AS A COURTESY TO THOSE AROUND YOU, PLEASE SILENCE YOUR CELL PHONE AND OTHER ELECTRONIC DEVICES. THANK YOU FOR YOUR COOPERATION.

WOUND INFECTION; HOUSTON WE HAVE A PROBLEM
CHUCK GOKOO MD, CWS
CHIEF MEDICAL OFFICER
AMERICAN MEDICAL TECHNOLOGIES
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PROGRAM OVERVIEW AND OBJECTIVES

Discuss the differences between acute and chronic wound healing models

Explain the importance of wound bed preparation to reduce bioburden levels.

Discuss the recommendations for clean versus sterile technique during wound care.
“Houston we’ve had a problem here”
Jack Swigert, April 13, 1970

ACUTE WOUND MODEL

Days after wounding (log scale)

Maximum response

I Inflammation
-II Cell proliferation and matrix deposition
-III Matrix remodelling

- Fibroplasia
- Angiogenesis
- Re-epithelialization
- Extracellular matrix synthesis
- Collagens
- Fibronectin
- Proteoglycans

- Granulocytes
- Phagocytosis

- Macrophages
- Cytokines

- Extracellular matrix synthesis, degradation and remodelling
  - Tensile strength
  - Cellularity
  - Vascularity
ACUTE WOUND MODEL

Matrix Metalloprotease
- Leukocyte influx
- Inflammation
- Angiogenesis
- Cell migration
- Re-epithelialization
- Contraction
- Scar remodeling

ACUTE TO CHRONIC WOUND MODEL

Microbial Flora
- Acute wound
  - S. aureus, and Beta-hemolytic Streptococcus
  - B Streptococcus and S. aureus - diabetic foot ulcers
- 4 weeks
  - Facultative anaerobic gram negative rods
- Chronic wound
  - Anaerobes
  - 95% of diabetic foot infections contain anaerobes
  - Coliforms (deep)
- Polymicrobial
  - Aerobic and anaerobic organisms
- Houston we have a problem
**CHRONIC WOUND MODEL**

**Chronic Wounds**
- Pro-inflammatory cytokines
  - 200 - 300 times higher in chronic wounds
- Increased Matrix Metalloprotease (MMP) levels
- Destruction of wound healing proteins
- Decreased TIMPs levels
- Elastase - fibronectin degradation
- Stimulates release of MMPs
- Impaired healing
- Houston we have a problem

**CHRONIC WOUND MODEL**

**Delayed Wound Healing**
- Fibronectin (elastase) bind and inactivate growth factors
- Neutrophils - release MMP’s in excess-digest extracellular matrix
- Fibroblasts – fail to respond to normal wound healing signals
- Connective tissue is degraded
- Diminished tissue inhibitors of metalloproteases (TIMPs)
- Houston we have a problem

(Cullen et. al 2009)
BIOBURDEN/INFECTION

Contamination
- Non replicating bacteria

Colonization
- Replicating bacteria without signs or symptoms of infection
  - Polymicrobial (aerobic/anaerobic)

Critical Colonization
- Bioburden levels cause a delay in ulcer healing
  - Increased pain
  - No acute host reaction

Infection
- Deposition and replication of bacteria in the tissue causing a host reaction

Infection = Dose X Virulence
Host resistance

> 100,000 \( (10^5) \) cfu/g of tissue or mL of fluid

Endotoxins - lipopolysacchrides/exotoxins - proteins

Host resistance
- Degree of chronicity
- Wound area
- Mechanism of injury
- Smoking
- Vascular disease
- Diabetes mellitus
- Poor nutritional status
- Immunosuppression or use of steroid medications
BIOBURDEN/INFECTION

Local Signs and Symptoms of Chronic Infection

- Erythema (Rubor)
- Warmth (Calor)
- Swelling (Tumor)
- Increased pain (Dolor)
- Tenderness
- Foul odor
- Purulent drainage
- Crepitation
- Pocketing at the base of the wound
- Bleeding or friable granulation tissue
- Tissue discoloration
- Ulcer breakdown

NERDS

- Nonhealing
  - Decrease in size 20 - 40% in 4 weeks and close by 12 weeks
  - Bacteria may be causing a chronic wound
  - Biopsy to rule out unsuspected diagnosis
- Exudative ulcer
  - Purulent or sanguineous exudate - bacterial imbalance
- Red and bleeding ulcer
  - Bright red tissue that bleeds - bacterial imbalance
  - Prolonged inflammatory state interferes with normal healing
- Debris in the ulcer
  - Necrotic tissue and debris is a source for bioburden buildup
- Smell from the ulcer
  - Cause of odor
BIOBURDEN/INFECTION

STONES
- Size change
  - Deeper and surrounding tissue damage by bacteria
- Temperature
  > 30°F between two mirror image areas
- Os probe to exposed bone
  - Osteomyelitis
- New or satellite area of breakdown
  - Separated from the main ulcer
- Exudate, erythema, edema
  - Frank purulence
- Smell
  - Putrid smell

BIOBURDEN/INFECTION

Systemic Effect
- Bacterial vs. viral
- Leukocytosis
- Hyperthermia (fever), chills, nausea, vomiting
- Altered mental status: confusion
- Elevated pulse
- Multi-organ involvement
- R/O (e.g. urosepsis, pneumonia, carcinoma, autoimmune disease)
**BIOBURDEN/INFECTION**

**Tissue Biopsy**
- Qualitative analysis
- Determine the colony count/g of tissue

**Needle Aspiration**
- Colony-forming units/volume of fluid
- May underestimate bacterial isolates

**Wound Culture**
- Semi-qualitative analysis
- Local signs of infection or if systemic signs resulting in sepsis occur
  - Aerobic and anaerobic

---

**BIOBURDEN/INFECTION**

**Culture Techniques**
- Cleanse
- Debride
- Swab viable tissue
  - Planktonic bacteria
- Levine Technique
  - 1 cm² area
  - Force to extract fluid
- Aerobes and anaerobes
**BIOBURDEN/INFECTION**

**Biofilms**
- 70% - 80% of chronic wounds
- Polymicrobial infections
- Attached to an environmental surface
- Encased in an extracellular polysaccharide or slime matrix
- TX
  - Debridement
  - Antibiotics
  - Topical antimicrobials

**Muti-Drug Resistant Organisms (MDROs)**
- Non responding infection
- MRSA (HA/CA)
- Vancomycin-resistant enterococci (VRE)
- Assess
  - Length of stay in the facility
  - Multi-patient room
  - Recent hospitalization
  - Previous antibiotic use
**Cellulitis**
- Inflammation of the interstitial tissue
- Warmth, swelling, tenderness, erythema, fever
- Rule of 2 cm
  - Mild, moderate, severe
  - Group A streptococcus
- Treatment
  - Systemic antibiotic for localized infection
  - Hospitalization with IV antibiotics for spreading cellulites

**Abscess**
- Involves the fascia tissue
- Treatment
  - Incise and drain
  - Debridement
  - Tissue graft may be necessary
  - Antibiotics therapy is variable
**BIOBURDEN/INFECTION**

**Osteomyelitis**
- Toes and/or small bones of the foot
- Associated with a non-healing or a recurring ulcer
- Severity of infection
  - Visible or palpable bone implies an 85% chance of osteomyelitis
- Treatment
  - Bone Biopsy
  - Bacterial culture
  - Debridement
  - Hospitalization with IV antibiotics

**BIOBURDEN/INFECTION**

**Oral**
- Severe periodontal disease 60 – 90%
  - Tooth loss (80%)
  - Ill fitting dentures (50%)
  - Mouth ulcers (30%)
  - Gum recession
  - Oral pain
  - Chewing abnormalities
  - Dry mouth
  - Gingivitis
  - Periodontal disease
- Swallowing Abnormalities (Dysphagia)
  - Disease of the oropharynx and esophagus
  - Dementia
  - Stroke
## ANTIMICROBIAL THERAPY

### Common Antiseptic/Antimicrobial Agents

- **Povidone - Iodine Agents**
  - 1% solution (10% polyvinylpyrrolidone iodine)
  - 10% ointment/5% cream
  - Fibroblast and keratinocyte toxicity (1%)

- **Sodium Hypochlorite Solution**
  - Dakin’s solution – 0.5% solution (0.125% - 0.25%)
  - Collagen degradation (granulation)
  - Fibroblast and endothelial cell toxicity

- **Acetic Acid**
  - 0.125% - 0.025%
  - Fibroblast and keratinocyte toxicity

- **Hydrogen Peroxide ($H_2O_2$)**
  - 3% solution – cytotoxic
  - 0.003% – non cytotoxic
  - Poor antimicrobial affect

- **Silver Sulfadiazine**
  - Antimicrobial affect
  - Sulfa allergy
  - Transient leukopenia (neutropenia with white cell depression)

- **Petrolatum**
  - Slows epithelialization

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## MOISTURE ASSOCIATED SKIN DAMAGE (MASD)

### Incontinence-Associated Dermatitis
- Axilla, groin, intertriginous areas
- Periulcer/peristomal
- Bile acids and enzymes in feces
- Urea converted to ammonia

### Daily skin inspections
- Compromised peripheral circulation

### Promote skin hygiene
- Cleanse with saline and skin cleanser
- Avoid alkaline agents which increase skin irritation
- Skin pH 4 - 6.8 to avoid bioburden build up and/or risk of infection
- Skin protectant or barrier
MOISTURE ASSOCIATED SKIN DAMAGE

Peristomal Skin

- Mechanical Stress
- Moisture
- Increased bioburden and fungi

End Result

- MASD
- Dermatitis
- Folliculitis
- Infection

PAIN

Dressings

- Dried out
  - Irritate local nerve endings
  - Wet-to-dry (gauze)
- Adherent dressings
  - Tissue in-growth into product matrix
  - Premature release - cause skin tears, damage tissue, cause pain
  - Gauze/Hydrocolloids
- Frequency of dressing changes
  - Uncomfortable
  - Biologically undesirable
  - Wound tissues - hypothermic
  - Nerve endings are irritated

- Dressing of choice
  - Non traumatic to tissues when removed
  - Low “peel” force
- Non adherent dressings
  - Moisture retentive dressings
  - Hydrogels, hydrofibers, alginites and soft silicones
  - Enzymatic debriding agent
  - Medicate before, during and after as appropriate

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**PAIN**

*Observation*
- Vocalization of pain
  - Constant muttering
  - Moaning or groaning
- Screaming/crying out
- Breathing
  - Strenuous
  - Labored
  - Negative noise on inhalation or expiration
- Pained facial expression
  - Clenched jaw
  - Troubled or distorted face
  - Crying

*Body language*
- Clenched fist
- Wringing of the hands
- Strained and inflexible position
- Fetal position
- Rocking

*Movement*
- Restless
- Altered gait
- Forceful touching
- Rubbing of body parts
- Afraid to move

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**Wound bed preparation**

- **Address patient issues**
  - Psychological issues
  - Social circumstances
  - Environmental factors

- **Wound diagnosis**
  - T.I.M.E.
    - Tissue: non viable
    - Infection or inflammation
    - Moisture balance
    - Edges/epithelialisation

- **Co-morbidity factors**
  - E.g.
    - Organ failure
    - Diabetes
    - Vascular disease
    - Pyoderma gangrenosum
    - Malignancy

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WOUND BED PREPARATION

Cleansing
- At every dressing change
- Non cytotoxic, non irritating cleanser
- Avoid cytotoxic solutions
  - Skin cleansers or antiseptics
- Irrigation pressure between 4 - 15 psi
  - 35 cc syringe with 19 gauge soft tipped catheter
  - 8 psi
  ≥15 psi may drive ulcer fluid & debris into the ulcer

WOUND BED PREPARATION

Debridement
- Removal of dead or devitalized tissue
- Debridement not considered surgical wound
  - Surgical or sharp
  - Mechanical (wet-to-dry, whirlpool, pulsed lavage)
  - Enzymatic (collagenase)
  - Autolytic (ulcer fluid)
  - Biodebridement (maggot therapy)
- Excessive debridement can result in a reinstitution of the inflammatory process with an influx of inflammatory cytokines
WOUND BED PREPARATION

Moisture Balance
- Reduce pain
- Softens eschar
- Promote perfusion
- Barrier against environmental contamination
- Promote rapid migration of epidermal cells
- Reduce nosocomial infection

WOUND BED PREPARATION

Bacterial Barrier
- Control the hydration and oxygen tension of a wound
- Barrier
  - Bacteria
  - Moisture
  - MVTR
- Preserve phagocytic function
WOUND BED PREPARATION

Thermoregulation

- Circulation/sweating
- Limit the effects of tissue cooling
  - 6°C cooler due to fluid evaporation
  - Rewarming the wound base
  - Vasoconstriction (↓ tissue oxygen tension)
- Hypothermia
  - ↓ Neutrophil function
  - ↓ Collagen deposition
  - ↑ Wound infection

WOUND DRESSING CHANGE GUIDELINES

Verify
- Policies and procedures
- Orders
- Treatment plan

Set up
- PPE/field
- Necessary equipment
- Assistant(s)
- Positioning/draping

Documentation
- Treatment procedure
- Resident concerns
- Discuss with legal proxy

Wash & Glove
- Dressing removal
- Cleanse
- Assess and treat
- Redress
- Repositioning

Clean up
- Field
- Dispose contamines

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STERILE TECHNIQUE

Sterile Technique
- Meticulous hand washing
- Use of a sterile field
- Sterile instruments
- Sterile supplies
- Sterile gloves for the application
  - Immunocompromised individuals
  - Severe burns
  - Surgical wounds
  - Extensive wounds debridement

CLEAN TECHNIQUE

Non-Sterile
- Hand washing
  - Reduce the overall number of microorganisms
- Maintaining a clean environment with a clean field
- Clean field & gloves
- Sterile instruments
- Prevent direct contamination of materials & supplies
## Technique for the Management of Chronic Wounds

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Handwashing</th>
<th>Gloves</th>
<th>Supplies</th>
<th>Instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wound cleansing</td>
<td>Yes</td>
<td>Clean</td>
<td>Normal saline or commercial wound cleanser-sterile; maintain as clean per care setting policy</td>
<td>Irrigation with sterile device; maintain as clean per care setting policy</td>
</tr>
<tr>
<td>Routine dressing change without debridement</td>
<td>Yes</td>
<td>Clean</td>
<td>Sterile; maintain as clean per care setting policy</td>
<td>Sterile; maintain as clean per care setting policy</td>
</tr>
<tr>
<td>Dressing change with mechanical, chemical or enzymatic debridement</td>
<td>Yes</td>
<td>Clean</td>
<td>Sterile; maintain as clean per care setting policy</td>
<td>Sterile; maintain as clean per care setting policy</td>
</tr>
<tr>
<td>Dressing change with sharp, conservative bedside debridement</td>
<td>Yes</td>
<td>Sterile Sterile Sterile</td>
<td>Sterile; maintain as clean per care setting policy</td>
<td>Sterile; maintain as clean per care setting policy</td>
</tr>
</tbody>
</table>

* "Maintain clean as per care setting policy" (address the parameters for maintenance, such as expiration dates for supplies, consideration of cost and correct interpretation of the manufacturer’s recommendations. WOCN Position Statement, Revised January 2005)
**FORMULARY**

**Final product inclusion**

**Make a short list of 2-3 products class**

**Evaluate on clinical basis**

**Literature review best evidence**

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**FORMULARY**

**Decision Tree (MEASURES)**

- Based on the resident, the ulcer characteristics, and the efficacy of the dressing
- Minimize trauma to wound bed
- Eliminate dead space
- Assess and manage exudate
- Support the body’s tissue defense system
- Use non-toxic wound cleansers
- Remove bacteria, debris, necrotic tissue
- Environment maintenance - thermal insulation and moist wound bed
- Surrounding tissue - protect from injury and bacteria
- Education for all staff involved

**Types**

- Gauze
- Transparent films
- Hydrocolloid
- Hydrogel
- Alginates
- Foam
- Composite
- Collagen
- Debriders
- Hydrofibres
- Ionic Silver
- Biologicals
FORMULARY

Chronic Exudate
- Biochemically different than acute wound fluid
  - Increased levels of MMPs break down matrix proteins
  - Increased macromolecules bind growth factors inhibiting cell proliferation
  - Slows down or block the proliferation of keratinocytes, fibroblasts and endothelial cells
  - Interferes with growth factor availability and inactivates essential matrix material
  - Loss of protein to the host, can damage the surrounding healthy skin
  - Excellent culture medium for bacterial growth

FORMULARY

Exudate Type
- Inflammatory
  - Serous - watery plasma, thin, clear or light color
  - Serosanguinous - plasma and red blood cells or thin, light red to pink
  - Sanguineous - thin, red, bloody
- Infection
  - Seropurulent - contains some white blood cells and living or dead organisms, cloudy, yellow, tan
  - Purulent - contains white blood cells and living or dead organisms, thick, creamy yellow, green, or brown
  - Bloody purulent
- Amount
  - Scant, Moderate, Heavy or Copious
STONE KNIVES, BEAR CLAWS AND GAUZE

Cost
Higher Infection Rate
Non Selective Debridement
Labor Intensive
Painful
Moisture Evaporation
Decreased Tissue Temp
Aerosolization of Bacteria

WOUND DRESSINGS

Transparent Film

- Polyurethane or copolymer
- Waterproof
- Vapor transmission (MVTR)
- Bacterial barrier
- Autolytic debridement
- Light exudate
- May be difficult to apply or tear fragile skin

Photo Courtesy of Dot Weir, RN, CWON, CWSP

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Hydrocolloid
- Self-adherent
- Bacterial barrier
- Autolytic debridement
- Decrease pain
- Cost effective
- Not for use with infected wounds, tracts or over exposed tendon or bone

Hydrogel
- Cross-linked or non-cross-linked polymers plus water and glycerin
- Amorphous or cast
- Hydrates ulcer bed
- Dehydrates if open to air
- Facilitates autolytic debridement
- Atraumatic
- May reduce pain
- Dry to light exudate
- Maceration possible

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**WOUND DRESSINGS**

*Calcium Alginate*
- Absorbent
- Biocompatible
- Atraumatic removal
- Autolytic debridement

*Hydrofiber*
- Alternative to calcium alginites
- Non-woven pad or ribbon
- Sodium carboxymethylcellulose
- 30% more absorptive

*Courtesy of ConvaTec*
WOUND DRESSINGS

Polyacrylate Dressings
- Polyacrylate core
  - Affinity for protein molecules found in wound debris, necrotic tissue and microorganisms
  - 'Pre-saturated' with Ringer’s solution
  - Protein molecules move toward the polyacrylate core
  - Ringer’s solution is pushed into the wound bed
  - “Rinsing effect” for 24 hours
  - Debrides, rinses, absorbs, cleans

Collagen
- Absorbent and non-adherent
- Promotes granulation tissue formation
- Facilitates autolytic debridement
- Not for 3rd degree burns or dry-black necrotic ulcers
  - Scarring

Courtesy MEDLINE Industries Inc.
WOUND DRESSINGS

Foam
- Primary or secondary coverage
- Absorptive
- Oxygen permeable
- Partial and full thickness wound
- Infected or non-infected wounds
- Minimal trauma
- Facilitate autolytic debridement
- Not used on dry eschar

ANTIMICROBIALS

Cadexomer Iodine
- Polysaccharide starch lattice
- 0.9% elemental iodine
- Sustained iodine released in lower levels over time
- Cadexomer - moisture balance
- Absorb 7 - 10 x wt in fluid
- Autolytic debridement
- MRSA, VRE, Staphylococcus aureus
ANTIMICROBIALS

Methylene Blue and Gentian Violet
- Polyvinyl alcohol sponge
- Bacteriostatic
- 3-dimensional open cell structure
- Trap and inhibit exudate and debris
- Absorb 12 x weight in exudate
- Alter redox/oxidation potential of bacterial cell wall
- Not for use on 3rd degree burns

ANTIMICROBIALS

Silver Misconceptions
- Silver dressings don’t improve healing rates
  - Silver dressings reduce wound bioburden treat local infection and prevent systemic spread
- Silver dressings are toxic to wounds and delay healing
  - Inconclusive
- Bacteria become resistant to silver
  - Unknown
- Silver dressings could make bacteria resistant to antibiotics
  - No evidence of a cross-resistance between silver and antibiotic
- Silver dressings are too expensive
  - Many direct and indirect costs may be difficult to measure
**ANTIMICROBIALS**

*Silver Sulfadiazine (SSD)*
- Burns
  - 1% in a carrier cream
  - Two antibiotics agents
  - Higher release of metallic silver
  - A lower relative concentration of ionized silver
  - Sulfa allergy
  - Short half life
  - May increase healing times

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**ANTIMICROBIALS**

*Ionic Silver*
- Broad spectrum
  - Effective against aerobic, anaerobic, gram + & gram - bacteria, yeast, fungi, virus
- Rare resistance
  - E Coli & Pseudomonas
- Saline
  - Reacts with the Ag+ cation
  - Forms silver chloride crystals
  - Decreases the amount of silver released
- Enzymatic debriders
  - Ag+ ion denatures

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**ANTIMICROBIALS**

- Ionic silver
- 3 pronged approach makes resistance less common

**ANTIMICROBIALS**

**Honey**
- *Leptospermum scoparium* tree
- *Echium vulgare* plant
- Osmotic effect
- Antioxidant affect
- Acidic mantel (low pH)
- May assist with microbial control
  - MRSA
  - VREs
  - Gram negatives
WOUND DEVICE

Negative Pressure Wound Therapy
- Sub-atmospheric pressure
- Contains effluent
- Increasing blood flow through reduction of interstitial edema
- Removal of inflammatory cytokines and management of exudate
  - Pressure ulcers
  - Diabetic foot ulcers
  - Arterial/venous insufficiency ulcers
  - Grafts and flaps

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IN SUMMARY

Wound Infection, Houston We Have a Problem
- Determining whether wounds are infected is often difficult
- Determine the accuracy of clinical symptoms and signs to diagnose infection
- Wound Bed Prep
- Advanced Wound Dressings

Questions
Answers
REFERENCES

Association for the Advancement of Wound Care (AAWC). Advancing your Practice: understanding wound infection and the role of biofilms. Malvern, PA. 2008.


REFERENCES


Contemporary Concepts in Wound Health, number 1, Sterile versus Nonsterile Wound Care...An interactive monograph for healthcare professionals, ©1998 Dumex Medical Surgical Products LTD.


REFERENCES


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REFERENCES

- Snyder RJ. Rationale for sequential use of topical wound products; preparing and closing the wound. Podiatry Mgmt. 2007;June/July:3-6.

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