Wound Care

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And Thanks to Our Speakers . . .

Who Will Speak About . . .

1. History of Wound Care
2. Skin Anatomy/Physiology
3. Normal Wound Healing
4. Altered Wound Healing
5. Infection Control
6. Wound Assessment
7. Dressings Treatments
8. Mechanical Treatments
9. Scar Modeling Clean
10. Surgical Incisions
11. Open Wounds
12. Burns, Frostbite

Brief talks designed to catalyze robust Q-and-A sessions
Some repetition is inevitable
Serves as a learning reinforcement
More than one speaker finds it important

Learning Objectives

1. Describe normal anatomy/physiology of skin and subcutaneous tissue
2. Describe sequence of normal wound healing and altered states that delay it
3. Show sterile technique and document wound assessment
4. Describe mechanical and chemical treatments to aid wound healing and scar modeling
5. Describe specific care procedures for clean surgical incisions, open wounds, thermal injuries

Before We Begin . . .

- Write questions as you think of them on note cards for Q-and-A
- Food/drinks allowed in here
- Restrooms outside
- Evaluation for speakers
- Let’s go!
History of Wound Care

Christopher Hanosh, MD
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History of Wound Care

STONE AGE TREPANATION
5-10% of skulls found from 6500 BCE

- Ritual?
- Release subdural hematoma?
- Survival indicated by rounding of bone edges
- Wound care?

History of Wound Care

Egypt >1600 BCE described >48 wound types. Dress wounds with honey/lint/grease

Sushruta, India, 1000 BCE
- Remove blood clots, stones, hair, nails, bone fragments, then thorough cleansing
- >100 plants to aid wound healing
- Types of suturing: straight, interrupted, continuous, subcuticular, interlocking

Hippocrates, Greece, 500 BCE
- Irrigate wounds/ulcers w/ vinegar/wine
  Dress both with fig leaves
- Place setons in fistulas
- Pus: unnatural, to be avoided

History of Wound Care

“rubor, calor, dolor, tumor” = inflammation
(redness, heat, pain, swelling)

Celsius
2nd Century, AD
### History of Wound Care

**Galen**  
2nd Century, CE  
- Writings = dogma for >1000 years  
- “laudable pus”

### Ideal Conditions for Wound Healing
- Control bleeding  
- Remove contaminated/necrotic material  
- Avoiding dead space  
- Carefully applying wound dressing  

“Avoid laudable pus” denounced by religious and medical colleagues until mid-19th century

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**Theodoric Borgognoni**, 1205-1296  
Dominican friar, personal physician to the Pope

---

**Ambroise Pare**  
Father of Surgery  
1510-1590

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**William Harvey**  
1578 –1657  
13th Century concept of circulatory system

---

**Antonie Philips van Leeuwenhoek**  
1632 -1723
### History of Wound Care

**Ignaz Semmelweis** (1818-1865)
- Savior of Mothers
  - Wash hands between cadaver lab and ward patient
  - Mortality drop: 10-35% to <1%
  - No scientific explanation
  - Ridiculed by peers
  - Went insane

**Louis Pasteur** (1822-1895)
**Robert Koch** (1843-1910)

**Joseph Lister** (1827-1912)
- **Carbolic Acid**
  - Sprayed on instruments, skin, dressings (anti-sepsis)
  - 1865: open femur fracture healed without suppuration

**Go to Hell, Galen**

### Recent Advancements in Wound Care

- Rubber gloves 1890s
- Sulfa 1930s
- Penicillin treatment 1942
- Vacuum-assisted closure
- Engineered tissue
- Skin substitutes
- Growth factors
- Genetic engineering

### References

### Images
- Courtesy of wikipedia.org. All are in the public domain.
Skin Anatomy & Physiology

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Outline
- Skin functions
  - Not just a barrier
- Skin anatomy
  - Two “types”
- Skin physiology
  - Key systems
- Nail anatomy/physiology

Skin Function
- Protection
- Fluids/toxins
- Water regulation
- Microbes
- UV light
- Temperature control
- Sensation
- Vitamin D regulation
- Social/Identification

Skin Anatomy
- Barrier Function
  - Epidermis relatively impervious
  - Lattice network of cells + lipid rich matrix
  - Keeps “out” water, sodium, potassium
  - Also important to keep water IN
  - Palm is least permeable skin in body
  - Dorsum of hand is most permeable

Skin Physiology
- Barrier Function
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**Temperature Control**
- Skin can harbor up to 1/4 of circulating blood volume (more than brain!)
- Arteriovenous plexus regulation
- From 1/10 teaspoon to 1/3 cup in the palm per min

**Cold vs Hot**

**Sweat Glands**
- 2.5 Million Sweat Glands
  - **Eccrine glands** = temp control
  - **Apocrine glands** = scent/pheromones
  - **Sebaceous glands** = waterproof/moisturize

**Skin largest water storage site**
- 1/3 of body fluid

**UV Protection/Pigmentation**
- Epidermal layer reflects some UV radiation
- UV stimulates melanocyte activity → melanin
- Conversion of cholesterol to Vit D3

**Immune Response**
- Mast cells and macrophages
  - Waiting/ready to neutralize foreign invaders
- Langerhans cells
  - Recognizes foreign invaders & presents them to T-cells

**Sensation**
- Exceptional density of nerve endings & sensor organs can detect:
  - Weight of 0.005g (1 mosquito)
  - Temperature 0-111°F
  - Send signals 2-120m/s
  - Up to 275 mph!

**Skin Sensory Organs**

- Meissner corpuscles: vibration/touch
- Merkel cells: pressure, light touch
- Ruffini: stretch, position
- Free: pain, temp, itch
- Pacinian corpuscle: pressure/vibration
Nail Function

- Protection
- Sensory perception
- Assist motor function
- Stabilize pulp for forceful pinch

Nail Anatomy

- Paronychium
- Nail Fold
- Germinial Matrix
- Nail Plate
- Eponychium
- Lunula
- Sterile Matrix
- Extensor Tendon

Nail Function

- Protection
- Sensory perception
- Assist motor function
- Stabilize pulp for forceful pinch

Nail Physiology

- Grows about ~3mm per month
- Full nail regrowth up to 6
- Transverse (Beau) lines akin to growth rings
  - Occur with changes in health, circulation

Citations

- Color Atlas of Dermatology; Rocken, M; Schaller, M; Thieme Medical Publishers, 1st Ed
- Fitzpatrick's Dermatology in General Medicine; Lowell G, Stephen K; McGraw Hill, 8th Ed
- "Basic physiology of the skin" Venus M, Waterman J; Surgery 29:10, 2011
- "Structure and function of hair, nails, and skin" Lai-Cheong J, Mcgrath J; Surgery 37:5, 2009

Normal Wound Healing

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UNM SCHOOL OF MEDICINE
Department of Orthopaedics & Rehabilitation
A Well-Organized and Orderly Cascade of Events That Occurs Following Tissue Damage To Restore the Integrity of the Tissue

So what is tissue?

Independently functioning cells “Let’s join together!”

Fibroblast
Collagen
Collagen cross-link

“Ground Substance” (principally hyaluronic acid) serves as water reservoir and facilitates even diffusion of nutrients through extracellular space

Cell reproduction
Cell death
Macrophage
Normal Wound Healing

All was well, until…

Bleeding from capillaries
Release of toxic intracellular fluid
Breakdown of communication

Fibrin meshwork
Platelet plug
Dilated capillary
Extracellular fluid
Chemical messengers (histamine, growth factors, etc.)

Fibroblast
White cell
Collagen
Capillary buds
Old blood

Collagen + capillaries = granulation tissue
Normal Wound Healing

Before

After

Phases of Wound Healing

I. Hemostasis

II. Inflammation

III. Fibroplasia (proliferation)

IV. Maturation

Wound Healing I: Hemostasis

- Seconds: coagulation cascade activated
- Forms fibrin meshwork of clot → scaffold for later repair
- Generates vasoactive & chemotactic factors, attract WBCs

- Minutes: platelets adhere to injured vessels
- To stop bleeding
- Platelets degranulate
  - Vasoactive amines (seratonin)
  - Growth and chemotactic factors (PDGF, TGF-β, IGF, fibronectin)

Wound Healing II: Inflammation

- Central to wound healing

- Functions
  - Ingests bacteria
  - Proteases degrade dead/foreign material
  - Secretes cytokines to recruit and activate fibroblasts and endothelial cells
  - PDGF, TGF-β, VEGF → stimulate fibroplasia, collagen synthesis, and angiogenesis
  - Orchestrates transition from inflammation to tissue repair

- Minutes to days
- Vessels dilate → WBCs, plasma, proteins leak out
- Neutrophils (24 hours)
  - Phagocytize bacteria
  - Release lysosomal enzymes to degrade necrotic tissue
  - Ingest and remove dead material
- Clinical: redness, swelling, warmth, pain

Macrophage

- Ingests bacteria
- Proteases degrade dead/foreign material
Wound Healing IIIa: Early Fibroplasia
- Day 2 to several weeks
- Granulation tissue: capillaries, fibroblasts, loose collagen, macrophages
- Fibroblasts migrate into the wound on the fibrin strands, proliferate, produce collagen ~ day 4
- Angiogenesis: new capillary formation

Wound Healing IIIb: Late Fibroplasia
- Weeks 4-5, fibroblasts decrease in number, collagen synthesis decreases
- Randomly oriented collagen fibers fill and support the wound
- Wound contraction: fibroblast mobility pulls attached collagen fibrils closer together
- +/- role of smooth-muscle-like myofibroblasts

Wound Healing IV: Maturation
- 3 weeks to 2 years
- Fibroblast population decreases
- New capillaries regress & disappear
- Swelling subsides (decreased extracellular water)
- Wound strength increases
  - Collagen synthesis = degradation
  - Collagen more organized, stronger (cross-links)
  - Type III collagen (embryonic) is replaced with Type I

Phases of Wound Healing
- Hemostasis
- Inflammation
- Fibroplasia
- Maturation
- Days
- Collagen accumulation

Primary vs. Secondary Wound Healing

Primary
- Cleanliness
- Infection
- Margins
- Healing
- Healing Period
- Healing Direction
- Outcome
- Clean
- No
- Clean
- Scant Granulation
- Short
- Direct
- Near Linear Scar

Secondary
- Contaminated
- Possible/Yes
- Irregular
- Gaps Fill
- Long
- Bottom to Top
- Contracted
- Irregular Wound

Primary

Secondary
Primary vs. Secondary Wound Healing

- Immediately after surgery
- No inflammation

Example of Primary Wound Healing

1. **1°**
   - Upper skin flap
   - No inflammation

2. **2°**
   - Lower skin flap
   - Inflammation

Example of Primary Wound Healing

- 2 Weeks
- 5 Weeks
- 10 Weeks
- Different Hands

Example of Secondary Wound Healing

- A. Pre-op
- Dupuytren Contracture >>>>
- Moderate at MCP
- Severe at PIP

Example of Secondary Wound Healing

- 2 days post-op
- At surgery
- McCash Open Palm Technique
- 3 Months
- 12 Months
- 48 months
- Different Hands
A. Pre-op

B. 3 months post-op

Dupuytren Contracture

Primary Closure and Healing

Primary Closure

Healing by Secondary Intention

Healing by Secondary Intention

Granulation/contraction

Drug abscess, immediate s/p I & D, 1 wk later

Granulation/contraction
Healing by Secondary Intention

- s/p finger felon I & D. healing by secondary contracture

Saw, near amp, wounds closed by secondary intension
(Courtesy A. Navarrete

Autodebridement, granulation, contraction and epithelialization: acute, 2 wks, 6 wks, 8 wks, 17 wks

Pulp amp sutured on, evolution over 15 weeks

Split Thickness Skin Graft (STSG)
- Epidermis and varying degrees of dermis
- No need for donor site closure
- Larger defects
- Secondary contraction

Full Thickness Skin Graft (FTSG)
- Entire epidermis and dermis
- Donor site must be closed
- Used to cover smaller defects
- Better color consistency, texture
- Less secondary contraction
### Flap Coverage and Features

#### Coverage
- Primary closure is impossible
- Secondary intention would take forever and limit function
- Injury is not amenable to skin grafting

#### Features
- Donor location: local vs regional vs distant
- Blood supply:
  - Random (capillaries)
  - Axial (robust arterial supply)
  - 1. Pedicle (artery not divided)
  - 2. Free (artery divided and transferred)

### Some Examples...

#### Flap Examples: Local
- V-Y advancement flap

#### Flap Examples: Regional
- Cross finger
- Thenar

#### Flap Examples: Regional Axial Pedicle
- Radial forearm flap
- Melanoma

#### Flap Examples: Regional Random Pedicle
- Groin

#### Flap Examples: Distant Axial Pedicle
- Groin
Three Phases of Wound Healing

- **Inflammatory phase**
  - Cytokines, growth factors, neutrophils, macrophages

- **Proliferative phase**
  - Begins when wound is covered by epithelium
  - Production of collagen is hallmark

- **Remodeling phase (maturation phase)**

Impaired Healing

- Persistent inflammation
- Acute to chronic
- Molecular changes
- Cytokines
- Growth factors
- Extracellular matrix
- Cellular changes

Cellular Changes

- Neutrophils
  - Help clean wound
  - Usually gone after 72 hours
  - Persistent in chronic wounds - inflammation

Cessation of the normal healing process occurs in the inflammatory phase.
**Cellular Changes**

- **Macrophages**
  - Release chemical factors (cytokines)
  - Release proteinases
  - Removes neutrophils
  - Impaired in diabetes
  - Signaling using cyclic-adenosine monophosphate (C-amp)
  - Affected by NSAIDS
  - Affected by steroids

- **Fibroblast**
  - Reduced activity
  - Impaired migration
  - Reduced response to growth factors
  - Collagen degradation exceeds synthesis
  - Premature senescence

- **Lymphocytes**
  - Stimulate fibroblasts
  - Produce IFN-γ

  - Stimulates the macrophage
  - Release inflammatory cytokines
  - Supresses collagen synthesis

**Molecular Changes**

- Extracellular matrix
  - Increase in degradative proteinases
  - Reduction in tissue inhibitors of proteinases
  - Imbalance between degradative versus protective enzymes
  - Growth factor concentrations reduced
  - Cells not as responsive (senescence)
  - Inflammatory cytokines predominate
  - Reduced concentration of factors that promote proliferation

**Factors Affecting Wound Healing**

- Age and gender
- Sex hormones
- Skin elasticity
- Stress
- Alcoholism
- Smoking
- Diseases & disorders
- Diabetes
- Collagen disorders
- Peripheral vascular disease
- Jaundice
- Cancer
- HIV/AIDS
- Obesity
- Nutrition

**Factors Affecting Wound Healing**

- Wound conditions
- Ischemia
- Infection
- Foreign body
- Edema
- Motion
- Tissue pressure
- Host quality
- Venous insufficiency
- Arterial blood flow
- Keloids
- Fibrosis
- Medications
  - Corticosteroids
  - NSAIDS
  - Chemotherapy
  - Radiation

**Identify Contributing Factors**

- **Patient controlled**
  - Stress
  - Some diseases
  - Obesity
  - Some medications
  - Alcoholism & smoking
  - Nutrition

- **No patient control**
  - Age & gender
  - Sex hormones
  - Ischemia
  - Decreased immunity
  - Cancer
  - Radiation therapy
  - HIV/AIDS
Optimize the Patient
- Circulatory (PVD, venous stasis, edema)
- Pulmonary
- Council for patient-controlled factors
  - Smoking
  - Alcohol
  - Nutrition
  - Obesity
  - Stress
- Adjust medications

Oxygen
- Initial hypoxia needed to stimulate normal healing process
- Most common cause of wound infection
- Large vessel disease
  - Atherosclerosis, diabetes, hypertension, peripheral arterial disease, thrombus, embolus
- Microvascular disease
  - Diabetic and hypertensive microangiopathy, thromboangiitis obliterans, Raynaud disorder

Chronic Wounds
- Draining sinus after ORIF comminuted proximal ulna fracture in a heavy smoker
- Needs blood supply
- Treatment: Debridement & flap

Hyperbaric Oxygen (HBO)
- Must have evidence of hypoxia
- Must have some arterial flow
- No effect on necrotic tissue

HBO
- Rx: 100% O₂, 3-5x/wk, 2-2.5 ATM, 1-2 hrs
- 4x in the oxygen diffusion at arterioles
- 2x at the venules
- Beneficial effects in animal models
  - Reduction of tissue edema
  - Improved wound healing
  - Increased angiogenesis
  - Increased fibroblast proliferation and collagen synthesis
  - Antibacterial properties

Kranke and Bennet 2015 Cochrane database
- Beneficial in first 6 weeks
- No difference long term
- No change in minor amputation rate
- May help reduce major amputation rate
- Effectiveness shown by accumulating clinical experience (mostly uncontrolled)
- Indications approved and recognized by professional organizations and third-party payers
- Good safety record
**Scleroderma**
- Previous amputations from severe ischemia
- Patient sick and refused sympathectomy
- First Botox injection: tip healed
- Second Botox injection: Ulcer healed

**Diabetes**
- Affects healing in many ways
- Impaired sensation
- Repetitive trauma
- Pressure
- Impaired large and small vessel flow

**Nutrition**
- Inadequate protein and nutrient intake
- Extreme body mass index (BMI)
- Limited mobility
- Hypoalbuminemia
- Impairs all stages of wound healing

**Infection**
- Contamination -> colonization -> local infection -> spreading invasive infection
- Degradation of growth factors, cytokines, metalloproteases
- Reduced oxygen
- Prolonged inflammation
- Polymicrobial: critical colonization leads to infection. Symbiotic

**Smoking**
- Nicotine -> vasoconstriction -> limits perfusion
  - 1 cigarette = vasoconstriction > 90 min
- Carbon monoxide competes with oxygen
- Multiple effects at cellular and molecular level
  - Decreased immunity and bone mineral density
  - Increased risk perioperative complications, fracture, tendon injury
- Brief perioperative cessation may mitigate these risks

**Drugs**
- Steroids
  - Arrest of inflammation response
  - Inhibit macrophages and neutrophils
  - Interfere with granulation and wound contraction
- Chemotherapeutic agents
  - Adriamycin
  - Tamoxifen
  - Angiogenesis inhibitors
  - Methotrexate
Obesity

Direct adverse effects
- Decreased vascularity in adipose
- Skin folds harbor bacteria
- Friction from skin on skin
- Increased wound tension & tissue pressure
- Hematoma & seroma formation

Indirect effects
- Coronary disease
- Atherosclerosis
- Stroke
- Hypertension
- Diabetes
- Cancer
- Dyslipedemia
- Respiratory problems

Age

Increased inflammation
- Coronary disease
- Atherosclerosis
- Stroke
- Hypertension
- Diabetes
- Cancer
- Dyslipedemia
- Respiratory problems

Systemic and local factors more important than age itself

Edema

- Too much of a good thing!
  - Moisture needed for epithelialization
- Extracellular water increases diffusion distances, resulting tissue hypoxia.
- Chronic edema
  - Protein deposition in the extracellular space
  - Diffusion barrier for growth factors & nutrients,
  - Growth factors and nutrients are relatively diluted in the edema fluid

Difficult Wounds

Hand surgery or therapy can’t heal these patients

Normal Wound Healing

Thank you
Techniques to minimize contamination of treatment environment

- To prevent surgical site infections (SSI)
  - Delay wound healing
  - Increase antibiotic use
  - Increase hospital stay
  - Increase costs of health care (Medicare does not reimburse for SSIs)

- To protect health care professionals

Introduction

1 trillion/person, mainly
- superficial epidermis
- hair follicles
Species vary by body area
Many harmless or beneficial

Normal Skin Flora

Harmful species in these groups may include:
- Staph, Clostridia
- Enterococcus (fecal)
- Pseudomonas

Percent Positive Bacterial Cultures

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First Surgical Scrub of Day

- Hand washing can result in lower bacterial counts and may help prevent SSIs
- Povidone iodine, chlorhexidine, and alcohol-based products can all be effective
- No consensus on optimal solution or duration
- Should last at least 90 seconds and involve organized, meticulous scrubbing of nails, web areas, all

Bacterial and Viral Transmission via Hand

- **Bacterial**
  - Unmedicated bar soap: 10-20% reduction in bacteria
  - >70% alcohol sanitizers: 60-80% reduction >99% bacteria
- **Viral**
  - 90% alcohol sanitizers: effective against flu, cold, HIV viruses
    - Flu: airborne or nose→hand→hand→nose
    - prevent: immunization
    - prevent: masks more effective than hand washing
    - Hepatitis B: blood borne
    - prevent: immunization
    - HIV, Hepatitis C: blood borne
    - prevent: assume everybody has it and take mechanical precautions

Drying Hands

- Use disposable towel
- Keep hands higher than elbows
- Dry hands first, then work up forearms
Gloves

- To protect you: exam gloves
- To protect wound: sterile gloves
- Double gloving provides significantly more protection
- Gloves too large
  - No tactile feedback

Gloves: Application

- To apply, touch only inside of first glove, outside of second glove
- To remove, touch only outside of first glove, inside of second glove

Needle Disposal

- Best: uncapped
- Distant second best: one-handed recap
- Unacceptable: two-handed recap
  - Most common way needle sticks

What to Do If You Get a Needlestick Injury or Splashed in Eye/Mouth

- Remove personal protective equipment
- Wash widely and copiously with soap and water
- Report to supervisor if hospital/clinic employed
  - to internist or ER if self-employed
- Have tests for HIV and hepatitis C
- Assess cause and avoid in future

What are OHSA Regulated Wastes?

- Liquid or semi-liquid blood or other potentially infectious material (OPIM)
- Items contaminated with blood or OPIM releasable in a liquid or semi-liquid state if compressed
- Items caked with dried blood or OPIM capable of releasing these materials during handling
- Contaminated sharps

Cleaning Up: Blood, Pus, and Other Potentially Infectious Material

- Wear gloves, consider eye protection
- 1:10 dilution bleach, or bleach
- Clean once
- Clean again
- Air dry
- Dispose gloves and wipes in red bag
- Dispose of red bag as hazardous
Laundering Towels and Lab Coats

OSHA:
“Employees are not permitted to take their protective equipment home and launder it. It is the responsibility of the employer to provide, launder, clean, repair, replace, and dispose of personal protective equipment.”

Separate Work and Break Areas

- No cold packs in food refrigerator
- No food/drinks in cold pack refrigerator
- No eating in treatment areas

Every Hand Therapy Unit Should Have . . .

- Hand sanitizer
- Gloves, exam and sterile, appropriate size(s)
- Eye protection
- Disposable towels
- Bleach
- Sharps box
- Biohazard plastic bags
- Separate refrigerators for therapy and food
- Separate breaks/food
treatment areas

Reference & More Information


Wound Assessment and Description

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Wound Assessment

- Needs emergent treatment
- Needs ongoing treatment
- Healing appropriately
- Need universally understood terminology to describe
Emergent Wounds: Infection
- Abscess (purulent fluid under pressure)
- Necrotizing soft tissue infection
- Ascending lymphangitis

What do you see?
Abscess

What else do you see?
Cellulitis/Erythema/Edema

Fibrinous Debris

What else do you see?
Necrotic Tissue

What else do you see?
Ecchymosis and/or Hematoma

Necrotizing Fasciitis
- Bullae: blisters
- Crepitus: crunchy, popping sound
- Denotes air bubbles in soft tissues

Ascending Lymphangitis
- Usually Strep
- Emergent antibiotics needed

Necrotizing Fasciitis
- Ecchymosis: red, purple bruising
- Petechiae: red, purple spots, edema

Necrotizing Fasciitis After Surgery
- Not life or limb threatening after debridement
Necrotizing Fasciitis After Surgery

- Exposed tendons
- Exposed subcutaneous fat

Dry Gangrene (Necrosis)

- Black, leathery, no drainage, no infection

Wet Gangrene

- Purulent drainage, erythema

Needs Ongoing Treatment

- Not life or limb threatening
- Macerated skin

Needs Ongoing Treatment

- Not life or limb threatening
- Exposed, desiccated tendons
**Needs Ongoing Treatment**
- Necrosis & fibrinous debris
- Healthy granulation tissue

**Odor**
- Foul smelling
- E. coli
- Fruity
- Pseudomonas
- Yeasty
- Candida
- No odor
- Staph
- Strep

**Drainage**
- Sanguineous: red/blood
- Serosanguinous: orange (reddish-yellow)
- Serous: clear yellow (not cloudy)
- Purulent: white or thick yellow-green
- Dishwater: thin yellow-green

**Putting it Together**
- Location
- Size
- Length
- Width
- Depth
- Description

**Practice**
- Erythema/edema over palm, index, middle, ring
- Dry necrosis of distal amputated middle finger
- Purulent drainage from 3rd web space
- Ischemia vs ecchymosis of distal palm
- Foul smelling

**Practice**
- Ischemia of thumb and palm
- Dry necrosis of thumb tip to IP joint
- Multiple stellate laceration in palm
- Edema
- No erythema, cellulitis, drainage
Practice

- 7.0 x 2.0 x 0.5 cm dorsal elliptical wound
- Healthy granulation tissue
- Erythema resolving
- Small fibrinous exudate distally
- Minimal surrounding erythema/edema

Practice

- 3.0 x 1.0 x 0.5 cm irregular linear wound over the small finger MCP joint and distal MC
- Minimal surrounding erythema/edema
- Small amount of fibrinous debris in base with no purulent drainage, no odor, no heat

Practice

- Healing surgical incisions over the dorsal index finger and ulnar side of thumb
- Healing full thickness skin graft over dorsal PIP of index finger with a small amount of epidermolysis

Quantitative Wound Assessment

<table>
<thead>
<tr>
<th>Date</th>
<th>Size</th>
<th>Length</th>
<th>Width</th>
<th>Depth</th>
<th>Volume</th>
<th>% healed</th>
</tr>
</thead>
</table>

S Barber. Ostomy Wound Manage. 2008

Wound Care Products and Dressings

Ian Power, MD
Chief Resident, Sports Medicine
UNM Orthopaedics

NO VESTED INTEREST
NO FDA OFF-LABEL USES PRESENTED
November 19, 2016

Thank You!

Questions?

HOW DO I DESIGNATE THAT MY BODY BE DONATED TO BE FRENCH FRIES.
What Makes an “Ideal” Dressing?

- **Absorb** and **contain** exudate without leakage
- **Impermeability** to water and bacteria
- **Lack of particulate contaminants** left in the wound by the dressing itself
- Avoiding wound trauma with dressing removal

### Categories

- **Knit pads (gauze)**
- **Tulle (impregnated gauze)**
- **Semipermeable film**
- **Hydrocolloids**
- **Alginates**
- **Silicone foams**

### Confusing Choices!

**Tulle Dressings (Impregnated Gauze)**

- **Examples:** Xerform, Adaptic
- Gauze soaked in paraffin or petroleum
- Preferred dressing is Xeroform (fine mesh gauze impregnated with petroleum/bismuth)

### Semipermeable Film

- **Examples:** Tegaderm
- **Pro:** Transparent, wound visible
- **Con:** Non absorbent
- Can combine gauze with tegaderm
- No good evidence regarding benefit

### Hydrocolloids

- **Occlusive dressing with hydrocolloid matrix**
- Hydrocolloid = water absorbing polymers
- Liquefies on contact with wound exudates producing moist environment
- Dressing is impervious to gas, bacteria, and liquid
- Examples: Duoderm, Tegasorb

### Hydrocolloid Dressing Continued

**Pros:**
- Warm, moist environment
- Less pain on dressing removal

**Cons:**
- Retained moisture can macerate skin
- No through-bandage wound assessment
**An Article**

"Effect of hydrocolloid dressings on healing by second intention after excision of pilonidal sinus"

A Prospective RCT  European Journal of Surgery

**Findings**

**Bacterial growth**
- 5 of 15 gauze control group
- 1 of 23 hydrocolloid group

**Leakage**
- 0 of 15 gauze control group
- 14 of 23 hydrocolloid group

**Pain**
- Gauze >> hydrocolloid

---

**Alignates and Silicone Foams**

- **Alignates** (a component of seaweed)
  - Similar to hydrocolloid: when in contact with the wound, it turns into a gel promoting a moist environment
- **Silicone foams**
  - Designed to absorb large amounts of exudate

---

**Bottom Line**

- Per Cochrane Database:
  - "We were unable to identify a single large, high quality RCT in this area. Only 13, poor quality trials were found, while worldwide all kinds of dressings and topical agents are used in wound care for surgical wounds"

**Cochrane Library**

---

**Wet to Dry Dressings**

**Suboptimal**
- Can delay wound healing by removing migrating epithelium
- Can cause pain by exposing sensitive nerve fibers in the wound bed
- May actually increase costs due to lack of effectiveness

---

**Wet to Dry Dressings**

**Definition:** A moist gauze is placed on the wound and allowed to dry, serially debriding crusted blood/exudate and necrotic tissue with each dressing change

**Commonly used**
**How does it compare?**

---

**Association for the Advancement of Wound Care**

**Guideline of Pressure Ulcer Guidelines**

- *Hydrocolloid, foam, and alginate heal wounds FASTER than gauze*
- *Foam and hydrocolloid have FEWER wound infections than gauze*
- *Overall cost: foam and hydrocolloid < gauze*
### Categories of Bacteria Ridding Agents

<table>
<thead>
<tr>
<th>Bactericidal</th>
<th>Barriers</th>
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<tbody>
<tr>
<td>Antibiotics: systemic or topical</td>
<td>Osmotic agents</td>
</tr>
<tr>
<td>Antiseptics: topical only</td>
<td></td>
</tr>
<tr>
<td>Disinfectants: not on tissues</td>
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### Topical Antibiotics

1. Bacitracin
2. Polymyxin B
3. Neomycin (Neosporin)
4. 1 + 2 Polysporin
5. 1 + 2 + 3 = Triple Antibiotic
6. Mupirocin (Bactroban) only one with excellent activity against MRSA

### Antiseptics

- Iodine
- Hydrogen peroxide
- Bleach
- Silver, Silvadene (silver sulfadiazene)
- Bactine (antibiotic + lidocaine)
- Some of these chemical agents can kill healthy tissue in addition to the bacteria

### Petroleum Jelly

- AKA White Petrolatum, AKA Vaseline, AKA soft paraffin
- Acts as a barrier between wound and bacteria outside

### Another Article

"Total Occlusive Ionic Silver Containing Dressing vs Mupirocin Ointment Application vs Conventional Dressing in Elective Colorectal Surgery: Effect on Incisional Surgical Site Infection"

- Prospective RCT with 147 pts
- Topical mupirocin ointment better results than silver-containing or standard dressing

### Bacitracin vs. White Patrolatum

"Infection and allergy incidence in ambulatory surgery patients using white petrolatum vs bacitracin ointment: A randomized controlled trial"

- 922 patients with 1249 wounds
- Bacitracin & white petrolatum performed equally
  - low infection rate
  - minimal risk for induction of allergy.
### Honey
- Creates moist healing environment
- Antibacterial
- Possibly b/c high osmolarity
- Hydrogen peroxide released by exudate
- Stimulates healing and epithelialization

### A Study on Honey

"Wound healing with honey – a randomized controlled trial"
- 42 wounds treated with honey
- Safe and effective healing agent
- Extremely cost effective

### Stages of Healing with Honey

### Sugar
- Cane sugar paste
- May prevent bacterial growth by lowering water activity available
- Also has osmotic effect helpful for debridement

### Study on Honey vs. Sugar Dressings

"Effects of honey and sugar dressings on wound healing"
- RCT with 40 patients
  - 18 sugar dressings and 22 honey
- Honey was *more* effective than sugar
  - reducing bacterial contamination
  - promoting wound healing
  - slightly less painful

### Epsom Salts (Magnesium Sulfate)

**Hypertonic solution**
- Draws fluid out of a wound and dries up weeping abrasions or scratches
- Does not penetrate skin: soaking in a warm bath may have a soothing effect and give the skin a softer feel
Chemical Cautery (Silver Nitrate)

- Kills hypertrophic granulation tissue (pyogenic granuloma)
- May suppress granulation sufficiently to allow for epithelium to close over

Assessing Wounds

Cost Analysis

How much would it cost to cover this wound?

- Plain Gauze = $.05-.10
- Adaptic = $.20
- Xeroform = $.35
- Tegaderm = $1.20
- Hydrocolloid = $2.50

Summary

- Dry gauze is painful to remove
- Wet to dry dressings may actually decrease effectiveness and increase costs
- Mupirocin is more effective than silver dressings and has activity against MRSA
- Honey is a safe and effective healing agent
- Choose appropriate dressing for appropriate indication

References

- Bolton et al. The Association for the Advancement of Wound Care (AAWC) venous and pressure ulcer guidelines. Ostomy Wound Manage. 2014 ;60:24.

References Continued

Mechanical Treatments for Hand Wounds

Moheb Moneim, MD
Professor and Chair Emeritus
Reconstructive Hand Surgery
UNM Orthopaedics

Outline

- Wound Biology
- Debridement / Cleansing
- Dressings / Dressing Materials
- Closure / Wound Stimulation

Wound Biology

- Types of healing
  - Primary intention
  - Secondary intention
    - Implies granulation tissue

Wound Biology

- Granulation tissue will close most wounds

- Which wounds won’t heal?
  - Exposed structures
    - tendons
    - vessels
    - bone
    - hardware

Normal Phases of Wound Healing

1 month

6+ months
Normal Phases of Wound Healing

- control pain
- minimize edema
- prevent / eradicate infection
- encourage collagen deposition
- encourage collagen maturation
- encourage angiogenesis
- prevent excess granulation

COMMANDMENTS

- Optimize health
- Remove physical barriers
- Reduce bacteria
- Control moisture
- Reduce or reverse stress

Wound Classification by Color

Category: Red

- Red / Granulating Wound
  - Goal: protection
  - Debridement: N/A
  - Cleansing: water
  - Topicals: N/A
  - Dressing: protective, maintain moisture

Category: Black

- Necrosis / Eschar
  - Goal: remove mechanical barrier to healing
  - Debridement: Sharp / Surgical
  - Cleansing: Soap and Water
  - Topical Treatment: N/A
  - Dressings: WTD, moisturize

Category: Yellow

- Exudative
  - Goal: eliminate debris / bacteria without harming healing tissue
  - Debridement: scrubs, irrigation
  - Cleansing: soap and water
  - Topical: Silvadene, Bacitracin, Etc.
  - Dressing: WTD, absorbants
Outline: Debridement / Cleansing

- Wound Biology
- Debridement / Cleansing
- Dressings / Dressing Materials
- Closure / Wound Stimulation

Sharp Debridement

- Viable or not viable?
  - Color
  - Consistency
  - Contractility
  - Capacity to bleed

How Does Wound Look?

Reccomendations

- Gravity irrigation works
- Additives unnecessary
- Betadine, Dakin’s, Hydrogen Peroxide...
  - ...kill granulation tissue
- Use to remove already dead tissue

Solutions

Advice

“The only solution that should be used in a wound is one that can be poured into the physician’s eye.”
Wet to Dry Dressings
- Will debride necrotic tissue
- Will damage granulation tissue
- Not to be used on exposed tendon, bone
- May do more harm than good

Whirlpool
- Sterility issues, time consuming
- Useful for:
  - loosely adherent necrotic tissue
  - soaking off dressings
  - diluting contaminants

Maggots?
- Maggots
  - May be sterilized
  - Necrophages
  - Extracorporeal digestive system
  - Crawl
  - Bite

Outline: Dressings / Dressing Materials
- Wound Biology
- Debridement / Cleansing
- **Dressings / Dressing Materials**
- Closure / Wound Stimulation

Dressings
- Goal is homeostasis – i.e. protection from:
  - bacteria
  - desiccation
  - maceration
- More “feel” than science
- Know what type of wound you’re treating
Films
- Allow visual monitoring
- $\$$

Cotton gauze
- inert
- adherent
- not a barrier
- $\$

Hydrofiber: Aquacel
- Absorbent
- Antimicrobial: Ag
- $\$$

Semipermeable Foams
- Absorbent
- $\$$

Hydrocolloids:
- Absorbant
- Maintain moisture
- $\$$

More materials
- Little evidence for Xeroform
  - Makes dressing removal easier
- Silvadene, Bacitracin
  - Useful in Yellow wounds
- Salt? Sugar?
  - Highly Hydrophillic

Dressing Materials Continued
Hypergranulation

- HYPERgranulation tissue
- Debridement
- Friction control
- Absorbent dressings

Outline: Closure / Wound Stimulation

- Wound Biology
- Debridement / Cleansing
- Dressings / Dressing Materials
- Closure / Wound Stimulation

“Wounds heal faster in plaster.”

VAC

- VAC dressing
  - Edema / hematoma control
  - Increased blood flow
  - Mechanical shrinking
  - Mechanical stimulation
  - Portable

VAC Contraindications

- VAC CONTRAindicated
  - Necrotic tissue
  - Osteomyelitis
  - Malignancy
  - Exposed Vessels
Vessel Loop Closure

Hyperbaric
- Hyperbaric oxygen
- Effects systemic
- Angiogenesis
- Growth Factors
- Antimicrobial
- Proven for diabetics
- 90 min / day x 30
- Does not work on necrotic tissue

Electrical
- Electrical Stimulation
  - Intact skin has electrical potential
  - Broken skin allows flow of current
  - Chronic wounds lose flow
  - Preliminary data suggest role

Low-level laser therapy
- Painless penetrates superficial tissue
- Causes proliferation of cell lines
- Too much can be harmful
- Hard to standardize / study

Unproven
- Many unanswered questions
  - How much?
  - How long?

UltraSound

3 phases of wound biology
- Inflammation, proliferation, and maturation
- Opportunity lies mostly in phase 2

Optimize natural healing
- Intervene constructively in a natural process

Commandments: Optimize health, Remove physical barriers, reduce bacteria, control moisture, reduce stress
- To do this effectively you have to know what type of wound you’re dealing with – black, yellow, red.
- Goal is red – debridement and dressings

Much of wound care is medicine not science
- Involves patience and reassurance

Conclusion
References


Scar Characteristics

**Height, Width, Color, Texture**

- Hypertrophic: within bounds of injury, flattens over time
- Keloid: out of bounds, no change over time, rare in hands

Scar Definitions

- **Hypertrophic:**
  - within bounds of injury
  - flattens over time

- **Keloid:**
  - out of bounds
  - no change over time
  - rare in hands

Phases of Wound Healing

1. Hemostasis
2. Inflammation
3. Fibroplasia
4. Maturation
   - Collagen accumulation

Scar Maturation: Natural Course (min 6-12 months)

- **Day of Surgery**
- 2 weeks
- 5 weeks
- 10 weeks
- 3 months
- 12 months
- 48 months

Scar Maturation and Modeling

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Hand Microvascular Surgery
UNM Orthopaedics

NO VESTED INTEREST - NO FDA OFF-LABEL USES PRESENTED
November 19, 2016

UNM School of Medicine
Department of Orthopaedics & Rehabilitation

Scarring Varies By . . .
- Age
  - young adults >
  - children and elderly >>
  - fetal
- Skin Color: dark >> light
- Body area: trunk > shoulder >>
- Mechanism of injury: burn > others
- Orientation to skin creases: ↓ >> ↑
- Individual

Results of Scar Modulation Studies Muddied By . . .
- Inconsistent definitions of keloid vs hypertrophy
- Different body sites
- Different injuries
- Different individuals
- Lack of adequate controls
- Different dosages/duration of treatment
- Inadequate length of follow-up
- Commercial bias

Best studies: randomized, double blinded, “split scar studies” (patient serves as own control)

A Study

Authors review:
- Different individuals
- Clinical trials since 2000
- 44 studies
- 3826 patients

An excellent reference source: current, comprehensive, EBM, free full text

Theoretical Mechanisms for Some Scar Modulation Modalities
Let’s look at these for quality of evidence, then some other modalities too.

Silicone Sheeting
Systematic review of trials evaluating silicone gel sheeting
- Improvement in scar thickness and scar color
- Studies poor quality and highly susceptible to bias

Silicone Gel
Level 1 evidence from split-scar study:
- Effect is from hydration of superficial skin layer not from pressure, temperature, or chemistry of silicone
Vitamin E
- Anti-oxidant properties
- Multiple studies: no convincing evidence of efficacy

Aloe Vera
- Centuries-old traditional medicine
- No convincing evidence for benefit

Green Tea
- Anti-oxidant/anti-inflammatory properties
- Inhibits collagen production in laboratory
- Only limited and low-level clinical evidence

Onion Extract Gel (Mederma)
- Anti-oxidant/anti-inflammatory properties
- Reduces fibroblast cell culture proliferation; 2 RCTs showed positive results, both funded by mfr
- Other studies: generally favorable results

Pharmaceuticals

**TOPICALS**
- **Mitomycin C**
  - anti-tumor/antibiotic
  - inhibits DNA synthesis, cell proliferation, keloid fibroblast formation in cell culture
  - clinical results mixed

- **Imiquimod**
  - immune response modifier
  - useful for warts and other viral conditions
  - results for scars mixed - at best

**INTRA-LESIONAL INJECTIONS**
- **Verapamil**
  - calcium channel blocker
  - stimulates collagenase production
  - intra-lesional injection
  - limited studies, but effective

- **Triamcinolone**
  - corticosteroid—anti-inflammatory
  - intra-lesional injection

Injections for Scar Modulation
- Review of 27 papers
  - Alone or in combination and with/without excision
  - 5-fluorouracil: anti-tumor agent
  - Mitomycin: anti-tumor agents
  - Bleomycin: steroid injections, esp triamcinolone

- Combined agents following surgery worked best
  - Recurrence incidence 61.9%

Other Modalities

Radiation
- 33 midlevel studies
- Radiation within 7 hours after excision -> low recurrence
- Reports with higher levels of evidence needed

Laser: "photobiomodulation"
- Basic science evidence is poor
- Substantial divide between the basic science rationale and clinical evidence of efficacy
- Blinded studies difficult
- Settings may not accurately indicate dose

Tamoxifen: inhibits estrogen, delays fibroblast proliferation
- One level 1 study: “It seems to work.”

What Is True About Scar Modulation?

Time and Topicals
- Patience is rewarded over at least 6-12 months
- Silicone gel definitely helps
- Mederma likely helps
- Vitamin E does not help

Invasive interventions
- Excision with injections help
- Excision with radiation help
Further Investigation Requires... 

Serial quantification of scar
- Vancouver burn scar assessment, others
- Photos w/ standard lighting/positioning/background

Serial outcomes measures
- PRISM (Patient-Reported Impact of Scars Measure)

Understanding scar formation on a molecular level
- New Molecular Medicine-Based Scar Management Strategies. Burns. 2014;40: 539 Free full text

The Right Way to Study Scar Modulation

Patient-Reported Impact of Scars Measure (PRISM)

37 items: Symptoms and Quality of Life

Symptom Scale
- My scar throbs quite a bit
- The pain is very severe
- My scar itches a lot
- My scar is very sensitive
- Clothes make my scar hurt

Quality-of-Life Scale
- It affects my confidence
- The pain is very severe
- It’s really annoying having to explain it
- I feel embarrassed when people ask about my scar
- I feel very unattractive
- I can’t see past the scar when I look in the mirror

References


* = Level 1 evidence
Management of Clean Incisions

**Erica Gauger, MD**
Hand Fellow
UNM Orthopaedics

NO VESTED INTEREST
NO FDA OFF-LABEL USES PRESENTED
November 19, 2016

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**Basic Biology**

- **Goal is to heal by primary intention**
  - Minimize inflammation/edema/skin
- **Clean, well approximated skin edges**
  - re-epithelialize in 24-48 hours
- **Goals of dressing are to manage**
  - exudate, prevent contamination,
  - provide moist wound healing
- **Some go farther by providing stability**
  - or biological action (anti-microbial
    activity)
- **Skin tensile strength**
  - 20% at 3 weeks
  - 50% at 6 weeks

---

**Basic Rules**

- **If dry...moisten (ointment, xeroform)**
  - Petroleum is equivalent to
    antibiotic ointment without
    the risk of allergy
- **If wet...dry (gauze, alginate)**
- **Ointment only effective until epithelialization**
  - (24-48 hours)
- **Crust is a biofilm (full of bacteria). Remove it.**

---

**Basic Rules Continued**

- **If dry...moisten (ointment, xeroform, tape, glue)**
- **If wet...dry (gauze, alginate)**
  - Ointment only effective until epithelialization (24-48 hours)
  - Crust is a biofilm (full of bacteria). Remove it.
- **If tension...leave sutures/dressing longer and**
  - consider immobilization
- **If signs of poor healing, leave sutures longer or**
  - remove offending agent (e.g. splint that’s
    rubbing)

---

**Not All Incisions are the Same**

**Consider the operation and the patient**

- **Patient factors for poorer healing:**
  - Diabetes, age, obesity, chronic disease, malnutrition,
    smoker, radiation, tension, motion (flexion crease)
- **Operative factors:**
  - Primary or revision surgery
  - Undermining of skin
  - Blood supply
  - Hardware or foreign body
    (e.g. Hunter rod)

---

**Dermabond (2-Octyl Cyanoacrylate)**

- **Sterile liquid topical adhesive**
  - “medical superglue”
- **FDA approved 1998**
- **Strong, waterproof (4-0 suture**
  - equivalent)
- **Classically not used in hand**
  - unless immobilized (can crack)
- **Not removed – sloughs with**
  - epidermal turnover in ~14 days
- **Can cause hypersensitivity**
  - reaction

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*Carpal tunnel incision with early dehiscence and prolonged inflammatory phase of wound healing*
Subcuticular Suture

Appearance after deep dermal closure (absorbable)
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Example of Primary Wound Healing

- Immediately after surgery
- No inflammation

How I Do It: April 2015 Survey Results

How do you handle your patients’ post-operative wound care for carpal tunnel release in particular, what type of closure do you use, how long does the dressing stay on, and how do the patients resume heavier activities such as lifting or sports?

- 4-0 nylon horizontal mattress sutures out 14 days, see after 1 week, 6 weeks for heavy lifting.
- 4-0 nylon horizontal mattress sutures, dry dressing, no split. Sutures out 12-14 days post op. Sutures out 12 days post op. Moderate lifting is OK. No showers for 2 weeks.
- I close with simple running 4-0 nylon. I place two, two 4-0 nylon, then wrap with a 5x5 cast and a 3-inch cast. I instruct patients to leave the on until they see. If they are instructions on how to replace it at home if it falls out and or any complications. I tell them to expect some swelling and any pain.
- 1. I close with a running 4-0 nylon. I place two, two 4-0 nylon, then wrap with a 3x3 cast and a 3-inch cast. I instruct patients to leave the on until they see. If they are instructions on how to replace it at home if it falls out and or any complications. I tell them to expect some swelling and any pain.
- I close with a running 4-0 nylon. I place two, two 4-0 nylon, then wrap with a 3x3 cast and a 3-inch cast. I instruct patients to leave the on until they see. If they are instructions on how to replace it at home if it falls out and or any complications. I tell them to expect some swelling and any pain.
- Simple sutures. Usually 2-3 weeks. Keep dry until sutures are removed, with 3-4 weeks to start Heavy lifting.
- 4-0 prolene sutures, horizontal mattress for the skin. Dressing on for 3 days, then you can get wet and then a dressing. If any problems, I remove the dressing. I then see patients out 1-2 weeks post op, then I see them out 3 weeks.
- 4-0 nylon horizontal mattress. Patient removes dressing at 5 days and covers with Band-Aid. Clean and dry.
- Simple sutures 4-0 nylon. Two weeks for suture removal and activity as tolerated. I can get wet and heavy activity in 4 weeks. No sports.
- Original dry dressing until sutures out 10-15 days post op. Wound wet after sutures out. No activity at 6 weeks. No sports in 2-3 months.

Does any of this matter?

Putting This in Perspective

Evidence in carpal tunnel surgery

100 patients had open carpal tunnel release
- 51 randomized to have dressing removed after 2 weeks
- 49 randomized to have dressing removed after 24 hours

No difference in complications. Slightly improved functional scores in 24h group.


Some General Hints . . .

- Wounds on the palm heal if you keep them clean and greasy
- If you expect swelling, DON’T use Steristrips
- Never leave a hematoma or seroma
- The best surgical dressing I know:
  - Wicks the blood away from the incision so you don’t get crusting
  - We generally use xeroform, gauze and then dry gauze wrap

Pin Care

- Clean interface daily with saline and Q-tip
- Anything stronger cytotoxic
- Remove crusting
- Increasing erythema, pain: oral antibiotics
- Pur: possible early removal of pin
- Pin loose: remove
What are the Goals?

- Keep wound clean
- Keep wound dry or moist
- Pack from inside out
- Frequent dressing changes
- Don’t be afraid to wash!

What Can Go Wrong?

- Constant irritation
  - i.e. flexing elbow with olecranon wound
- Not immobilized enough to heal
- Pressure points

How Do I Approach the Open Wound?

- Assessment of patient and history
- Assessment of the wound

Managing Open Wounds

Eric Lew, DPM, AAGFAS
Assistant Professor, Podiatry
UNM Orthopaedics
Center for Healing In the Lower Extremity (CHILE)

NO VESTED INTEREST - NO FDA OFF-LABEL USES PRESENTED

What Do I Need to Think About with Open Wounds?

- Bacterial colonization
- Nutrition
- Debridement, dressings
  - Keep wound clean
  - Keep wound dry or moist
  - Pack from inside out
  - Frequent dressing changes
  - Don’t be afraid to wash!

What Can Go Wrong?

- Bandages too tight
  - Ulcers
  - Macerated skin

References/More Reading

Surrounding area
• Edema
• Erythema
• Induration
• Pain/tenderness
• Heat

Location
• Size
• Age
• Depth
• Volume
• Odor
• Necrotic tissue
• Undermining
• Tunneling
• Edema

Characteristics

Common Dressings

- Wet to dry
- Wet to wet
- Dry gauze (bleach)
- Soaks (betadyne)
- Vaseline gauze (xeroform)
- Subatmospheric pressure ("negative pressure" wound therapy (VAC))
- Accuzyme/Panifil
- Antimicrobials (bacitracin)

Wet to Dry

- Debridement
- Good for "dirty wounds"
- Can be painful

Dry Dressings

- Good for wet wounds
- Good to protect
- Keeps wound dry
- Limits skin maceration

Getting back to Galen (120-201 AD)

- Wounds heal in a moist environment
- Dry debridement hurts neoepithelium


Xeroform = Bismuth (Both Bactericidal and Bacteriostatic)

- Non-adherent
- Keeps moist
- Limit to wound area
  - not on normal skin
- Multiple layers impermeable
Non-Adherent

- Little debridement
- Less pain
- Function similar to dry gauze

Silver Dressings

- Storm-Versloot MN, Vos CG, Ubbink DT, Vermeulen H. Topical silver for preventing wound infection. Cochrane Database Syst Rev 2010; 17(3)

Negative Pressure Wound Therapy (Vacuum-Assisted Closure = VAC)

- Increases local perfusion and stimulates angiogenesis
- Stimulates cell proliferation (granulation)
- Reduces tissue edema
- Draws wound edges together
- Inhibits bacterial growth
- Promotes cell hyperplasia
- More effective than standard moist wound therapy
- Ottawa, 2014 Aug
- Guffanti, 2014
- Blume, Walters,

Vacuum dressing

- Granulation tissue
- Healing by secondary intention
- Reduces edema

NPWT Creates an Environment That Promotes Wound Healing

In What Settings Can You Use NPWT?

- Indications: Most type of wounds
  - Chronic
  - Acute
  - Traumatic
  - Sub-acute
  - Dehisced
  - Partial thickness burns
  - Diabetic
  - Pressure
  - Venous insufficiency
  - Grafts
  - Flaps
**Infection/NPWT – Case Example**

**HPI:**
- 68 Male with DM, PN
- Acute R Foot infection
- Rapid Onset
- Osteomyelitis, septic arthritis
  - 5th MPJ
- Severe Local infection
  - Advancing erythema, purulence, edema
- Palpable pulses

**Plan**
- Incision and drainage
- 5th MPJ arthroplasty, wide excision
- NPWT
- STSG

**Case Example – Bioengineered Alternative Tissue**

- 61 y/o Male
  - h/o DM, PAD, CAD, EToH abuse
  - Admitted to SRMC for right foot gangrene/sepsis
  - Underwent 2nd-4th transmetatarsal amputation
  - Chronic ulceration, non-healing for 8 weeks

**1 Week S/P Revisional TMA**

- Vascular Consult: Medial artery calcinosis and small vessel disease, not amenable for revascularization
- Patient underwent conversion to a full TMA
- 1 week later: underwent a hypotensive event
  - Admitted to the ICU
  - Sepsis with poor dentition as source

**Week 0 (1/18/2016)**

- 4 weeks s/p excisional wound debridement and application of NPWT
- Wound bed fully granular
- STSG considered, but patient not a candidate for further surgery

**Thus:**
- Initiated 1st

**Week # 3 (2/1/2016) – after two applications**
### Week 6 (2/15/16) – After 5 Applications

![Image of chronic LE wound after 5 applications]

### Week 8 (3/14/16) - Fully Healed (6 Applications Total)

![Image of healed chronic LE wound]

### Case Example – Chronic LE Wounds

| 63 F, SLE |
| Chronic b/l LE ulcerations |
| R – 10 years |
| L – 3 years |
| Previously treated as Venous Stasis Ulcerations |
| Unna boot, Compression |
| Silver – based |

### Plan

- **Admit:**
  - Skin biopsy
  - Rheum Consult
  - NPWT with instillation
- **Wound Debridement**
- **STSG**
Management of Thermal Injuries

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November 19, 2016

Introduction: “A burn is for life”

- Hand = 3% TBSA
- Hand burns = 80% burn injuries

Thermal Injuries: Concepts

Mechanism of Injury

- Thermal Injuries
  - Scalds
  - Flame burns
  - Flash burns
  - Contact burns
  - Frostbite
- Chemical injuries
- Electrical burns
- Radiation burns

Classification

- 1st Degree (Superficial)
- 2nd Degree (Partial Thickness)
- 3rd Degree (Full Thickness)
- 4th Degree (Tendon/bone/joint)
Thermal Injuries: Concepts

Jackson’s Zones of Injury

Zone I: Zone of Necrosis
Zone II: Zone of Stasis
Zone III: Zone of Hyperemia

Greene’s Operative Hand Surgery 6th Ed, Figure 63.1

Acute Thermal Injuries: Management (“Cool the Burn, Warm the Patient”)

- Acute Management:
  - Airway
  - Breathing
  - Circulation
- Debridement with Reconstruction
- Rehabilitation

First Degree Burns

Second Degree Burns: Superficial

Photos courtesy of Dr. Andrew Navarette

Second Degree Burns: Deep

Second Degree Burns: Indeterminate
Hand Burn Rehabilitation

- As soon as patient enters ER
- Elevation – can affect burn depth
- Intrinsic plus orthosis
- Supervised early motion
- Pressure garments (23hrs/day x 6-12 months)

Photo – Greene’s Operative Hand Surgery 6th Ed. Figure 63.8

Hand Burn Rehabilitation

Photo – Greene’s Operative Hand Surgery 6th Ed. Figure 63.7

Post Burn Contractures

Best Treatment = Prevention

Photo courtesy of Dr. Roy Meals

Photo courtesy of Dr. Roy Meals

Post Burn Contractures


Frostbite

“Nothing burns like cold”

- < 15°C – Adaptive hunting reaction
- Two mechanisms:
  - Direct cellular damage
  - Dermal ischemia

Frostbite: Classification

- First degree = reversible changes
- Second degree = superficial dermal damage
- Third degree = deep dermal damage
- Fourth degree = damage to subcutaneous tissue/ muscle/ nerve/ bone

Note:
1) Severity cannot be determined acutely
2) Treatment directed at
   a) Promoting circulation
   b) Preventing infection
   c) Allow tissues to declare themselves over time


Frostbite: Management

- Rapid rewarming
  - To thaw ice + halt direct cellular damage
  - Avoid thawing until definitive rewarming possible
  - Water bath (38°C -40°C) with mild antibacterial agent
- Post thawing rehab to minimize dermal ischemia
- Active wound care to promote healing
- Early vs. late surgical intervention

Patience is USUALLY Rewarded

On admission

After rapid rewarming

8 days

12 days

84 days

Frostbite: Patience Can Be Rewarded

Demarcation of dry gangrene is obvious

Time to remove necrotic tips

Photos courtesy of Dr. Roy Meals

Frostbite: Patience Not Always Rewarded

Frostbite adjuvant therapies: evidence is weak

- Low-molecular weight Dextran
- Vasodilators – Resperpine
- Anticoagulants – tPA
- Sympathectomy
- Hyperbaric oxygen
- Early subatmospheric pressure wound therapy
- Prostacyclins

Reference


Reinforcement Quiz

Honey has been used on open wounds since
- medieval times
- Renaissance era
- ancient Egyptian times
- 19th Century

Split thickness skin grafts transfer
- epidermis
- hair follicles
- sensory end organs
- sweat glands
- all of the above

Skin provides
- dehydration barrier
- infection defense
- vitamin D production
- sensation
- all of the above plus temperature regulation

Reinforcement Quiz

The first 3 phases of normal wound healing in sequence are
- inflammation, fibroplasia, hematostatis
- fibroplasia, inflammation, maturation
- fibroplasia, hematostatis, inflammation
- hematostatis, inflammation, fibroplasia
- hematostatis, fibroplasia, inflammation

Scar maturation in normal wound healing
- is complete upon suture removal
- requires a minimum of 6-12 months
- is entirely individual specific
- produces permanent regional erythema
- leads to progressive local induration

Wound healing is favorably affected by
- Staph infection but not Strep infection
- lymphedema
- adequate oxygenation of tissues
- volar locking plates and screws
- low-moderate nicotine levels
Reinforcement Quiz

What are OSHA regulated wastes?
- contaminated sharps
- soggy dressings
- caked, dried blood
- pus on lab coat sleeve
- all of the above

Drying fingers, then palms, then wrists after a surgical scrub is easy to remember because finger, palm, wrist are in alphabetical order.
- softens the towel for the sensitive wrist skin
- bestows an air of professionalism
- moves towel away from cleanest, most critical skin surfaces
- allows the fingers more time to dry before donning gloves

Which wound description suggests a favorable outcome?
- fetid odor, patchy necrosis
- ascending lymphangitis
- odorless pus
- granulation without exudate
- watery exudate, marked swelling

Benefits of negative-pressure assisted closure include
- control of hematoma and edema
- increase in local blood flow
- mechanical shrinkage of the wound
- stimulation of granulation tissue
- all of the above

Keloids on the hand are
- avoided by layered wound closure
- identical to hypertrophic scars
- fragile and bleed easily
- easily managed with topical silver nitrate
- rare in all races

Triple antibiotic ointment
- costs three times as much as regular
- good for wounds undergoing tertiary healing
- has three times the potency of other ointments
- contains penicillin, sulfa, and cipro
- contains bacitracin, polymyxin B, and neomycin

Wet-to-dry dressings may
- be less painful than non-adherent dressings
- promote faster healing than hydrocolloid dressings
- cause less bleeding on removal than honey-soaked gauze
- ultimately cost less than fancier alternatives
- remove new fragile epithelium

The rationale for use of Epsom salts on open wounds is that the hypertonic solution draws excess fluid from the wound. Their antibiotic properties have been known since antiquity.
- the salt solution stings less than pure water
- bacteria are repelled by magnesium
- the resultant skin softening eases pain

Use of a whirlpool to treat open wounds may
- pose sterility problems
- loosen necrotic bits of tissue
- soak adherent bandages loose
- dilute wound contaminants
- cause all of the above

CONGRATULATIONS!
You may find it helpful to remember the quiz answers
And for future learning......
Details on all courses and self-study programs are at www.doctorsdemystify.com
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Please pick up around you.

On Monday, complete the quiz and evaluation form at www.doctorsdemystify.com and receive your CE certificate

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Input your Username & Password
Select "Log In"
Then look to the left hand side of the screen and select MY COURSES
Under "ACTIVE" you'll see "Wound Care" and next to "WOUND CARE" select "View Results"
Scroll down and select "View Lesson Quiz"

After you complete and pass the course quiz here are the instructions to the course certificate.
Certificate:
Go to "My Courses"
"Completed Courses"
"Wound Care"
"View Results"
"View Certificate"