What is New in Wounds

Nancy Broderick, APRN/CFNP, CWOCN, DNPc
Kaiser Permanente
South Bay Medical Center
Harbor City, CA

Objectives

- Review of the skin
- Review of the healing cascade
- Factors influencing wound healing
- Different wound types
- Wound Management
- Research

www.clinimed.co.uk/wound-care/education/wound
Review of Skin

First line of defense

Function
- Protection
- Temperature regulation
- Sensation
- Prevents loss of body fluids
- Synthesizes vitamin D

Has its own immune system
- Langehans' cells – antigen presenting cells
  - Recognize, process, uptake and present antigens to T-lymphocytes
- Tissue Macrophage – derived from monocytes
  - Destroy bacteria, present antigens to lymphoid cells
  - Secrete growth factors and cytokines
- Mast Cells – secrete hormones
  - Present in inflammation, acute or chronic
  - Protection from parasites, promote phagocytosis

Support skin
- Acid mantle pH of 4.5-5.5 with low pH soaps
- Liquid soaps only
- Moisturizers
- Increase water intake - po

Why discuss the skin
- Age
- Chronic disease
- Devices
Inflammatory Phase (2-5 days)
- Hemostasis phase
  - Lasts a few hours
  - Vasoconstriction
  - Platelet aggregation to form clot
  - Major player thromboplastin

Inflammatory Phase (2-5 days)
- Inflammation phase
  - Vasodilation, phagocytosis
  - Leakage of cytokines, plasma and neutrophils into tissue surrounding injury
  - Visual --- edema/erythema
  - Does not mean infection part of the process
  - Need labs to prove infection
  - Mediators
    - Nitric oxide, neutrophils, macrophages
 Healing Cascade

*Proliferative Phase (2 days -3 weeks)*
- **Granulation phase**
  - Macrophages release fibroblasts
  - Formation of wound matrix, granulation tissue and connective tissue
  - Fill in the space
- **Major mediators**
  - Macrophage
  - Vascular endothelial growth factor (VEGF) responsible for angiogenesis

Healing Cascade

*Proliferative Phase*
- **Epithelialization**
  - Wound edges stimulated to start epithelialization
  - Major mediator
  - Keratinocytes

*Remodeling Phase*
- Most vulnerable time after closure
- Changing collagen structures (matrix)
- Strengthen scar
- May take up to 3 years

http://www.nature.com/nri/journal/v4/n8/fig_tab/nri1412_F1.html
Factors Influencing Wound Healing

- Comorbidities
  - Diabetes
  - Chronic Inflammation / autoimmune diseases
  - Obesity
  - Peripheral Arterial Disease (PAD)
  - Chronic Venous Insufficiency (CVI)
  - End stage renal disease
  - Crisis
  - Skin first to lose blood supply

Factors Influencing Wound Healing

- Age of wound
  - How long has it been open
  - Changes chemically with age
  - Prolonged inflammatory phase
  - Cellular senescence
  - Deficiency of growth factor receptor sites
  - No initial bleeding event to trigger cascade
  - High level of proteases (protein eating enzymes)

Acute / Chronic Wound

![Diagram](http://www.jyi.org/articleimages/1078/originals/mj0.jpg)
Infection vs. colonization
- Colonization
  - Bacteria that have adhered to superficial tissue,
  - Form colonies
  - Without generating a host immune response
  - Without delay of wound healing

Infection vs. colonization
- Infection
  - Usually in hypoxic wounds
  - Wound cultures show higher concentrations of 10 to the 5th power
  - Cultures - swab is acceptable
  - Cleanse base well
  - Granulation tissue only
  - NOT ON DEAD TISSUE

Biofilm
- A surface-associated microbial community
- Composed of various bacteria
- Which encases itself in a 3-dimensional matrix (polysaccharides, nucleic acids and proteins)
- Demonstrates increased resistance to cellular and chemical attack.
- Delay wound healing
Medications

- Impairs wound healing
  - Corticosteroids
    - Interfere with vascular proliferation, granulation tissue and epithelialization
  - NSAIDs / Antiplatelet
    - Inhibit inflammatory process and platelet aggregation
  - Anti-coagulants
    - Same as NSAIDs
    - Serosas and hematomas
  - Nicotine
  - Anti-cancer medications

Antibiotics

- Causes changes in collagen formation and anti-inflammatory
- Anti-RA medications
- Cytotoxic to the macrophages
- Vasoconstrictor
- Immunosuppressive
- Increase the risk of infection

Medications

- Enhance wound healing
  - Growth factors
    - Essential for wound healing
  - Vitamin A and C
    - Vitamin A -
      - might help reverse problems with corticosteroids
    - Stimulates / regulates growth factors
  - Vitamin C
    - Fibroblast and neutrophil function
    - Epithelialization, angiogenesis
Factors Influencing Wound Healing

Medications
- Enhance wound healing
  - Phenytoin / Dilantin - topical
  - Decrease inflammatory response in chronic wounds
- Retinoids
- CCB calcium channel blockers
  - Improve blood flow
- Sex hormones - topical
  - Specifically estrogen derived

Types of Wounds

Lower Extremity Wounds
Venous Ulcers
- Associated with LE Venous Disease (LEVD)/Chronic Venous Insufficiency (CVI)
- Accounts for about 70% of all LE ulcers

Ischemic Ulcers
- Associated with LE Arterial Disease (LEAD)/Peripheral Arterial Disease (PAD)
- PAD affects 12-20% of Americans > age 65; only 25% are being treated

Neuropathic Ulcers
- Associated with LE Neuropathic Disease (LEND)/Loss of Protective Sensation (LOPS)
- 60-70% of diabetics will develop LOPS,
- Up to 25% of will develop a foot ulcer
Chronic Venous Insufficiency/Lower Extremity Venous Disease (LEVD)

Venous Stasis Ulcers
- 20,556 new cases annually
- One in four persons over the age of 65
- Most commonly occurring lower extremity ulcer
- Higher percentage women
- Increasing prevalence with younger obese patients

Severity of CVI
- Duration of venous hypertension
- Extent of valvular damage in veins
- Calf muscle dysfunction

Skin assessment
- Skin warm to touch
- Might have an elevated ankle temperature
- Pulses present, posterior tibial and pedal
- Ankle Brachial Index (ABI) 0.96 to 1.2
LEVD: Characteristics

- Ulcers
  - Medial malleolar areas of BLE "gaiter area"
  - Usually superior to malleolus
  - Irregular wound edges
  - Shallow
  - Copious drainage increases proportionately with amount of edema
  - Usually edema noted BLE
  - Hemosiderous markings gaiter area

- Prominent veins
  - Varicose veins

- Telangiectasia
  - Spider veins: dilation of groups of capillaries, form elevated, red, wart-like spots

- Ankle flare
  - Collection of visible dilated capillaries at medial malleolus
LEVD: Characteristics

- **Pain**
  - Aching discomfort, heaviness
  - May increase with activity
  - Relieved by elevation

- **Management**
  - Control edema with compression wrap
  - Compression stockings 30-40 mmHg for life
  - 20-30 mm Hg
  - Avoid skin irritants...dermatitis

Forgotten Skin Care

- Cleanse before you put the compression bandage on
- Evaluate for stasis dermatitis
- Moisturize – beware of some products
  - Stay away from anything you can pour (evaporates too quickly)
- Lactic acid/urea preparations
  - Lac-Hydrin (12% lactic acid)-lotion (150, 360ml) or cream (140, 385ml)
  - Atrac-tain (Sween)-cream 10% urea, Lotion 5%
- Sometimes can get cutaneous fungal infections under moist bandages after a time

Ankle – Brachial Index

- Ankle systolic/brachial systolic
- Normal: 0.96-1.2
- Decreased: 0.40-0.80
- Severe: < 0.40
- Diabetics may be falsely high due to non-compressible vessels, may need segmentals or toe pressures
- Ask your facility who does ABI measurements
Interpreting ABI Values

Ratio of ankle to arm systolic BP

- Normal: 1.0
- LEAD: < 0.9
- Borderline: 0.6-0.8
- Severe ischemia: < 0.5
- Referral indicated
- Critical Ischemia: < 0.4
- Urgent referral indicated
- Elevated: > 1.3
  - Indicates incompressible arteries-medial artery calcification

(From LEVD Guidelines, 2005)

ABI Issues/Limitations

- **ABI > 1.2**
  - Artery calcification associated with diabetes, renal failure, arthritis
- **ABI > 1.4**
  - Predicts mortality with similar strength to ABI < 0.9
- **Post exercise ABI**
  - Useful to dx LEAD in "at risk" with normal resting ABI & symptomatic or without classic pain
- **TBI recommended if ABI > 1.3**
  - TBI > 0.6 is normal

Toe-Brachial Index Measurement

- The toe-brachial index (TBI) is calculated by dividing the toe pressure by the higher of the two brachial pressures
- TBI values remain accurate when ABI values are not possible due to non-compressible pedal pulses
- TBI values ≤ 0.7 are usually considered diagnostic for lower extremity PAD
Peripheral Arterial Disease (PAD)
Lower Extremity Arterial Disease (LEAD)

Peripheral Arterial Disease
- Calf muscles that shrink (wither)
- Hair loss over the toes and feet
- Thick toenails
- Shiny, "tight" looking skin
- Dependent rubor
- Leg pain with exercise, relief with rest

Pathophysiology
- Atherosclerosis

Risk Factors:
- Age, diabetes, hypertension, hyperlipidemia, family history, ethnicity
- Tobacco use #1 risk factor & smoking more strongly associated with LEAD than coronary or carotid atherosclerosis
- Starting smoking at 16 years or earlier more than doubles risk of LEAD
LEAD Facts

- 40-50% LEAD
  - unrecognized & undiagnosed
- Premature LEAD
  - < 60 years age
- Chronic Renal Insufficiency
  - highly predictive of premature LEAD
  - 70-90% with LEAD have coronary disease & > 50% have cerebrovascular disease
  - ABI < 0.9
  - strong predictor of CV mortality in pts with LEAD

LEAD: Assess Pain History

- Type, duration, & location pain
  - Location can be a clue to the site of stenosis or blockage
  - Pain generally occurs one joint below the area of stenosis or blockage
  - Elevation, heat, & activity increase pain in arterial ischemia
  - Think angina of the leg - worse with activity, improves with rest

LEAD: Classical Pain

- Intermittent Claudication
  - Reproducible, predictable pain weakness, cramping, or fatigue in the leg, calf, buttack, or thigh, brought on by walking or exercise & relieved only by approximately 10 min rest
  - Indicates 50% stenosis
  - Diabetics have higher incidence of asymptomatic LEAD
- Resting or night pain
  - Pain & numbness occurs when pt is supine & has to dangle legs over side of bed or sit up with legs dependent to < pain
  - Ominous sign: suggests > 90% stenosis
Critical Limb Ischemia (CLI)

- CLI:
  - chronic ischemic rest pain,
  - ulcers, or gangrene due to objectively proven arterial occlusive disease
  - if untreated, leads to LEA in 6 months
- Implies chronicity
- Timely referral to vascular specialist
- Associated with >20% 1-yr mortality rate

Acute Arterial Occlusion

- Sudden onset of symptoms
- Was there a rapid decrease in perfusion with sudden onset of 6 P's?
  - pain, pallor, paresthesia, paralysis, pulselessness, & polar (cold)
- Often due to an embolism or thrombus
  - limb threatening
- Warrants urgent & immediate referral

LEAD: Assess Circulation

**Capillary Refill**

- Blanch toenail bed with sustained pressure, release, check time nail regains full color
- Normal cap refill is <3 sec & prolonged in LEAD
**LEAD: Assess Circulation**

- Pulse palpation & history
  - *Alone* are not sensitive to detect LEAD
  - DP may be congenitally absent (4-12%)
- Ankle Brachial Index (ABI)
  - 94% sensitive/99% specific compared to arteriographic proven disease
  - 15% change indicates disease progression
  - Monitor every 3 months with wounds

**LEAD: Assess Skin & Tissue**

- Skin characteristics:
  - Temp: cool to touch
  - Thin, shiny, atrophy, hairless, taut, & dry
- Dystrophic nails
- Dependent rubor
- Pallor on elevation
- Onset pallor:
  - 25 sec = severe occlusion
  - 25-40 sec = mod occlusion
  - 40-60 sec = mild occlusion

**Peripheral Arterial Disease**

- Ulcer of PAD
  - Usually edges of wound are well defined
  - “punch-out” look, well defined edges
  - Wound base pale
  - Can be deep
  - Minimal drainage
  - Extremely painful
**Ischemic Ulcer Characteristics**

**Location:**
- Terminal digits, bony prominences, areas pressure & between or tips of toes
- Sites exposed to minor trauma (i.e., mid tibia, shin, or lateral malleolus)
- Dorsum foot

**Pain:**
- Often painful
- Elevation > pain
- Edema not typical of arterial ulcers

**Color Ulcer**
- Pale, non-viable, grey
- Minimal granulation, desiccation, & necrosis common

**Exudate**
- Minimal drainage

**Surrounding tissue**
- Halo of erythema around wound
- Signs of infection
  - Gangrene after trauma
  - Dry gangrene vs. wet

**LEAD: Key Issues in Wound Care**

- Monitor for infection / cellulitis
  - Treat with systemic antibiotics
- Surgery
  - Evaluate need for angioplasty or revascularization
- Adjunctive therapy
  - Hyperbaric oxygen therapy
  - Arterial flow augmentation

(WOCN LEAD Guidelines, 2002)
**LEAD: Caution**

- Do not debride dry stable eschar until assess perfusion
  - If dry, non-draining, no s/s infection: keep dry, relieve pressure, & protect
  - If open, draining & exposed bone/tendon: carefully monitored trial of moist TX
- Maintain stable dry eschar if blood flow inadequate for healing
- ABI < 0.5...REFER

(WOCN LEAD Guidelines, 2003)

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**LEAD: Systemic Care**

- Quit smoking
- Lipid lowering drugs (statins):
  - LDL cholesterol to < 100mg/dL (< 70mg/dL if CAD)
- BP < 140/90 for non diabetes & < 130/80 DM
- Hg A1c < 7%
- Homocysteine lowering drugs (< 10 micromoles/L) benefit of folic acid/B12??
- Antiplatelet/antithrombotic drugs (ASA 75-325mg safe in at risk for CV events + LEAD)
- Increase exercise to level of pain
- Proper foot care

(2005 ACC/AHA guidelines; 2007 Inter-Society Consensus for Management of Peripheral Arterial Disease (TASC II))

www.bangkokhospital.com/eng/Peripheral_Arterial_Di...
Wound management

Systemic Assessment

**A MUST**

- History of current ulcer:
  - How did this start? How long have you had it?
  - Associated symptoms
  - Relieving/aggravating factors
- Comprehensive history
  - Both medical & surgical/glycemic control
  - Smoking/ETOH use
  - ADLs/safety

**Risk Factors**

- Family history, DVT/phlebitis
- Trauma, surgeries, fractures
- Varicosities, obesity, age
- Female, pregnancy history
- Sedentary lifestyle, standing occupation
- Thrombophilia (protein S, C deficiency)
Systemic Assessment

- Medication & allergy history
- Good physical assessment
  - Head to toe

Nutrition

Intact skin  25-30 kcal/kg
Stage I-II  25-30 kcal/kg
  (partial thickness)
Stage III-IV  30-35 kcal/kg some say up to 40
  (full thickness)

Calories

- How many kcal depends on depth of wounds & co-morbidities
Inadequate Caloric Intake

- Forces the body to break down protein stores for an energy source
- This decreases lean muscle mass, causes muscle atrophy, organ dysfunction, & increased oxygen needs
- This decreases available protein for healing

Protein

- Made up of amino acids (AA)
- Supplies the structural & binding material of muscle, cartilage, ligaments, hair, & fingernails
- Provides, as antibodies, the basis of the immune system

Protein Requirements

- Normal: 50g/day
- Wounds: 1.2-1.5g/kg/day, up to 2.5 in severe wounds
- Caution: 2g/kg/day can affect renal & hepatic function - need to monitor & know baseline
Arginine
- AA normally synthesized inside the body, but under stress becomes conditionally essential as demand outstrips supply
- Precursor to collagen
- Essential for synthesis of nitric oxide: NO activates wound macrophages & vasodilates
- Stimulates T-cell function

Arginine Dosing
- Ideal dose is unknown, doses up to 30g/day for 1 week have been tolerated
- Supplements contain - 4.5g/packet
- Common dosage is 2-3g tid
- GI side effects
- Careful with renal insufficiency

Glutamine
- AA normally synthesized inside the body but like Arginine, under stress becomes conditionally essential as demand outstrips supply
- Major AA in muscle tissue, most abundant in the body
- Primary fuel for many metabolic processes as well as for lymphocytes & fibroblasts
- Essential for immune system function
Glutamine Dosing

- Ideal dose not known
- Supplementation has been shown to enhance & improve overall nitrogen balance in at risk populations
- Typical dietary consumption is < 10/day
- Up to 40g/day has been tolerated in a catabolic state
- Should meet general protein/calorie requirements before supplementing

Carbohydrates

- Supplied primarily by starch
  - Grains, cereals, legumes, pasta, bread, natural sugars in fruits, vegetables, milk
- Most readily available source of energy for the body
- Spares protein for its primary use: building & maintaining tissue
- Cellular activity is fueled by ATP which is derived from glucose; if inadequate glucose, body will breakdown protein

Fat/Fatty Acids

- Maintains normal cell membrane structure & function
- Produce substances involved in cellular defense mechanisms, inflammatory response, & vascular tone
- Supplies 2/3 of body's ongoing energy needs (shares with glycogen)
- Reserve emergency fuel
Vitamin C

- Water soluble vitamin, not stored so need a daily intake
- Stress, smoking, liver disease, cancer, elderly-lower vitamin C levels
- Antioxidant properties to help neutralize free radicals
- Supports immune response
- Helps counteract the negative effects of hyperglycemia on wound healing

Vitamin C & Wounds

- May increase the activation of leukocytes & macrophages to the wound site; fibroblast proliferation
- Essential cofactor for collagen synthesis, maintains integrity of capillary wall for angiogenesis

Vitamin C Dosing

- Consistent large doses not proven to affect outcomes
- Doses in excess of 2000mg/day can place some at risk for kidney stones
- At least 1 serving/day
- Recommended daily intake: 60mg
- Wound healing may need up to 2000mg/day divided
**Vitamin A**
- Fat soluble, stored in liver
- Vitamin A exists in several forms; using Beta Carotene to supply Vitamin A avoids toxicity of Vitamin A
- Bioavailability depends on protein status
- Antioxidant & free-radical scavenger

**Vitamin A & Wounds**
- Promotes re-epithelialization & granulation of wound
- Involved in cellular differentiation & proliferation
- May increase collagen deposition & tensile strength
- Counteracts effects of steroids on wound healing

**Vitamin A Dosing**
- To supplement or not?
- Corticosteroids: 10,000-24,000 IU/day x 7-12 days only
- Recommended daily intake: 5,000 IU
Trace Minerals: Zinc

- Essential cofactor of over 200 enzymes; important role in the metabolism of nutrients/immune response
- Cofactor for collagen & protein synthesis
- Cell proliferation/re-epithelialization
- Crucial for maintaining & integrity of cell membranes
- Transported by albumin
- Helpmate of Vitamin A

Zinc Dosing

- Fortified cereals, red meats, seafood
- Supplement only if a deficiency is suspected or when increase losses s/a large draining wounds
- Prolonged use can affect body’s copper status
- Recommended daily allowances - 15mg/day
- 25-50mg daily for up to 14 days

Nutritional Assessment: Tools

- Nutrition Screening Initiative
- Mini Nutritional Assessment (MNA)
- Subjective Global Assessment
- Weight/BMI
- Nutrition focused physical exam
### Laboratory Diagnostics

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<th>Norm</th>
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<td>Serum Albumin</td>
<td>&gt; 3.5</td>
<td>2.8-3.5</td>
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<td>Transformin</td>
<td>&gt; 200mg</td>
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<tr>
<td>Total Lymphocytes</td>
<td>&lt; 15,000</td>
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### The Myths

- Leave wounds open to air
- The more often you change the dressing the better
- If the wound is draining, it's infected

### Wound Management

Optimizing wound healing
- Debridement
  - Assess Vascular Supply
    - Adequate
    - Inadequate
      - Sharps
      - Autolytic
      - Enzymatic
    - Refer to Vascular
Moist wound healing
- Faster, less painful, lower infection rates, costs less

The Ideal wound environment
- Moist
- Free of excess exudate
- Free from necrotic tissue
- Free from trauma
- Warm
- Protected from bacterial infection
- Acidic
- Oxygen sensitive

Wound Bed Preparation
The process of preparing the wound as to provide optimal healing

- Removal of slough/necrotic issue
- Reduction of bacterial burden
- Removing local barriers to healing
Goals of wound care dressing
- Absorb exudate
- Facilitate autolytic debridement
- Maintain a moist wound environment
- Minimize pain
- Protect the periwound skin
- Protect wound from contamination

Wound care product selection
- Wounds are dynamic
- Continually reassess patient and wound
- Topical therapy is one part of wound care
- Eliminate cause and support patient
- Continually educate self on products

Types of Dressings
- Hydrogel
- Transparent film
- Hydrocolloid
- Alginate/hydrofibers
- Foam
- Silver
- Enzymatic debriders
Wound Management

- **Hydrogel**
  - Maintain a moist wound base
  - Variety of forms to meet a variety of clinical applications
  - Sterile and non-sterile forms
  - Non-adhesive forms require a secondary dressing

- **Hydrogel Dressing**
  - Not appropriate for draining wounds
  - May macerate periwound skin
  - Require a secondary dressing

- **Transparent Film**
  - Polyurethane sheet
  - Acrylic hypoallergenic adhesive on one side
  - Impermeable to fluids and bacteria
  - Semi-permeable to gas, such as oxygen and water vapor
  - Different levels of vapor loss with different manufacturers
Wound Management

Not for heavily draining wounds, infected wounds or burns

Hydrocolloid dressings
- Adhesive
- Thickness varies
- Indications vary between dressing
  - (i.e. full thickness vs. partial thickness)
  - Backing varies
  - Sterile

Not to be used on infected wounds
May macerate periwound skin
May strip fragile periwound skin
Not appropriate with heavily exuding wounds
May not adhere in high friction areas
**Wound Management**

**Hydrofibers/alginate**
- Are highly absorbent
- Hydrofibers - carboxymethylcellulose fibers
- Alginates brown seaweed
- Can hold up to 40x more drainage than gauze
- For heavily draining wounds

**Antimicrobial dressing**
- AMD products
- Long shelf life
- Stay in wound up to 72 hrs
- Impregnated with broad spectrum antiseptic
- Works against gram negative and gram positive, microorganisms, MRSA, VRE and fungal

**Disinfectant Agent**
- 3% Bismuth in a petroleum gauze
- For clean non-draining wounds
- Can stay in place 3-5 days
- Primary dressing
Wound Management

- **Foams**
  - Can absorb large amounts of drainage
  - Increase wear time
  - Can offer some protection from pressure
  - Can be used as a primary or a secondary dressing

- **Silver**
  - Two forms, ionized and nanoparticle
  - Come in foams, alginates, hydrofibers, hydrocolloids
  - Kills MRSA, VRE
  - Expensive

- **Compression**
  - Tubigrip
  - Profore wrap
  - Unna’s Boot
Debriding agent
- Santyl only agent left
- Contains enzyme collagenase

Hyperbaric therapy
Mist therapy
Other antimicrobial dressings
- Hydrofera blue
- Dakin’s
- Acetic Acid

References
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References