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Wound Care: Basic Concepts and Treatments

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April 17, 2017

Since when do PTs do Wound Care?

- Typical question asked
- One of our 4 Practice Patterns
  - Just not one people typically associate with physical therapy
- Wound Care Special Interest Group of the Academy on Clinical Electrophysiology and Wound Management is currently working with the APTA on the development of a wound care certification, like those currently available for neuro, ortho, pediatrics, etc.
  - Right now still have to become certified through other organizations such as American Board of Wound Management

Since when do PTs do Wound Care?

- Even if you don't choose to specialize in wound care, it is important to have a basic understanding
  - In an outpatient setting, may have an orthopedic patient with a non-healing incision
  - In a rehab or acute care setting, may have patients with pressure injuries
- This webinar will serve as an introduction to basic concepts in wound healing as well as treatment options

Objectives

1) List at least 3 phases of normal wound healing.
2) Identify 4 of the following: arterial, venous, diabetic/neuropathic, and pressure ulcers based on clinical presentation.
3) Describe at least 2 differences between various dressing types for wounds.
4) List at least 3 treatment options to heal the following wounds: arterial, venous, diabetic/neuropathic, and pressure ulcers.
5) Identify at least 3 ways to address atypical wounds.
6) Identify at least 2 signs/symptoms when a patient should be referred to an outside specialist.

Types of Wound Healing

- Primary Intention Healing: When a wound is closed by sutures, staples, etc.
  - Wound does not have to granulate or re-epithelialize
  - Rarely have to deal with this type of wound unless it opens
- Secondary Intention Healing: also called Full Thickness Healing
- Tertiary Intention Healing: When a surgeon leaves a wound open to granulate prior to closing it with sutures or staples
  - Typically seen if an infection is expected or after a traumatic injury where there is debris in wound

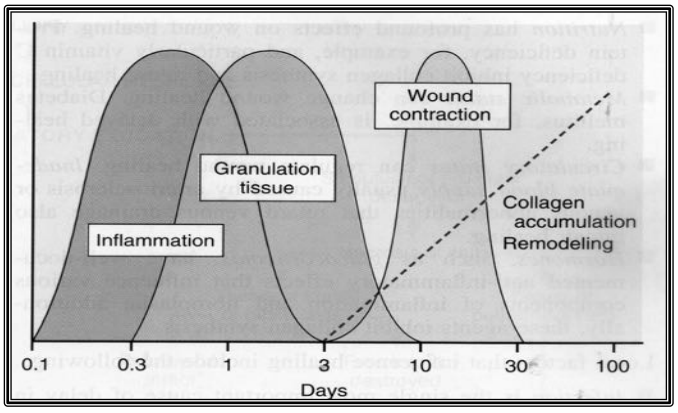
Full-Thickness or Secondary Intention Healing

- Most effective form of healing when a wound goes through all layers of skin and/or into underlying tissues
- Heals by formation of granulation tissue and contraction of wound edges
- Involves scar tissue formation
- Wounds that heal this way are not the same anatomically as the tissue that was present before
  - **Thus, only 80% as strong as normal tissue**

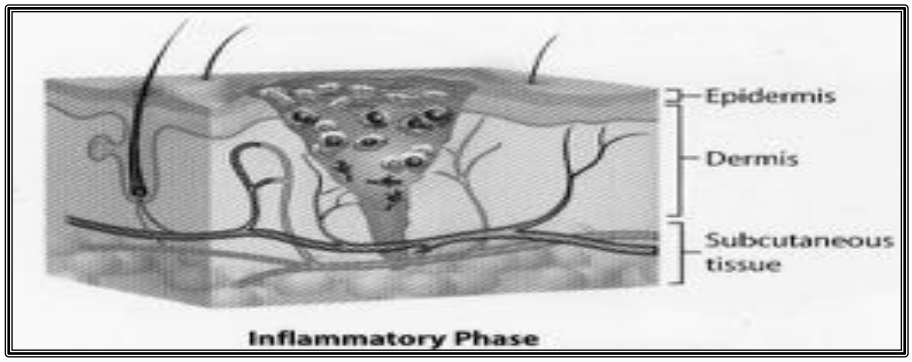
Wound Healing Physiology

- Described as cascade of overlapping events that occurs in a reasonably predictable fashion
- Cascade is same for all wounds, acute and chronic
  - However, time spent in each phase is primary difference in acute vs. chronic wounds
- Three Phases Of Wound Healing
  - Inflammation/Hemostasis: Initial reaction after a wound occurs; Need to stop the bleeding
  - Proliferation: Granulation, re-epithelialization, wound contraction
  - Maturation: Collagen accumulation and remodeling

Phases of Tissue Repair



Inflammatory Phase



Inflammatory Phase

Inflammatory Phase

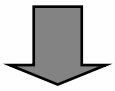
- First 1-4 days after injury
  - First step in repair process
- Series of events which are interconnected
- Vascular and cellular response to injury
  - Vascular reactions, cellular elements, and various chemical mediators
- Protective role and is generally beneficial to the body

Inflammatory Phase

- Events that occur:
  - Vasoconstriction(chemically mediated)
    - Insult to blood vessels in the dermis→immediate constriction to reduce blood loss and achieve hemostasis
  - Platelets begin coagulation by thrombin and collagen
    - Aggregation of platelets
    - Fibrin enforces platelet plug
  - Vasodilatation
    - Triggered by histamine
    - Pathway to wound healing
  - Increased cell membrane permeability(chemically mediated)
    - Increases post trauma
    - Influx of fibroblasts, neutrophils(early), macrophages(later on), monocytes and mast cells

Inflammatory Phase

- Local Indicators of Inflammation:
  - Rubor – Redness
  - Tumor – SWELLING
  - Calor – HEAT
  - Dolar – PAIN



Decreased Functional Ability

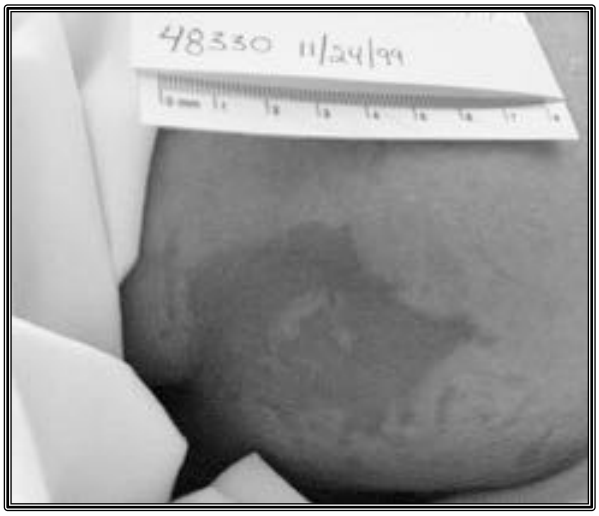
Inflammatory Phase

- Systemic Indicators of Inflammation:
  - Fever
  - Leukocytosis

Inflammatory Phase

- Acute vs. Chronic Inflammation
  - Acute: Lasts typically from 24-48 hours, may last for up to 2 weeks
  - Following acute: A subacute phase may last an additional 2 weeks

Acute Inflammation



Acute Inflammation

- Vascular Responses:
  - Vasodilation occurs in response to injury
    - Tissue becomes warm and red
  - Capillary permeability increases
    - Exudate flows into tissue
    - Swelling occurs
    - Blood clot forms
  - Leukocytosis – accumulation of leukocytes at injury site
    - Phagocytosis occurs
- Cellular repair begins

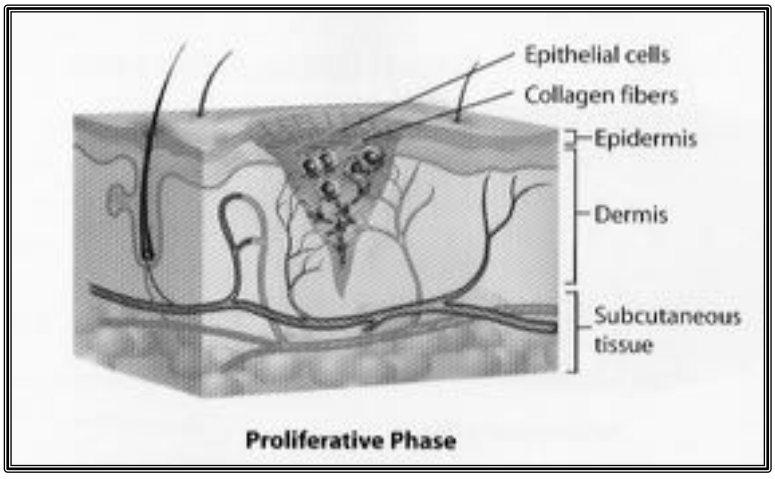
Chronic Inflammation

- May occur from unresolved acute inflammation
- May develop from microtrauma
- May develop when sealed necrotic tissue is contaminated with pathogens or contains foreign material
- *NO cardinal signs of infection*
- Presence of higher number of monocytes, lymphocytes, histocytes and macrophages

Chronic Inflammation

Chronic Inflammation

Proliferation



Proliferation

- Days 5-20
- Goals: Granulation tissue, Angiogenesis, Re-epithelialization
- Beginning of proliferative phase:
  - When wound is essentially clear of foreign substances
  - Free from infection
  - When wound has an infiltrate of macrophages and fibroblasts forming in the matrix

Proliferation

- Macrophages release PDGF and fibroblast growth factor→attracting fibroblasts→ producing collagen and elastin→leading to growth of new connective tissue and capillary growth

Proliferation

- Fibroplasia:
  - Laying down of the collagen matrix known as granulation tissue (type III, then type I)
  - Undifferentiated tissue
  - Enhanced cell activity fills in the wound bed
  - Angiogenesis: Building of a vascular network –For increased oxygen and nutrients, removes metabolic waste
  - Begin to see decrease in wound size via wound contraction

Proliferation

- Cellular Activity of Proliferation Phase:
  - Fibroblasts, myofibroblasts, endothelial cells and epidermal cells are high
  - Cross-linkage of collagen is formed
  - New collagen matrix looks like red granules piled on top of each other – called granulation tissue
    - Highly vascular tissue
    - "Beefy" red tissue
    - Moist
    - Fragile
    - Requires protection

Proliferation

- Granulation Tissue:

Proliferation

- Myofibroblasts and Wound Contraction:
  - Myofibroblasts have contractile properties of smooth muscle
  - Myofibroblasts connects itself to wound skin margins and pulls epidermal layer inward
- Clinical Presentation
  - Controlled moist environment
  - "Velvety" or "Beefy" red granular appearance
  - Migration of immature epithelial tissue across the wound bed
  - Gradual reduction in wound size
  - Controlled wound contraction is optimal

Proliferation

- Clinical Considerations
  - Eschar/slough formation can occur and slow the healing process
    - Eschar/slough is made of dried plasma proteins and dead skin cells
    - Debridement is necessary at this stage to promote healing
  - Control bacterial load
    - Drainage, pain and odor indicate potential infection
    - Wound culture needed to identify organism

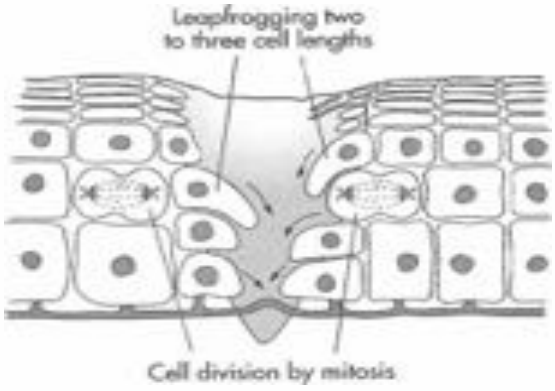
Re-Epithelialization

- Goals: Resurfacing of the wound and changes in wound edges
- Begins immediately after injury and continues alongside other phases of healing
- Prominent cell at work is keratinocytes
  - Make up layers of dermis and epidermis as well as linings of multiple organs and dermal appendages
  - Initiate from epidermal stem cells found in hair follicles
  - Migrate from bulge area of hair follicle to basal layers of epidermis
  - Proliferate and differentiate to produce epidermis

Re-Epithelialization

- Epithelial cells migrate from wound edge and dermal appendages – "leap frog" or "train"
  - Moist wound environment will hasten this process
  - Also oxygen-dependent; if not enough oxygen to cells, will slow process
- Partial thickness wounds, scrapes, skin tears – primary closure through epithelial cell migration
- Full thickness and deep wounds require base of collagen and granulation tissue before epithelial cells can bridge the gap

Re-Epithelialization



Sciencedirect.com

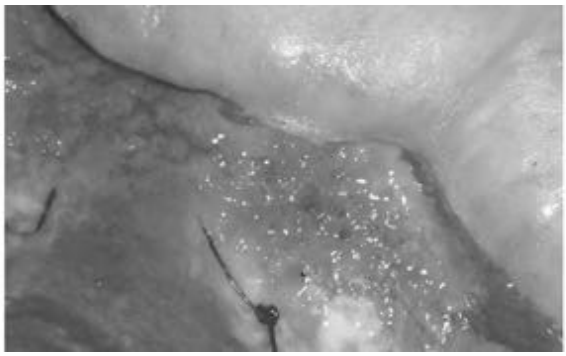
Re-Epithelialization

- Keratinocytes guide neoangiogenesis at the wound edges with help of growth factors
- Macrophages, neutrophils, and current of injury stimulate response of the epithelial cells
- In chronic wounds, there will be a decrease in keratinocyte migration, thus causing a delay in the epithelialization process

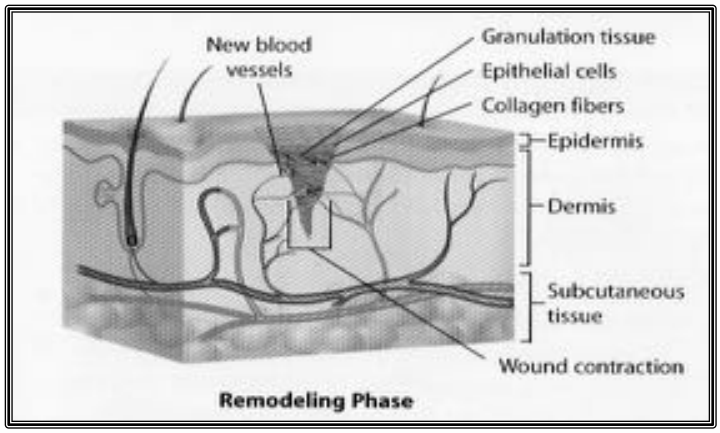
Re-Epithelialization

- When dermal appendages are lost in full-thickness wounds, epithelialization can only occur from the wound edges
  - Dermal appendages: Hair follicles, sebaceous glands, and sweat glands
- As the epithelial cells can only advance a few millimeters, if a wound is not fully granulated, the cells will go to wound base and start to curl under, causing a ridge around the wound and slowing contraction of the wound
  - This is called “epiboly”

Epiboly



Maturation



Maturation

- Once area has been resurfaced by epithelialization – collagen matrix progresses
- Type I collagen fiber bundles become thicker and more organized to add increased tensile strength
- Balance between collagen lysis and collagen synthesis will give mature scar

Maturation

- Matrix Metalloproteinases(MMPs): Enzymes that destroy protein and play key role in remodeling phase
  - Important to maintain proper balance of these as too many can slow wound healing
- Scar Formation: As remodeling continues, scar color will change from bright red or pink to gray or white and scar will become flatter and more flexible
- Entire process of remodeling of wound can take from 3 weeks post injury to 2 years

Maturation

- Once a wound is epithelialized, the epidermal cells begin to mature into type I collagen
- New skin will only be 70-80% as strong as original skin
- At time of closure, newly epithelialized wounds are only 15% as strong as original skin
  - Important to educate patients that even though wound looks "healed," it still must go through the maturation phase and area of healed wound will always be at increased risk for future breakdown

Types of Wounds

- Pressure injuries*
- Neuropathic/Diabetic Wounds*
- Vascular Wounds:
  - Arterial Wounds
  - Venous Insufficiency*
- Traumatic Wounds

*Most typical ones we will see as physical therapists

Classification by Depth of Tissue Injury

- Used to classify wounds whose primary cause is something other than pressure such as skin tears, lacerations, surgical wounds, burns, and vascular wounds
  - Pressure injuries are staged
- Superficial wounds: Affect only the epidermis; Like Stage 1 in pressure injury classification
  - Heal by subcutaneous inflammatory processes
- Partial-Thickness wounds: Extend through the epidermis and into, but not through the dermis; Like Stage 2 in pressure injury classification
  - Heal by epithelialization
- Full-Thickness Wounds: Extend through the epidermis and dermis and may involve subcutaneous tissue, muscle and possible bone; Like Stage 3-4 in pressure injury classification
  - Heal by granulation and wound contraction

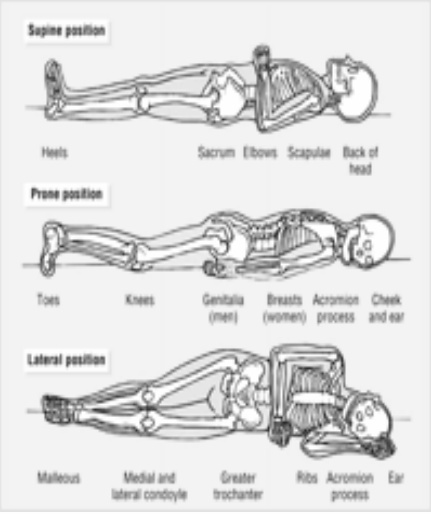
Pressure Injuries

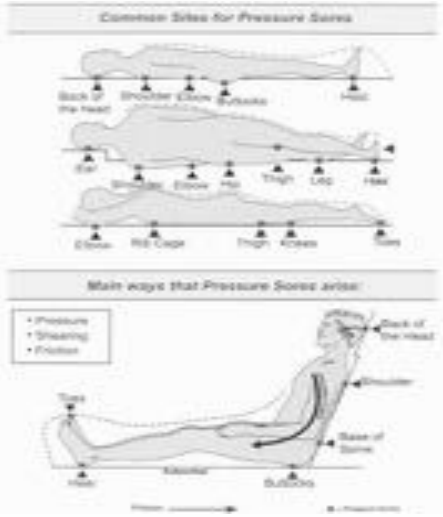
- Commonly referred to as bedsores or decubitus ulcers but better term is pressure injuries
  - In April 2016, National pressure injury Advisory Panel voted to change term from Ulcer to Injury and to move from Roman numeral to Arabic
- A better term for their cause is tissue load because it is more than just pressure that contributes to these wounds
  - "Tissue loading is caused by pressure, friction, shear, and exacerbated by moisture and temperature"
- Huge cost to treat these wounds→Approximately $125,000 for a Stage 4
- Centers for Medicare and Medicaid decided, in 2007, any condition that developed while a patient was in the hospital would NOT be reimbursed→Only pays for those conditions "Present on Admission"
  - Pressure injuries
  - Urinary tract infections
  - Surgical site infections
- So, huge need for hospitals to prevent pressure injuries from occurring or else risk losing thousands or even millions of dollars

Location of Pressure Injuries

- Anywhere there are bony prominences
- Ears, occipital, shoulder, scapula, elbow, iliac crest, sacrum, trochanter, ischium, medial malleolus, lateral edge of foot, lateral malleolus, great toe, heel
- More than 95% of pressure injuries occur over 5 locations: Sacral/coccygeal area, greater trochanter, ischial tuberosity, heel and lateral malleolus

Common Pressure Injury Locations





National pressure injury Advisory Panel(NPUAP) Pressure Injury Staging System

- ONLY TO BE USED FOR pressure injuries!!!!!*
- 4 Stages and then 2 classifications
  - Deep tissue injury
  - Stage 1
  - Stage 2
  - Stage 3
  - Stage 4
  - Unstageable

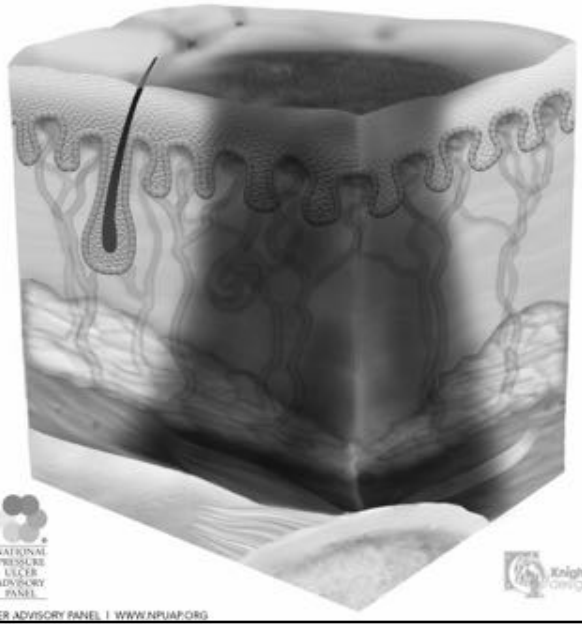
*Cannot stage pressure injuries on mucus membranes such as in the mouth or nose due to different histology in this tissue

Deep Tissue Injury(DTI)

- **Purple or maroon localized area of discolored intact skin or blood-filled blister** due to damage of underlying soft tissue from pressure and/or shear. The area may be preceded by tissue that is painful, firm, mushy, boggy, warmer or cooler as compared to adjacent tissue.

  Further description:
  Deep tissue injury may be difficult to detect in individuals with dark skin tones. Evolution may include a thin blister over a dark wound bed. The wound may further evolve and become covered by thin eschar. Evolution may be rapid exposing additional layers of tissue even with optimal treatment.

Deep Tissue Pressure Injury



Deep Tissue Injury

Deep Tissue Injury

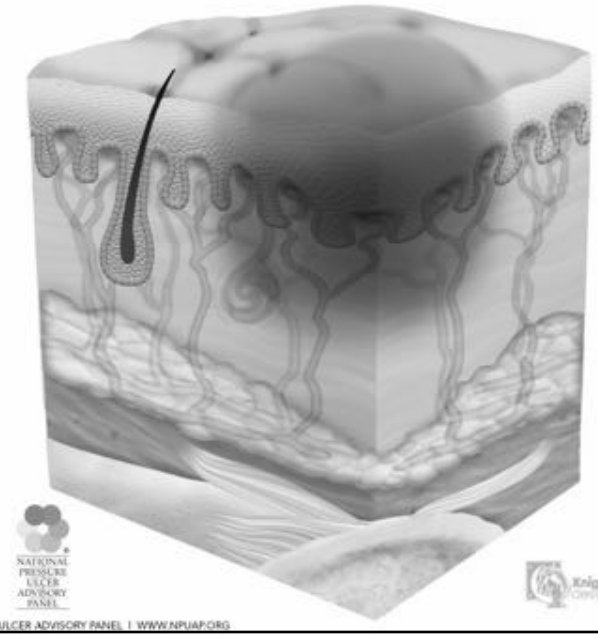
This is not eschar but a blood-filled blister

Stage 1 pressure injury

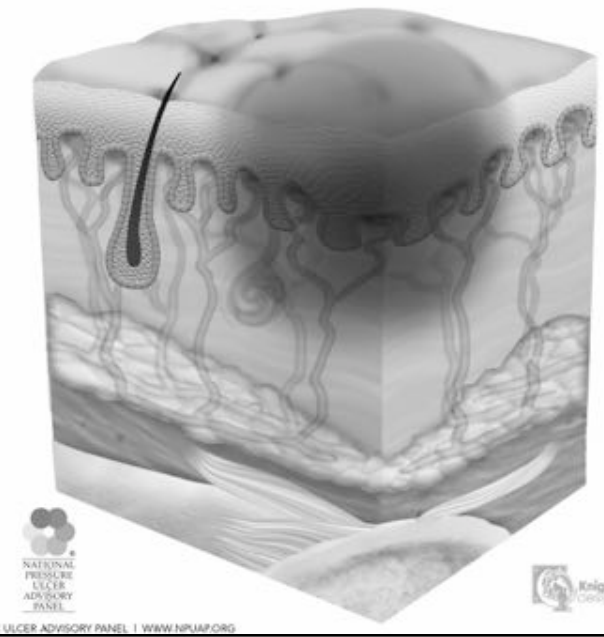
- An observable pressure-related alteration of intact skin whose indicators as compared to the adjacent or opposite area on the body may include changes in one or more of the following:
  - Skin temperature
  - Tissue consistency(firm or boggy feel) and/or
  - Sensation(pain, itching)
- The ulcer appears as a defined area of persistent redness in lightly pigmented skin, whereas in darker skin tones, the ulcer may appear with persistent red, blue or purple hues
- Intact skin with non-blanchable redness of a localized area usually over a bony prominence. Darkly pigmented skin may not have visible blanching; its color may differ from the surrounding area.

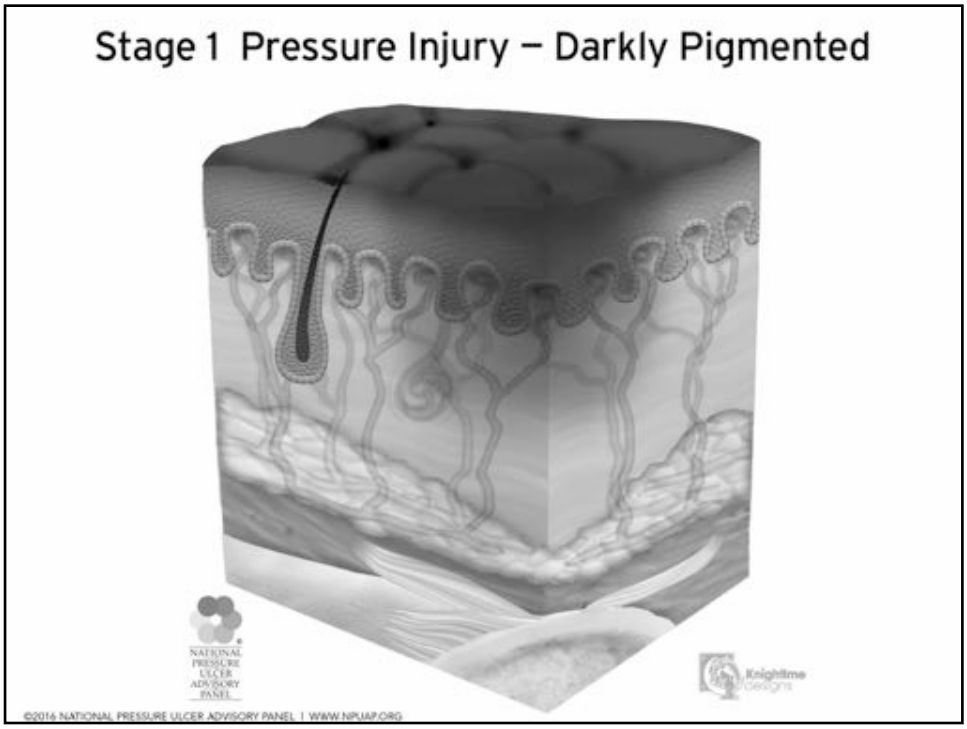
Further description:
The area may be painful, firm, soft, warmer or cooler as compared to adjacent tissue. Stage I may be difficult to detect in individuals with dark skin tones. May indicate "at risk" persons (a heralding sign of risk)

Stage 1 Pressure Injury – Edema



Stage 1 Pressure Injury - Lightly Pigmented




Stage 1 Pressure Injury – Darkly Pigmented
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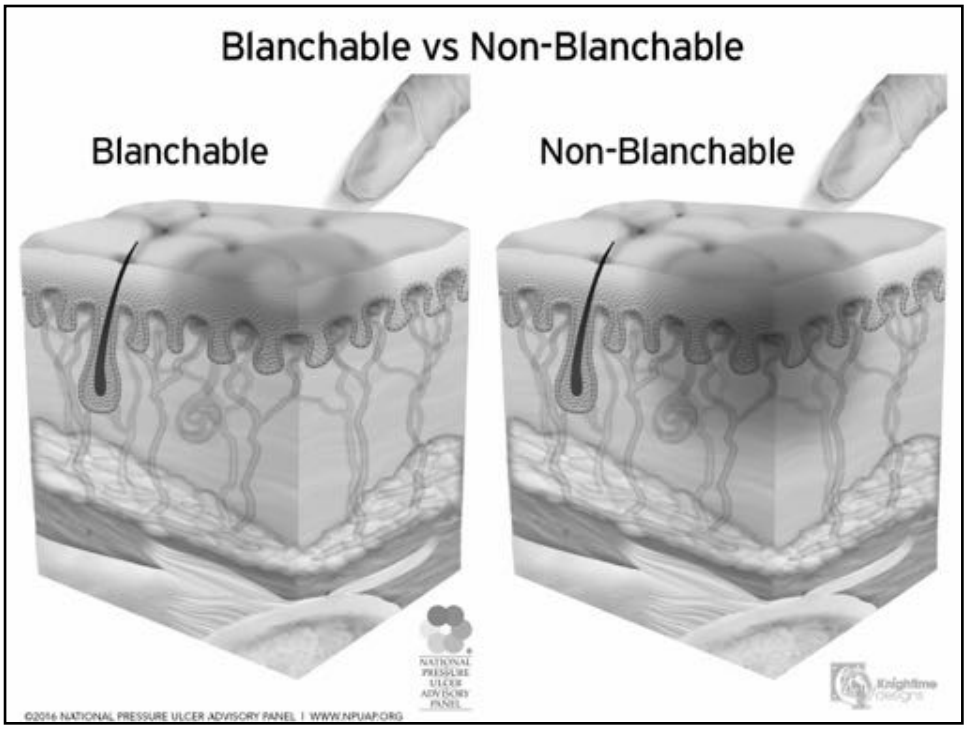
Blanchable vs Non-Blanchable
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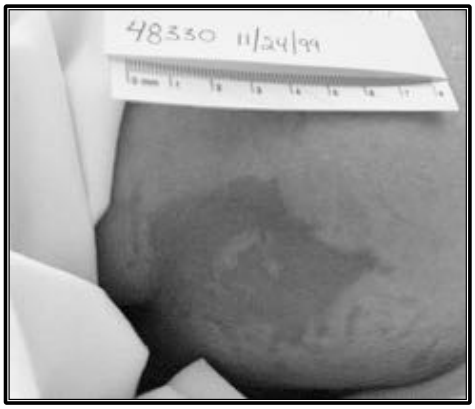
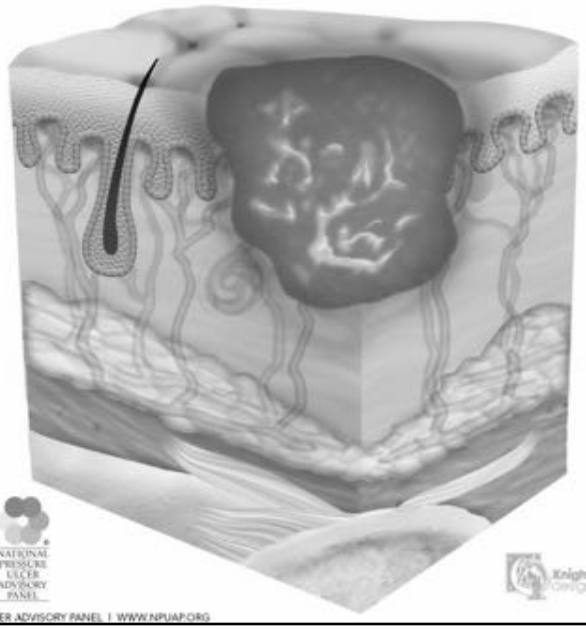
Stage 1 pressure injury



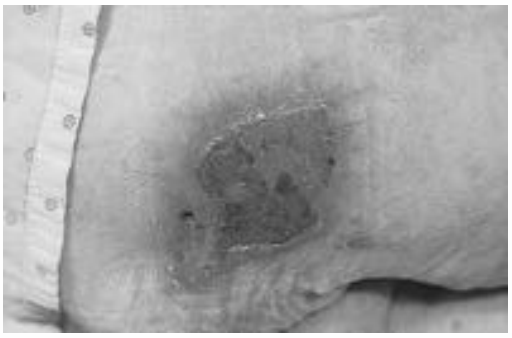
Stage 2 pressure injury

- The ulcer is superficial and presents clinically as an abrasion, blister, or shallow crater; PAINFUL
- Partial thickness loss of dermis presenting as a shallow open ulcer with a red pink wound bed, without slough. May also present as an intact or open/ruptured serum-filled blister.
- Further description: Presents as a shiny or dry shallow ulcer without slough or bruising.*
  - This stage should not be used to describe skin tears, tape burns, perineal dermatitis, maceration or excoriation.
    *Bruising indicates suspected deep tissue injury

Stage 2 Pressure Injury



Stage 2 pressure injury

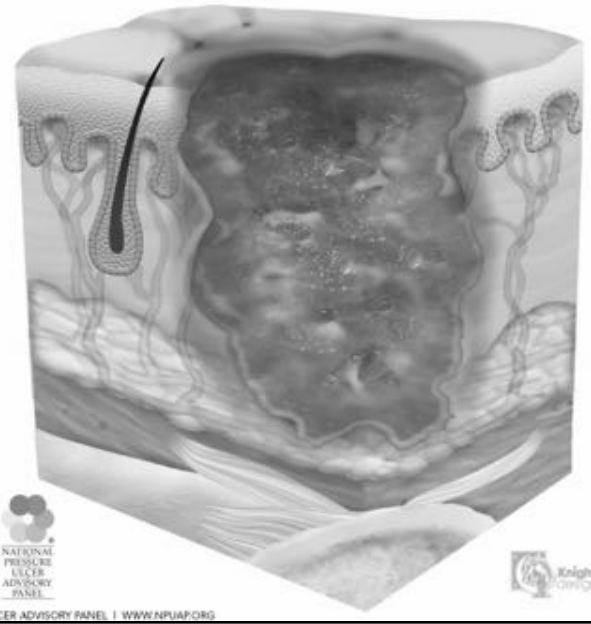


Stage 3 pressure injury

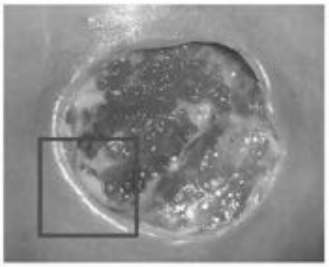
- Ulcer presents clinically as a deep crater with or without undermining of adjacent tissue; USUALLY NOT PAINFUL
- Full thickness tissue loss. Subcutaneous fat may be visible but bone, tendon or muscle are not exposed. Slough may be present but does not obscure the depth of tissue loss. May include undermining and tunneling.

Further description:
The depth of a stage III pressure injury varies by anatomical location. The bridge of the nose, ear, occiput and malleolus do not have subcutaneous tissue and stage III ulcers can be shallow. In contrast, areas of significant adiposity can develop extremely deep stage III pressure injuries. Bone/tendon is not visible or directly palpable.

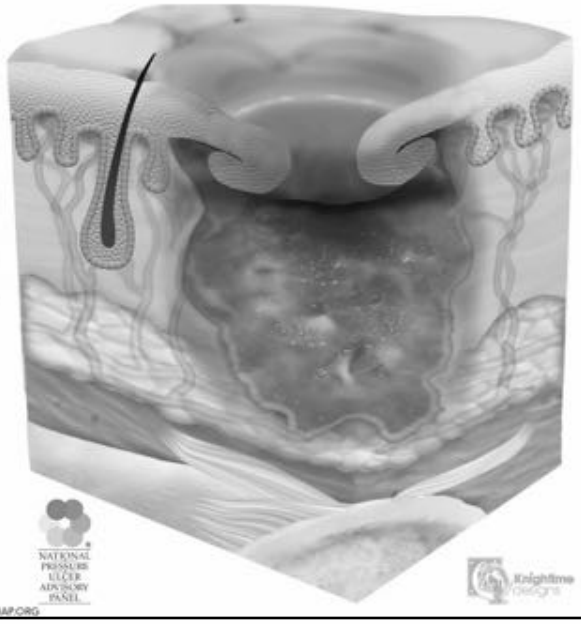
Stage 3 Pressure Injury



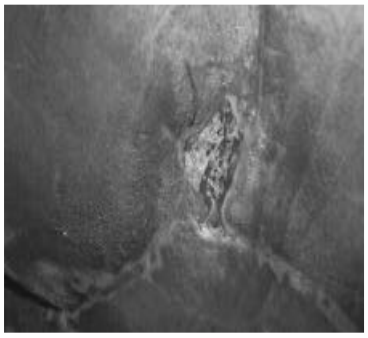
Stage 3 Pressure Injury with Epibole



Area of Focus



Stage 3 pressure injury

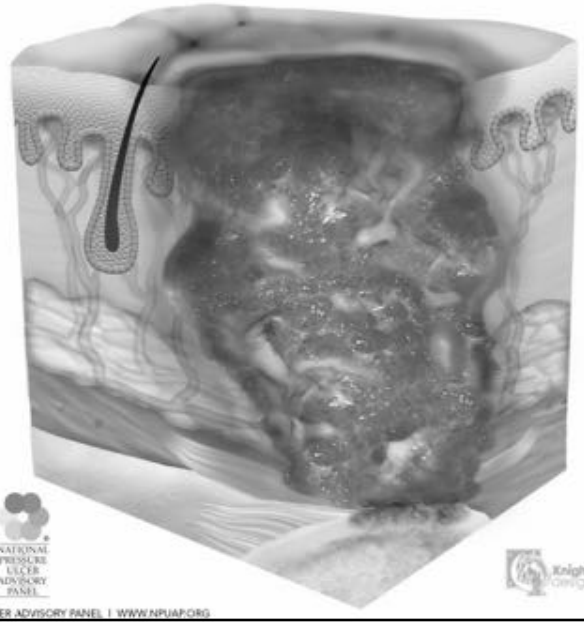


Stage 3 pressure injury

Stage 4 pressure Injury

- USUALLY NOT PAINFUL
- Full thickness tissue loss with exposed bone, tendon or muscle. Slough or eschar may be present on some parts of the wound bed. Often include undermining and tunneling.
- Further description:
  The depth of a stage 4 pressure injury varies by anatomical location. The bridge of the nose, ear, occiput and malleolus do not have subcutaneous tissue and these ulcers can be shallow. Stage 4 ulcers can extend into muscle and/or supporting structures (e.g., fascia, tendon or joint capsule) making osteomyelitis possible. Exposed bone/tendon is visible or directly palpable.

Stage 4 Pressure Injury



Stage 4 pressure injury

*BONE EXPOSED

Unstageable

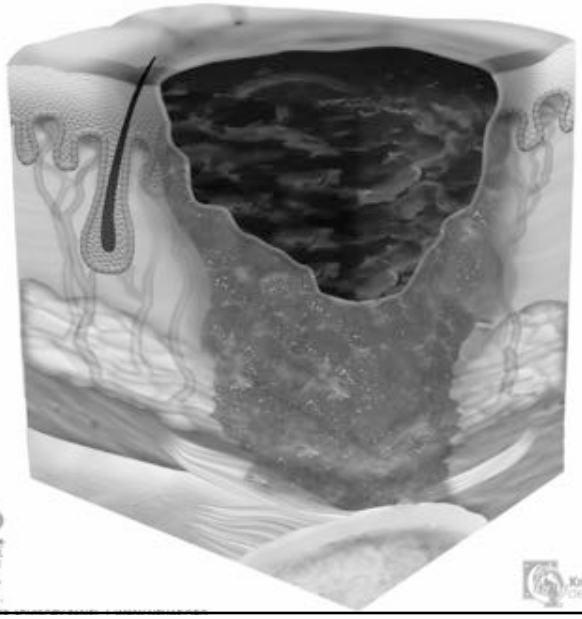
- Full thickness tissue loss in which the base of the ulcer is covered by slough (yellow, tan, gray, green or brown) and/or eschar (tan, brown or black) in the wound bed.
- Further description:
  Until enough slough and/or eschar is removed to expose the base of the wound, the true depth, and therefore stage, cannot be determined.
  - *Stable (dry, adherent, intact without erythema or fluctuance) eschar on the heels serves as "the body's natural (biological) cover" and should not be removed.
- Cannot accurately stage wound as wound may be covered with eschar or slough
  - Eschar: Nonviable(dead) wound tissue that's characterized by dry, leathery, black crust; Strongly attached to wound base; Usually indicative of older wound
  - Slough: Nonviable tissue that's loosely attached to wound base; Characterized by stringy, moist necrotic tissue, can be green, yellow or gray in color; Usually indicative of younger wound
- Once evolved to an open wound, it will be a stage 3 or 4

Unstageable

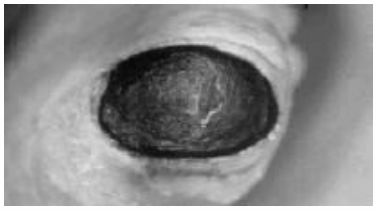
Pre-debridement: Can't be staged

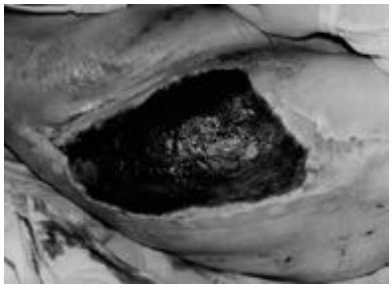
Post-debridement

Unstageable Pressure Injury – Dark Eschar



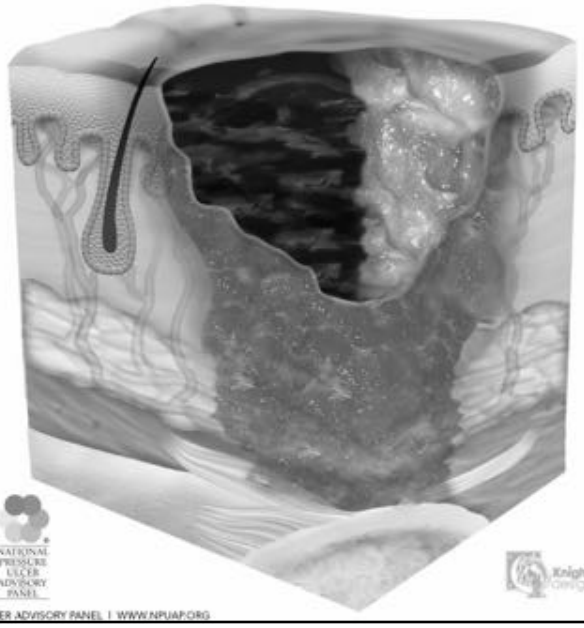
Examples of Eschar*



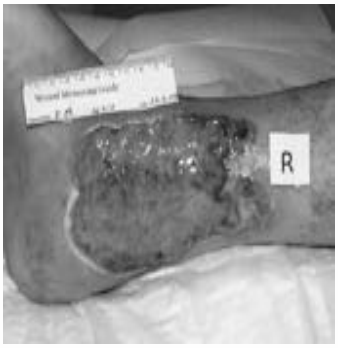


*Not Necessarily a pressure injury

Unstageable Pressure Injury – Slough and Eschar



Examples of Slough*



*Not Necessarily a pressure injury

Reverse or Back Staging of pressure injuries

- This is not acceptable practice, though some insurance companies will ask you to do this to demonstrate wound healing
  - i.e. "Wound has improved from Stage 4 pressure injury to Stage 3"
- Once an ulcer is staged, it cannot change
- Correct terminology is "Healing Stage 2, 3, or 4"

Device-Related Pressure Injuries

- Keep in mind that devices can also cause pressure injuries
- C-Pap masks, trachs, casts, braces, oxygen tubing, etc.
- They should be removed frequently and skin assessed to ensure these devices aren't causing pressure injuries

MDR Pressure Injuries–Examples

NDNQI.org

MDR Pressure Injuries–Examples

NDNQI.org

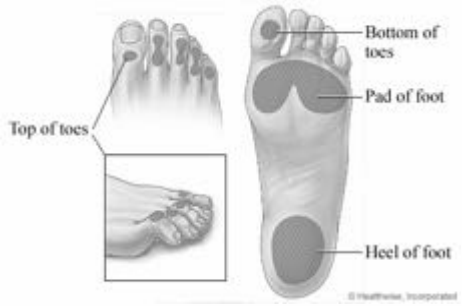
MDR Pressure Injuries–Examples

NDNQI.org

MDR Pressure Injuries–Examples

Neuropathic/Diabetic Foot Ulcers

- Wounds caused by lack of sensation in foot
- Typical locations include metatarsal heads, lateral foot, toes, any area of pressure/friction



Neuropathic/Diabetic Foot Ulcers

Neuropathy

- Per Sussman et al, "the patient with neuropathy often has dysvascular components that must be addressed by a medical team rather than one specialty."
- This team approach can help best treat the patient and help maintain the patient's ambulatory ability.
- Goal is to prevent or delay amputation and/or limb salvage of lower extremities

Pathogenesis

- Poorly understood
- Foot is affected by a tri-neuropathy:
  - Sensory neuropathy: Loss of sensation
  - Motor Neuropathy: Loss of intrinsic muscles, resulting in claw toes and eventual foot drop
  - Autonomic Neuropathy: Loss of autonomic nervous system, resulting in absence of sweat and oil production
- Can be broken down into 2 forms:
  - Gradual onset, usually painless
  - Sudden onset, very painful until loss of sensation occurs

Many different diseases can cause neuropathies:

- Diabetes
- Spina bifida
- AIDS
- Lupus
- Multiple sclerosis
- Cancer
- Charcot-Marie-Tooth muscle disease
- Stroke
- Spinal Cord Injury

Diabetic neuropathy

- 54,000 lower extremity amputations per year with 50-84% of these preceded by a foot ulcer
- Mortality rate after amputation is 50% within 3-5 years and the rate of contralateral amputation is 50% within 4 years
- Of all amputations, 86% could have been prevented by proper footwear and patient education
- Diabetic neuropathic ulcers occur in feet with severe sensory neuropathy, though they may have adequate blood flow to heal the wound
- Highest incidence of ulceration occurs at sites of previous ulcers

Wagner Scale

- Commonly used by podiatrists; wounds graded based on depth of ulcer and presence of infection or necrosis
- Developed for diagnosis and treatment of dysvascular foot, especially for diabetic and neuropathic ulcers
- 6 grades, 0-5 in order of severity of breakdown
  - Grade 0: Pre-ulcerative lesions, healed ulcers, presence of bony deformity; Skin is intact
  - Grade 1: Superficial ulcer without subcutaneous involvement
  - Grade 2: Penetration through the subcutaneous tissue; exposed bone, tendon, ligament, or joint capsule
  - Grade 3: Osteitis, abscess or osteomyelitis
  - Grade 4: Gangrene of toes or forefoot
  - Grade 5: Gangrene of midfoot or hindfoot requiring disarticulation/amputation

Gangrene

- 2 types:
  - Dry gangrene: Due to loss of nourishment to a part, followed by mummification. Area is dry, black and shriveled with well-defined line of demarcation. Will self-amputate if left long enough
  - Wet gangrene: Necrosis of tissue followed by destruction caused by excessive moisture. Bacterial gases accumulate in the tissue. Line of demarcation is ill-defined and limb is painful, purple and swollen
  - Do not DEBRIDE! Refer to surgeon.

Dry vs. Wet Gangrene

Dry Gangrene

Wet Gangrene

Charcot joint examination

- Charcot arthropathy is relatively painless, progressive and degenerative process of single or multiple joints caused by underlying neuropathy
- Usually painless, swollen and red
  - In acute stage, involved foot is 5-10 degrees hotter than contralateral limb
- Frequently misdiagnosed and mistreated
- Usually will NOT have a skin opening or ulceration

Theories behind Charcot Foot

- Multiple microtraumas to joints cause microfractures which lead to relaxation of the ligaments and joint destruction
- Increased blood flow and bone re-absorption; Bounding pulses
- Changes in spinal cord lead to trophic changes in bones and joints
- Osteoporosis is accompanied by abnormal brittleness of bones, leading to spontaneous fractures

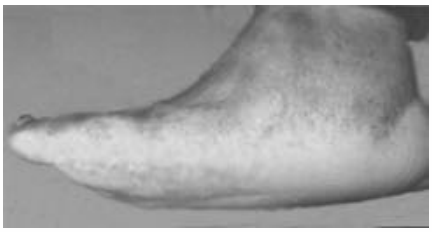
Examples of Charcot foot

health.yahoo.com/media/healthwise/nr551599.jpg

Example of an Acute Charcot Foot

www.aafp.org

Charcot Foot



Example of Charcot Foot with Open Wound

www.mamc.amedd.army.mil

X-ray of Charcot Foot

medicine.ucsd.edu

Wounds due to Chronic Venous Insufficiency (CVI)

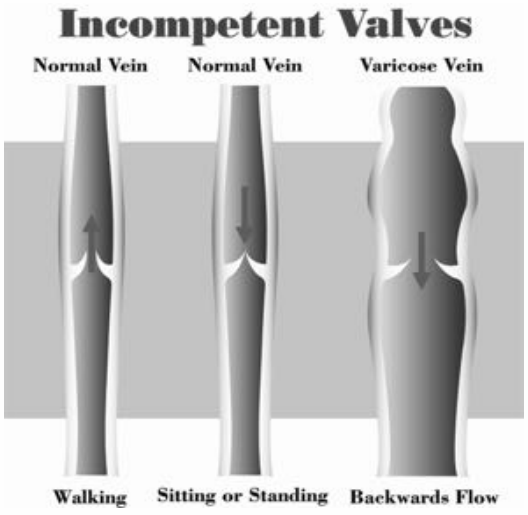
- Typically seen on "gaiter" region of the leg, usually medial malleolus but can be lateral
- 70% to 90% of all leg ulcers
- Afflicts 1% of general population and 3.5% of those over 65 with recurrence rate of 70%
- Women affected 3 times more than men
- Up to 26% of patients with venous ulcers have concomitant arterial disease

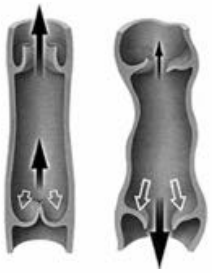
Venous Insufficiency Ulcers

- Mechanism behind these ulcers is poorly understood
- Sustained venous hypertension is common factor in all patients with venous insufficiency ulcers
- First common complaint is swelling of legs which can be accompanied by discomfort and feeling of heaviness in legs
  - This is relieved by elevation

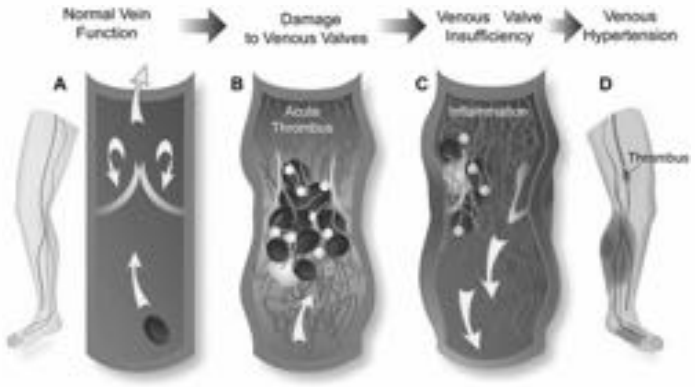
Function of the Venous Pump

- Calf muscle contracts, pumping blood from lower extremity via veins with one-way valves
- When valves are incompetent, it allows blood to leak back down into interstitial space, thus causing edema and hemosiderin staining

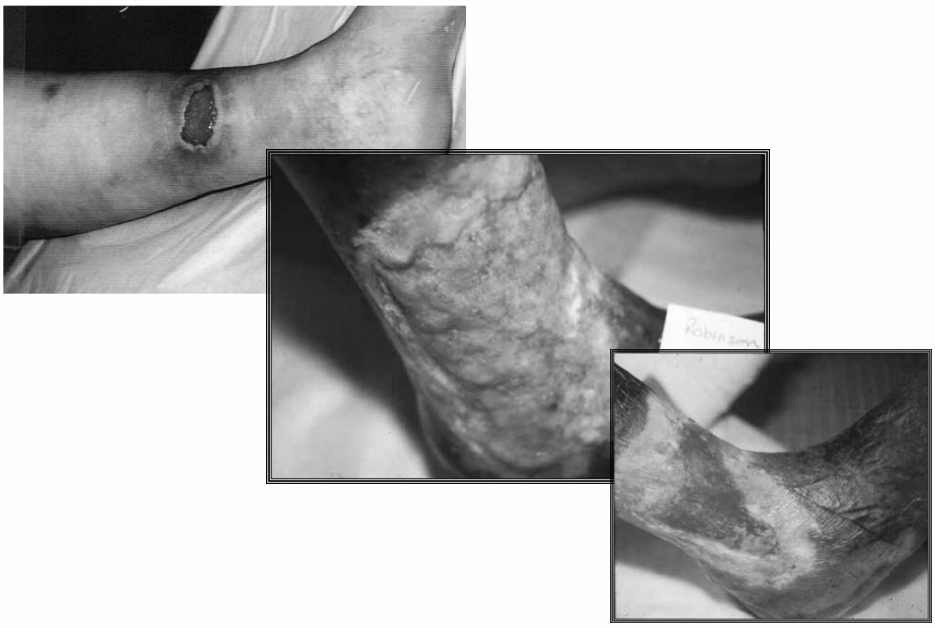




Venous Stasis



Examples of Venous Stasis Ulcers



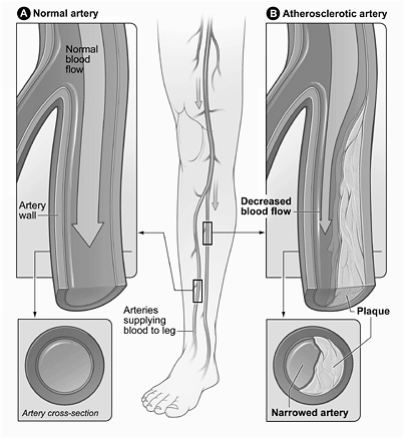
Wounds Associated with Peripheral Arterial Disease

- Caused by inadequate blood flow to the legs
  - Can be due to narrowing or complete blockage of arteries
- Physical findings of this include lack of hair growth on dorsum of foot, thickening of toenails, and delayed capillary filling
- Sequelae of this disease include:
  - Intermittent Claudication
  - Nocturnal Pain
  - Rest Pain
  - Ulceration and Gangrene
- Ischemia is also common in other diseases such as sickle cell disease, Buerger's disease(thrombangiitis obliterans), Raynaud's disease, etc.

Intermittent Claudication

- Pain from this is characterized by cramping or aching sensation while ambulating
- This is relieved by resting
- Pain occurs most often in calf
  - However, if occlusion occurs higher up, patient can complain of pain in buttocks and upper thigh
- Symptoms depend on degree of ischemia to which leg muscles are subjected to

Intermittent Claudication



Nocturnal Pain

- Form of ischemia neuritis
- Usually precedes rest pain
- Occurs at night as blood flow circulates around core of body and not the extremities
- Pain usually occurs in the toes, across the base of the metatarsals and in the plantar arches
- Pain is relieved with standing, dangling feet over edge of bed and occasionally with walking

Rest Pain

- Caused by increased nerve ischemia due to arterial insufficiency
- Pain is worse at night and usually requires narcotics to treat pain
- Pain decreased by dependency of lower extremities and is increased by heat, elevation, and exercise
- Usually seen with at least 2 significant arterial occlusions
- Patients with rest pain will usually have an ABI of less than 0.5mm Hg

Ulceration and Gangrene

- When arterial disease has become its most severe, ischemic ulcers occur
- These are generally seen on distal portions of foot, toe or heel and are exquisitely painful
- Commonly result from ill-fitting shoes, positional pressure, or shearing in medically compromised patients

Ulceration and Gangrene

- Ulcers generally do not bleed and often have necrotic rim or crater
- Pain can be relieved by dependence of limb

Examples of Arterial Ulcers

How do I know what dressing to use?

Dressing Options

- Dressings picked based on:
  - Pathophysiology of wound
  - Ease of use by patients
  - Amount and quality of drainage
  - Presence or absence of infection
  - Depth
  - Social and economic issues
  - Properties of dressing
- One should also consider:
  - Is dressing easy to apply?
  - Is dressing cost effective?
  - Can it be used in infected ulcers?
  - Will it stay where you put it?

Purpose of Wound Dressings

- Dressings help provide an environment conducive to wound healing
- The proper dressing can affect a wound in many ways:
  - Debriding
  - Deodorizing
  - Granulating
  - Epithelializing

Ideal Dressing Criteria

- Remove excessive drainage but not dry out the wound
- Allow gaseous exchange so oxygen, water vapor, and carbon dioxide can pass into and out of dressing
- Be thermally insulating to maintain core body temperature at wound
- Impermeable to microorganisms
- Free of contamination
- Nontraumatic and non-adherent to wound base

Introduction to Moist Wound Healing

- The traditional theory, i.e. old school of thought, behind wound healing has been:
  - Wounds should be kept clean and dry so that a scab can form over the wound
  - Wounds should be exposed to the air and sunlight as much as possible
  - When tissue loss is present, the wound should be packed to prevent surface closure before the cavity is filled
    - This is correct but must be careful what you are packing the cavity with and how hard you are packing the cavity
  - Wound should be covered with dry dressings

Is this theory right? NO!!!!!

- A scab is a barrier to wound healing by slowing down migration of epidermal cells
- Allowing wounds to be open to air reduces temperature of wound, thus slowing flow of blood, oxygen, nutrients, etc. to wound
- Packing a wound with dry gauze can dry out the wound and cause trauma to the wound

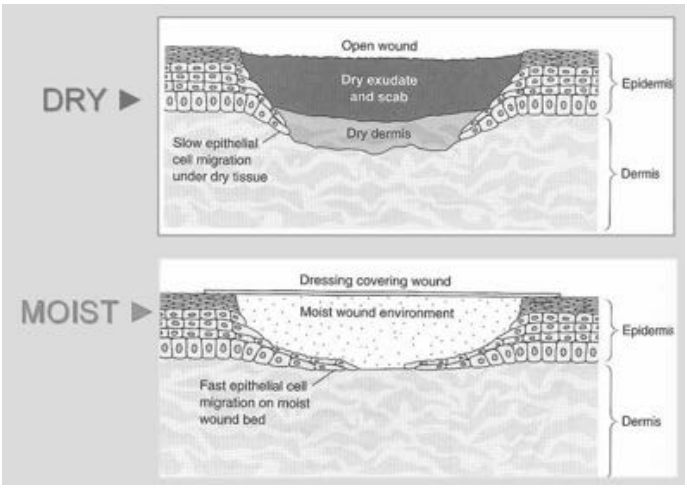
No more wet-to-dry…

- Wet-to-dry dressings used to be standard wound care option until it became apparent that they ripped off good tissue with bad

Newer theory…Moist Wound Healing

- Moist wound healing does not allow a scab to form thus allowing for migration of epidermal cells
- Moist wound healing does not allow a wound to dry out and can help with autolytic debridement of a wound
- Moist wound healing protects granulating tissue and, as mentioned above, encourages epithelialization

Moist Wound Healing



Non-adherent Dressings

- Intention is to not stick to wound bed and maintain moist environment
- Unfortunately, they do not work as well as originally intended and can still stick to wounds, either because drainage dries and adheres it to the wound bed or granulation tissue grows through the dressing
  - Absorbent pads with plastic film to prevent adherence, i.e. Telfa, used for minor wounds and wounds w/minimal drainage
  - Petrolatum dressings, i.e. Vaseline gauze or Adaptic, can be non-adherent as well but may cause problems such as maceration and increased susceptibility to infection
  - Contact Layer: Allows water and electrolytes to cross dressings but not cells and proteins that can cause sticking to wound bed

Telfa

Adaptic

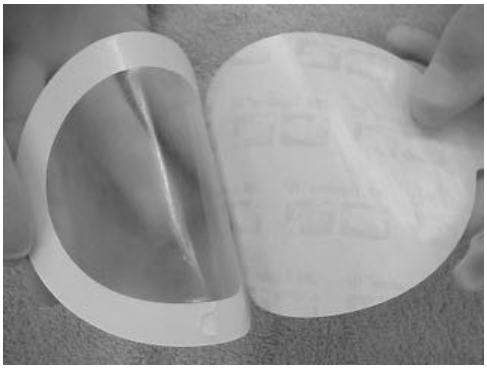
Semipermeable Film Dressings

- Thin membranes coated with an adhesive
- Provide moist wound environment
- Allow for autolytic debridement
- Provide protection from chemicals, friction, shear and microbes
- Transmits oxygen into and carbon dioxide, water vapor out of dressing
- Can function as secondary dressing
- Not highly absorptive

Semipermeable Film Dressings

- Indications: management of minor burns and simple injuries, over suture lines, prevention and treatment of superficial pressure injuries
- When to discontinue use: Increased amount of drainage that may indicate infection or may cause maceration
- Contraindications: Deep ulcers, full-thickness burns, infected ulcers
- Must take care to remove correctly or risk tearing skin
  - Skin should be stabilized
  - Lift one corner and then stretch the dressing, like taffy, causing the dressing to stretch and loosen
- Examples: Opsite, Tegaderm, Dermafilm

Semipermeable Film Dressings



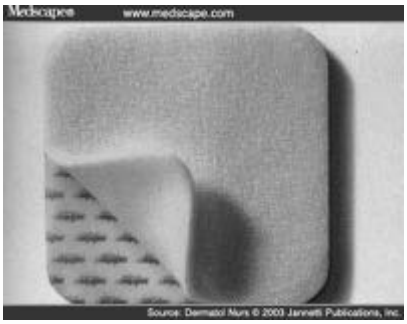
Semipermeable Foam Dressings

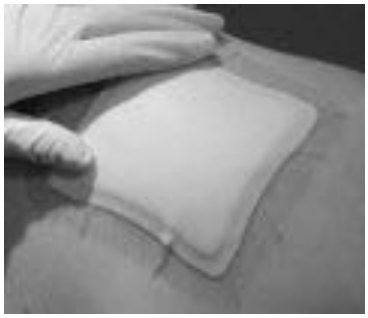
- Polyurethane, open cell sheets
- Absorb exudate to prevent maceration, raise core temperature of wound and maintain moist environment
- Provides protection by cushioning
- Non-adherent
- Often requires no secondary dressing
- Examples: Allevyn, Hydrasorb, Curafoam

Foam dressings

- Indications: Minor and major wounds, over skin grafts, donor sites and minor burns, over hydrogels, around tracheotomy tubes and other drainage tubes and catheters
- When to discontinue: Minimally draining wounds

Foam Dressings

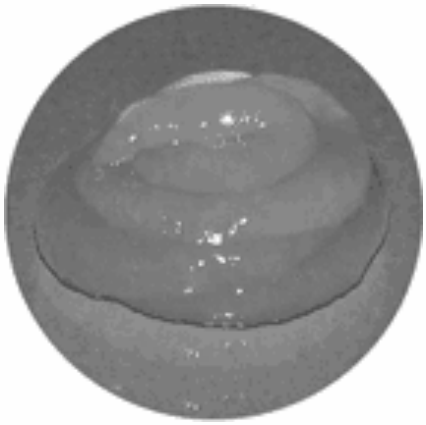




Hydrogels

- High water content
- Provides moist environment
- Aids in autolytic debridement
- Conforms to wound shape
- Non-adherent
- Soothing on burns, abrasions
- 2 forms: Sheets and Amorphous(actual gel)
- Indications: Dry and necrotic wounds to increase moisture and encourage autolytic debridement. Facilitates granulation and epithelialization. Simple and complex wounds.
- Contraindications: Excessive drainage
- Examples: Carrasyn, Solosite

Hydrogels



Hydrocolloids

- Gel-forming polymer with adhesive
  - When polymer comes in contact with drainage, forms a gel
- Most occlusive of microenvironmental dressings
- Can be left on for several days at a time
- When removed from wound, gel is yellow and may have odor but does not indicate infection
- Indications: Management of superficial ulcers, necrotic but not infected ulcers
- When to discontinue: Wound is granulated or hypergranulation occurs; However, can be used to assist with epithelialization

Hydrocolloids

- Provides moist environment
- Aids in autolytic debridement
- Conforms to body shape
- Protects from antimicrobial contamination
- Provides a waterproof surface
- Requires no secondary dressing
- Examples: Duoderm, Tegasorb

Hydrocolloids

See how color of hydrocolloid changes from brownish color to whitish-yellow color with absorption of drainage? Expect to see this.

Alginates

- Calcium or calcium/sodium salts composed of acids obtained from seaweed
- Turns to gel once in contact with wound drainage
- Indications: Highly exuding wounds, over areas of bleeding, can be used with infected ulcers
- When to discontinue: If level of drainage is insufficient to cause fiber to turn to gel
- Examples: Tegagen, Sorbsan

Alginates

- Provide moist environment
- Provide high absorptive capacity
  - Can absorb up to 20 times their weight in drainage
- Conforms to body shape
- Protects
- Provides hemostasis
- Non-adherent

Alginates

Hydrofibers

- Look like alginates but are made of polymer carboxymethylcellulose(CMC)
- Activated by moisture in wound
- Able to absorb more drainage than alginate
- Example: Aquacel, CombiDERM, Versiva

Hydrofibers

Antibiotic Creams and Ointments

- Not recommended for all wounds as they can increase resistance and sensitivity
- Mupirocin(Bactroban)→Used with MRSA abscesses
- Silver Sulfadiazine: "Silvadene"; used to treat burns; Thickness of 1/16 of inch
- Neosporin/Polysporin: Petrolatum-based ointments; both have several antibiotic ointments in them
- Cadexomer Iodine: Contains sustained release iodine; Indicated for heavily draining or heavily infected wounds; Examples include Iodoflex, Iodosorb

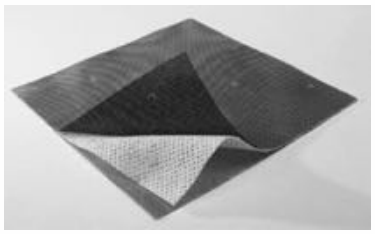
Use of Antiseptics in Wounds

- Antiseptics can reduce bacteria on skin by up to 95%
- However, research has shown that wounds continue to heal even if wound is not sterile and that antiseptics do not guarantee a wound will not become infected
- Antiseptics are cytotoxic, so they kill not only bad organisms but the good organisms that actually help wounds to heal
- Antiseptics are useful in an acute, traumatic wound or in burns to help decrease bacteria
- Examples: Povidone-Iodine, Dakins' solution, Acetic acid, Hydrogen peroxide

Antimicrobial Dressings

- Silver or cadexomer iodine dressings
- Come in all types, including gauzes, films, hydrocolloid, foams, and alginates
- May be primary or secondary dressings
- Assists wound closure by protecting the wound from bacterial contamination and helping to maintain a moist wound environment
  - Faster kill rates for micro-organisms, longer wearing times
  - Effective against gram +, gram – and fungal infections(including MRSA and VRE)
  - Examples: Aquacel Ag, Acticoat, Silvasorb, Actisorb; Iodosorb

Antimicrobial Dressings



Acticoat-Silver dressing

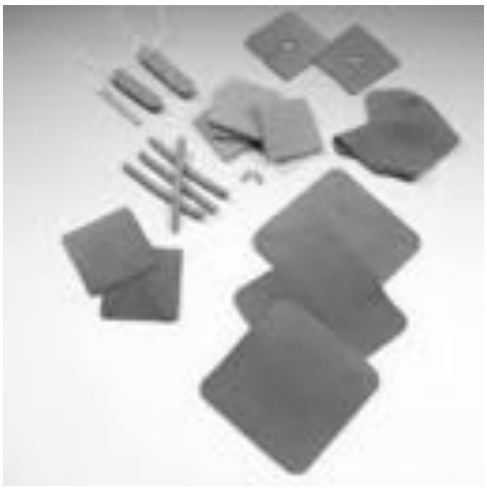
Silver Hydrofiber

Iodosorb Paste and Gel-Cadexomer Iodine

Bacteriostatic Dressings

- Doesn't kill bacteria; rather it prevents bacteria from multiplying
- Hydrofera Blue
  - Foam dressing
    - Highly absorptive
  - Must hydrate it with saline if wound does not have a lot of drainage
    - New dressing called Hydrofera Blue Ready is already moist so needs no hydration
  - Can use with Santyl and growth factors
  - Can use under compression
  - 7-day dressing

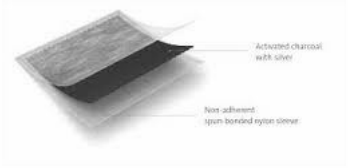
Hydrofera Blue



Charcoal Dressings

- Used to control odor
- Good for necrotic wounds or fungating wounds from cancer
- Help improve quality of life; doesn't have any healing qualities

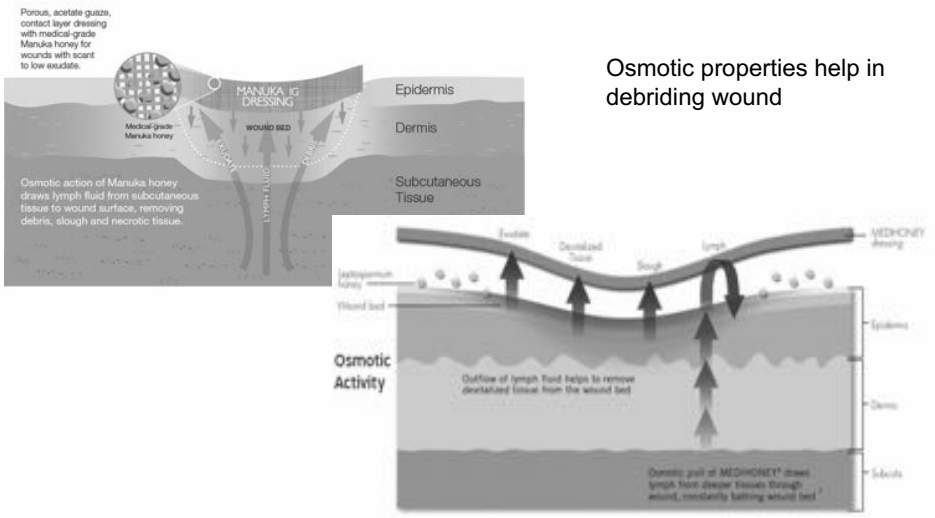
Charcoal Dressings



Honey-Impregnated Dressings

- Made from specific honey found in New Zealand, called Manuka honey
- Comes in many delivery systems
  - Gel, alginate, hydrocolloid
- Helps to fight bacteria and control odor
- Aids in autolytic debridement
- Change pH in wound to improve healing
- Decreases pain
- Faster healing time

Honey-Impregnated Dressings



Osmotic properties help in debriding wound

Honey-Impregnated Dressings

What happens if your dressings can't contain the drainage?

Figure 2: Poor control of exudate: dressings are soaked with exudate and strikethrough is evident

Outcomes of good exudate management

- *Less periwound maceration*
- *Lower bacterial burden on the wound bed*
- *Promotion of rapid granulation from the base of the wound (WUWHS, 2007).*

Superabsorbent Dressings

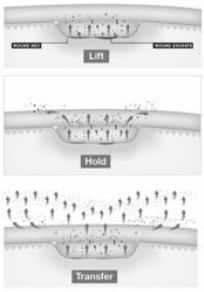
- Made to absorbent moderate to copious amounts of drainage
- Absorb 4-5 times their weight in drainage
- Some have "diaper technology"→gels up when comes in contact with drainage
  - Xtrasorb, Sorbion
- Some have multiple layers that wick the fluid away from the wound and to the outer core of the dressing
  - Drawtex, Cutisorb
- Cost-effective because you don't have to change dressings as often

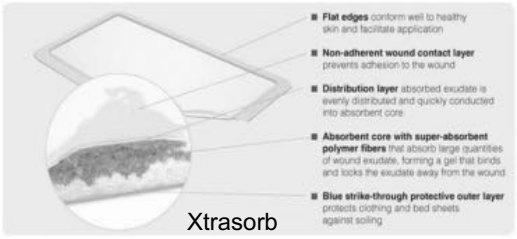
Superabsorbent Dressings

Cutisorb

Xtrasorb

Drawtex





Xtrasorb

Composite Dressings

- Can be a primary or secondary dressing
- Usually have 3 layers(from inside to out)
  1. Non-Adherent layer protects wound
  2. Absorbent layer absorbs drainage and protects periwound from maceration
  3. Bacterial barrier, usually made of semipermeable film

Recent Trends

- Paradigm shift from moist wound environment to wound bed preparation, i.e. you want to prepare the wound bed to allow for granulation and epithelialization to occur
- Trying to optimize the chemical environment of the wound as well as the moisture balance

When to use Advanced Therapies

- Not all wounds should be treated with advanced therapies
- Rather, advanced therapies should be used on wounds that have failed to heal with conventional methods or on acute wounds that may be hard to heal
- It is commonly understood that advanced therapies should be used on "refractory" wounds
  - "Refractory" used to describe wounds that have not healed, despite "good" wound care
  - Used to define difficult-to-heal wounds and those not progressing towards healing
- Include:
  - Collagen dressings
  - Topical growth factors
  - Living skin equivalents
  - Synthetic skin dressings

Collagen Dressings

- Promogran:
  - Introduces collagen into wound matrix as collagen is framework responsible for granulation tissue
  - Also introduces oxygen reconstituted cellulose(ORC) into wound which binds MMPs with growth factors and allows growth factors to work more effectively
- Prisma:
  - Similar to Promogran but also has silver in it to fight bacteria
- Endoform:
  - Contains 90% native, intact collagen and 10% extracellular matrix components, Broad spectrum MMP reduction
- All 3 are cost efficient as they only need to be applied weekly

Collagen Dressings

Dressing Materials Releasing Growth Factors and Components of Wound Matrix

- Growth factors are important because they help regulate cell proliferation, differentiation and organ growth
- Also help fight MMPs

Platelet-Derived Growth Factor(PDGF):

- Regranex: FDA approved for LE diabetic ulcers only. Can be used for other wounds "off-label." Contains platelet-derived growth factor which stimulates angiogenesis and formation of granulation tissue. Prescription required. Skill in application. Must be kept refrigerated. Very expensive. Should be discontinued if patient has extensive necrosis, untreated infection or ischemia.

Biological Skin Substitutes

- Use as an alternative to skin grafting
- Some are available for off the shelf use
  - Thus are quickly and easily accessible
  - Others need to be temperature controlled
- Eliminate need for donor site
- Minimize contracture and scarring
- Immunologically compatible

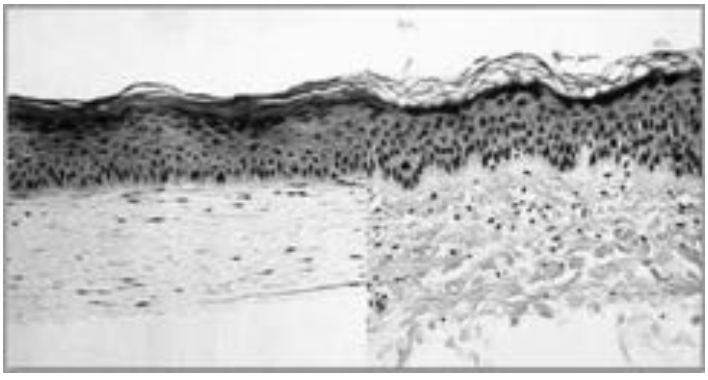
Apligraf

- FDA approved for diabetic foot ulcers and venous stasis ulcers
- Supplied as a living, bi-layered skin substitute
- Dermal layer combines bovine type 1 collagen and human fibroblasts
- Epidermal layer is formed by promoting human keratinocytes(epidermal cells)
- Outpatient surgical procedure
- Obtained from neonatal foreskin

Apligraf

- Method of Application: Comes in thermally controlled box. Must be incubated before it is used. Graft is placed on the wound with overlapping edges and compression wrap is used to fix it in place.
- Expected Outcomes: Initially looks like skin graft and then takes on appears of gelatin. Must be careful not to disrupt the "taking" of this product. Apligraf acts as a "biologic growth factor factory." Minimal contracture with healing

Apligraf



In this picture, Apligraf is on left and normal skin is on right. You can see that Apligraf contains the 2 primary layers of skin like normal skin.

Apligraf

How it is shipped

Healing with Apligraf

OASIS

- Natural acellular collagen matrix
- Derived from porcine(pig) small intestine submucosa(SIS)
- Provide environment for formation of dermal and epidermal tissue with minimal scarring
- Indications: Surgical wounds, traumatic wounds, diabetic ulcers, venous ulcers, pressure injuries, chronic vascular ulcers
- Contraindications: Untreated infected wounds, patients with sensitivity to porcine material; 3rd degree burns

OASIS

- Application:
  - Cut to fit the shape of the wound
  - Moisten with saline
  - Apply directly to the wound bed
  - Secure with steri-strips, wound glue, sutures
  - Cover with secondary dressing
  - Apply weekly

OASIS

Secondary Dressings and Bandaging Techniques

- Hold primary dressing in place, increase absorption, provide compression, provide comfort, warmth and protection to area
- Will depend on type of wound, location of wound and amount of exudate
- Films, foams, gauze can all function as secondary dressings

Management of Cavities

- Any time there is "dead space," this must be filled→prevents abscess formation
- Used to be called "packing" a wound but this is should only be done when heavy bleeding is noted and hemostasis needs to be obtained
- Otherwise, it is called "filling" a wound

Management of Cavities

- Prevents epiboly and allows dead spaces to fill with granulation tissue
- Can fill wounds with packing strips which can be either plain cotton strips or cotton strips soaked in iodine, called Iodoform
- May also fill wounds with alginate or hydrofiber ropes or bandage rolls depending on size of wound and amount of drainage
- Can use cotton tipped applicator or tongue depressor to fill the wound
- Must be sure to leave enough of a tail hanging out of the wound to be able to adequately remove the filling material at the next dressing change

Tolerance for Adhesives

- Many people are intolerant of adhesives and adhesives can cause extensive tissue damage when used
- Any type of dressing that has adhesives in it can be damaging
- Use of skin protectant such as 3M No-Sting Skin Barrier film acts as a second skin and protects skin when adhesive is removed
- Can also use stretch netting or tubular bandages to secure dressings

Economics of Dressing Changes

- Dressings can be very costly and not always reimbursed by insurance
- If dressings can be used that can stay on for 3-5 days, this is more cost-effective
- Another factor to consider is manpower
  - Twice daily or daily dressing changes in the hospital requires a skilled practitioner to do the dressing change so even if cheaper dressing used, it still costs more!

Economics of Dressing Changes

- Medicare Part B is very strict with what they will pay for
  - Will only pay for primary and secondary dressings caused by a surgical procedure, treated by a surgical procedure, or require debridement
  - Will not pay for dressings used on skin conditions treated with topical medications, draining cutaneous fistulas, dressings used to protect a wound from friction, shear, and moisture, dressings over IV sites, first degree burns, skin tears, abrasions

Economics of Dressing Changes

- Can only order 1 month of supply at a time
- Medicare will only pay 80%, encourage patients to get secondary insurance to cover other 20%
- Medicare will pay for dressings based on wound size; if request bigger dressing than appropriate, Medicare will not pay

Treatment Options

- In addition to dressings, there are many adjunctive therapies for acute and chronic wounds
- Surgeons can do surgical debridements, skin grafts, and muscle flaps
- Next several slides will discuss options that PTs have in wound care

Treatment Options

- "Gold Standards" based on 4 common wound types
  - Venous: Compression
  - Pressure: Offload pressure, turn schedule
  - Arterial: Re-vascularization
  - Diabetic: Offload, frequent foot inspections

Physical Therapy Options: Many of these options are suitable for all types of wounds

- Mechanical Debridement
  - Wet-to-dry
  - Hydrotherapy
    - Whirlpool
    - Pulsatile Lavage
- Sharp Debridement
- Enzymatic Debridement
- Compression wraps
- Intermittent compression
- Ultrasound
- Electrical Stimulation
- Negative Pressure Wound Therapy (NPWT)
- Hyperbaric Oxygen (HBO)
- MIST therapy
- Offloading

Mechanical Debridement

- The use of some outside force to remove necrotic tissue
- Wet-to-dry, pulsatile lavage, whirlpool
- Advantages: Familiar to most health care practitioners; effectively decrease bacterial burden in wound, thus decreasing chance of infection
- Disadvantages: Nonselective; wet-to-dry not used appropriately, painful on removal and more costly in regards to labor and supplies; delays normal healing time; maceration to surrounding tissue may occur; possible chance of cross-contamination between patients if whirlpool not adequately cleaned.
- Typically used on wounds with large amounts of necrotic tissue in an attempt to loosen necrotic tissue and make it easier for sharp debridement to be performed

Sharp Debridement

- Can be performed as a one-time procedure or can be ongoing with more necrotic tissue being debrided at each treatment session
  - New recommendation is that sharp debridement be an ongoing process to keep wound free of microscopic debris
- Can convert chronic wound to an acute wound
- Removal of loose nonviable tissue with scalpel, forceps and/or scissors
- Depending on state practice acts, both physical therapists and nurses can perform sharp debridement
- APTA recommends that PTAs should not perform sharp debridement as it entails constant re-assessment; however, the APTA has left it up to individual states to make their own determinations

Sharp debridement

- Advantages: Selective, quick and effective; Can be used with other types of debridement techniques; less invasive; can be performed at bedside
- Disadvantages: Requires level of skill or expertise to be performed safely; questionable reimbursement when performed by non-physicians; can be painful
- Contraindications: Coagulopathy

Sharp debridement

Enzymatic debridement

- The use of enzymatic topical agents to remove nonviable tissue
- Collagenase Santyl: As name describes, it works by breaking down collagen; works at interface of necrosis and wound base. Can use topical antibiotic powder with it if wound infected; Not to be used with silver dressings
- Useful with patients who can't tolerate sharp debridement
- Physician's order is required as the agents are obtained from pharmacy
- Not active in dry environments
- Dry eschar must be cross-hatched and wound maintained with moist environment for enzymatic debridement to be effective
- Best used on large wounds with >50% necrosis
- Advantages: Selective, works only on non-viable tissue, can be used in conjunction with other debridement options
- Disadvantages: Slower form of debridement, inflammation can occur to surrounding skin due to pH changes

Compression Therapy

- Works with exercise to facilitate movement of fluid from lower extremity back to heart
- Depending on patient's need for vascular support, different levels of compression are available
- For venous disease, ~40mm Hg is needed; however, this is only for those who are ambulatory and able to work the calf muscles
  - In non-ambulatory patients, lower compression is better tolerated

Compression Therapy

- Be cautious when placing compression therapy on patients with ABI's less than 0.8 as this is suggestive of arterial disease
  - Recommendations:
    - ABI 0.8-1.0, use high compression(40-50mm Hg)
    - ABI 0.5-0.8, use light compression(18-24mm Hg)
    - ABI 0.5 or below, compression is contraindicated
- Elastic bandages are relatively easy to apply, inexpensive and easily removed
- Some can be removed at night

Different types of Compression Therapy

- Tubular bandages: Give light compression; must be tapered at ankle so more compression is given at ankle than at calf
- Inelastic Systems:
  - Paste Bandages: Also called Unna boots; Consists of fine gauze impregnated with zinc oxide, gelatin and glycerin. Some may also have calamine. Applied without tension in circular fashion from base of toes to fibular head. Does not apply compression but simply does not allow the foot to swell any further. Must be changed every 7-10 days.
  - CircAid: Non-elastic, adjustable garment. Consists of a legging with interlocking, non-elastic bands and Velcro fasteners that surround the leg. Can adjust bands as edema increases or decreases, providing constant compression.

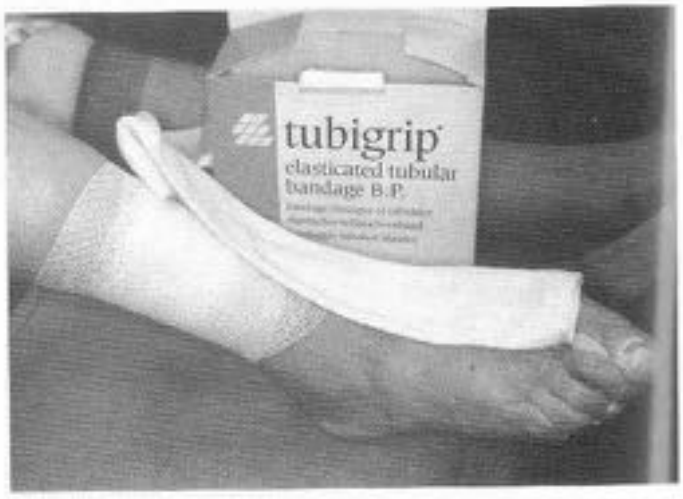


Figure 9–3 Tubular bandages. Courtesy of Convatec, Skillman, New Jersey.

- Multilayer bandages: Provides graduated, sustained compression through series of layers providing protection, padding and compression. Can be changed weekly. Examples are Coban 2, ProFore and FourPress.
- Graduated Compression Stockings: Assists venous return by reducing edema. Client is measured and fitted for compression stockings when edema is absent or minimal. Can be difficult to don. Needs frequent replacement as elasticity is lost and adequate amount of compression is not sustained.

Multi-layer Compression Wrap

Graduated Compression Stockings

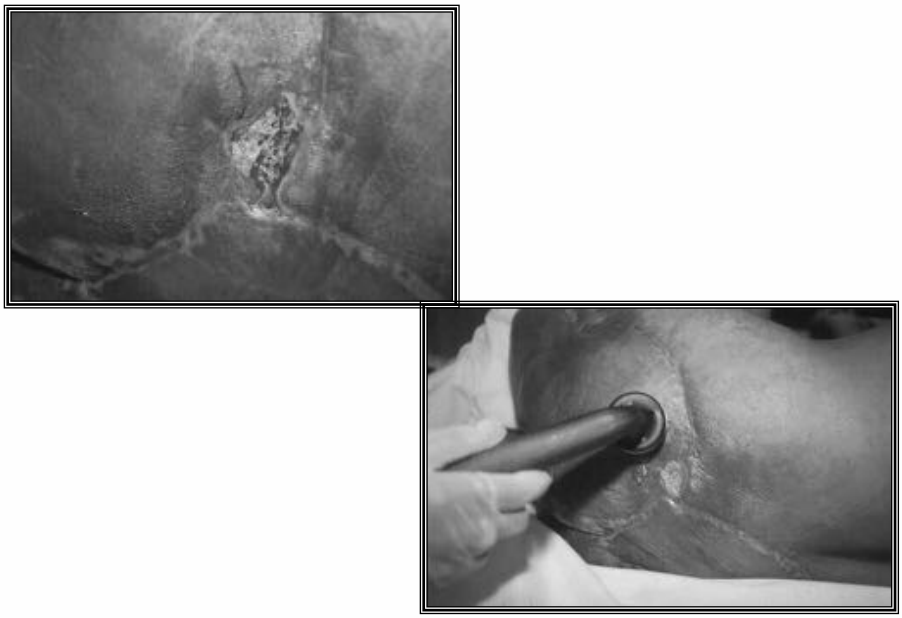
Figure 9–6 Compression stocking. Courtesy of Beiersdorf-Jobst, Inc., Charlotte, North Carolina.

- Compression Pump Therapy: Consists of leg sleeve with 3-, 5- or 10-chambers with peak pressures of 45-60 mm Hg. Inflates first at ankle, then works up to thigh. Can be done 1-2 hours twice a day. Should be followed by application of compression bandage or garment.
- With all compression therapy, close monitoring of patients with congestive heart failure should be done due to increased intravascular fluid burden

ure 9-7 Compression pump and sleeve. Courtesy of Progressive Medical Technology, Inc., Lansing, Michigan.

Ultrasound

- Theory: Cells close to stable bubbles are subject to bubble-associated microstreaming that has been shown to increase their plasma membrane permeability to calcium ions temporarily acting as a stimulus to cell activity such as cell migration and proliferation as well as synthesis and release of growth factors
- Thermal and non-thermal effects



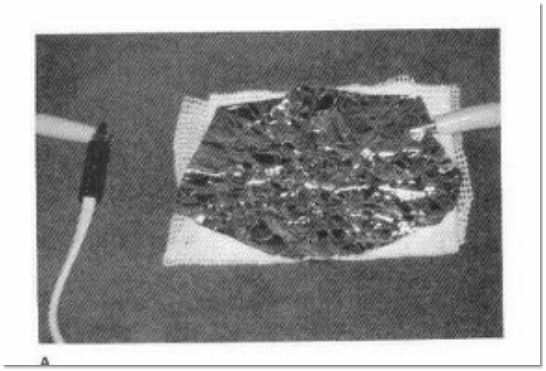
Electric Stimulation for Tissue Repair

- Rationale:
  - Liquefies or softens necrotic tissue
  - Reduces pain and edema
  - Antibacterial effects
  - Increase ATP generation and improve membrane transport
  - Increase collagen synthetic capacity
  - Organizes collagen matrix to increase wound tensile strength

Application of ESTR

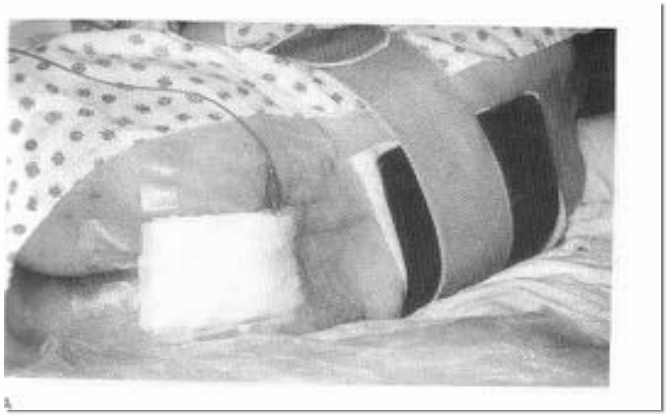
- External Electrode Placement
  - Place electrodes along side of wound
  - Called “Bipolar” technique
  - Closer together the electrodes, the more superficial the result
- Internal Electrode Placement
  - Place moist 4x4 in wound with aluminum foil over moist 4x4 hooked to e-stim machine with alligator clip
  - Called “Monopolar” technique
  - Must use dispersive

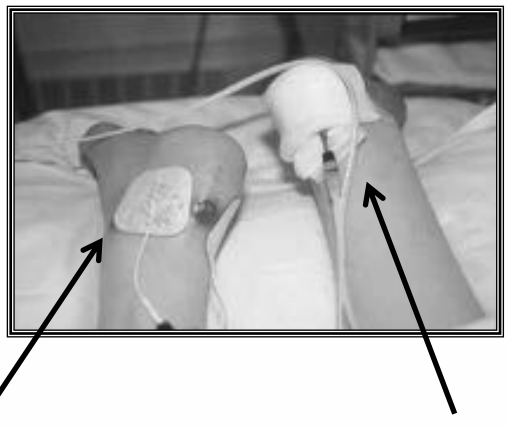
Aluminum foil with Electrode



Bipolar technique

Monopolar Technique





Bipolar Technique *Monopolar Technique*

Negative Pressure Wound Therapy(NPWT)

- System uses special open-cell polyurethane ether foam dressing cut to size of wound
- Foam then placed in wound and covered by film
- Tube placed over sponge and then attached to pump which generates negative pressure between 50-200 mmHg
- Drainage is collected in canister in pump

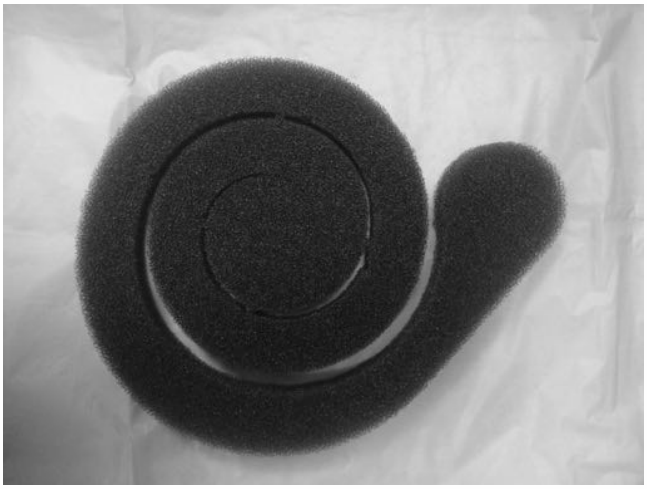
VAC Ulta-Newest Hospital Model

With Veraflo Therapy

Types of Foam

- 3 different types:
  - Black, sterile, polyurethane foam has large pores and is more effective for stimulating granulation tissue and wound contraction
  - White, sterile, polyvinyl alcohol soft foam is denser with smaller pores and is recommended when growth of granulation tissue is less needed or when patient can't tolerate polyurethane foam due to pain
  - Silver: Similar to black foam but has silver in it for its antimicrobial effects

Black Foam



White Foam

Silver Foam

Rationale

- Negative pressure distorts/stretches cells
  - Causes mitosis and granulation tissue formation
  - Stimulates growth of new blood vessels
- Lowers bacteria count in wound bed
  - Removes wound fluid which could provide medium for bacterial proliferation
- Vacuum removes excess fluid from interstitium
  - Pulls excess interstitial fluid from surrounding tissues
  - Removes pressure from blood vessels and improves flow of oxygen and nutrients to wound

Indications

- Stage III and IV pressure injuries
- Venous wounds
- Arterial wounds
- Neuropathic/diabetic ulcers
- Dehisced incisions
- Split thickness meshed skin grafts
- Muscle flaps
- Non-surgical candidates
- Enteric fistulae(abnormal opening from organ to skin surface)

- Contraindications:
  - Presence of eschar and necrotic tissue(must be less than 25% necrotic)
  - Untreated osteomyelitis
  - Malignancy in wound
- Precautions:
  - Active bleeding
  - Difficult wound hemostasis
  - Patients on anti-coagulants

Hyperbaric Oxygen Therapy

- Delivery of 100% oxygen through a sealed chamber at a pressure greater than 1 atmosphere
- Capable of inducing revascularization of damaged tissue
- Medicare has list of conditions it will reimburse HBO for; very specific
- Time-intensive; 5 days a week for 6-8 weeks
- 2 forms available where oxygen is inhaled:
  - Single person total body chamber(more common)
  - Multi-person total body chamber

Total Body Chambers

Total Body Chamber

Multi-person Chamber

MIST therapy

- Designed to deliver therapeutic ultrasound to the wound bed without direct contact with the body
- Emphasizes wound bed preparation to promote wound healing.
  - Wound cleansing, debriding and removal of bacteria
  - Promotes new blood vessels and attracts appropriate cells to wound
- System generates and propels the therapeutic ultrasound mist towards the tissue
- Saline solution is directed to the tip surface and is atomized through the vibration of the tip surface. This surface creates atomization of the fluid, breaking it apart into small particles of uniform size.
- Once the particles of fluid are released from the tip, a second phenomenon, the acoustic pressure wave, drives them toward the wound

MIST Therapy

- A Healing Device for Wounds

Offloading

- The use of various techniques to eliminate pressure around diabetic foot ulcers
- Need for offloading continues after ulcer is healed to ensure wound does not recur or a new wound does not form

Treatment for Neuropathic Wounds

- Total Contact Cast
  - The cast must be changed in 1 week to accommodate fluid changes
  - Can then be changes every 2-3 weeks
  - Once temperature is equal to other limb, can gradually wean patient from cast to splint and then to shoes

Total Contact Casting(TCC)

- Provides decreased plantar pressures by increasing weight bearing over entire lower leg
- Works well on plantar ulcers
- Requires careful application, close follow-up and patient compliance
- Average healing time with TCC is 6 weeks

Total Contact Cast(TCC)

www.aafp.org

http://www.medefficiency.com

Neuropathic Walker

- Combo of ankle foot orthosis and boot that is custom designed to be total contact for weight distribution
- Ankle is locked
- Indicated for patients with Charcot joint in tarsal and ankle joints, chronic recurrence of Charcot disease and chronic ulcerations
- Keep in mind that wearing a TCC or a Walking boot will change the patient's gait pattern

Walking boot

Walking shoes


PLANTAR PAD
Selective pressure relief
Shear reduction
Pressure distribution
Easily removed for cleaning
Removable toe piece

Atypical Wounds

- Sometimes wounds do not fit neatly into one of the above categories discussed
  - Inflammatory disease such as Vasculitis
  - Malignancy such as Malignant Melanoma, Basal Cell Carcinoma, or Squamous Cell Carcinoma
  - Associated with other diseases such as Pyoderma Gangrenosum or Calciphylaxis
  - Autoimmune disease such as Bullous Pemphigus
  - Hereditary disease such as Sickle Cell Anemia or l Bullosa
  - Traumatic such as gunshot wounds, skin tears, burns
- These are just a few disorders that may cause wounds
  - Non-healing wounds need to be biopsied to determine etiology

When to refer to a specialist

- Important to remember that we are not just looking at the hole in the patient but the whole patient
- As mentioned earlier in the presentation, sometimes a referral is needed for wounds that aren't healing as anticipated
  - Dermatologist
  - Vascular surgeon
  - Infectious disease
  - Podiatrist

Conclusion

- As mentioned at the beginning of this presentation, it is important to have at least a baseline of knowledge about wound care
- 4 “typical” wounds include diabetic, pressure, arterial and venous
- However, wounds frequently do not fall into one of these categories and thus require referral to an outside specialist
- Many different treatment options that promote wound healing, including topical ointments, various dressings and physical agents

Questions?