HEAL UNIVERSITY
A Division of United Wound Healing

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Beyond the Basics of Wound Care: Integrating Advanced Modalities in Clinical Practice

Disclaimer

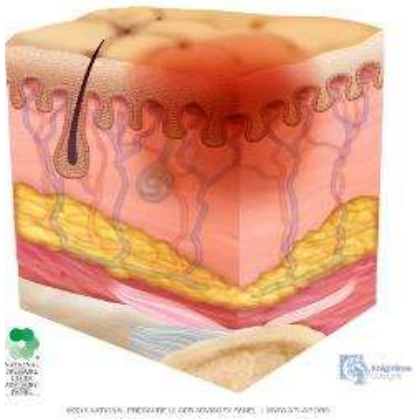
This information is provided for informational purposes only. Patient care decisions should be based on relevant clinical guidelines, including current evidence-based literature, state and federal guidelines (CMS), and facility protocols.

*Decisions for wound management should be based on a holistic review of the patient's clinical condition. The clinical team members are encouraged to rely on their training and expertise, as well as **all** available clinical and other pertinent information, prior to making treatment decisions for any individual patient.*

Pressure Injuries

Stage 1 Pressure Injury:
Intact Skin

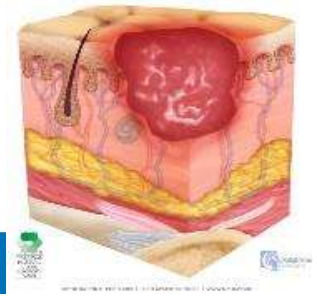
Intact skin with a localized area of non-blanchable erythema (redness). In darker skin tones, the PI may appear with persistent red, blue, or purple hues. *The presence of blanchable erythema or changes in sensation, temperature, or firmness may precede visual changes*.



Stage 1 Pressure Injury with Edema

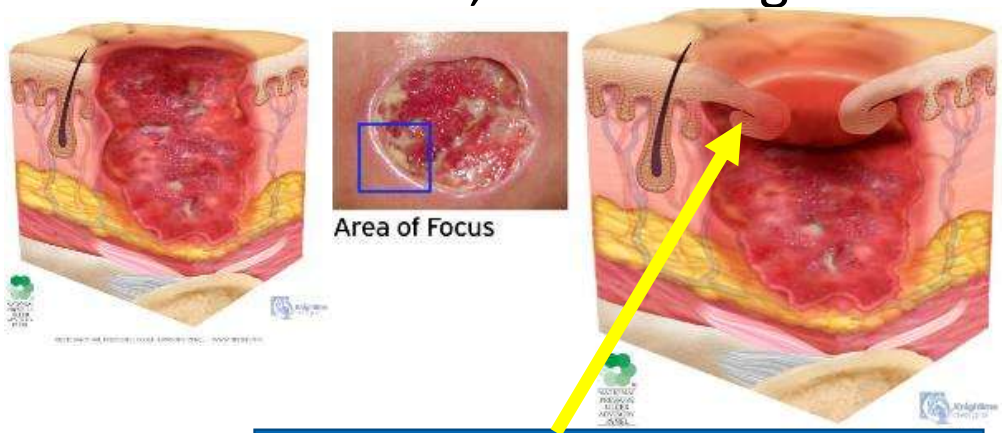
Stage 2 Pressure Ulcer:
Partial-thickness Skin Loss with Exposed Dermis

- Presenting as a shallow open ulcer.
- The wound bed is viable, pink or red, moist, and may also present as an intact or open/ruptured clear fluid-filled blister.
- Adipose (fat) is not visible and deeper tissues are not visible.
- Granulation tissue, slough and eschar are not present.
- *This stage should not be used to describe moisture associated skin damage, medical adhesive related skin injury, or traumatic wounds (skin tears, burns, abrasions).*



Stage 3 Pressure Ulcer:
Pressure Injury: Full-thickness Skin Loss

- Full-thickness loss of skin, in which subcutaneous fat may be visible in the ulcer and granulation tissue and epibole (rolled wound edges) are often present.
- Slough and/or eschar may be visible but does not obscure the depth of tissue loss.
- The depth of tissue damage varies by anatomical location; areas of significant adiposity can develop deep wounds.
- Undermining and tunneling may occur.
- Fascia, muscle, tendon, ligament, cartilage and/or bone are not exposed.



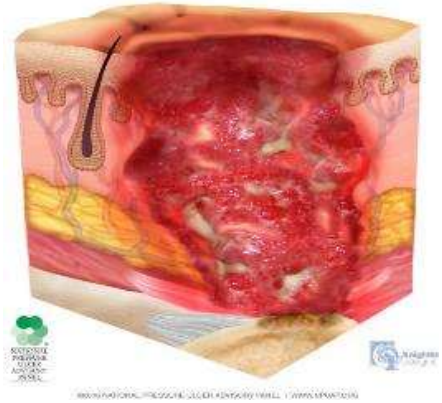
Stage 3 pressure injury with epibole (rolled edges)

Stage 4 Pressure Ulcer: Full-thickness Skin & Tissue Loss

- Full-thickness skin and tissue loss with exposed or **directly palpable** fascia, muscle, tendon, ligament, cartilage or bone in the ulcer.

- Slough and/or eschar may be visible. Epibole (rolled edges), undermining and/or tunneling often occur.

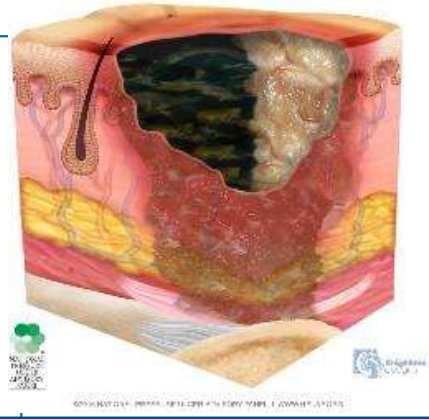
- Depth varies by anatomical location.



NOTE: Wound base does **NOT** need to be completely free of necrotic tissue. If you can see the wound base you should be able to stage.

Unstageable Pressure Ulcer - Obscured Full-thickness Skin & Tissue Loss

- Full-thickness skin and tissue loss in which the extent of tissue damage within the ulcer cannot be confirmed because the wound bed is obscured by slough or eschar.
- If the slough or eschar is removed, a Stage 3 or Stage 4 pressure ulcer will be revealed.
- If the anatomical depth of the tissue damage involved can be determined, then the reclassified stage should be assigned.
- **The pressure ulcer does not have to be completely debrided or free of all slough or eschar for reclassification of stage to occur.**



Unstageable Pressure Injury due to Eschar & Slough

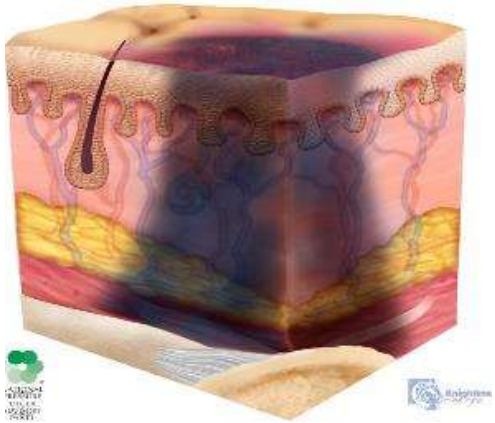
Unstageable Pressure Injury due to Eschar

Deep Tissue Pressure Injury (DTPI): Persistent Non-blanchable Deep Red, Maroon or Purple Discoloration

- Intact skin with localized area of persistent non-blanchable deep red, maroon, purple discoloration due to damage of underlying soft tissue.
- This area may be preceded by tissue that is painful, firm, mushy, boggy, warmer or cooler as compared to adjacent tissue.
- This injury results from intense and/or prolonged pressure and shear forces at the bone-muscle interface.
- The wound may evolve rapidly to reveal the actual extent of tissue injury, or may resolve without tissue loss.

- *Once a deep tissue injury opens to an ulcer, reclassify the ulcer into the appropriate stage.*
- *Do not use DTPI to describe vascular, traumatic, neuropathic, or dermatologic conditions.*

Deep Tissue Pressure Injury Examples



Deep Tissue Pressure Injury in Evolution

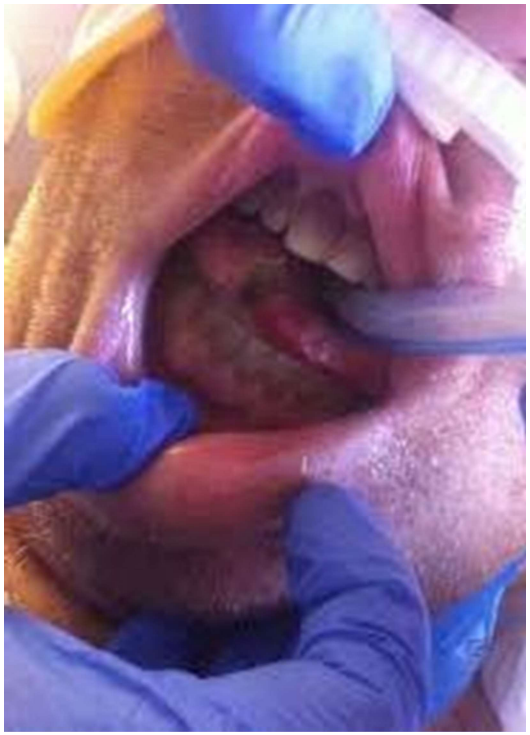
New Definition in SOM
Medical Devices Related Pressure Injury

This definition describes an etiology.

- Medical device related PU/PIs result from the use of devices designed and applied for diagnostic or therapeutic purposes. The resultant pressure injury generally conforms to the pattern or shape of the device. **The injury should be staged using the staging system.**

New Definition in SOM
Mucosal Membrane Pressure Ulcer/Injury

- Mucosal membrane PU/PIs are found on mucous membranes with a history of a medical device in use at the location of the injury. Due to the anatomy of the tissue, these ulcers cannot be staged.

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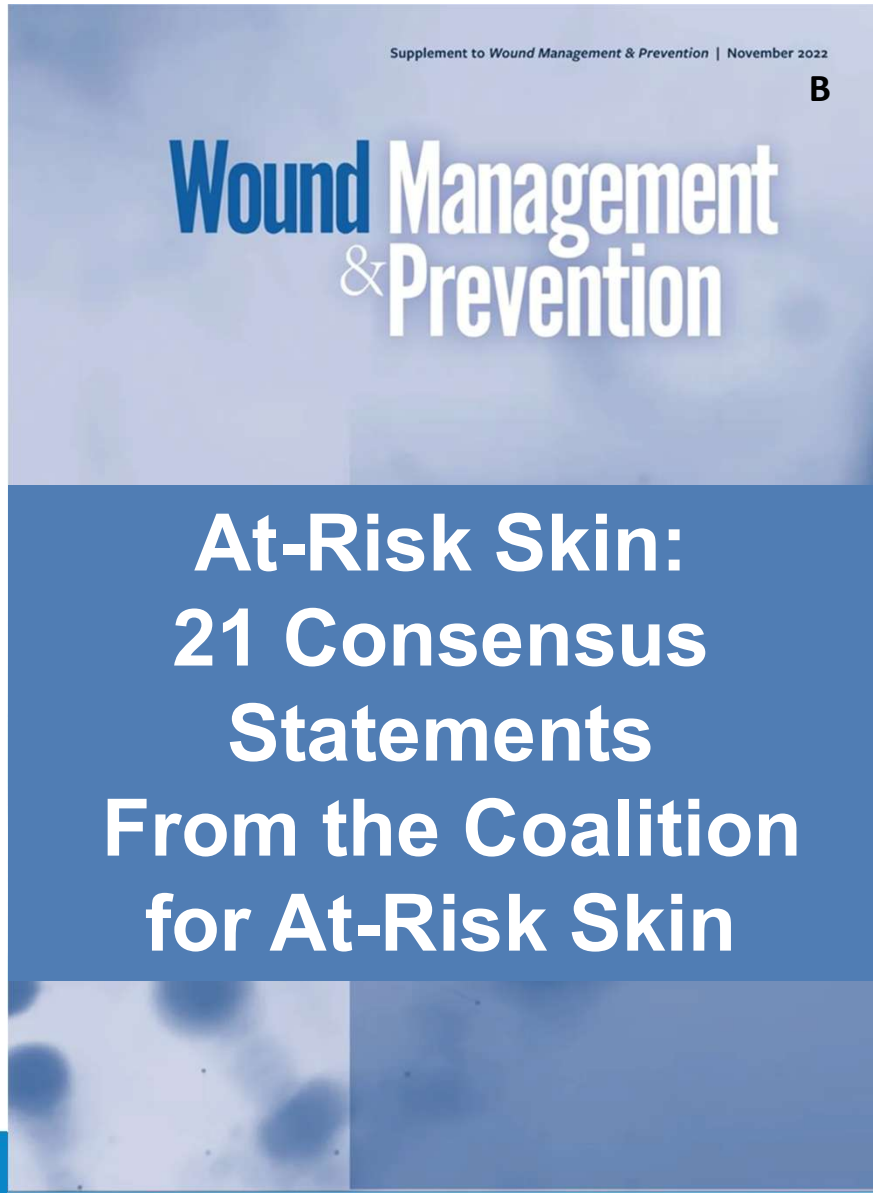
First Step in the Prevention of PU/PI

Identification of the resident at risk of developing PU/PIs.

This is followed by implementation of appropriate individualized interventions and monitoring for the effectiveness of the interventions.

Updated Perspectives on Skin Health

Component of PU/PI and Skin Tear Prevention Programs



Category 1	Definition of “At-Risk Skin”
Category 2	Practice considerations for skin health or at-risk skin
Category 3	Moisturizers and their role in skin health
Category 4	Practice considerations for moisturizers and skin barriers
Category 5	Special population considerations to promote skin health
Category 6	Organizations perspectives or considerations
Category 7	Skin health is important for everyone

Category 1

At-Risk Skin is defined as:

"The potential for impaired barrier function of the skin due to associated intrinsic or extrinsic risk factors, conditions, and comorbidities."

At-risk skin may occur at any stage in life, early in life, at advanced age, or at end of life.

Recognition of At-Risk Skin

The Question IS:

Who in your care does NOT have AT-RISK SKIN???

Present on Admission

"As close to the actual time of admission as possible."

NOTE: Many of the over 100 PU/PI risk factors are the same for other skin-at-risk issues.

CMS SOM F686

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Skin Health Begins PRIOR TO ADMISSION

- Each existing PU/PI be identified
- Whether present on admission or developed after admission
- Identify factors:
  - Influenced development of PU/PI
  - For potential for development of additional PU/PI
  - Causing the deterioration of PU/PIs
- All factors be recognized, assessed and addressed
- Any new "facility acquire" PU/PI suggests a need to reevaluate the adequacy of prevention measures in the resident's care plan

Category 2

Practice Considerations for Skin Health or At-Risk Skin

- **All persons should have an evaluation to determine if they have at-risk skin.**
- Individuals who are immobile and chronically ill are susceptible to developing at-risk skin conditions such as:
  - Pressure Injuries,
  - Incontinence Associated Dermatitis (IAD),
  - Skin Tears,
  - Intertriginous Dermatitis (ITD) (inflammation of skin fold).

Stage 3 PU

IAD

Skin Tear

Intertrigo

Common Risk Factors Associated with At-Risk Skin:

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- **Age >65 yrs**
- Anticoagulant use
- Atopic Dermatitis, Eczema, or Xerosis
- **Cognitive Impairment**
- Contact Dermatitis
- Drugs, Alcohol, or **Tobacco use**
- Emotional Stress
- **Endocrine disorders (DM, thyroid)**
- **History of corticosteroid use**
- **Impaired mobility**
- Incontinence
- **Lack of sleep**
- Malnutrition and dehydration
- Open wounds or fistulas
- Physical stress
- Polypharmacy
- Social determinants
- **Use of medical devices** or PPE

There are over 100 risk factors for PU/PIs!!!

Category 3

Moisturizers and Their Roles in Skin Health

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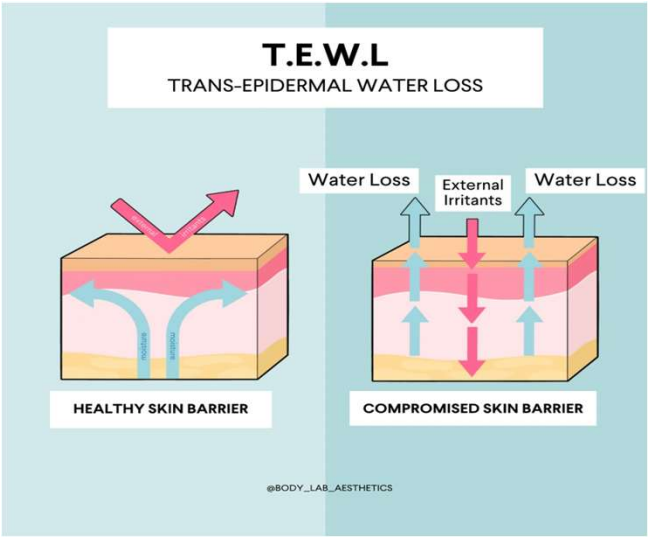
- For individuals with at-risk skin, **creams or ointments** are preferred to improve skin barrier function by decreasing **transepidermal water loss (TEWL).**
- **Lotions may be drying (have alcohol as ingredient) and therefore may not achieve the desired effect.**



Moisturizers

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Function to improve skin barrier integrity by :

1. Reducing water loss
2. Improving/restoring the skin barrier
3. Maintaining the lipid structure of the stratum corneum

Moisturizers commonly have a combination of the following…

3 Ingredients/Properties:

1. **Emollients**= *trap moisture in the skin and reduce water loss*
2. **Humectants**= *draw moisture from the dermis to the epidermis*
3. **Occlusives**= *oil base creates a hydrophobic barrier over the skin BLOCKING water loss*

Examples of Each Ingredient

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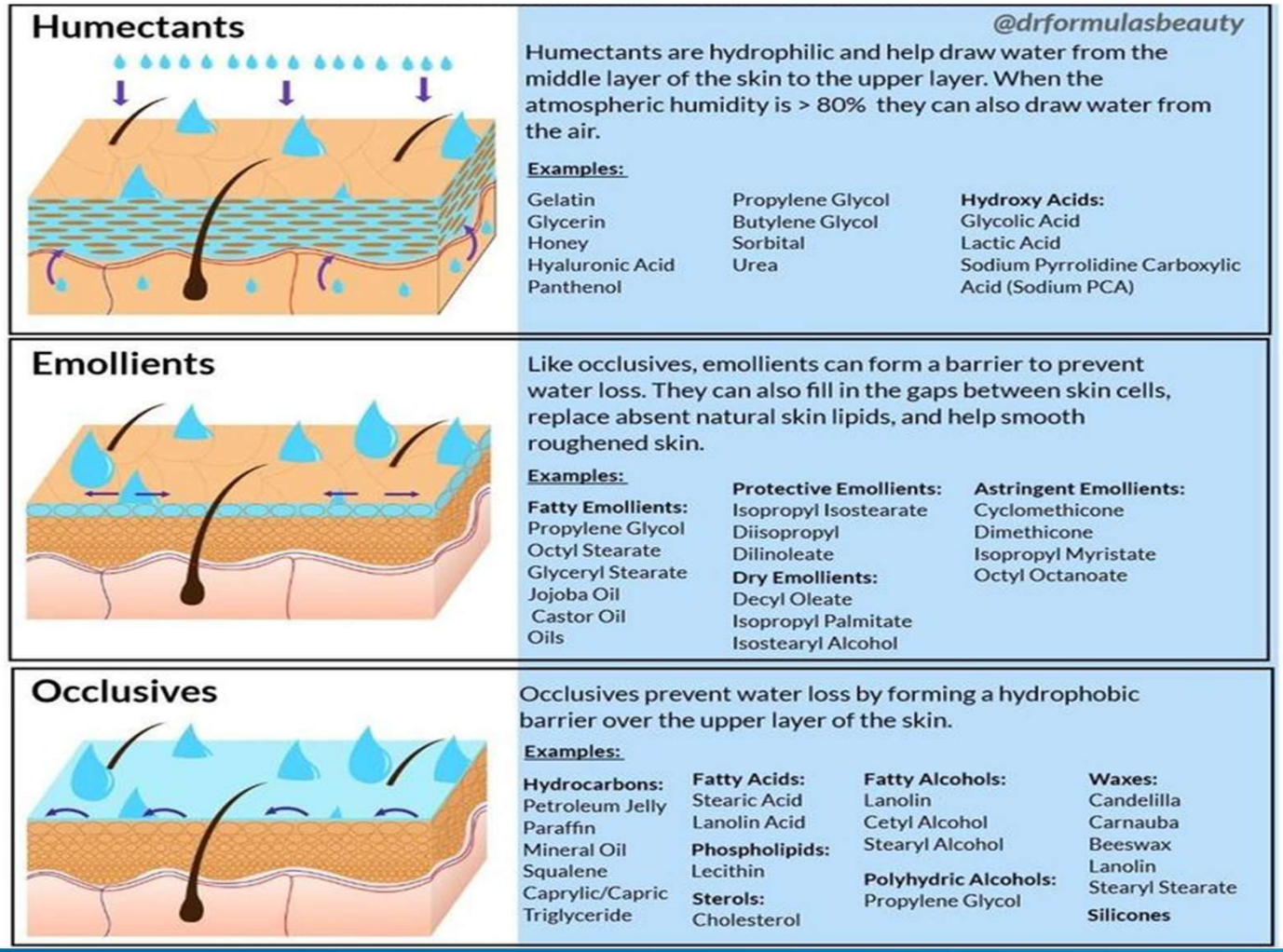

Humectant Examples
Glycerin
Honey
Hyaluronic Acid
Glycolic Acid

Emollient Examples
Castor Oil
Jojoba Oil
Dimethicone

Occlusive Examples
Petroleum Jelly
Lanolin
Beeswax
Silicones

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Category 4

Practice Considerations for Moisturizers and Skin Barriers

- For individuals with at-risk skin, a moisturizer should be applied daily at minimum and always after bathing
- Twice daily moisturization has been demonstrated to show additional benefits
- Typically, moisturizers are applied to the hands, arms, legs, and face unless applied after bathing
- **Approximate amount needed for a single application of moisturizer to the entire standard-sized adult body is 30 g or 1 oz.**

Total Body Surface Area

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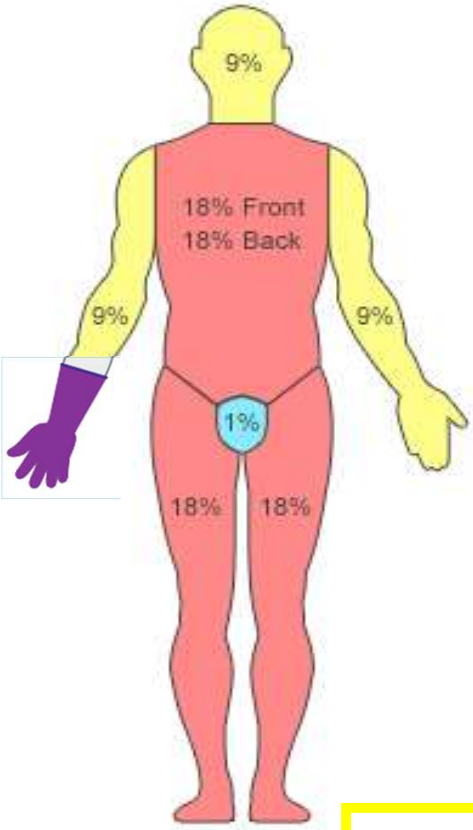

Head	9%
Each arm	9%
Anterior torso	18%
Posterior torso	18%
Each leg (hip-ankle)	18%
Genitals/perineum	1%
Entire foot	2.5 %

Percentages based on Rule of 9's

- Most facilities fall far short of the 2-applications per day of 1 oz to average-sized adult's skin
- **Study shows less being purchased by facilities than amount needed to treat half the arm of an average individual.**

- Skin barrier disruption in its early stages **may be invisible to the naked eye,** and erythema suggests that an inflammatory response **has already occurred**."
- "Proper skin care should be initiated before the appearance of erythema"

Clopp T, Rogers C, Koshy T. Moisturizers and barriers in the post-acute setting: we're not using enough! Poster presented at: Wild on Wounds Conference; September 7-10, 2022; Hollywood, FL.

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Advanced Modalities in Wound Care

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SEM scan

SEM

- Allows targeted interventions to support reductions of pressure injury incidence
- Inflammatory response to deformation is part of the damage cascade
- Damage occurs at the cellular level **before skin color changes are** visible
- Subepidermal moisture is one of the earliest signs of cell death
- SEM Scanner differentiates between healthy and inflamed tissue providing an objective and anatomically specific measure of pressure injury risk

Sacrum and Heels: Two areas of body MOST at risk for PU/PIs in the LTC Setting

Subepidermal Moisture the *FIRST* Indication of Tissue Damage

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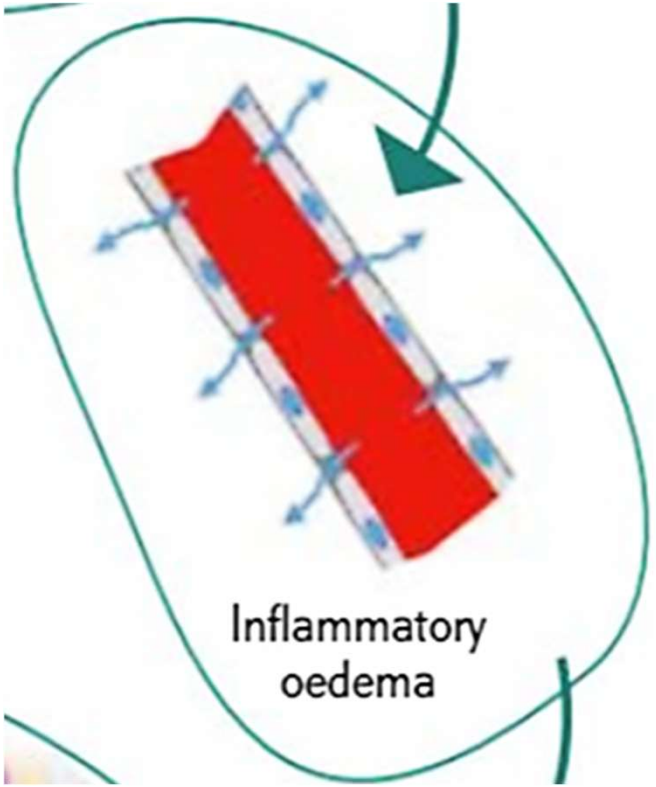
- SEM = **S**ub**E**pidermal **M**oisture
- Measures inflammatory edema under skin from pressure induced cellular damage
- Will **identify edema 5 days earlier** than visual skin assessments
- **Regardless of skin tone!!!**
- This device changes Present of Admission opportunities to pick up early pressure damage before visually apparent



1. Okonkwo H. et al. (2020). A blinded clinical study using a subepidermal moisture biocapacitance measurement device for early detection of pressure injuries. Wound Repair and Reg 2020;1-11.
2. Bates-Jensen, B. M., Mccreath, H. E. & Pongquan, V. (2009). Subepidermal moisture is associated with early pressure ulcer damage in nursing home residents with dark skin tones: pilot findings. J Wound Ostomy Continence Nurs, 36, 277-84.
3. Gershon, S. & Okonkwo, H. 2021. Evaluating The Sensitivity, Specificity And Clinical Utility Of Algorithms Of Spatial Variation In Sub-epidermal Moisture (SEM) For The Diagnosis Of Deep And Early-stage Pressure-induced Tissue Damage. J Wound Care, 30, 41-53.

Ankle Brachial Index & Toe Brachial Index; Assessing Vascularity

Assessing Vascularity
A Practice Standard

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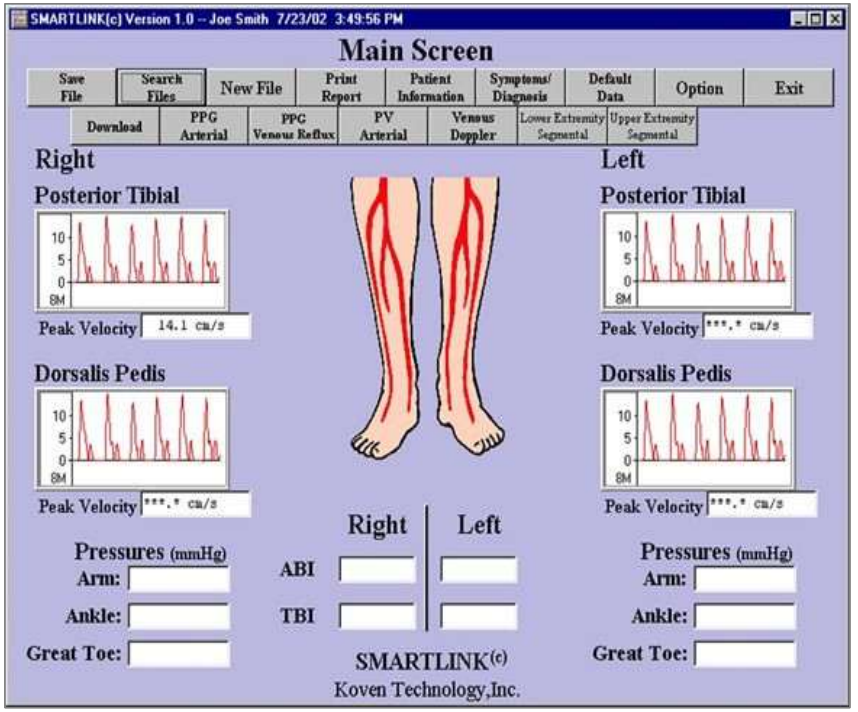
- Vascularity is required for lower extremity wounds to heal
- All legs with hard-to-heal ulcers and/or tissue loss should have vascular studies
- Non-invasive studies can guide clinicians with treatment decisions related to safety and potential for healing
- Non-invasive vascular tests can aid clinicians with decisions for referrals to vascular surgeons
- Pedal pulses are inadequate to determine ability for lower extremity wounds to heal
- Standard of care for compression to be safe and effective is at minimum ankle-brachial index studies performed (toe-brachial pressures added in people with diabetes)

Ankle Brachial Index

$$\frac{\text{“A”nkle}}{\text{“B”rachial}} = \text{“I”ndex}$$

- Also known as “ABI”
- Ankle pressure / arm pressure = ABI
- Correlation of ABI values with pain and tissue loss
- Must interpret with caution in diabetics because of non-compressible vessels



Diabetes and Non-Compressible Vessels

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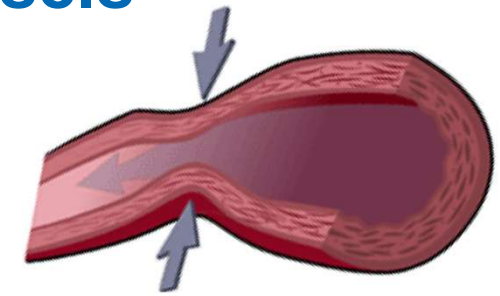
- Diabetes and diabetic vasculopathy leads to medial calcific stenosis
- Causes non-compressible vessels
- Elevated ankle blood pressures cause falsely elevated indices
- Greater than or equal to 1.4 = falsely elevated
- Greater than 250 mm Hg at any given level is considered non-compressible
- So, what do we do?



Compressible vessel

VS

Non-compressible vessel

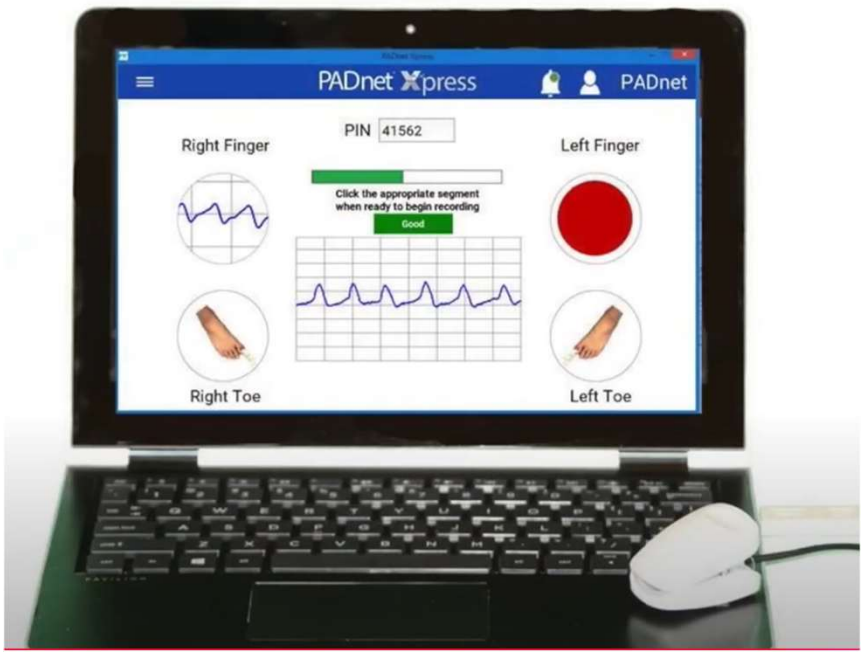
Gerhard-Herman MD, et al. 2024 ACC/AHA guideline for the management of lower extremity peripheral artery disease. *J Am Coll Cardiol.* 2024.

Toe Brachial Index = TBI

- Use next unaffected vessels: Digital Arteries
- Also known as Toe Brachial Index
- Represents the drop in blood pressure in smaller digital vessels
- Digital arteries **do not undergo medial calcinosis** to the extent of the infra-popliteal arteries
- Normal is greater than or equal to 0.70

Rapid TBI Xpress

- 2-minute test at the bedside
- Obtains pulse volume recordings (PVR's) from the fingers and TOES
- AI is used to correlate PVR waveforms with ABI values from thousands of prior ABI exams
- Does not require compression of vessels resulting in less false negatives and "non-compressible" readings.
  - https://youtu.be/4EAm3q025tQ



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Negative Pressure Wound Therapy

Negative Pressure Wound Therapy (NPWT)

- Systems that continuously or intermittently apply sub-atmospheric pressure to the surface of a wound to assist healing
- Reticulating open cell foam (ROCF) directly on wound surface
- Sealed with an acrylic drape
- Attached by a tube to the mechanical pump
- In its third decade of use

NPWT Indications

- Chronic wounds
- Acute wounds
- Traumatic wounds
- Sub-acute wounds
- Partial-thickness burns
- Dehisced wounds
- Closed surgical incisions that continue to drain following sutured or stapled closure
- Ulcers, such as
  - Diabetic
  - Venous insufficiency
  - Pressure
- Flaps
- Grafts

NPWT Contraindications/Warnings

- Inadequately drained wounds
- Necrotic tissue, such as eschar or adherent slough
- Exposed blood vessels, anastomotic sites, organs, tendons, or nerves
- Wounds containing malignancy
- Fistulas
- *Untreated* osteomyelitis
- Actively bleeding wounds or patients with bleeding risks

Clinical Benefits of NPWT

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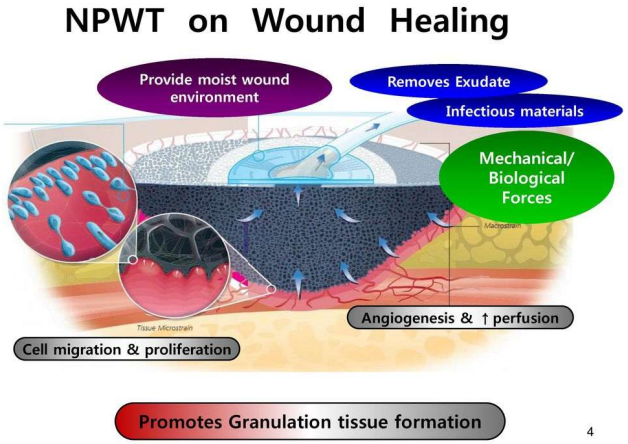
- Increases local blood flow
- Reduces edema
- Stimulates granulation tissue formation
- Stimulates cell proliferation
- Removes soluble healing inhibitors from the wound
- Reduces bacterial load
- Draws the wound edges closer together
- Controls exudate, odor; ↓clothes soiling, ↑ patient comfort
- Reduces dressing changes
- Reduces treatment costs

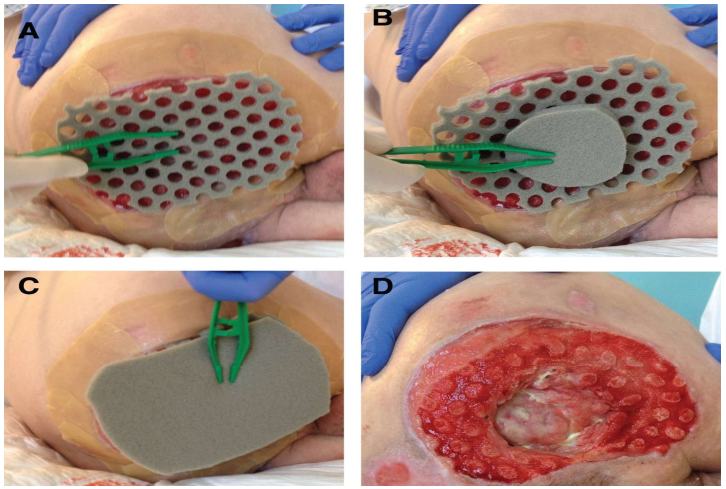


Kim PJ, Attinger CE, Constantine T, et al. Negative pressure wound therapy with instillation: International consensus guidelines update. *Int Wound J.* 2020;17:174-186.

Microdeformation and Macrodeformation

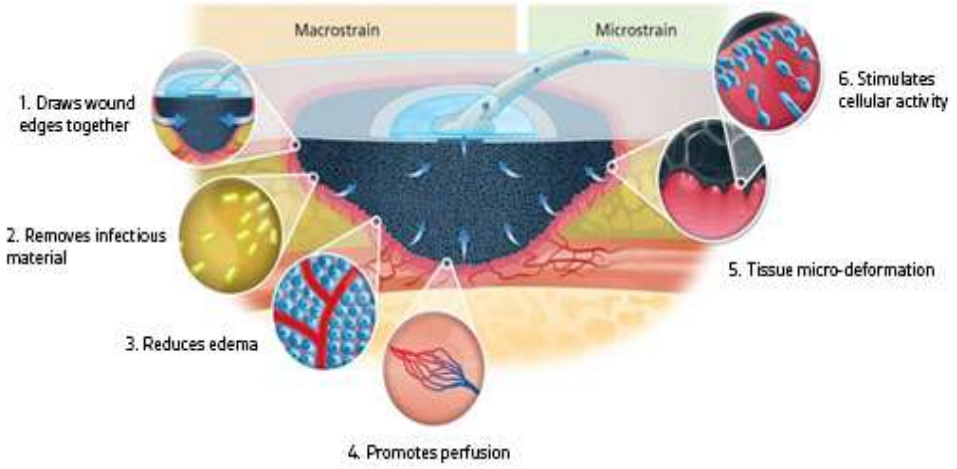
Microdeformation (Microstrain):

- How wound tissue reacts at the microscopic level.
- Cells respond to applied stress of micromechanical forces to help promote wound healing.



Macrodeformation (Macrostrain):

- Forces that pull the wound edges closer together as the intervening foam decreases in size.



https://www.todaysgeriatricmedicine.com/archive/ND16p24.shtml#:~:text=Microdeformation%20describes%20the%20way%20the,to%20help%20promote%20wound%20healing.
chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.acvs.org/files/proceedings/2013/data/papers/0168.pdf

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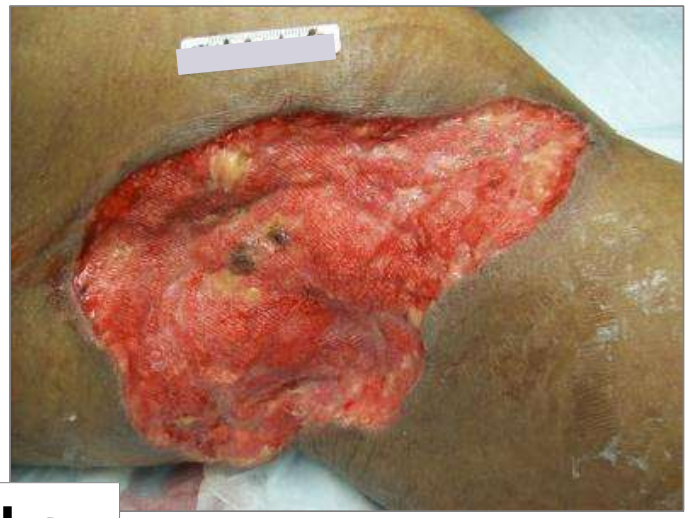
What Should We See?



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2 wks

Negative Pressure Devices

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Non-Contact Low Frequency Ultrasound

Non-Contact Low Frequency Ultrasound D

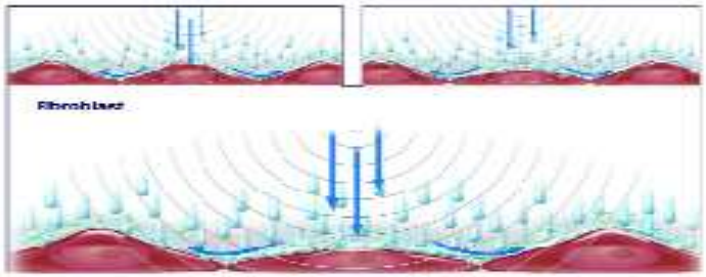


Figure 2. *Acoustic energy deforming fibroblasts. Ultrasound activates inflammatory cells that play a role in the production of chemical mediators that activate fibroblasts.*

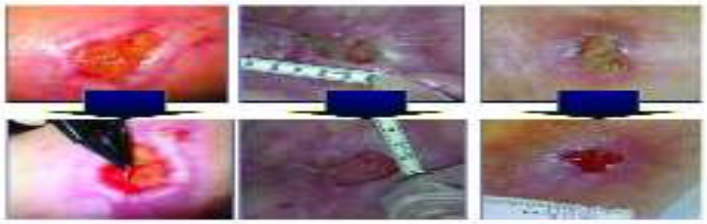


Figure 3. *Wound debridement. Ultrasound activates inflammatory cells, which results in wound debridement.*

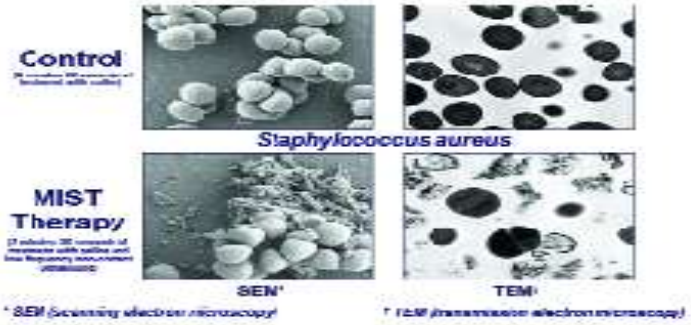
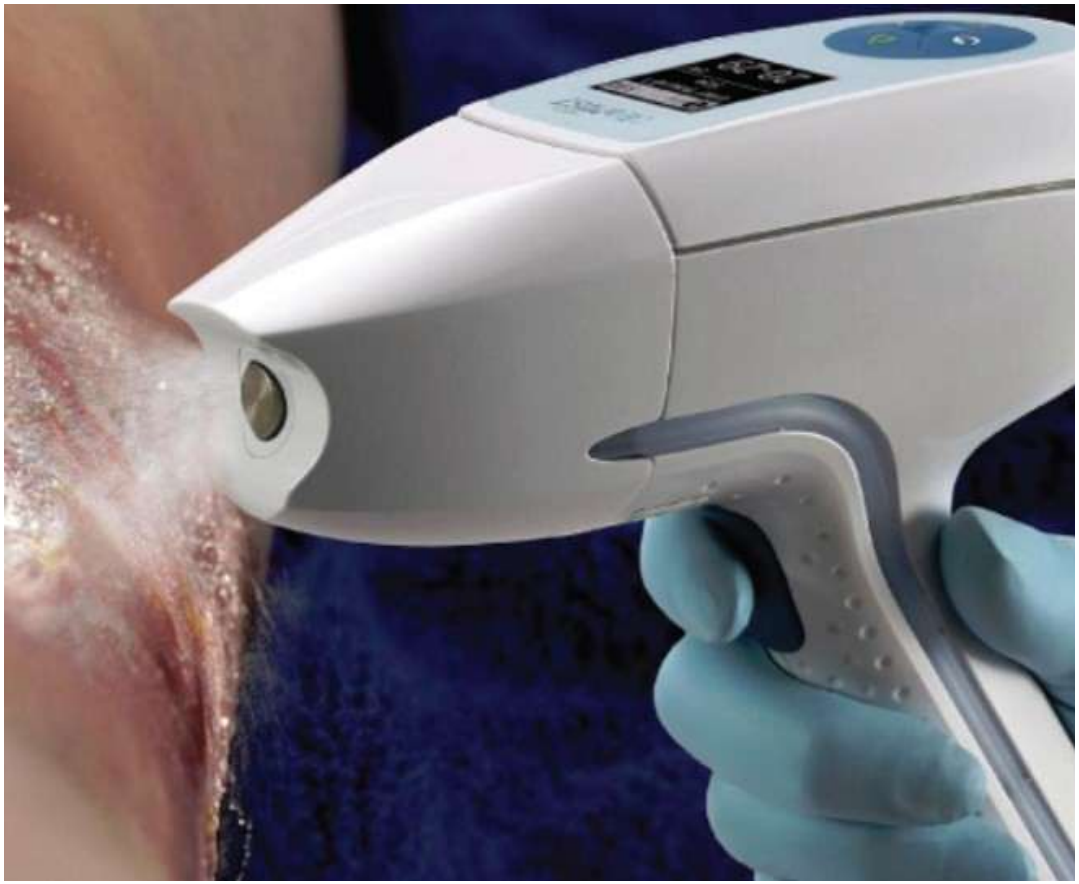
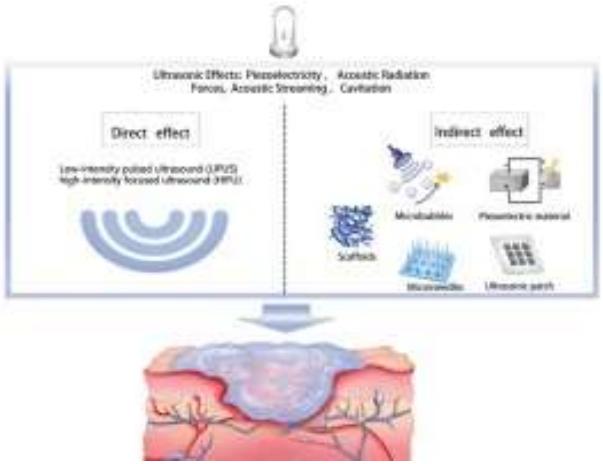


Figure 4. *Cell wall destruction of Staphylococcus aureus following application of ultrasound therapy.*



Low-Frequency Ultrasound (LFUS)

- Cavitation effects: Pressure changes create gas-filled microbubbles constantly expanding and compressing
- Pulsed, non-thermal, low-frequency ultrasound enhances inflammatory response and tissue repair
- Bactericidal effects
  - Disrupts biofilms – blows up biofilm and bacteria cell walls
- Pressure wave affects cell membrane permeability
- Facilitates leukocyte adhesion (supports infection control)
- Produces growth factors
- Increases cellular activity responsible for healing (fibroblasts)
- Great intervention for wound bed preparation
- **Upregulates nitric oxide**



Driver VR, Yao M, Miller CJ. Noncontact low- frequency ultrasound therapy in the treatment of chronic wounds: a meta-analysis. *Wound Rep Reg*. 2011;19(4):475-80.

Low-Frequency Ultrasound (LFUS) Outcomes

- Stimulation of cells
  - Fluid sheer stress results in release of **nitric oxide = vasodilation of vessel for increased blood flow to the area**
  - Stimulates fibroblasts, macrophages and endothelial cells

Indications for Low-Frequency Ultrasound

- Locally infected wound
- Wounds with impaired circulation
- Wounds needing debridement, irrigation, and topical treatment
- Pressure, diabetic, arterial and venous ulcers, posttraumatic, and surgical
- DTPI a race against time -"interventions that improve microcirculation and reduce inflammation early may shift the wound from progression to recovery. Non-contact low-frequency ultrasound is one of the few modalities with evidence suggesting it can influence that trajectory."

1.Honaker JS, et al. Effects of non-contact low-frequency ultrasound on healing of suspected deep tissue injury. *J Wound Care*. 2012.
2.Honaker JS, et al. Adjunctive noncontact low-frequency ultrasound for deep tissue pressure injury. *Adv Skin Wound Care*. 2016.
3.Wagner-Cox P, et al. Use of noncontact low-frequency ultrasound in deep tissue pressure injury. *J Wound Ostomy Continence Nurs*. 2017.
4.Wiegand C, et al. Noncontact low-frequency ultrasound therapy and wound healing mechanisms. *Int Wound J*. 2017.
5.Chen H, et al. Low-frequency ultrasound for chronic wounds: meta-analysis. *Int Wound J*. 2022.

What is Edema?

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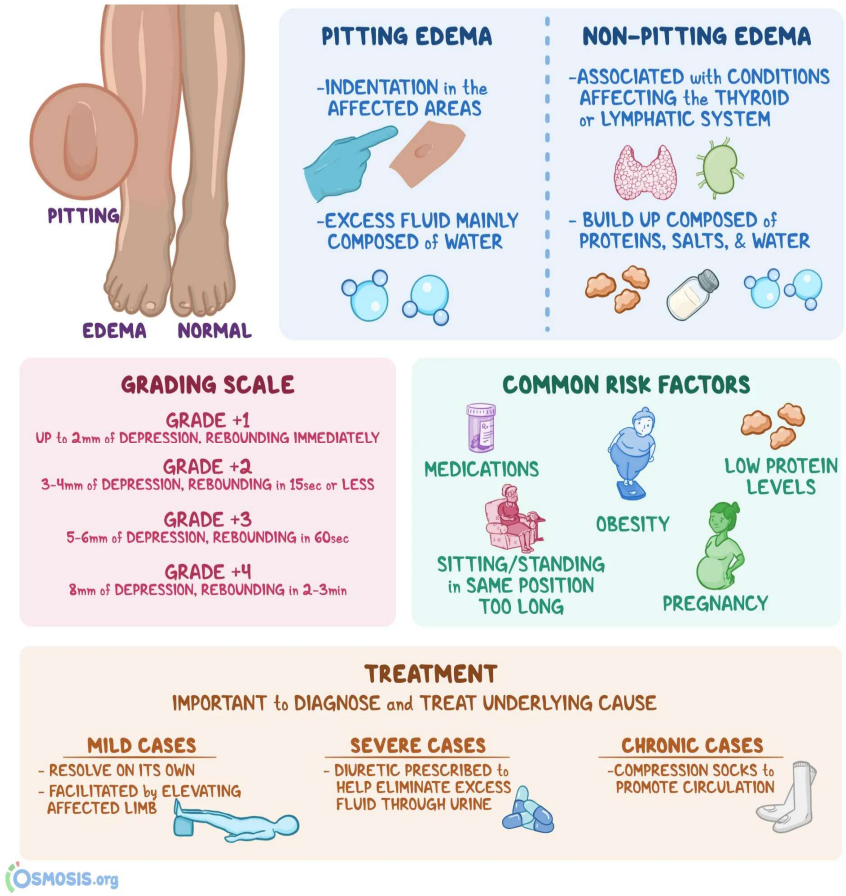
Edema is not a diagnosis, it is a symptom

- **Edema = swelling caused by excessive build-up of fluid in the body's tissues.**
- **Some of the more common causes are:**
- Liver Disease (Cirrhosis)
- Chronic Venous Insufficiency
- Lymphatic Obstruction (Lymphedema)
- Acute Inflammation
- Medication-Induced Edema
- Malnutrition and Protein Deficiency
- Thyroid Disorders
- Deep Vein Thrombosis (DVT)
- Trauma or Injury



Edema

- **There are different types of edema some more common ones are:**

- **Peripheral** – affects upper/lower extremities
- **Dependent** – affects lower extremities
- **Pulmonary** – affects lungs
- **Cerebral** – affects brain
- **Macular** – affects eyes
- **Pedal** – affects lower legs, ankles, and feet
- **Lymphedema** – affects upper and lower extremities and trunk

- **Edema may also be pitting or non-pitting and is usually associated with peripheral or dependent edema**

- **Pitting edema**
- mostly composed of water
- when skin is depressed, an indentation occurs
- Uses a grading scale to determine the severity of edema

- **Non-pitting edema**
- Will not indent when pressed upon
- Usually related to conditions affecting the thyroid or lymphatic system

Compression Effects for Venous and Lymphatic Dysfunction

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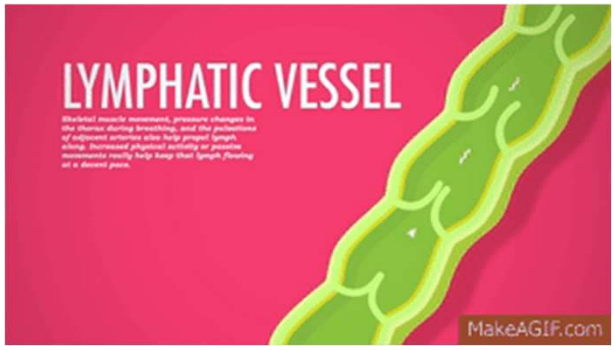
- **Venous System**
  - Increase venous return
  - Reduce venous reflux
  - Reduce venous HTN
  - Reduce capillary filtration
  - Increases calf muscle pump

Venous Leg Ulcer Wrapping

- **Lymphatic System**
  - Improve volume and rate of flow
  - Reduced lymphatic load due to reduced filtration
  - Increased resorption of fluid from interstitium into lymphatic system
  - Stimulates lymphangion motricity



Lymphedema Wrapping

Mosti G et al. 2019, Chassagne F et al. 2017, Rasmussen JC et al. 2016, Chassagne F et al. 2015, Mosti G et al. 2015, Partsch H et al. 2015, O'Donnell TF et al. 2014, Damstra RJ et al. 2013, Mayrovitz HN et al. 2010.

Summary – Advanced Modalities in Wound Care

- Early identification of **at-risk skin** is essential for prevention and improved outcomes
- Comprehensive assessment guides clinical decision-making
- Advanced modalities support healing when standard care is insufficient, including:
  - Negative Pressure Wound Therapy (NPWT)
  - Low-Frequency Ultrasound (LFUS)
  - Subepidermal Moisture (SEM) technology
  - Advanced compression therapy
- Addressing underlying factors is critical
- Interdisciplinary, patient-centered care improves healing and reduces complications
- Prevention and early intervention remain the most effective strategies

Case Study

Case Study: Diabetic Foot Ulcer with Peripheral Arterial Disease

Patient Profile

Patient: 67-year-old female
Primary Conditions: Type 2 diabetes mellitus and peripheral vascular disease
Current Problem: Full-thickness diabetic foot ulcer
Additional Findings: Bilateral hemosiderin staining; inadequate glycemic control; no therapeutic/offloading footwear-Charcot foot, increasing erythema and purulent drainage

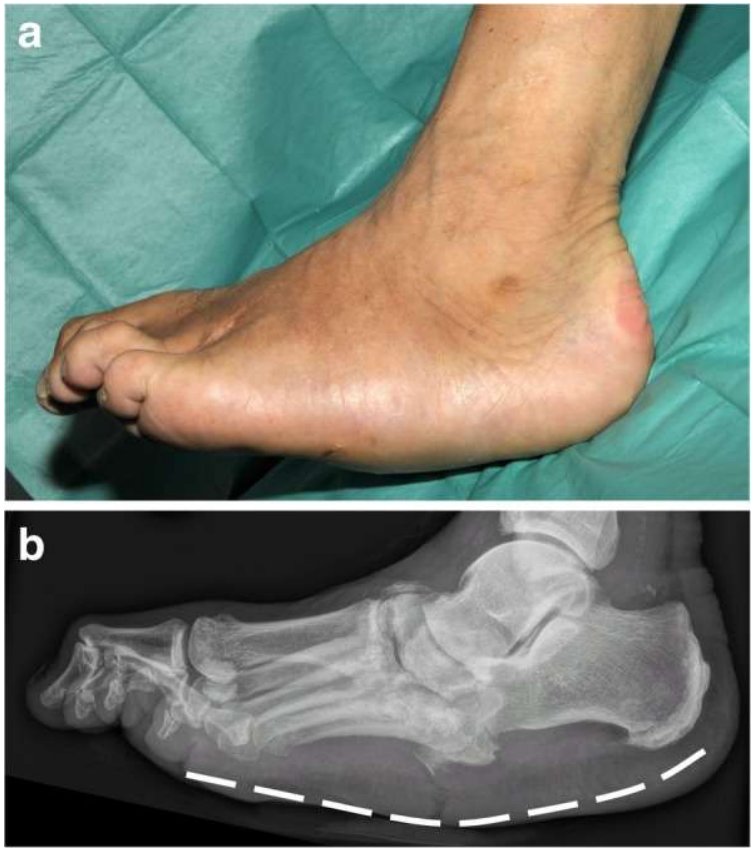
Vascular Assessment

Assessment	Right	Left
ABI	0.90	0.60
Interpretation	Borderline/near-normal	Abnormal; consistent with PAD

Charcot Foot

Charcot Foot Deformity: The breakdown of bones, joints, and supporting soft tissues, leading to deformities like a rocker bottom foot and collapse of the ankle and midfoot bones

The pathophysiology of this disease is unclear: there is agreement that the cause is multifactorial and that polyneuropathy (reduced pain sensation and proprioception) is the underlying basic condition of this disease.



Assessment and Management

- Nursing Assessment.
- Lower-Extremity Vascular Assessment
- Venous Assessment
- Neurologic/Diabetic Foot Assessment
- Glycemic Assessment
- Wound-Bed Management
- Nutrition Plan
- Patient Education and Prevention Plan
- Diabetes Management

Case Study Summary

- **Case Summary**
- This 67-year-old woman presents with a **high-risk diabetic foot ulcer complicated by suspected infection, peripheral arterial disease, inadequate pressure redistribution, and hyperglycemia**. The left ABI of 0.60 demonstrates significant arterial impairment, while bilateral hemosiderin staining raises concern for a concurrent venous component.
- The combination of a **full-thickness 1.8-cm-deep ulcer, purulent drainage, 3 cm of erythema/induration, diabetes, PAD, hyperglycemia, hyperkeratotic margins, and lack of appropriate footwear** places the patient at substantial risk for delayed healing, deeper infection, osteomyelitis, hospitalization, and lower-extremity amputation.
- Successful management requires more than topical wound treatment. The care plan should simultaneously address **infection control, perfusion, offloading, wound-bed management, glycemic control, nutrition, appropriate footwear, patient education, and recurrence prevention**, with coordinated nursing, wound-care, podiatric, vascular, and medical management.

IDT Care Plan

Discipline	Primary Responsibility
Nursing	Daily foot/skin surveillance, wound assessment, dressing care, infection surveillance, glucose monitoring and education
Wound-care clinician	Wound diagnosis, treatment plan, debridement strategy and healing surveillance
Primary/medical provider	Diabetes management, infection treatment and overall medical management
Podiatry/wound care provider	Foot biomechanics, callus management, debridement, infection evaluation and preventive foot care
Vascular specialist	PAD assessment, perfusion testing and consideration of revascularization
Orthotist/Pedorthist	Pressure redistribution, diabetic footwear and custom inserts
Dietitian	Nutrition assessment and individualized nutritional intervention
Diabetes educator	Glucose-management education and self-management support
PT/OT	Mobility, gait, fall risk and safe use of offloading devices, adjunct therapies-UM, estim,