

# Differential diagnosis and PT management of Wounds



# Objectives –

- ⑩ Discuss the stages of wound healing, and determine the stage of a healing wound.
- ⑩ Describe possible problems which affect wound repair.
- ⑩ Perform a detailed wound assessment including diagnosis and prognosis.
- ⑩ Differentiate among different wound types and appropriate treatments.
- ⑩ Perform accurate wound measurements.
- ⑩ Design a wound treatment program based on wound characteristics including edema, infection, necrotic tissue, and wound environment.
- ⑩ Choose appropriate technology to facilitate wound healing in the chronic or problem wound.
- ⑩ Discuss the use of ultrasound and electrical stimulation in wound healing.

# Healthy Skin

- General Characteristics
  - Largest organ (sensory) of the body
    - Protects against :
      - pathogens and irritants and loss of fluid
    - Provides temperature control- thermoregulation
  - Normally dry, supple, acidic-antifungal
    - Acid mantle (pH of 4.5 to 5.5)
    - Elastic and well hydrated

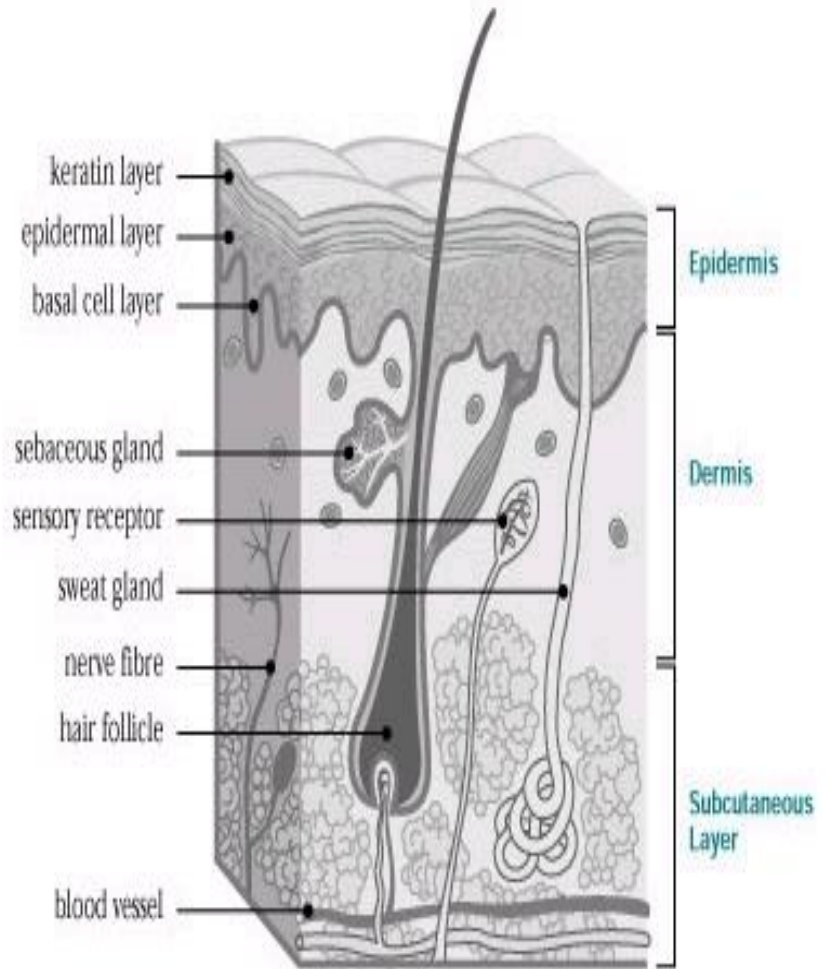
# Layers of the skin

## Epidermis

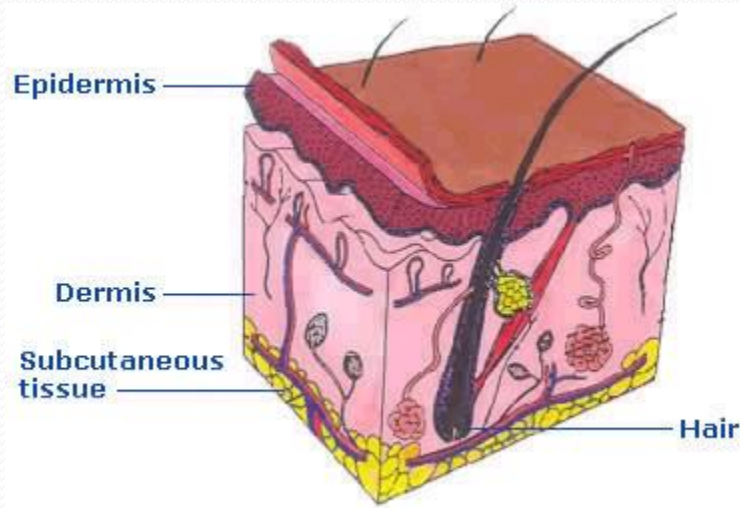
- outermost layer
- primarily dead cells-epithelial cells
- No blood vessels
- .06 to 6 mm thick

- **Dermis**

- Inner layer
- Provides strength and endurance
- has collagen, elastin, blood vessels, epidermal appendages
- Key cells: fibroblasts and macrophages



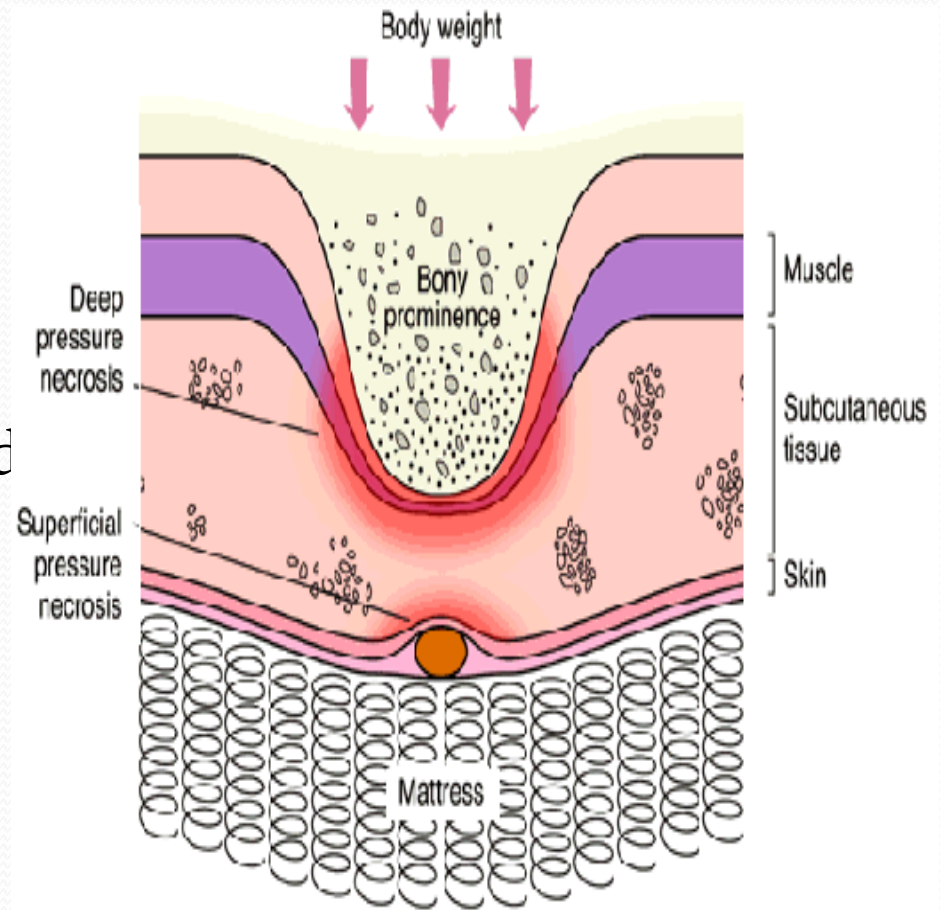
# Healthy skin Cont'd



- Subcu Tissue(not a true skin layer)
  - Provides padding (adipose) and even pressure
  - Needed for prevention of skin breakdown
  - Fascia

- **Muscle layer**

- highest metabolic rate
- rich blood flow
- uses O<sub>2</sub> at most rapid rate
- first tissue to get in “trouble” with prolonged pressure

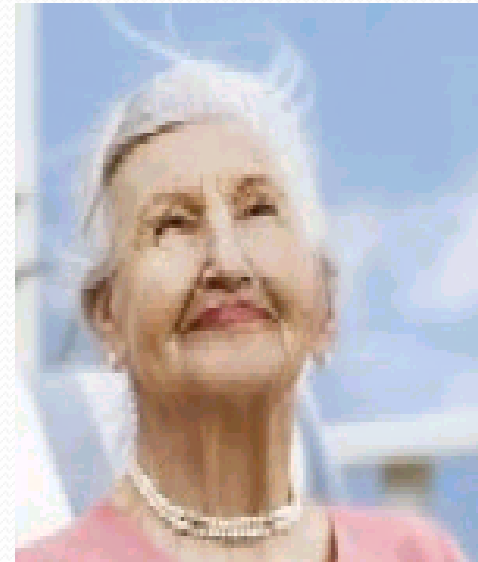


# Changes in skin

- Epidermal regeneration-
  - “turnover” time in young adult:21 days
  - Age 35-doubles to 42 days
- Neonates-
  - increased permeability
  - increased vulnerability to skin tears
- Infants
  - Increased risk of occipital pressure ulcers

# Elderly Skin

- Loss of subcu-tissue
- Decreased cohesion of epidermis and dermis
- Loss of sensory awareness
- Diminished blood flow
- Thin skin- “Onion skin”
  - May be due to reduced estrogen production and function





# Effects of Estrogen on Skin

- Estrogen Receptors located in fibroblasts, macrophages, endothelial cells and epidermal cells
- Estrogen action on skin
  - Increases mitosis in epidermal cells
  - Enhances angiogenesis
  - Modulates Inflammatory response
  - Accelerates re-epithelialization
  - Regulates proteolysis
  - Stimulates wound contraction

# Risks of Estrogen Deficiency

- Reduced phagocytosis – increases risk of infection
- Accelerated and excessive tissue breakdown
  - **Possible Treatment Options**
    - Systemic hormone replacement
    - Topical Estrogen application

# Wound Healing

## Phases of Wound Healing

The entire wound healing process is a complex series of events that begins at the moment of injury and can continue for months to years.



# Phases of Wound Healing

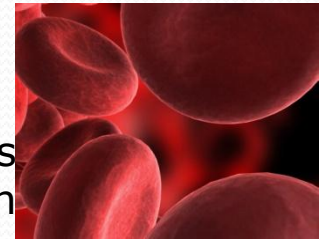
**I. Inflammatory Phase - Immediate to 2-5 days -  
Allows body to control blood loss and fend off bacteria**

## **1. Vascular reaction-**

Injured Blood vessel walls allow fluid called **transudate** to leak into interstitial space and cause edema- heparin is released  
**vasoconstriction**- to control blood loss-by serotonin  
clotting-platelet plug- releases **thrombin**  
neutrophilic leukocytes- phagocytosis of bacteria  
vasodilation

## **2. Cellular reaction -**

decreased local blood volume results in slow flow of WBC's  
platelets- platelet plug- to ward off area and stop bleeding  
lymphocytes- phagocytosis



## **3. Chemical mediators -**

**histamine**- short term vasodilation,  
**serotonin**- vasoconstrictor of smooth muscle  
**kinins and prostaglandins**- lead to longer lasting vasodilation

# Phases of Wound healing

## ■ II. Proliferative Phase

### ● A) 2 days to 3 weeks

### ● B) Granulation

- Fibroblasts lay bed of collagen - collagen synthesis

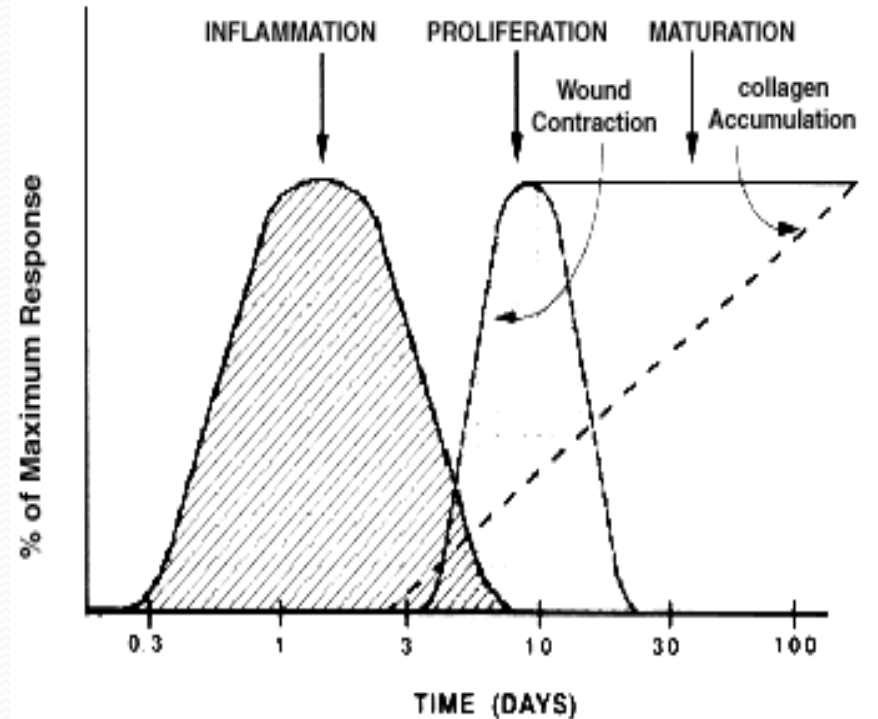
- Fills defect and produces new capillaries

### ● C) Contraction

- Wound edges pull together to reduce defect

### ● D) Epithelialization

- epithelial cells migrate across moist surface



# Phases of Wound healing

## ■ **III. Remodeling Phase**

- A) 3 weeks to 2 years
- B) New collagen forms which increases tensile strength to wounds
- C) Scar tissue is only 80 percent as strong as original tissue

# Problems That Affect Wound Repair

- Chronic wounds:- When wound repair is not occurring, can be :
  - 90% of all chronic wounds are:
    - Vascular
    - Pressure
    - Neuropathic: Diabetic
  - Intrinsic- age, circulatory diseases, neuropathy, malnutrition, immunosuppression
  - Extrinsic- medication, irradiation, psychophysiologic stress, wound bioburden: necrosis or infection
  - Iatrogenic- Local ischemia, inappropriate wound care, trauma, pressure, inattention to controlling pathology, patient noncompliance

# Wound

## Examination/Assessment

- **Integumentary System:**
  - **Practice Patterns 7A-7E**
- Purposes:
- ☐ To examine the severity of the lesion
- ☐ To determine the phase of wound healing
- ☐ To establish a baseline
- Assessments should be done weekly or biweekly, and performed with a method or instrument which recognizes valid, significant change.





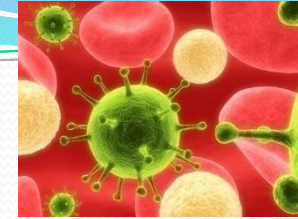
# Wound Assessment

- Patient History
- Barriers to wound healing
  - Medical
  - Psychological
  - Demographic
- Past or present treatment of wound and results
- Patients level of mobility and function
- Equipment use

# Physical Exam/Assessment

- Wound Appearance
  - Size and shape
  - Color – Presence of necrosis
  - Odor
  - Drainage/Exudate
- Appearance of surrounding skin, hair and nails
- Circulation Tests
  - Peripheral pulses, skin color, temp capillary refill, ABI (Ankle Brachial Index)

# Infection



- Common infections
  - S. Aureus-
    - creamy yellow pus
  - E. Coli
  - Proteus –
    - fish
  - P. aeruginosa
    - green or blue, with fruity odor

## Control of Infection

- Exogenous
- Endogenous
- **Development of bacteria depends on total bacterial count: culture or biopsy**



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# Signs of infection

- Local: pus, redness, pain, swelling, red streaks on wound
- Systemic-fever, chills, increased HR, confusion in older adults
- Treatment
  - Antimicrobial broad or narrow- topical or systemic
  - Antifungal- for yeasts and molds
  - Debridement

## Infection vs. inflammation

Wound characteristic	Inflammation	Infection
Erythema-Rubor	Well-defined borders. Not as intense Skin discoloration in dark-skinned persons	Edges of erythema may be indistinct  Intense with distinct borders Red stripes or streaking
Elevated temperature-Calor	Wound site and surrounding tissues	Systemic temperature
Exudate: odor	May be due to necrotic tissue, type of wound therapy, not necessarily wound	Specific odor according to pathogen
Exudate: amount	Minimal and decreasing	Moderate to large, and increasing
Exudate: character	Bleeding and serosanguineous to serous	Serous to seropurulent to purulent
Pain	Variable	Persistent and continuous
Edema and induration-Tumor	Slight swelling	Indicate infection if swelling accompanied by warmth

# Necrosis

Predominant color	Moisture content	Adherence
Black/brown eschar	Hard	Firmly attached
Tan-yellow slough	soft-soggy	Attached at base
Yellow fibrinous	soft-stringy	Loosely attached
White-gray	Mucinous	clumps

# Necrosis Cont'd

- Percentage of wound covered
  - Tracing
  - Measure
- Types of Necrosis
  - Eschar
  - slough
  - Fibrin
  - Hyperkeratosis
  - Gangrene

# Medication

- NSAIDS
- Steroids
- Immunosuppressive drugs
- Antineoplastic
- Anticoagulants
- Antiprostaglandins



# Wound Assessment

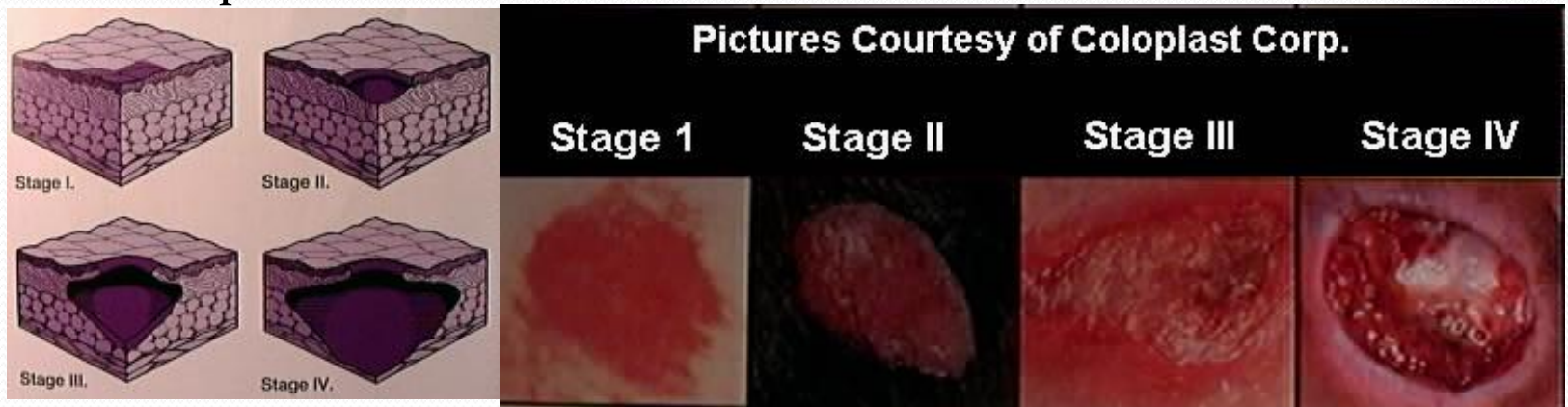
- Wound Classification
  - NPAUP
  - Wagner
  - Red, Yellow, Black
  - Skin Loss

# Pressure Ulcers

- Etiology
  - Tissue necrosis due to ischemia
- Iceberg effect
  - Visual damage is the “tip of the iceberg”
- Prevalance
  - 15% of all hospital residents (acute care)
  - Malnutrition – including obesity
  - Can lead to serious complications, risk of death

# Pressure ulcer staging system

- Stage I – nonblanchable erythema, involves the epidermis only
- Stage II – superficial ulcer, shallow blister or crater, - epidermis and dermis
- Stage III – deep ulcer, may have undermining, to but not through the underlying fascia
- Stage IV – deep ulcer through underlying structures, with extensive necrosis, may have undermining, tunnels, or tracts
- The following information was copied verbatim from the AHCPR Guidelines, which is consistent with the recommendations of the National Pressure Ulcer Advisory Panel (NPUAP) Consensus Development Conference:



# Pressure Ulcer



- *This patient has a stage III pressure ulcer on the outer lower quadrant of the buttock. The wound surface area is covered with 50% slough and 50% pale pinkish tissue.*

# Pressure Ulcer

- Pressure ulcers take a few days to “mature” to the point that they can get staged
- Do not “reverse stage” as the pressure ulcer is healing

# Pressure Ulcer Characteristics

- Can be painful, but maybe not
- Position should provide a clue
- Necrotic base is usually present at first
- The periwound skin is usually inflamed or mottled in appearance
- Typically warm to the touch

# Pressure Ulcer Assessment

- Many assessment tools available
- Make sure you are using whatever scale is used at the institution correctly.
- Don't use a scale if not approved and understood by whoever is going to be reading the note
- Most common is the NPUAP

# Intervention

- Education and coordination re: movement and positioning
- Nutrition
- Assurance of appropriate reimbursement
- Educate patient or caregiver about monitoring the wound and dressing changes
- Prevention is the key



# Procedural intervention

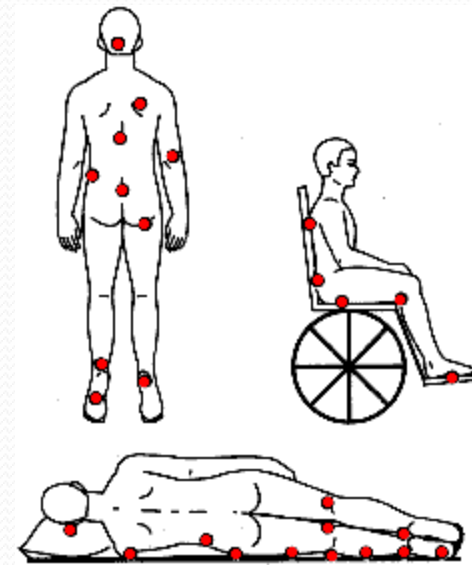
- Depth may be greater than it first appears
- Classification is often inaccurate or impossible due to eschar and necrotic tissue
- Deep ulcers may extend into body cavities
- Prioritize treatment of pressure ulcers in those who are terminally ill

# Reduce pressure

- Pressure-reducing and pressure relieving devices
- Static and dynamic support surfaces
- Foam or fluid filled devices
- Air-fluidized devices
- See Table 12-11

# Pressure ulcer

- When soft tissue is trapped between hard surface and bony prominence
- If pressure is greater than intercapillary pressure, ischemia results
- Metabolic wastes are trapped as lymph channels are blocked
- Decubitis – bed sore
- Bed or chair bound, casts, braces, shoes



# Pressure Ulcer

- In absence of neuropathy or movement disorder, pressure causes pain
- Positional changes reduce pressure
- Reactive hyperemia occurs – blanchable erythema
- Length of time for reactive hyperemia proportional to tissue ischemia

# Pressure ulcers – risk factors

- Friction and shear – tunneling ulcers more common
- Moisture and maceration – especially bowel and bladder incontinence
- Impaired mobility
- Malnutrition
- Impaired sensation
- Age
- Previous ulcer

# Prevention of pressure ulcers

- Risk assessment scales
  - Norton pressure ulcer scale
  - Braden scale
- Components of intervention
  - Education of patients, caregivers, HCW
  - Positioning
  - Mobility
  - Nutrition
  - Incontinence

# NeuroPathic Ulcer Classification

- Wagner classification system (Figure 13-3)
  - 0- no open lesions, deformity or cellulitis
  - 1- superficial ulcer
  - 2- deep ulcer to tendon, capsule, or bone
  - 3- deep ulcer with abscess, osteomyelitis, or sepsis
  - 4- localized gangrene
  - 5- gangrene of the entire foot

# Neuropathic ulcers

- Diabetic ulcers
- Etiology
  - RBC's become sticky, stick to endothelial walls, decreases lumen size and increases microvascular pressure
  - Glycosylation of proteins, messes up normal processes
  - Sorbitol accumulation



# Risk factors

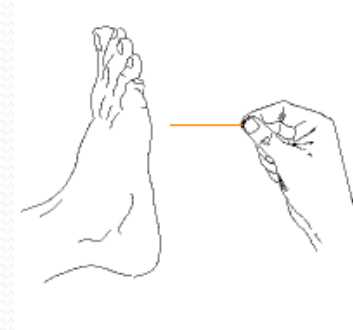
- Vascular disease
- Neuropathy
  - Sensory neuropathy – loss of protective sensation
  - Motor neuropathy – paralysis of intrinsic muscles, less stable foot, derangement of normal biomechanics
  - Autonomic neuropathy – disturbances in sweat and blood flow
- Mechanical stress – rate of breakdown exceeds rate of repair

# Risk factors

- Abnormal foot function
  - Impaired ROM
  - Foot deformities
  - Previous ulcer or amputation
  - Inadequate or inappropriate footwear
- Impaired healing and immune response
- Poor vision
- Ulcer characteristics
- Disease characteristics
- Inadequate professional and patient education

# Tests and measures for Neuropathic Feet

- Examine pulses
- ABI or doppler
- Capillary refill
- Sensory integrity
  - Monofilament testing



# Physical therapy intervention

- Team approach
  - Podiatrist
  - Endocrinologist
  - Diabetes educator
  - Nutritionist
- Patient/ client instruction
  - Foot wear
  - Role of exercise and precautions
  - Glycemic control (diet, exercise, and medication)

# Characteristics of Neuropathic ulcers

- Not painful-usually
- Found on plantar aspect of foot, or areas of increased shear forces
- Round punched out lesion with callus and little drainage
- Usually not necrotic
- Dry, cracked, callused skin
- Structural deformities of foot, often prior amputations
- Normal pulses
- Normal or elevated temperatures



Diabetic neuropathic ulcer. He was healing well after the application of Graftskin but became non-compliant with off-loading. There is now necrosis of the previously healed area



# Procedural interventions

- Precautions
  - Do not exhibit the cardinal signs of infection when infected
  - Patients with osteomyelitis need surgical intervention
  - Foot care guidelines and appropriate footwear
  - Monitor for signs of hypoglycemia in patients with ulcers (metabolic stress)

# Procedural interventions

- Remove calluses
- Moisturize (not between the toes)
- Toe spacers
- Total contact casting with a walking splint
- Take care with this
- Otherwise maintenance of clean, warm, moist, granular wound bed

# Definitions: Skin Loss Classification

**Superficial-** is a superficial, reddened area of skin like a sunburn.

**First-degree burns** affect only the epidermis, or outer layer of skin. The burn site is red, painful, dry, and with no blisters. Mild sunburn is an example. Long-term tissue damage is rare and usually consists of an increase or decrease in the skin color.

**Partial.....**is a blistered injury site which may heal spontaneously after the blister fluid has been removed.

**Superficial- Partial thickness burns**

**Second-degree burns** involve the epidermis and part of the dermis layer of skin. The burn site appears red, blistered, and may be swollen and painful.

**Deep Partial Thickness-** Involves the epidermis and dermis. Burn site appears mottled and white, painful



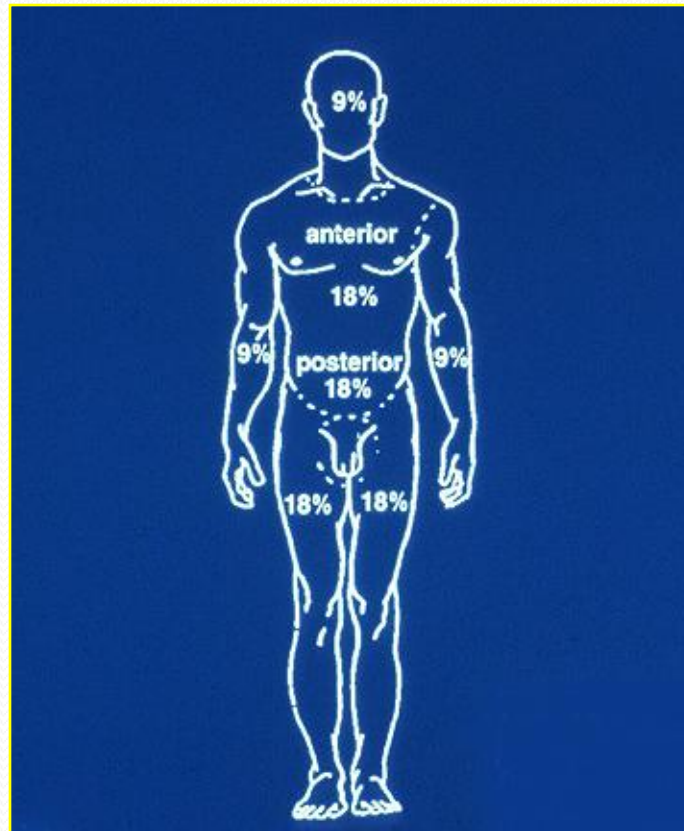
# Skin Loss Continued

- **Full Thickness burn**.....is a burn through the entire skin and will usually require surgical intervention for wound healing.
  - **Full thickness burns**  
Third-degree burns destroy the epidermis and dermis. Third-degree burns may also damage the underlying bones, muscles, and tendons. The burn site appears white or charred. There is no sensation in the area since the nerve endings are destroyed.
- **Subdermal**- Destruction of epidermis, dermis and through the subcutaneous tissue

# Types of Burns

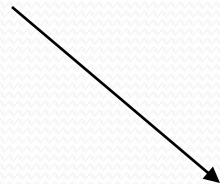
- **Scald**.....May occur from scalding hot water, grease or radiator fluid.
- **Thermal**.....May occur from flames, usually deep burns.
- **Chemical**.....May come from acid and alkali, usually deep burns.
- **Electrical**.....Either low voltage around a house or high voltage at work
- **Explosion Flash**.....Usually superficial injuries.
- **Contact Burns**.....Usually deep and may occur from muffler tail pipes, hot irons and stoves.

# Rule of Nine's- Determine Total Body Surface Area (TBSA)

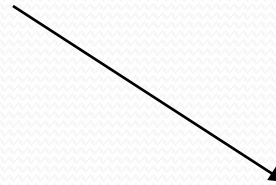


# Arterial insufficiency

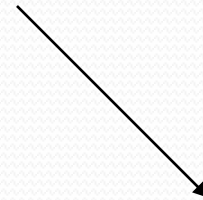
Intermittent claudication



Ischemic rest pain



Arterial ulcers



gangrene

# Arterial ulcers

- Decrease in arterial blood supply (arterial insufficiency)
  - DM, RA, trauma, embolism
  - Arteriosclerosis - thickening and hardening of artery walls
  - Atherosclerosis – cholesterol deposits in artery lumen

Note how this patient has arterial ulcers on the lateral malleolus and dorsum of the near foot as well as the medial malleolus of the far foot



# Tests and measures

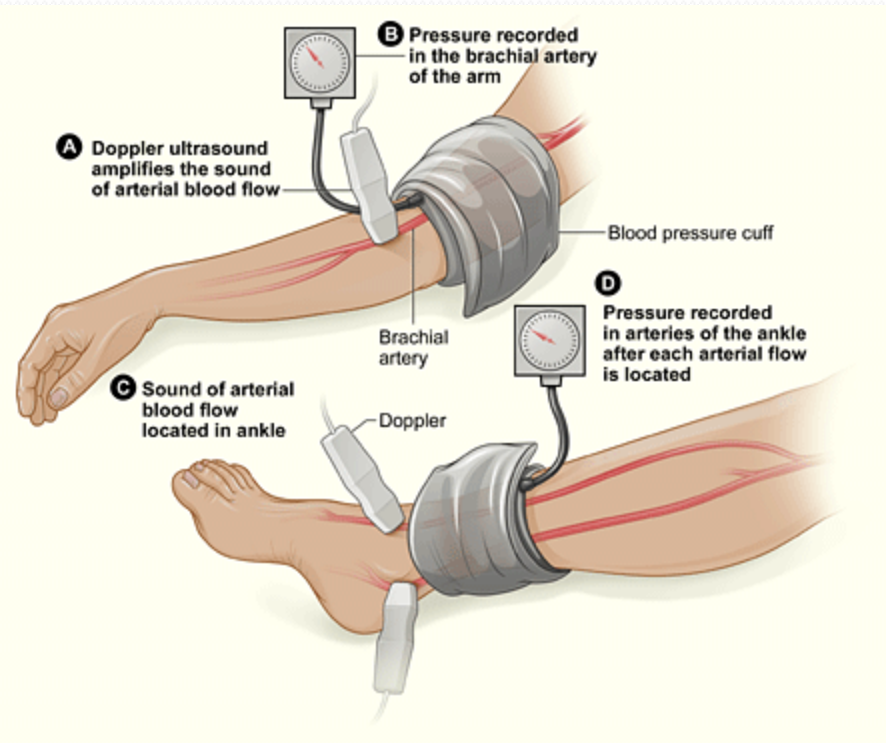
- Pulses
  - Femoral in femoral triangle
  - Popliteal-post with relaxed flexed knee
  - Dorsalis pedis-over second ray
  - Posterior tibial-superior to medial malleolus
  - Grading Table 4-8
- Doppler ultrasound

# Arterial Circulation

- **Capillary refill time**- blanch the toe with pressure and record time it takes to get back to normal color  
Normal= $<3$ sec
- **Rubor of dependency**
  - Observe color in supine
  - Time takes to become pale when you move the legs from supine to 60 degrees of elevation
  - Look at color in dependent position
- **Venous filling time**
  - Patient in supine, observe superficial veins of foot
  - Elevate legs and wait for veins to drain
  - Time it takes to refill
    - $>20$  seconds – arterial insufficiency
    - $<5$  seconds – venous insufficiency

# Ankle Brachial Index

- ABI – ratio of systolic blood pressure of the lower extremity to the upper extremity
  - Done with ultrasound





# Risk factors

- Hyperlipidemia
- Smoking
- Diabetes
- Hypertension
- Trauma
- Age

# Arterial ulcers - characteristics

Painful

- Pain increased with elevation
- Lateral malleolus, distal toes, dorsum of foot
- Pale granulation tissue
- Round wounds with regular edges “punched out”
- Black eschar
- Little drainage
- Thin, shiny, dry skin
- Loss of hair
- Thick, yellow nails
- Pale, dusky, blue skin
- Decreased/absent pulses
- cold

# Intervention

- Education
  - Tighter control of HTN and blood sugar
  - Hydration, limit caffeine
  - Appropriate nutrition
  - Smoking cessation
  - Relieve stress
  - Injury prevention
  - Foot care guidelines (Table 10-7)

# Procedural intervention

- Precautions –
  - Sharp debridement
  - Compression
  - Surgically remove gangrenous tissue
  - If no response in 2-6 weeks, refer
  - Patients with low ADL will not heal



# Procedural intervention

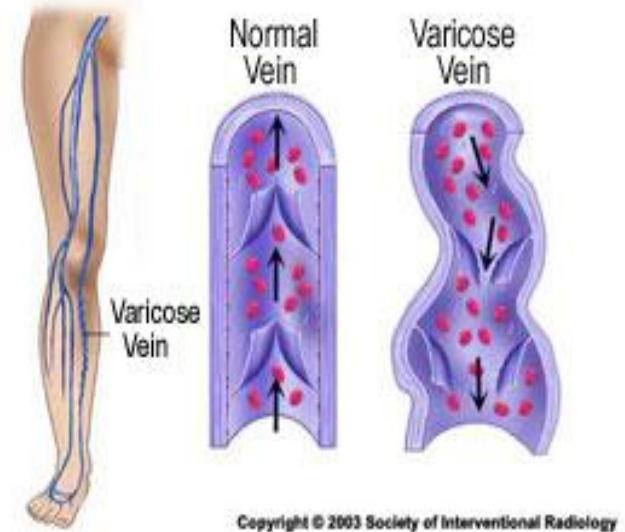
- Hydrate with cream or emollient
- Protect toes to reduce friction
- Debride (not sharp)
- Wound dressing that donate moisture
- Do not elevate
- Gait training if needing to minimize weight bearing on open wounds
- Orthotic footwear
- Patient positioning to minimize trauma and pressure
- Aerobic exercise
- Flexibility exercises

# Venous insufficiency ulcers

- **Calf muscle pump** – increases pressure proximally and moves blood toward lower pressure proximally
- Valves keep blood from flowing back into calf when muscle relaxes
- When valves malfunction – venous hypertension
- Sustained venous hypertension leads to venous insufficiency ulcers

# Risk factors for venous insufficiency ulcers

- **Valve dysfunction** – due to damage or varicosity
- **Calf muscle pump failure** - damage, weakness, or prolonged standing
- **Trauma** – minor trauma to edematous leg
- **Previous venous insufficiency ulcer**
- **Age**
- **Diabetes**



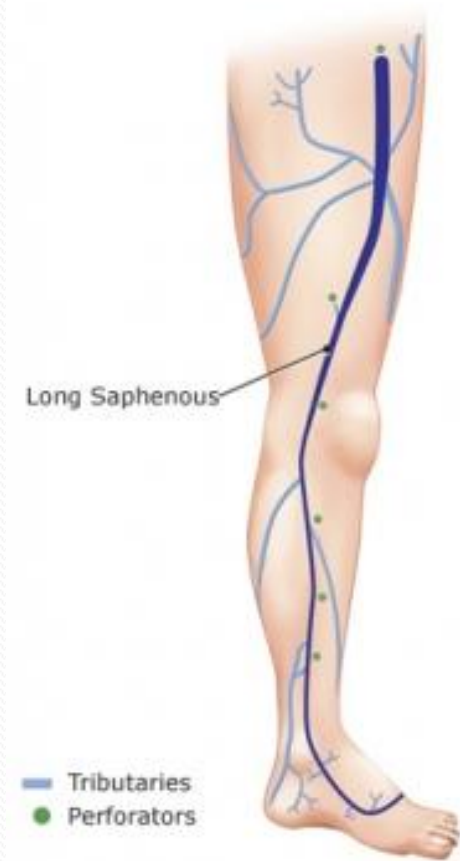
# Tests and measures

- Percussion Test
- Trendelenburg test
- Doppler ultrasound (harder than arterial)
- Homan's sign
- Venous filling time
- ABI



# Venous insufficiency ulcers

- Less painful than arterial
  - Pain alleviated with elevation and compression
- Medial malleolus or medial lower leg
- Irregular shape
- Red, wet wound bed
- Yellow fibrin over wound bed
- Copious drainage
- Edematous leg
- Cellulitis common
- Hemosiderin staining
- Pulses can be normal or decreased
- Temp normal or increased



# Venous Ulcer

## Picture



The patient above presented with this stasis ulcer which had been present for one and one half year. Treatment consisted of debridement, Woundress, Allevyn and a dry sterile dressing.

Hyperpigmentation is the discoloration (bronze-brown or purple) of the skin in patients with chronic venous reflux disease and chronic inflammation of varicose veins. Hyperpigmentation occurs in the ankles, feet and lower legs in patients with venous disease.



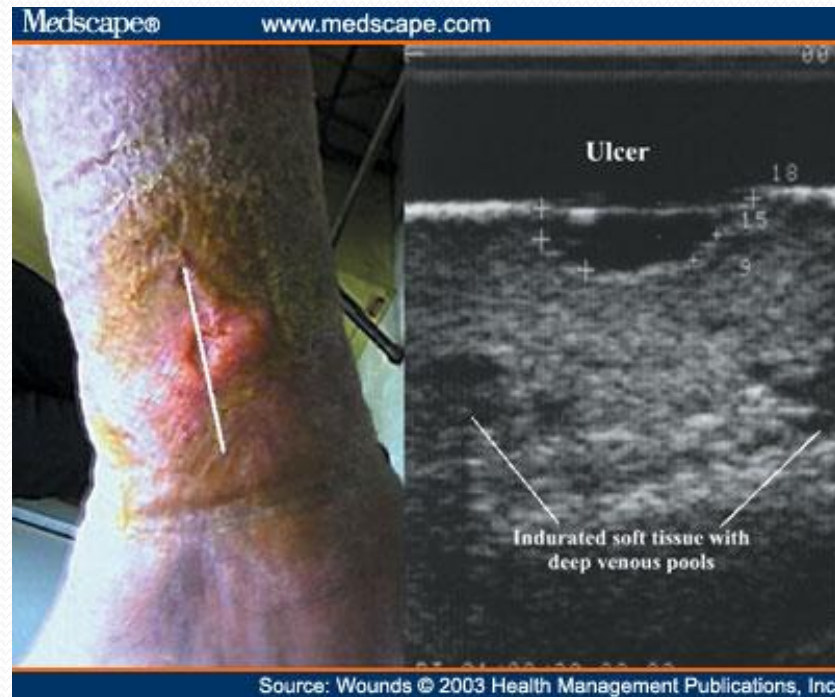
# Intervention

- Education re: diabetes/obesity
- Education re: compression and wound care
- Procedural intervention
- Compliance and adherence
- Understanding of etiology



# Venous insufficiency ulcers

- Usually concomitant arterial insufficiency
- Higher risk for allergic reactions
- **Whirlpool requires dependent position of limb and warm water, both of which can increase edema**



# Management of wound edema

- Non-elastic bandage enhances the action of the calf muscle pump
- Elastic bandages (such as ace) are not as effective in providing compression
- Compression also moves fluid and blood from superficial to deep
- If compression makes the patient less comfortable, consider that arterial insufficiency is the problem

# Compression therapy

- Compression garments
  - Custom made by making a series of circumferential measurements
  - Need to specify the amount of compression needed
    - 20-30 mm Hg for mild insufficiency
    - 50-55 mm Hg for severe insufficiency
  - Must wear them all of the time, and replace every 6 months
  - Can be expensive
  - Compliance a problem, especially with thigh high

# Compression therapy

- Paste bandages – gauze impregnated with zinc oxide
  - Left on for one week, this can be a problem
  - Do not get wet or shower
  - Allergies and sensitization
- Short-stretch compression wraps
  - Hard to apply and train patient
  - Not used much here in U.S.
  - Hard to gauge amount of pressure applied



# Compression therapy

- Vasopneumatic sequential compression pump
  - Single chamber not very effective
  - Multi chamber more effective, but need 2-4 hours per day
  - Use the pump, then must put on a compression garment
  - Questionable effectiveness, little research
- Ankle pumps and aerobic exercise



- Compression important, but not in the presence of arterial insufficiency

# Venous insufficiency ulcers

- Local wound care
  - Protect periwound skin (moisturizers, topical steroids)
  - Absorb drainage (moisture absorbing drainage)
  - Enhance venous return (should reduce drainage)
  - Patient/caregiver education (adherence important)

# Local wound care

- Warm, moist, granular wound bed
- Protect periwound skin
- Absorb excess drainage, or donate moisture
- Fill space
- Debride
- Minimize pressure and shear

# RED, Yellow, Black

- RED- wound bed red, pink, granulation tissue  
**Treatment -protect**
- Yellow- moist, yellow slough, **Treatment-**  
debride, absorb drainage, protect skin
- Black- thick and adhered **Treatment- debride**

# Assessment

- Wound Phasing
- Prognosis
- Differential Diagnosis
- Vascular Exam

# Wound Exudate Classification

<b>Drainage/Exudate Type</b>	<b>Color</b>	<b>Consistency</b>	<b>Significance</b>
Sanguineous/bloody	Red	Thin, watery	Indicates new blood vessel growth or disruption of blood vessels
Serosanguineous	Light red to pink	Thin, watery	Normal during inflammatory and proliferative phases of healing
Serous	Clear, light color	Thin, watery	Normal during inflammatory and proliferative phases of healing
Seropurulent	Cloudy, yellow to tan	Thin, watery	May be first signal of impending wound infection
Purulent/pus	Yellow, tan, or green	Thick, opaque	Signals wound infection; may be associated with odor


# Definitions

- Adjacent Tissue

- Turgor
- Scar tissue
- Callus
- Maceration
- Edema
- Color





- 
- Ecchymosis
  - Pain
  - Sensation, protective sensation, hot/cold discrimination
  - Adjacent skin temp
  - Hair distribution
  - Toenails
  - Blister

# Differential diagnosis – Abnormal Wound Healing

## - Red flags

- ☒ Scales associated with psoriasis
- ☒ Papules such as warts and tumors,
- ☒ Chickenpox or shingles
- ☒ Nonhealing
- ☒ Deep: bones that communicate with bone
- ☒ Chronic inflammation phase ☒ need revascularization
- ☒ Deep tunneling

- Hypogranulation-pothole type
- Hypergranulation-mound
- Hypertrophic Scarring-raised-red fibrous lesions
- Keloids-indiv with highly pigmented skin
- Contractures-pathological shortening- results in deformity
- Dehiscence-separation of wound margins

# Prognosis

- As a PT you must:
  - predict optimal level of improvement
  - determine frequency and duration
  - type of intervention required
  - time required to reach this level

# Wound Measurements

- Basics
- Photo graph
- Tracing
- Measurements

# Wound Healing- Closure

- Primary Intention-Surgical incision
  - Edges of the wound are physically approximated and held in place by, sutures, staples, tape.
- Secondary Intention-
  - granulation matrix must be built to fill the defect, contraction to decrease size, epithelialization to bridge the wound margins
- Tertiary Intention-combo 1° and 2°
  - AKA - Delayed Primary Closure

# Types of Wound Debridement

- Mechanical Debridement
- Enzymatic Debridement
- Sharp/Surgical Debridement
- Autolytic Debridement
- Maggots

# Compression therapy

- Vasopneumatic sequential compression pump
  - Single chamber not very effective
  - Multi chamber more effective, but need 2-4 hours per day
  - Use the pump, then must put on a compression garment
  - Questionable effectiveness, little research
- Ankle pumps and aerobic exercise

# Sterile vs Clean

<b>Sterile</b>	<b>Clean</b>
Preparation of a sterile field	Preparation of a clean field
Clean gloves	Clean gloves
Decontamination of the wound and surrounding skin with an antimicrobial cleanser	Cleansing of the wound and surrounding skin
Change gloves: sterile gloves	Change gloves: clean gloves
Use sterile forceps, scalpel, and scissors	Use sterile forceps, scalpel, and scissors
Allow only “sterile to sterile” contact of instruments and materials used for the procedure	Prevent direct contamination of materials and supplies, but no “sterile to sterile” rules apply
Apply sterile dressing	Apply clean dressing
Settings: acute care hospitals and clinics	Settings: home care, LTC facilities, community clinics, MD offices
Procedures: Invasive procedures, sharp debridement	Procedures: routine procedures, dressing changes
Patients: Immunocompromised, very young, diabetic	Patients NOT at high risk for infection



# Common Topical Agents used with Burn Patients

- Silver Nitrate
- Silvadene
- Sulfamylon - 10% water-miscible cream based
- Povidone-iodine - 1% water miscible cream based
- Accuzyme
- Bacitracin Ointment
- Xeroform
- Acticoat

A. Non-adherent gauze, B. 3 x 4 gauze square, C. absorbent gauze pad, D. 6-ply gauze roll, E. bismuth-impregnated gauze, F. petrolatum-impregnated gauze, and G. 2-ply roll gauze



Moisture retentive dressings labeled counterclockwise, from top left: *A.* semi-permeable film, *B.* sheet hydrogel, *C.* alginate sheet, *D.* alginate-tipped applicator, *E.* hydrocolloid, and *F.* semi-permeable foam.



# Wound Care Dressings

- Ag- Silver Dressings**.....up to several days
- Alginate wound cover**.....Dressing change once daily
- Alginate wound filler**.....Dressing change once daily, up to 2 six inch strips allowed per dressing change
- Composite dressing** .....3 times per week, one dressing per dressing change
- Contact layer** .....once per week
- Foam dressing**.....up to 3 times per week
- Foam wound filler**.....once daily
- Gauze**.....3 times per day, no more than 2 pads on a wound  
(non-impregnated)
- Gauze** .....once daily  
(impregnated - other than water or saline)
- Gauze**.....Non-covered, reduced to regular non-impregnated gauze level  
(impregnated with water or saline)

# Wound Care Dressings

<b>Hydrocolloid cover and filler</b>	.....3 times per week
<b>Hydrogel wound cover</b>	.....once daily (or 3 times per week if using adhesive border)
<b>Hydrogel wound filler</b>	.....once daily, no more than 3 ounces per wound in a 30 day period
<b>Specialty absorptive dressing</b>	.....once per day (or every other day if using adhesive border)
<b>Transparent film</b>	.....up to 3 times per week
<b>Wound filler not classified</b>	.....once per day
<b>Wound pouch</b>	.....up to 3 times per week
<b>Tape</b>	.....determined by frequency of dressing change
<b>Elastic bandage</b>	.....one per week
<b>Gauze, elastic</b>	.....determined by the frequency of dressing change of the primary dressing
<b>Gauze, non-elastic</b>	.....determined by the frequency of dressing change of the primary dressing

# Other Treatments

- Ultrasound
- Electrical Stim
- Pulsed Lavage

Vacuum Assisted Closure (VAC)



Hyperbaric oxygen therapy



# Physical agents

- Hydrotherapy
  - Wound irrigation
  - Whirlpool
  - Pulsed lavage
- Electrical stimulation
- Ultrasound
- Hyperbaric
- Others
  - Negative pressure wound therapy
  - Laser therapy
  - Ultraviolet

# Wound irrigation

- Use of fluid to remove loosely adherent debris, bacteria, exudate, topical agents and dressing residue
- Indications – most effective intervention for granular wounds but can't hurt other wounds
- Contraindications – active profuse bleeding



# Wound irrigation

- Procedures
  - Normal saline
  - Some force needed – Waterpik at lowest setting
  - Some absorbent layer needed beneath the area being cleaned
  - Use appropriate PPE
  - Dry with towel (sterile better)

# Wound irrigation

- Advantages – easy, cheap, and can be done anywhere
- Disadvantages – can be messy

# Whirlpool

- Cleans
- Softens necrotic tissue
- Hydrates the wound bed
- Improves circulation
- Decreased patient pain
- Makes rom easier (burns)
- Can help take off adherent dressings

# Whirlpool

- Indications - On infected wound to reduce bacterial load
- Contraindications –
  - Venous insufficiency
  - Bowel incontinence (body whirlpool)
  - Urinary incontinence (precaution)
  - Psychological
  - Multiple wounds
  - Insufficient for tunneling wounds
  - Granulating wounds

# Whirlpool

- 92-98, warmer for full body, but never more than 102 degrees
- 10-20 minutes
- No chemicals unless REALLY dirty
- ROM exercises in whirlpool
- Can debride a little in pool
- PPE

# Whirlpool

- Advantages –
  - easy
  - Accessible
  - Rom exercise
- Disadvantages
  - Unable to check force of water
  - Hard to clean
  - Can be costly

# Pulsed Lavage with suction

- Delivery of (saline) to wound bed in regularly calibrated pressurized bursts accompanied by suction to remove fluid from the wound bed
- Indications
  - Tunneling or undermining wounds
  - Venous insufficiency
  - Proliferative phase
- Contraindications
  - Exposed arteries, nerves, tendons, etc.
  - Body cavities
  - Grafts or recent surgery
  - Active bleeding
  - Latex caution

# Pulsed Lavage


- Advantages
  - Portability
  - Less painful
  - Can use with venous insufficiency
- Disadvantages
  - Disinfection
  - Wasteful and expensive
  - Not appropriate for large wounds





# Electrical stimulation - HVPGS

- Restores the current of injury – normally epidermis is more negative than the dermis, but this relationship is disrupted
- Inflammation changes the skin current through the “current of injury” which is a trigger for wound healing
- This system is dysfunctional in chronic wounds
- E-stim applied to the wound can reset the current of injury
- Same principle as moist wound healing

- 
- Galvanotaxis – movement of cells across electric gradient, macrophages, neutrophils, etc.
  - Stimulates cells proliferation, enhancing cell function
  - Increases blood flow, thus more access to oxygen
  - Decreases bacterial load by attraction of macrophages and neutrophils to area (cathode more than anode)
  - Reduces edema
  - Facilitates debridement

# Electrical stimulation

- Indications – any type of wound, but chronic wounds especially useful
- Contraindications –
  - Simple uncomplicated wounds
  - Osteomyelitis
  - Topical agents with heavy metal ions
  - Actively bleeding
  - Sensory neuropathy
  - Intensity that is less than submotor

# Electrical stimulation

- Direct technique – one electrode (negative or cathode) on saline or hydrogel soaked gauze directly in wound bed, and the other return electrode approximately 15-20 cm proximally
- Immersion technique – immerse in a nonmetal basin, place positive (anode) contact side down within the basin, and the other electrode proximally so that electricity flows from the water (treatment electrode) through the extremity.
- Indirect technique – electrodes straddle the wound bed, you can leave dressings on



# E-stim parameters

- 80-125 Hz
- 50-100 microsecond interpulse interval
- 75-200 volts (comfortable paresthesia)
- 30-60 minutes bid to tid
- Debate about whether positive or negative electrode should be the treatment electrode
  - Cathode (negative) to reduce infection
  - Anode (positive) to promote proliferation

# E-stim

- Advantages –
  - Less set-up
  - Portable
  - Versatile
- Disadvantage
  - Takes a long time
  - Wound contamination
  - Not good for extensive wounds

# Ultrasound

- Inflammatory phase – stimulates the release of chemotactic agents
- Proliferation phase – stimulate fibroblast proliferation, facilitates angiogenesis, strengthens collagen framework
- Remodeling – increases wound tensile strength, increases strength and flexibility of scar tissue

# Ultrasound



- Indications – any type of wound, chronic wounds especially
- Contraindications –
  - Osteomyelitis
  - Severe bleeding
  - Severe arterial insufficiency
  - DVT
  - Untreated infections
  - Large amounts of eschar
  - Simple, uncomplicated wounds



# Ultrasound

- Direct technique
  - Directly to wound bed
  - Fill with amorphous hydrogel
  - Cover wound with barrier (film, hydrogel sheet, glove filled with water)
  - Ultrasound gel on top of barrier
- Can treat periwound only
- Immersion
  - Non-metal water filled basin
  - Moving head 0.5-1.0 cm away from the wound surface
  - Increase intensity

# Parameters

- Deep wounds 1.0 MHz
- Superficial wounds 3.0 MHz
- Pulsed 0.5-1.0 W/cm<sup>2</sup>
- 2-3 minutes per zone (1.5 times size of head)
- Bid-tiw
- For scar remodeling increase intensity and/or continuous

# Ultrasound

- Advantages
  - Portable
  - Short application time
  - Less set up and clean-up, no maceration
- Disadvantages
  - Little research
  - Small wounds only
  - May be painful
  - Wound contamination

# Hyperbaric oxygen

- Tissue trauma causes increased oxygen demand and decreased supply due to damage to microvasculature
- Systemic and topical hyperbaric oxygen may be a useful adjunctive therapy
- Indicated for hypoxic wounds ( $<30$  mm Hg partial pressure of oxygen)
- Assessed by transcutaneous oxygen monitoring (TCOM)

# References

- Meyers BA. *Wound Management Principles and Practice*. 1<sup>st</sup> ed. Upper Saddle River (NJ): Pearson Education, Inc.; 2004.