up scheduled for 1–12 weeks for foot/shoe evaluation, and as needed for skin/callous/nail care.
** Patients who are in Categories 1–3 and who do not wear institutional safety shoes must be removed from work details that require the wearing of the institutional safety shoe.*		

- **Treatment of Foot Ulcerations**

  It is critical that neuropathic ulcerations are appropriately offloaded to relieve pressure, shearing, and friction over the specific area(s) of ulceration. It is also critical that wounds are appropriately debrided. Without these two forms of intervention, the chances of meeting healing goals and preventing amputation are unlikely. *Patient education regarding the importance of complying with these interventions is crucial.*

  - ***Limit any standing or walking:*** Walking or standing on the ulcerated area can continue to exacerbate the mechanism of injury. Patients with active neuropathic ulcerations should limit their walking or standing as much as possible. They may need a walker, in addition to a wheelchair, in order to transfer from one surface to another without standing on the affected foot. It is optimal to have patients with neuropathic foot ulcers shower in a handicap stall that allows them to sit. Standing in the shower should be avoided.
  - ***Wheelchair use***
  - ***Wound shoe, specialty off-loading boot, or total contact casting—NOT medical footwear:*** *Medical (diabetic) footwear is not appropriate for use when a patient has an active neuropathic ulcer.*

There are two readily available "wound shoes" that should appropriately offload most neuropathic ulcerations. These include the DARCO® Wound Care Shoe System and the DARCO® Peg Assist insole for use in an open-toed surgical shoe. Both shoes include instructions for use and come in multiple sizes.

Additional offloading devices such as specialty offloading boots and total contact casting are also available. Their use usually requires specialty evaluation and care.

- ***Debridement of callous and wound bed:*** Patients should have any callous formation around the wound debrided by a qualified provider. In addition, the provider should consider gently scraping the wound bed with a curette. Although some capillary oozing may occur, it is not necessary to use enough force to cause capillary bleeding of the wound bed. The purpose of this type of debridement is to remove any biofilm (see *Biofilms* under *Colonized versus Infected Wounds*). Biofilm is not normally visible to the naked eye, but commonly forms on these types of wounds. It is often advisable to do this regularly. Scope of practice must be considered when using this technique.

  When patients are not appropriately offloaded or they continue to walk, ulcers often develop a shiny, gelatinous "false" tissue which easily separates from the edge of the wound. This should also be debrided with a curette by a qualified provider with enough pressure to remove the visible gelatinous tissue with only minor capillary oozing of the wound bed.

- **Patient education:** Provide neuropathic foot disease patient education at each visit. Give patients a copy of the *Neuropathic (Diabetic) Foot Disease* patient education handout available in *Appendix 4.*

SPECIFIC TOPICAL TREATMENT RECOMMENDATIONS

The principles of Basic Supportive Wound Care Algorithm should be followed. Appropriate offloading of the foot and wound debridement is critical to the success of the treatment plan.

MIXED LOWER EXTREMITY DISEASE

Although mixed disease was touched on in the earlier section on *Venous Insufficiency Wounds* through the recommendation to evaluate arterial blood flow prior to initiating compression, it is not uncommon for a patient to have a combination of arterial, venous, and neuropathic disease of the lower extremities. The risk for pressure ulcer development over the heel increases for these patients. Oftentimes, the indicated treatment for one of these conditions in isolation is contra-indicated for another. *As such, these patients can have a number of competing management issues that should be evaluated.*

General recommendations include:

1. Pay particular attention to the critical decision points and the life/limb-threatening issues listed in *Table 2* and *Table 3*.
2. ***For patients with moderate to severe arterial insufficiency***, there are additional recommendations to consider, including protective footwear and a wheelchair if the

ulcerations appear on the heel or ankle. In addition, these patients should receive consideration for additional DME to allow them to elevate their heels off the bed to prevent pressure ulcerations of the posterior heel. In the section on *Arterial Insufficiency Wounds*, see *Interventions to Alleviate Mechanism of Injury*.

3. ***For patients with concurrent venous insufficiency and arterial insufficiency***, caution should be used in initiating compression. In the section on *Venous Insufficiency Wounds*, see *Interventions to Alleviate Mechanism of Injury*.
4. ***For patients with concurrent venous insufficiency and neuropathic disease***, ensure that the compression therapy selected does not significantly alter the fit of the patient's shoes. This is especially important in patients with LEAP Category 2 and Category 3 neuropathic feet. In the section on *Neuropathic Disease*, see the descriptions of the LEAP Categories under *Prevention of Foot Ulcerations*.

GENERAL CONCEPTS OF WOUND HEALING SCIENCE

Wound healing involves a complex series of cellular-chemical interactions in a moist wound bed, starting with hemostasis and ending with the continual strengthening (for up to two years) of the newly closed wound. This process is normally well-regulated by the body and is predicated on at least a minimal function of the body's natural healing processes. When this process becomes interrupted or poorly supported by the general condition of the body, wounds do not heal, become chronic, and in some cases become life threatening. Thus, the primary role of the health care professional, with regards to healing, is to evaluate and support the body's natural healing processes.

In order to do this, an assessment of more than just the wound is crucial. Wound healing involves much more than "what type of dressing to use." The patient with a wound exists as an individual within their own social context, and with their own set of limitations and strengths. Thus, a plan of care for wound healing includes:

- Evaluation of the *intrinsic* and *extrinsic barriers* to healing, as identified in *TABLE 1.2*
- Alleviation of the mechanism(s) of injury causing the wound
- General support of the body in terms of optimizing co-morbidities, nutrition, and pain control
- Evaluation and support of the wound's cellular-chemical processes, mainly through assessment of the wound bed color as a basis for setting healing goals and determining topical therapy

The cellular-chemical processes within the wound environment are not directly testable in most laboratories. On the other hand, many of the interactions are well-studied and documented in the wound care literature, including the matrix metalloproteinase-tissue inhibitor of matrix metalloproteinase (MMP-TIMP) imbalance, the degradation of the extracellular matrix, and the senescence of fibroblasts—all of which are alterations common to a chronic non-healing wound. Thus, wound care specialists use specialty treatments to restore the normal cellular-chemical processes to promote healing.

GENERAL HEALING PHYSIOLOGY

This section provides an introduction to the complex histo-chemical processes involved in wound healing. This environment is not static and can be altered by repeated injury, nutrition deficits, and comorbid conditions. Wound care performed too frequently, use of agents with a high cytotoxic profile, or lack of good moisture balance are factors that can alter the normal histo-chemical complex cascade—potentially converting a healing wound to a non-healing one. Thus, the primary role of any provider is to support the body's natural healing processes.

In the most general sense, full-thickness wounds (e.g., those that are completely through the dermal layer into the subcutaneous tissue or deeper) heal through primary or secondary intention. In primary intention, the wound edges are approximated, usually with sutures, shortly after injury. In secondary intention, wounds are left open to fill with granulation tissue and then epithelialize. This is accomplished through an overlapping series of cascading processes. The cells involved in one stage produce chemical stimuli and

substances that serve to move the wound into the next phase. Although the nomenclature of these events varies between disciplines, they invariably contain the following events: hemostasis, inflammation, proliferation of tissue with contraction and concurrent epithelialization, followed by remodeling for increased strength for up to two years. The complex processes involved are covered in more detail in *Appendix 1*, *Phases of Healing.*

GENERAL THERAPY GOALS: HEALING, STABILIZATION, AND PALLIATION

It is helpful for health services personnel to have knowledge of the following simple classification system (*healing*, *stabilization*, and *palliation*) in order to be realistic about overall therapy goals. Although complete healing may seem to be the logical goal for all patients, some patients do not have the ability to heal their wounds, either physiologically or psychologically. Sometimes they are unable to comply with the work that is necessary to heal. Sometimes their underlying conditions make healing an unrealistic goal. Thus the following classification helps, to identify these situations.

- **Healing:** This is a realistic goal if the patient has adequate tissue perfusion to the affected area, and does not have medical conditions that cannot be compensated for well enough to allow for healing. In addition, the patient must show that he or she is able to do the work involved in healing. Barriers can include psychological instability, inability to comprehend instructions, and negative extrinsic factors found in the patient's environment.
- **Stabilization:** Stabilization is a goal for patients who cannot be healed without further intervention or commitment to the plan of care. They may have wounds with physical complications that are not resolvable in their current environment without consultation or without a level of intervention only available by referral. For example, consultation to vascular medicine may improve blood flow in a leg or foot, so that healing becomes a realistic goal. Until the patient receives re-vascularization, stabilization is the goal. Some patients may need referral to a higher level of care in order to appropriately offload and treat their neuropathic foot ulcer or their ischial tuberosity pressure ulcer. Until they are referred, stabilization is the goal. Patients with the ability to commit to the necessary plan of care, but have not made that commitment, may also be more appropriate for therapy consistent with stabilization.

  Therapy choice related to stabilization is patient-specific. As indicated previously, if the patient presents with a black necrotic wound in the setting of arterial blood flow that is either suspected or confirmed to be inadequate for healing, then antiseptics with higher cytotoxic profiles are recommended. In this situation, keeping the microorganism level low, at the expense of possibly killing cells involved in healing, is appropriate. The same is true for patients with a stable ulcer (i.e., without cellulitis) with confirmed underlying osteomyelitis. *In the above cases, the goal would be to stabilize the wound until the patient can be referred for definitive treatment.*

  In contrast, some patients are appropriate for stabilization therapy because they cannot adhere to the plan of care. In these cases, stabilization can be accomplished through the use of simple moist saline dressings. Antiseptics—either with or without higher cytotoxic profiles—could be used, depending on the patient's situation. However,

increasing the complexity of interventions is unwarranted, because the patient's actions are undermining the chance that such interventions would be successful. Good documentation about the patient's "negative actions" (non-adherence) and the attempt to negotiate more "positive actions" (adherence) is important in justifying this course of action.

- **Palliation:** Palliation is a realistic goal when a patient's life expectancy is limited and comfort becomes the guiding principle. These patients are often enrolled in hospice or palliative care programs, and it is desirable in these situations to clarify and follow their wishes, if realistic.

COLONIZED VERSUS INFECTED WOUNDS

All open wounds are quickly contaminated by body fluids and normal skin flora. Microorganisms compete for the limited nutrients and oxygen present in the wound. They produce endotoxins and exotoxins that destroy or alter normal cellular activities. In wound care, the level of microorganism presence is commonly categorized from least to most using the following terms: contamination, colonization, critical colonization, and infection. These categories are described below:

- **Contamination:** Contamination is the presence of non-replicating microorganisms on the surface of the wound. Early organisms are often gram-positive, followed later by gram-negative and finally anaerobic organisms. The level of competition for scarce resources and toxin production is low. The body's immune system can manage these organisms; the use of local or systemic antibiotics, as well as topical antiseptics, is not recommended.
- **Colonization:** Colonization is a state where the microorganisms adhere to the surface of the wound and replicate, but still do not inhibit healing. Again, the body's immune system can manage these organisms; the use of local or systemic antibiotics, as well as topical antiseptics, is not recommended.
- **Critical Colonization:** Critical colonization is a state where microorganisms have still not invaded the tissue, but their numbers on the surface of the wound have reached a level that impairs healing, and healing goals will likely not be met. Necrotic tissue that remains in the wound can increase the likelihood of developing critical colonization, but is not necessarily indicative of critical colonization. Because the tissue has not been invaded, the classic signs of infection are not present. Key indicators include:
  - A clean appearing wound that fails to decrease in size over 2–4 weeks
  - Unhealthy-appearing granulation tissue (dull dark red or overly bright red)
  - Tissue that bleeds easily (friable)
  - Exuberant hyperplastic-like granulation tissue
  - Increased drainage and odor
  - An increase in wound bed pain

  Initial treatment of critical colonization is best accomplished with topical antiseptics with a low cytotoxic profile. It is widely accepted that their use does not create the resistance

issues seen with antibiotics, but are effective in resolving the problem). Commonly used antiseptics are listed in in *Table 5*, and additional antiseptics are listed in the section on *Use of Topical Antiseptics*.

- **Biofilms:** The development of a biofilm is a subcategory of critical colonization. It differs in that the microorganisms do not only adhere to the wound surface, but they also group together, often in poly-microbial symbiotic colonies, and secrete a protective hydrated polysaccharide matrix. This matrix is firmly attached to the wound bed and is virtually invisible to the naked eye. The matrix protects the organisms from the body's immune system, as well as from oral, topical, and intravenous antibiotics and most antiseptics. They also become elusive to simple culture techniques. Almost 70% of chronic wounds have biofilms present, whereas biofilms are present in only 6% of acute wounds. Pseudomonas aeruginosa and Staphylococcus aureus are the most common microorganisms that form chronic biofilms.

  Biofilms cause the wound to have a smooth, pink or red appearance. There will be no size reduction with basic supportive wound care. Treatment requires both removal of the matrix and treatment of the organism with antiseptics. There are a number of removal methods; the simplest is to drag the entire wound surface with a curette. It is not necessary to use such force as to cause extensive capillary bleeding, but with enough force to disrupt the matrices. It is often advisable to do this regularly. Scope of practice must be considered when using this technique.

- **Infection:** Infection occurs in wounds when the microorganisms penetrate the surface into the underlying tissue and structures. A classic systemic response is seen in healthy, non-immunocompromised patients. Signs and symptoms include increased erythema, increased and/or change in drainage, odor, increased local warmth of surrounding tissue, edema or induration, pain or tenderness in the wound bed and surrounding tissue, fevers, chills, and leukocytosis. *Wound culture is strongly encouraged prior to the use of antibiotics in order to guide appropriate antibiotic therapy.*
  - ➔ Culture from a tissue biopsy is the gold standard in wound care. However, if local resources include only swab cultures, then use the *Levine method* outlined in *Wound Culture Techniques* below.

WOUND CULTURE TECHNIQUES

Culturing wounds is not generally recommended in the initial steps of therapy unless clinical signs of an infection are present. Cultures are usually reserved for wounds that do not respond after 2–4 weeks of empiric antiseptic therapy, when other contributing factors are reasonably controlled. Wound cultures are done to identify the specific organisms present and their susceptibility to antibiotics.

There are two recommended culture techniques available: tissue biopsy and swab. A gram stain should be ordered for all cultures, in addition to the wound culture sensitivity. Following is a discussion of each type of culture and the appropriate method to use for collection.

- **Tissue Biopsy Culture:**

  Rationale: This culture type is considered the gold standard for wound cultures and is preferred in most cases. Biopsy requires removal of a piece of tissue with a scalpel or punch biopsy.

  Methodology: The procedure is performed by a qualified provider. The suspected wound infection site should be cleansed with normal saline (not povidone-iodine or other antiseptics), anesthetized with preservative-free lidocaine (preferably 1%) as needed, superficially curetted, and a 3mm punch biopsy performed. If curetting is not performed, the top of the biopsy should be cut off with a scalpel and the bottom portion submitted for culture. Potential risks resulting from disruption of the tissue include pain, bleeding, delayed healing, and infection. Procedural guidelines and handling should be in accordance with local institution policy.

- **Swab Cultu**re: Swab cultures detect some of what is growing on the surface of the wound, but also are prone to picking up skin contaminants. Data show that culture of wound exudate, compared with tissue biopsy, has a predictive validity of 60%. If swab cultures must be used, a semi-quantitative culture is recommended where available. A second swab is recommended if a gram stain is ordered. The Levine technique described below is preferred. Scope of practice should be considered when choosing to perform a culture technique.

- **Levine Swab Culture Method**

  Rationale: The Levine method of wound swab culture is used to decrease the chance of picking up skin contaminates.

  Methodology:

  1. Clean the wound with a non-antiseptic sterile solution, preferably normal saline.
  2. Moisten the sterile swab applicator tip with sterile normal saline.
  3. Press the swab tip into the tissue and rotate in a 1 cm by 1 cm area of clean-appearing tissue.
  4. When the swab is saturated, place it in a sterile container, label, and transport according to policy.
  5. For best results, transport culture specimen quickly (within 1 hour) to the laboratory.

USE OF ANTIBIOTICS FOR WOUND CARE: TOPICAL AND SYSTEMIC

Resistance to antibiotics has become a serious problem in recent years, particularly with the rise of epidemic strains of antibiotic-resistant organisms. The overuse of broad-spectrum antibiotics will only serve to exacerbate the situation. It could therefore be argued that all antibiotic use for wound care should be either based on known sensitivities or reserved for emergency situations, and only be used on a specific case-by-case basis.

Antibiotics are chemical substances that are produced by a micro-organism and that have the capacity, in dilute solutions, to selectively kill or inhibit the growth of other micro-organisms. Whereas it is now generally accepted that systemic antibiotics are essential for the management of clinically infected wounds, the choice of antibiotic to be used is not always apparent. Only after a comprehensive assessment process—including consideration of patient characteristics, the results of microbiological investigations, and the identification of both the nature and location of the wound—can the most appropriate antibiotic be identified.

➜ *The routine use of topical antibiotics is not justified for most critically colonized wounds.*

USE OF TOPICAL ANTISEPTICS

Although the term *antimicrobials* is used among wound care professionals to identify topical agents that are not antibiotics, for the sake of clarity, the term *antiseptics* is used in these guidelines.

Antiseptics are topical agents that inhibit the growth and reproduction of microorganisms on the surface of the wound. Although there is indication to use them as adjunctive therapy to antibiotic use in clinically infected wounds, their primary use is as first-line therapy to treat heavily colonized (*critically colonized*) wounds. Antiseptics can be initiated empirically when healing goals have not been met after 2–4 weeks, despite following the basic wound care algorithm or when the signs of critical colonization are found on assessment. Their use is generally limited to 2–4 weeks.

- **Antiseptics with Low Cytotoxic Profiles:** When selecting which antiseptic to use, it is important to balance the agent's effectiveness against the intended microorganisms (bacterial kill) with its potential toxicity (cytotoxicity) to the cells that promote healing in the wound bed. Initial recommendations for antiseptics with low cytotoxic profiles are listed in *Table 5*.

- **Additional Antiseptics Used in Wound Care:** There are also a number of non-pharmaceutical controlled antiseptic dressing categories commonly used by wound care practitioners. The categories include the following: silver impregnated dressings and topical agents; combinations of gentian violet and methylene blue (e.g., Hydrofera Blue®), medical-grade honey (Medihoney®), polyhexamethylene biguanide (e.g., AMD dressings by Kendall™ or Prontosan™).

- **Antiseptics with Higher Cytotoxic Profiles:** These agents are recommended on a case-by-case basis when stabilization is the goal. For clarification about setting goals, see the earlier section, *General Therapy Goals: Healing, Stabilization, and Palliation*. Antiseptics with higher cytotoxic profiles include:
  - Povidone-iodine, any form with a concentration greater than 1%
  - Hydrogen peroxide solution at any concentration
  - Hibiclens® and chlorhexidine in concentrations greater than 0.2%
  - Sodium hypochlorite (Dakin's®) in concentrations of 0.125% or greater

NUTRITION RECOMMENDATIONS FOR WOUND HEALING

Although limited evidenced-based research is available on the topic, there is general professional consensus—published in national guidelines—that *nutrition is an important aspect of a comprehensive care plan for treatment of wounds*. Adequate calories, protein, fluids, vitamins, and minerals are required by the body to maintain tissue integrity, to prevent breakdown, and to support the body's natural healing processes. Nutrition deficiencies may contribute to delayed wound healing, and assessment of nutrition status should be performed in all chronic wound patients who are not meeting healing goals after four weeks of basic wound care interventions.

Members of the primary care provider team are encouraged to perform a basic nutrition assessment, including: **(1)** a dietary recall history, in which the inmate describes the amount, frequency, source (e.g., mainline vs. commissary), and type of food consumption; **(2)** computation of body mass index; **(3)** history of recent weight loss or gain; and **(4)** assessment of glycemic control in the diabetic. Although nutrition deficiency may be readily apparent in the presence of unintentional weight loss, determination of nutrition deficiencies and the person's individual nutrition needs may be complicated by a variety of factors such as body weight, activity level, amputation of a limb, and amount consumed. ***Therefore, a comprehensive assessment of an individual inmate's nutrition needs should be completed by a Registered Dietitian.*** At BOP Medical Referral Centers and FCI Fort Worth, this should be conducted by institutional Registered Dietitians. For inmates at all other BOP facilities, a Central Office Registered Dietitian should be consulted in accordance with the BOP Tele-Nutrition Standard Operating Procedures, available at: *http://sallyport.bop.gov/co/hsd/food_svc/docs/Tele-Nutrition%20Info.jsp*.

If a comprehensive nutrition assessment determines that an inmate's nutrition needs are clinically indicated to be greater than what is available through mainline offerings, then supplemental feeding, medical diet, formulary and non-formulary nutrition, or vitamin and mineral supplements may be administered in accordance with BOP policy, BOP formulary requirements, and the BOP clinical practice guidelines, *Guidelines for Medical Diets* (available at: *http://sallyport.bop.gov/co/hsd/food_svc/docs/Tele-Nutrition%20Info.jsp*).

Note: *Laboratory testing is no longer routinely recommended to assess for general nutrition status, but may be performed on a case-by-case basis when a specific deficiency is suspected.*

USE OF ADVANCED THERAPIES AND SPECIALTY EQUIPMENT

NEGATIVE PRESSURE WOUND THERAPY (NPWT)

Negative pressure wound therapy is commonly called *VAC therapy*, since the KCI Vacuum Assisted Closure® device was the first NPWT on the market and is still the mostly commonly employed brand of the device. However, please note that there are a variety of NPWT devices on the market today. While KCI V.A.C. therapy is described below, this should not be considered a BOP endorsement of this brand over another manufacturer of NPWT.

NPWT uses sub-atmospheric pressure to promote healing by: **(1)** maintaining a moist wound healing environment while removing stagnant wound fluid that may contain pro-inflammatory mediators; **(2)** optimizing wound perfusion by decreasing periwound edema; **(3)** mechanical stretching of the cells, resulting in increased vessel formation (neoangiogenesis) and granulation tissue formation; and **(4)** managing the bacterial colonization in the wound. NPWT can also be used for wound bed preparation and bolstering grafts, incisions, and living skin equivalents.

- **Indications and Contraindications**
  - ***Indications*** are for most wounds types, including chronic wounds, although current evidence for NPWT is limited and inconsistent.
  - ***Contraindications*** include presence of necrotic tissue in the wound bed, untreated osteomyelitis, non-enteric or unexplored fistulae, and malignancy. Use cautiously in patients with unstable hemostasis and exposed vital organs.

- **Guidelines for Use**

  Guidelines for use are brand-specific. Guidelines and application videos for KCI products are available at:
  http://www.kci1.com/KCI1/vac-therapy-application-videos-and-guides

  Select the V.A.C. Therapy System Clinical Guidelines, the Basic V.A.C. Therapy Dressing Application Pocket Guide, or the V.A.C.® Dressing Application Overview for general assistance.

- **Expected Healing Goals**

  In general, NPWT should produce the measurable healing goals of 25% size reduction within 2–4 weeks. If these goals are not attained, it is unlikely that the therapy will be successful. A wound care consultation is advised at this point to consider alternative therapy options.

CLINITRON® AND OTHER SPECIAL SLEEP SURFACES AND SPECIALTY BEDS

Specialty sleep surfaces are commonly used for pressure ulcer treatment and prevention, as well as for large surface area wounds such as burns. The number of specialty sleep surfaces in the United States has grown exponentially over the last ten to fifteen years. They come as overlays, mattresses, and bed replacement systems. They are constructed out of a variety of materials. Since the evidence basis for their use is inconclusive, most of the health care systems in the United States use the guidelines provided by the CMS in *Medicare Policy Regarding Pressure Reducing Support Surfaces – JA1014* (see the CMS link under *References*). In the document, CMS divides support surfaces into three categories, based on indications for use.

In addition, the following indications can be helpful in accommodating individual patient needs: **(1)** condition, number, and location of the wound(s); **(2)** patient activity level and ability to reposition; **(3)** risk for falling or entrapment; **(4)** patient size and weight; and **(5)** the patient's response in terms of healing. The CMS Medicare Policy categories incorporate some of these considerations, including the patient's response to healing.

Air-fluidized therapy is a category of sleep surface that uses filtered air and silicone beads to provide pressure redistribution. It is generally considered the highest level of therapy surface. (The Clinitron is the most common brand used in the United States; however, alternative brands are available.) This bed is usually used for very extreme cases with multiple pressure ulcers, as well as for six weeks after reconstructive flap surgery on the buttocks. The daily rental cost is about $75–$100 a day. It is rarely used for prevention alone or for long-term stabilization or treatment. Long-term rental of a Clinitron or specialty bed for a patient who is not meeting healing goals should be reviewed periodically. Reviews should also be conducted for patients who are not compliant with their plan of care. In either case, consultation with a BOP wound care specialist is recommended to assist with the review. Ultimately, the goal is to match the patient's need with the appropriate support surface.

HYPERBARIC OXYGEN (HBO) THERAPY

Hyperbaric oxygen therapy, in which increased atmospheric pressure is applied in a chamber, has been used to treat a variety of acute and chronic wounds. However, the available evidence has not demonstrated superiority of HBO over other established wound care treatments. At this time, use of HBO for wound therapy with BOP inmates requires secondary medical review.

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APPENDIX 1: PHASES OF HEALING

A brief review of the phases of healing are included to illustrate the complex cellular-chemical processes involved in wound healing. All wounds proceed through these phases. The length of each phase is largely dependent on the size and depth of the wound.

Hemostasis Phase

Hemostasis starts immediately after injury through clot formation and vasoconstriction. Clot formation is followed by a number of significant events. Fibrinolysis and degranulation of platelets within the fibrin clot release growth factors and cytokines that attract many mediators and cells, including leukocytes and fibroblasts, to the wound bed. The brief period of vasoconstriction—and the resulting hypoxia in the wound environment—act as signals to recruit endothelial responder cells and stimulate angiogenesis, which occurs during the *proliferative phase*. Together with the chemical signals, the clotting system initiates the plasma protein systems, the complement system, and the kinin system. The effects of these systems include direct pathogen destruction, as well as activation and regulation of the inflammatory response. These events are central to initiating the entire wound-healing cascade by providing the substances and communication that transition the wound to the next phase of healing.

Inflammatory Phase

The *inflammatory phase* is the immune system's reaction to injury and insult. Inflammation begins shortly after hemostasis. The goal is to remove invading pathogens, as well as necrotic and damaged tissue, to provide a clean wound base in preparation for the *proliferative phase* of healing. Thus, the use of anti-inflammatory medications during this phase should be limited.

Ten to fifteen minutes after injury, vasoconstriction subsides and vasodilatation is induced, which results in the classic inflammatory presentation—signaled by increased redness, warmth, induration, and pain around the wound, as well as white blood cell migration.

Clean-up of the wound environment is largely accomplished through the phagocytic activity of the neutrophils and macrophages that are chemo-tactically attracted to the site of injury. They begin to arrive at the wound site within the first hour after injury and are the dominant cell for the first 2–3 days. Growth factors released by the neutrophils attract additional leukocytes to the area. The neutrophil starts to be replaced by the macrophage as the primary white blood cell in the wound on about the third day after injury.

Macrophages that migrate to the area of injury are activated by the exposure to microorganisms, cytokines, and inflammatory products to increase in size, as well as in the number of enzyme-containing lysosomes and mitochondria, in preparation for phagocytosis. Macrophage activity increases during the later stage of inflammation and functions as the key cellular regulator in both the *inflammatory* and *proliferative phases* of healing.

Macrophages also assist in the clean-up of the wound environment by supporting activation of the specific immune system as antigen-presenting cells to T lymphocytes. T lymphocytes' cytokines also bind to macrophages, thereby enhancing their phagocytic activity. The

culmination of these events leads to a clean wound bed and the dissolution of the original clot, preparing the wound bed for the next phase of healing. Macrophages already have started to secrete growth factors to initiate angiogenesis and granulation tissue formation.

Proliferative Phase

The *proliferative phase* of healing is initiated during the *inflammatory stage*. Cells that regulate the inflammatory stage are also involved in the initiation of the proliferative phase once most of the necrotic and damaged tissue is removed. The goal is to fill the wound defect with new tissue and to restore the integrity of the skin. Wounds that are healing by secondary intention take longer to heal, as the dermis does not regenerate, but is instead filled with connective tissue called *granulation*. Granulation tissue is composed of new blood vessels and connective tissue.

The key processes of the proliferative phase include: the synthesis of the extracellular matrix (ECM) synthesis (largely comprised of collagen and elastin), angiogenesis, wound contraction, and epithelialization. These processes occur concurrently.

The *macrophage* continues as a primary regulatory cell, secreting multiple chemical messengers to attract key components, including fibroblasts and endothelial cells. The wound bed extracellular matrix (ECM), once cleared of necrotic tissue and debris, is also critical in regulation of healing. The ECM provides a three-dimensional scaffold upon which granulation tissue will form. In addition, the ECM provides attachment points for cells in the wound bed to accomplish cellular signaling.

Fibroblasts migrate into the wound bed from the surrounding tissues, in response to the growth factors that are released by degranulated platelets and activated leukocytes (neutrophils and macrophages). Fibroblasts begin to appear in the wound bed toward the end of the *inflammatory phase* and are the predominant cell in the wound matrix. Once fibroblasts arrive at the wound site, growth factors bind to fibroblast receptor sites and trigger intracellular processes that move the fibroblast into the reproductive phase of the cell cycle—thus stimulating proliferation of the fibroblast. Finally, the fibroblasts are converted into “wound fibroblasts” by TGF-ß, a growth factor secreted by macrophages, and promote collagen synthesis and wound contraction.

Restoration of vascular integrity (*angiogenesis*) occurs concurrently. In response to these stimuli, endothelial cells in the vessels adjacent to the wound bed begin to multiply and produce enzymes that create pathways into the ECM. These pathways sprout new capillary tubules that reconnect to vascular channels in the surrounding tissue. Finally, ECM components are deposited to create a new basement membrane within the capillaries.

Wound contraction is necessary for closure of all wounds, but especially in those left to heal by secondary intention. Contraction occurs in the later stages of proliferation. Differentiated fibroblasts called *myofibroblasts* contain bundles of parallel actin and myosin fibers similar to those found in smooth muscle. They contract their fibers while anchoring themselves to the wound bed and neighboring cells.

Epithelialization is the resurfacing of the wound. The primary cell is the *keratinocyte*, derived predominantly from epidermal stem cells located in the bulge area of the hair follicle and the

epidermis at the edges of the wound. Keratinocytes respond to signals from the macrophages, neutrophils, and other factors within hours after injury. Later, they respond to growth factors and oxygen delivered by the newly established vascular network, by advancing in a sheet to reestablish the epidermis. In full-thickness wounds, however, the sheet will be slightly thinner, as it is covering scar and lacks the anchoring structure of undamaged tissue, thus making it more prone to friction injury. The new skin and tissue have a tensile strength of approximately 15% of normal and must be protected from re-injury.

Remodeling Phase

The *remodeling phase* is marked by the activities of growth factors, matrix metalloproteinases (MMPs), fibroblasts, macrophages, and epidermal cells to rebuild scar tissue under the reformed epidermis. The result is increased tensile strength, but decreased vascularity. This process of ECM degradation and deposition begins in the *proliferative* phase and extends for one to two years after closure. As a result, the tensile strength of the scar increases from the initial 15% of normal for the newly formed scar, to 80% of the original pre-injury tissue.

APPENDIX 2: BASIC DRESSING TYPES

There is no one "ideal" dressing for a particular type of wound. The key thing to remember is that all basic dressing types are tools to maintain the principles of basic supportive wound care found in these guidelines. Regular inspection of the wound during dressing changes will reveal whether or not these goals are being met. The major categories of dressings are as follows:

SALINE-MOISTENED GAUZE

Saline-moistened gauze is available as packing strips, sheets of gauze, and as roll gauze. Saline-moistened gauze is used to deliver some moisture to the wound bed. Depending on the amount of saline used or the amount of dry gauze and additional dressings that are applied, it can be used to donate moisture and absorb drainage. It is the simplest type of dressing used in wound care.

A few key points when using saline moistened gauze: **1)** Make sure the actual gauze that is in contact with the wound *does not dry out.* If the gauze does dry out, it should be moistened with saline and allowed to soften prior to removal at the next dressing change. **2)** If saline-moistened gauze is used for packing a wound, the gauze should *loosely* fill the wound cavity. Over-packing can inhibit new tissue growth. **3)** Saline-moistened gauze is *always* covered with a dry dressing of some type and needs to be secured in place.

Note: *Saline-moistened gauze should not be confused with "wet-to-dry" dressings, in which saline moistened gauze is left to dry in a wound bed and is pulled out as a form of non-selective debridement. Wet-to-dry dressings are rarely appropriate, due to the trauma induced to the fragile healing wound bed.*

HYDROGELS

Hydrogels are used to provide moisture to a dry wound. *They should not be used for wounds that have moderate to copious amounts of drainage.* Hydrogel dressings are water in a weak polymer matrix, and are available as a gel or as a sheet (depending on water content) that can be applied to a dry wound. They are used to provide moisture to healing wounds that tend to dry out, as well as to provide moisture to promote autolytic debridement of yellow, brown, or black necrotic tissue. Hydrogels are also used in burn care to provide pain relief over exposed nerve endings in partial thickness burns. ***Key points for use are the same as those listed above for saline-moistened gauze.***

Examples: Intrasite® Gel, Vigilon®, SAF-Gel™, Skintegrity™ Hydrogel

HYDROCOLLOIDS

Hydrocolloids are a combination of gel-forming polymers and adhesives held in suspension, usually with a film or foam backing. They can absorb a moderate amount of drainage, and help retain the wound's natural moisture to provide for healing, especially reestablishment of the skin (re-epithelialization). They are also effective in providing an environment that promotes autolytic debridement of yellow, brown, or black necrotic tissue. They usually come in the form of sheets, which are placed directly over the wound bed. When the dressing absorbs wound fluid, it forms a soft, minimally adherent gel in the wound bed, while the dry dressing in contact with intact

surrounding skin adheres firmly. When applying a hydrocolloid, it is not necessary to first apply a moist dressing over the wound. The wound will provide its own moisture. Dressings are usually changed every seven days, or when the dressing starts to leak or come off. A cover dressing can be used, but is usually not necessary.

Examples: DuoDERM®, Exuderm™

ALGINATES AND HYDROFIBERS

Alginates and hydrofibers are used to absorb moderate to copious amounts of drainage. Their use usually allows dressings to be changed less frequently. Alginates are dressings derived from a highly processed form of seaweed. They present as a white, fibrous material similar in appearance to cotton and come in the form of a flat sheet or rope for packing tunneled wounds. When alginates come in contact with wound fluid, a soft hydrophilic gel is formed, providing a moist wound healing environment. It is not necessary to moisten the dressing before application as it normally absorbs only excess moisture. The wound will provide its own moisture. An additional cover dressing should be used to secure the alginate dressing in place and to allow it to absorb additional drainage. Because wound fluid is required to "activate" the alginates, they are not effective in excessively dry wounds or wounds covered with thick, dry tissue. If the alginate appears to be dried out or adhered to the wound bed, simply irrigating with sterile normal saline will soften it and ease removal. If this repeatedly occurs, then consider using an alternative dressing.

Examples: Sorbsan®, KALTOSTAT®, Maxorb®

Note: *Hydrofibers such as AQUACEL® are similar in appearance and overall function to alginates, but are seen by some as easier to use because they tend to hold their structure better when saturated with fluid. The two types of dressings can be used interchangeably in wounds, with availability, cost, and provider preference being the most common factors in selection.*

FOAM DRESSINGS

Foam dressings are composed of open-cell polyurethane sheets of differing sizes and thicknesses. They are moderately absorbent and also create a moist, non-adherent environment over the wound bed, while wicking away excess fluid to prevent maceration of surrounding tissue. It is not necessary to moisten the dressing before application as it normally absorbs only excess drainage. The wound will provide its own moisture. If the dressing is adhered to the wound bed, moisten with sterile normal saline to ease removal. If this repeatedly occurs, then consider using an alternative dressing. Dressings come both with and without adhesive, so a cover dressing may or may not be needed for retention. Thicker foam dressings provide greater absorption, as well as additional padding over areas prone to trauma from direct pressure such as digits and bony prominences.

Examples: Allevyn®, Optifoam®

TRANSPARENT FILM DRESSINGS

Film, or more properly termed "semi-permeable film," dressings are thin membranes with a gentle adhesive on one side. The membrane is permeable to both oxygen and a small amount of moisture vapor. The ability of oxygen to pass through the layer helps to inhibit the growth of anaerobic bacteria. Film dressings are used to retain the wound's natural moisture to provide for healing, especially reestablishment of the skin (re-epithelialization). It is not necessary to moisten the dressing before application. The wound will provide its own moisture. They are also effective in providing an environment that promotes autolytic debridement of yellow, brown, or black necrotic tissue. These dressings are also effective when used over grade I or II pressure ulcers to prevent further breakdown from friction and shear. Due to their very limited ability to either absorb fluid or allow significant amounts of fluid to pass through, film dressings are not indicated for wounds with moderate to copious drainage. However, for moderately draining wounds, larger size film dressings can be used effectively as cover dressings over more absorptive dressings such as foams or alginates.

Examples: OpSite®, BIOCLUSIVE®, Tegaderm®, Suresite™

APPENDIX 3: DURABLE MEDICAL EQUIPMENT (DME) RESOURCES

Throughout these guidelines, various categories of durable medical equipment (DME) are recommended. A range of manufacturers make products that meet the specifications for each category. Below is a list of the categories and a sampling of different brands that are available. Their inclusion here should not be considered an endorsement of these specific brands. They are included merely as examples of DME to assist BOP health services departments.

1. **GROUP 1 SUPPORT SURFACE:**

   Defined by CMS as a mattress replacement or an overlay added to the current mattress that meets specifications to provide pressure redistribution in bed as part of a more comprehensive strategy to prevent pressure ulcers while in bed.

   - EHOB WAFFLE® Mattress Overlay
   - Gaymar Sof•Care® II
   - Span-America Geo-Matt®
   - KCI TheraRest® SMS
   - Hill-Rom Tempur-Pedic® Mattress

2. **WHEELCHAIR SKIN PROTECTION CUSHION :**

   Defined by CMS as offering at least 4 cm of immersion; comes in various sizes.

   - ROHO High Profile® Cushion with Cover
   - Supracor Stimulite® Classic Cushion

3. **WATERPROOF SHOWER CUSHION:**

   - SkiL-Care™ Sittin' Pretty Foam Cushion

4. **ELASTICATED TUBULAR BANDAGE SIZE F:**

   - Mölnlycke Healthcare Tubigrip® Elasticated Tubular Bandage
   - Medline Medigrip™ Elasticated Tubular Bandage

5. **WOUND HEALING SHOE:**

   - DARCO® PegAssist™ Insole System (requires a cloth DARCO type shoe)
   - DARCO® WCS™ Wound Care Shoe System

6. **MEDICAL FOOTWEAR:**

   - Propét USA M4070 Village Walker
   - Propét USA Stability Walker
   - Propét USA Ped Walker (consider if moderate-to-severe toe deformity)

APPENDIX 4: PATIENT EDUCATION HANDOUTS

The following pages contain four patient education handouts on the topics listed below. They are designed to be printed out and distributed to patients so they can better understand their medical conditions and how they can contribute to their own healing—and help prevent further complications.

The handouts cover the following conditions:

- *Pressure Ulcers*
- *Arterial Insufficiency*
- *Venous Insufficiency*
- *Neuropathic (Diabetic) Foot Disease*

Pressure Ulcers: Prevention and Treatment

What Are Pressure Ulcers?

Pressure ulcers are often called "bed sores" because they were commonly found in people who were lying in bed or sitting too long in one position, without relieving the pressure on bony areas of the body. Unrelieved pressure over a bony area for as little as an hour can decrease blood flow and deprive the tissue of the oxygen it needs—similar to how kinking a water hose can cut off the flow of water. In the case of the body, when the blood flow gets too low, tissue and skin can die. You do not have to be skinny to develop a pressure ulcer. Even people with a lot of muscle and fatty tissue can develop these ulcers.

Common Locations for Pressure Ulcers

Pressure ulcers can develop on the heels, ankles, tail bone, elbows, hips, lower buttocks, or any area where there is direct pressure (such as from sitting or lying) over a bony area of the body.

Prevention of Pressure While Lying in Bed

- Change positions every 2 to 4 hours. (You may need to set an alarm to remind yourself.)
- Avoid lying on bony areas of your body. If lying on your side, turn just enough that you are on the thickest part of your buttocks.
- Keep the head of your bed as low as possible. Flat is best.
- If you have a pressure ulcer on your heel, or you have a spinal cord injury, make sure your heels do not rest on the bed or touch the end of the bed. Lift them up by putting blankets or pillows behind your calves. You can also use special pressure relief boots. Use what has been issued to you by your health care practitioner.

Prevention of Pressure While Sitting in a Chair

- Limit time in your wheelchair to 4 hours (or less), if possible. Take at least an hour break by lying in bed between these times in your wheelchair. This may make it easier to heal your pressure ulcer.
- Special cushions for your wheelchair are not enough to prevent you from getting pressure ulcers. If you are issued a special cushion for your wheelchair that contains air, check it often (at least daily) to make sure it is properly inflated. Please notify the medical team as soon as you notice a problem with your wheelchair cushion.
- Doing special exercises called "Pressure Reliefs" every 15 minutes are very important, even if you have not had ulcers in the past. Lift yourself up for 1 full minute so that your buttocks are not touching the cushion under you. If you cannot do this, then lean forward for 1 full minute so that the pressure is on the back of your thighs, not your buttocks. (You may need to set an alarm to remind yourself.)

- Posture while sitting is important! Sit up straight in your wheelchair or chair. Leaning to one side can increase pressure (and slow the blood supply), which could cause an ulcer or prevent an existing ulcer from healing.
- If you use a wheelchair and do not have a pressure ulcer on your heel or foot, always wear shoes with a firm bottom to prevent getting pressure ulcers on your feet.
- If you use a wheelchair and already have a pressure ulcer on your heel or foot, and are issued a special boot to keep your foot from resting on the foot pedal, be sure to use the boot consistently.
- If you have a spinal cord injury or a sitting ulcer, you may be issued a waterproof shower pad for the shower. Sitting on a hard bench makes ulcers hard to heal. It also makes it easier to get pressure ulcers.

Important Tips

- Check your skin at least daily, preferably using a mirror for areas that are hard to see. (Mirrors may be available through commissary. The availability of mirrors is governed by local institutional policy.)
- If you notice a change in skin color or a scab over a bony area, you may have a pressure ulcer.
- If you notice blood or drainage on your clothing, you may have a pressure ulcer.
- Stopping an ulcer from getting worse is important! Sign up for sick call as soon as possible.

Arterial Insufficiency

Arterial insufficiency is a disease that most often affects the lower legs, and may tend to run in families. It is called "lower extremity arterial disease" or "atherosclerotic disease." Over time, the same conditions that cause people to have narrowing in the arteries of the heart can also affect the arteries that carry blood to the legs. If you have had a heart attack or surgery to open the vessels in your heart, you may have arterial insufficiency in your legs, as well.

Common Causes of Arterial Insufficiency

- Overweight
- High blood pressure
- Elevated lipids (fats) in your blood
- Poorly controlled diabetes
- Tobacco use (smoking or other forms)

Signs & Symptoms

- Hair loss on your legs and feet
- Thick, brittle toenails
- Pale, thin, easily bruised skin
- Pale, cool skin on your legs or feet
- Cramping pain that develops in the calves after walking for a few minutes, especially when the pain goes away after resting
- Legs turning dark red when below the level of your heart (a sign of advanced arterial Insufficiency)

What You Can Do

- Protect your legs from injury with extra padding or clothing.
- Use properly fitting footwear and socks or stockings that are not tight around your legs.
- Examine your feet daily for blisters, wounds, and skin or nail changes.
- Increase physical activity as much as you can tolerate—unless you have been counseled by your medical team to limit or stop walking.
- Apply a lotion to your legs to keep the skin from becoming too dry.
- *DO NOT* cross your legs.
- *DO NOT* elevate your legs above your heart when in bed—unless instructed to do so by your medical team.
- *DO NOT* soak your feet.
- *DO NOT* go barefoot (even for short distances).
- Avoid temperature extremes (heat or cold) to your legs and feet.

Follow the recommendations of your medical team regarding:

- Healthy body weight
- Blood pressure control
- Decreasing your blood lipids (fats)
- Blood sugar control (if diabetic)
- Protective footwear
- Avoiding pressure to your heels and toes

Report to Sick Call Quickly If …

- You develop corns or callouses (do not wait until these become open wounds).
- You notice redness or drainage, or suspect you may have an ingrown toenail.
- You discover ulcers (open sores), blisters, or skin changes on your feet or legs.
- You have an injury to your legs or feet.

Venous Insufficiency

What Is Venous Insufficiency?

Venous insufficiency is a disease that most often affects the lower legs. It is also called "lower extremity venous disease." Over time, the vessels that return blood from the feet to the heart become stretched and damaged. These vessels (veins) have one-way valves that stop working properly, causing blood to pool or stay in the legs instead of moving back to the heart. There are many reasons that this happens, including:

- Genes inherited from parents
- Being overweight
- Damage to the leg vessels from blood clots, surgery, or injury
- Any condition that makes it difficult to walk

Signs & Symptoms

Signs of venous insufficiency include:

- Development of big, ropy veins that can be seen or felt in the legs
- Swelling in the lower legs and feet
- Brown or red color changes to skin
- Itchy dry skin

Once venous insufficiency develops, it cannot be cured. Venous insufficiency is progressive and will worsen over time if it is ignored. Eventually, ulcers (open sores) can develop on the lower legs. When ulcers develop because of venous insufficiency, the skin around the ulcer is usually red or discolored and warm/hot to the touch. The exact reason for this is still not understood, but it does not usually indicate an infection unless you have a fever, chills, or changes in your blood work showing an infection. ***If you develop an ulcer, report to sick call immediately!***

The good news is that venous insufficiency, and the ulcers that may result from it, can be controlled—so don't wait to start treatment.

Treatment

Unless advised differently by your medical team, you will need to wear compression for the rest of your life. Compression keeps venous insufficiency from becoming worse and developing into ulcers. It also helps the existing ulcers to heal.

Compression comes in many varieties including stretchy elastic socks and different types of wraps. If you apply the compression yourself, put it on first thing in the morning when you wake up and leave it on until you go to bed. If your compression is applied by medical staff, keep it in place, protect it from getting wet, and come back as instructed for routine changes.

Bathing

Be sure to use a shower cast bag, or plastic bags and tape, to keep your compression dressings dry when bathing. Do not remove the dressing unless it gets wet or you notice that your toes have become discolored, swollen, or painful. If you remove the dressing for any reason, please notify your medical team.

Skin Care

If you put on your own *compression stockings each day, apply a moisturizer to the legs.* Moisturizers should be applied lightly in the morning before applying your compression stockings, and generously at bedtime after removing them. If you have open ulcers and only remove your compression once or twice a week, apply a moisturizer before having the compression replaced. Petroleum jelly is a good alternative. The best treatment for itchy, dry skin is to consistently wear your compression garments.

What You Can Do

- Commit to lifelong use of compression therapy.
- Guard your legs from injuries; protect your legs with extra padding or clothing.
- Avoid crossing your legs.
- Avoid sitting for prolonged periods of time.
- Walk as much as you can tolerate because it helps move blood out of the legs and back to the heart.
- Manage your weight. If you are overweight, ask your medical team for advice on weight loss.
- Do not smoke—it interferes with blood flow, worsens the problem, and interferes with healing.

Neuropathic (Diabetic) Foot Disease

What Is Neuropathic Disease?

Neuropathic disease affects the nerves in the feet. It is also called "lower extremity neuropathic disease" or "diabetic foot disease," because it most often happens to people with diabetes. However, people with any type of nerve injury can develop neuropathic disease.

When the nerves in the foot become damaged, the skin on the foot is less able to detect touch, and sometimes the foot gradually changes shape. The foot may also become dry and develop a numb or prickly feeling. When this happens, it is difficult for your foot to sense pain or injury caused by wearing ill-fitting shoes or walking on an object that has fallen into your shoes, for example. Also, dry skin can crack and make it easier to develop infections. These problems can make it easier for ulcers (open sores) to develop, which can sometimes lead to amputations.

Neuropathic disease is progressive and will worsen over time—if it is ignored. ***The good news is that, with proper care in most cases, neuropathic disease can be controlled and ulcers and amputations can be prevented.***

Signs & Symptoms

- Changes in the shape of the foot, like clawing of the toes or fallen arches (flat feet)
- Change in the ability of the skin to feel light touch
- Feelings of numbness or prickling ("pins and needles")
- Skin becomes thinner and dry
- Loss of hair on lower legs, feet, or toes
- Callouses or corns on the toes or bottoms of the feet

What You Can Do

- Work with your medical team to control your blood sugar if you are diabetic.
- Wash your feet daily; dry well (especially between your toes). ***DO NOT*** *soak your feet!*
- Apply a moisturizer or petroleum jelly on legs and feet daily***.*** ***DO NOT*** *put moisturizer between your toes!*
- Wear only clean, dry socks. It is best to change socks every day.
- Make sure socks and shoes are completely dry before you put them on.
- Check your shoes before you put them on. Make sure nothing has fallen into them.
- If your feet swell, make sure your shoes still fit and are not too tight.
- If you have been issued medical shoes, wear them whenever you are out of bed. ***DO NOT*** *walk barefoot!*
- ***DO NOT*** *try to cut corns or callouses yourself.* Report to sick call for help. Try to keep your skin clean and well-moisturized.

- Don't cut your toe nails too short. Cut them so that the end of the nail is the same shape as your toe.
- Check your feet at least daily for cuts, blisters, callouses, corns, cracks or ulcers, and red areas around your toenails. Check your socks or shoes for blood or drainage. *If you find any of these conditions, report to sick call.*

  Using a mirror can be helpful for checking your feet. Mirrors may be available through commissary. The availability of mirrors is governed by local institutional policy.
- If you are a spinal cord injury patient, stretch your ankles and toes each day to keep them flexible and to prevent them from becoming stiff.

If You Have a Foot Ulcer (Open Sore) …

- If you have been issued a wound healing shoe, wear it whenever you are out of bed (even if only walking short distances).
- If you have been issued a wheelchair, use it whenever possible to limit standing or walking.
- Keep all of your call-outs and medical appointments.
- *Report to sick call IMMEDIATELY if you develop any of these symptoms: fever, chills, flu-like symptoms, discolored skin around the wound, or your skin feels hot to the touch!*

Tips on Purchasing Footwear

- Feet change over time. The size shoes you wore when you were younger may not be the size shoes you need to wear today. It is important that shoes are the right length, width, and shape for your foot. Your shoes should allow for some "wiggle room" for your toes.
- If the last pair of shoes you wore was a size 11, for example, don't assume that a pair of size 11 shoes you select from commissary will fit you the same way.
- Your feet are *NOT* the exact same size. Select a pair of shoes that are as big as your largest, longest, or widest foot.
- ***Here is an easy way to determine proper sizing of your shoes:***
  - In the evening (your feet are slightly larger at the end of the day, so this is the best time to measure them), place your bare feet down on separate sheets of blank paper. With a pencil or pen, trace an outline of each of your feet.
  - Bring these tracings with you when you buy your shoes. When purchasing shoes, allow for a ½ inch space beyond your longest toe and the end of the shoe. Make sure that the shoes are wide enough for your feet. Also, if you have clawed toes, make sure that the toe end of the shoe is deep enough so that the tops of your toes don't touch the shoes. Try to select shoes that match the shape of your feet.
  - Following these suggestions will help you determine whether the pair of shoes you are thinking of buying from commissary are the proper fit for your feet.