

AMT Education Division

W28
WOUND INFECTION; HOUSTON WE
HAVE A PROBLEM
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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.

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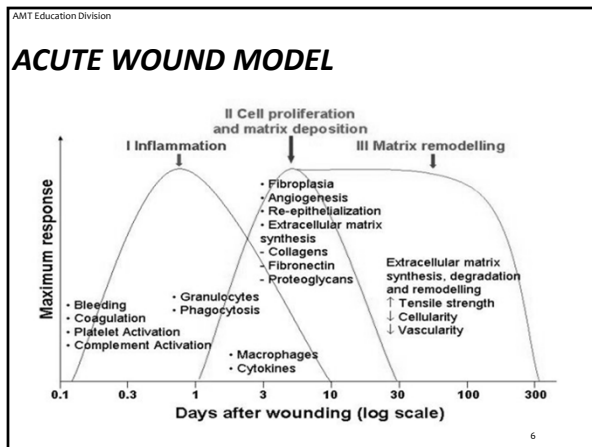


APOLLO 13

“Houston we’ve had a problem here”
Jack Swigert, April 13, 1970



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ACUTE TO CHRONIC WOUND MODEL

Microbial Flora

- Acute wound
 - S. aureus, and Beta-hemolytic Streptococcus
- 4 weeks
- Facultative anaerobic gram negative rods
- Chronic wound
 - Anaerobes
 - Coliforms (deep)
 - Polymicrobial
 - Aerobic and anaerobic organisms
 - Houston we have a problem

The flowchart shows 'Bacteria' at the top. Two arrows point down from 'Bacteria' to 'Exogenous proteinases (eg MMPs, elastase)' on the left and 'Inflammation (Endogenous (neutrophil) activity: MMPs, elastase, ROS)' on the right. Both of these lead to 'Introduce production of MMPs'. From 'Introduce production of MMPs', an arrow points down to 'Inhibit TIMPs'. This leads to 'Chronic Inflammation Proteinase imbalance'.

MMPs = Matrix metalloproteinases
TIMPs = Tissue inhibitors of metalloproteinases
ROS = Reactive oxygen species

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CHRONIC WOUND MODEL

Chronic Wounds

- Pro-inflammatory cytokines
- 200 - 300 times higher in chronic wounds
- Neutrophils - release MMP's in excess
- Digest extracellular matrix
- Fibronectin (elastase) bind and inactivate growth factors
- Diminished tissue inhibitors of metalloproteinases (TIMPs)
- Connective tissue is degraded
- Houston we have a problem

The top graph, labeled 'Normal MMP Levels', shows a bell-shaped curve that peaks around day 5 and returns to baseline by day 21. The bottom graph, labeled 'Chronic MMP Levels', shows a curve that rises to a peak by day 5 and then remains at a high, sustained level through day 21.

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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

The diagram shows a horizontal axis representing the 'Contamination - Infection Continuum'. From left to right, it is divided into four stages: 'Contamination', 'Colonized', 'Critical Colonization', and 'Infection'. Above the axis, 'Bacterial Burden' is indicated. Below the axis, 'Local' and 'Systemic' infection are marked. A double-headed arrow is shown below the 'Critical Colonization' and 'Infection' stages.

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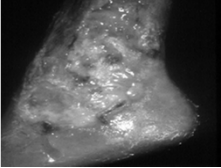
BIOBURDEN/INFECTION

→ Infection = $\frac{\text{Dose} \times \text{Virulence}}{\text{Host resistance}}$

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

→ Host resistance

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



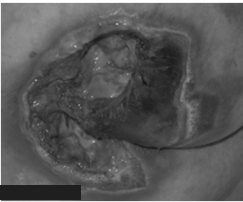
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BIOBURDEN/INFECTION

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




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BIOBURDEN/INFECTION

NERDS

- Nonhealing
 - Decrease in size 20 - 40% in 4 weeks and closed 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
 - Cause of odor




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BIOBURDEN/INFECTION

STONES

- ↪Size change
 - Deeper and surrounding tissue damage by bacteria
- ↪Temperature
 - >3°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



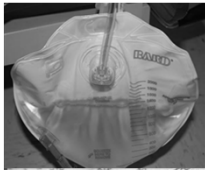
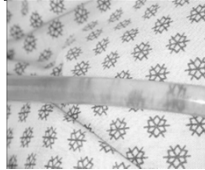
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BIOBURDEN/INFECTION

Systemic Effect

- ↪Bacterial vs. viral
- ↪Leukocytosis
- ↪Hyperthermia, chills, nausea, vomiting
- ↪Altered mental status: confusion
- ↪Elevated pulse
- ↪Multi-organ involvement
- ↪R/O (urosepsis, pneumonia, carcinoma, autoimmune disease)

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BIOBURDEN/INFECTION

Tissue Biopsy

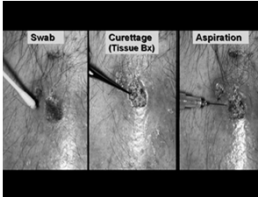
- ↪Qualitative analysis
 - ↪Determine the colony count/g of tissue

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



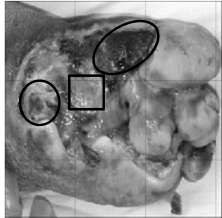
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BIOBURDEN/INFECTION

Culture Techniques

- Cleanse
- Debride
- Swab viable tissue
 - Planktonic bacteria
- Levine Technique
 - 1 cm² area
 - Extract fluid and tissue
- Aerobes and anaerobes



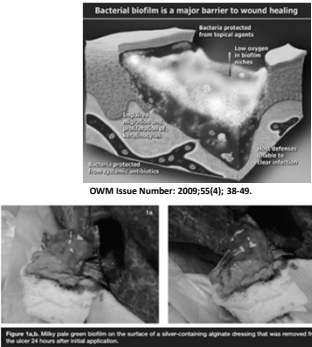
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BIOBURDEN/INFECTION

Biofilms

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




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BIOBURDEN/INFECTION

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




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BIOBURDEN/INFECTION

Cellulitis

- Inflammation of the interstitial tissue
- Warmth, swelling, tenderness, erythema, fever
- Rule of 2cm
- Mild, moderate, severe
- Group A streptococcus
- Treatment
- Systemic antibiotic for localized infection
- Hospitalization with IV antibiotics for spreading cellulites



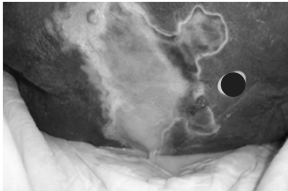
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BIOBURDEN/INFECTION

Abscess

- Involves the fascia tissue
- Treatment
- Incise and drain
- Debridement
- Tissue graft may be necessary
- Antibiotics therapy is variable




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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





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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

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ANTIMICROBIAL THERAPY

Common Antiseptic/Antimicrobial Agents

<ul style="list-style-type: none"> ➔ 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 	<ul style="list-style-type: none"> Hydrogen Peroxide (H₂O₂) -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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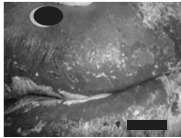
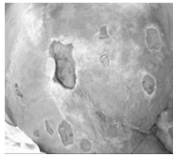
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MOISTURE ASSOCIATED SKIN DAMAGE

MASD

- ➔ Incontinence-associated dermatitis
- ➔ Intertriginous dermatitis
- ➔ Periwound moisture-associated dermatitis
- ➔ Peristomal moisture-associated dermatitis

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MOISTURE ASSOCIATED SKIN DAMAGE

Peristomal Skin

- Mechanical stress
- Moisture
- Increased bioburden and fungi

End Result

- MASD
- Dermatitis
- Folliculitis
- Infection




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MOISTURE ASSOCIATED SKIN DAMAGE

Maintain Skin Integrity

- Daily skin inspections
 - Compromised peripheral circulation
- Promote skin hygiene
 - Cleanse skin with saline and skin cleanser
 - Avoid alkaline agents which increase skin irritation
 - Maintain skin pH 4 - 6.8 to avoid bioburden build up and/or risk of infection
 - Use skin protectant or barrier
 - Do not massage or rub over bony prominences



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PAIN

Dressings

- Dried out/adherent
 - Irritate local nerve endings
 - Wet-to-dry (gauze)
 - Tissue in-growth into product matrix
 - Premature release - 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, alginates 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

Cleansing

- ➔ **Dressing change**
- ➔ **Non cytotoxic, non irritating cleanser**
 - Skin cleansers/wound cleansers
- ➔ **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



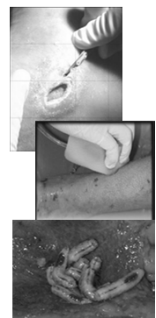
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WOUND BED PREPARATION

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**



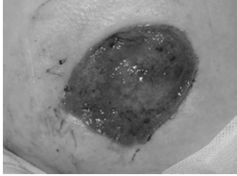
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WOUND BED PREPARATION

Moisture Balance

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




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WOUND BED PREPARATION

Bacterial Barrier

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



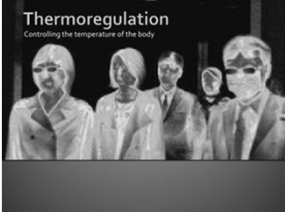
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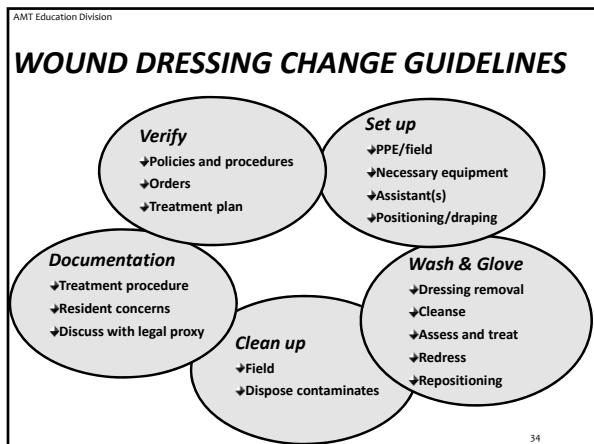
WOUND BED PREPARATION

Thermoregulation

- Circulation/sweating
- Limits the effects of tissue cooling
 - 6° cooler due to fluid evaporation
 - Rewarming the wound base
 - Vasoconstriction (decreased tissue oxygen tension)
- Hypothermia
 - Decreased neutrophil function
 - Decreased collagen deposition
 - Increased wound infection



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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

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CLEAN TECHNIQUE

Non-Sterile

- Hand washing

- Reduce the overall number of microorganism

- Maintaining a clean environment with a clean field
- Clean field & gloves
- Sterile instruments
- Prevent direct contamination of materials & supplies

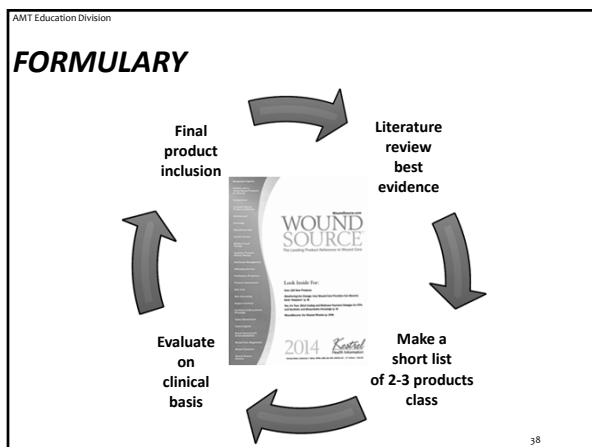
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Technique for the Management of Chronic Wounds

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

* "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.



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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

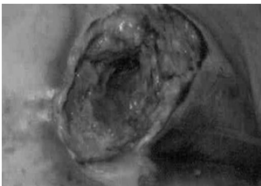
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FORMULARY

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 blockage of keratinocytes, fibroblasts and endothelial cells
- Loss of protein to the host, can damage the surrounding healthy skin
- Excellent culture medium for bacterial growth



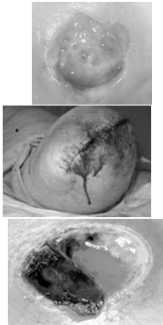
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FORMULARY

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



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STONE KNIVES, BEAR CLAWS AND GAUZE

Cost

Higher Infection Rate

Non Selective Debridement

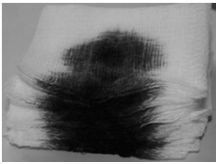
Labor Intensive

Painful

Moisture Evaporation

Decreased Tissue Temp

Aerosolization of Bacteria



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WOUND DRESSINGS

Transparent Film

- Polyurethane or copolymer
- Waterproof
- Vapor transmission
- Bacterial barrier
- Autolytic debridement
- Light exudate
- Difficult to apply
- Cause skin tears


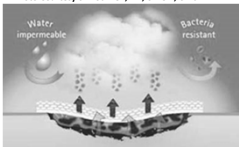


Photo Courtesy of Dot Weir, RN, CWON, CWS




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WOUND DRESSINGS

Hydrocolloid

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




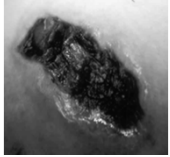
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WOUND DRESSINGS

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

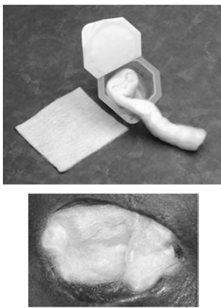
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WOUND DRESSINGS

Calcium Alginate

- ➔ Absorbent
- ➔ Biocompatible
- ➔ Atraumatic removal
- ➔ Autolytic debridement



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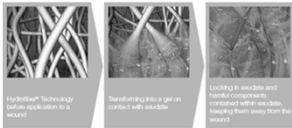
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WOUND DRESSINGS

Hydrofiber

- ➔ Alternative to calcium alginates
- ➔ Non-woven pad or ribbon
- ➔ Sodium carboxymethylcellulose
- ➔ 30% more absorbent

Hydrofiber® Technology at work



Courtesy of ConvaTec

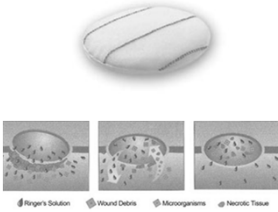
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WOUND DRESSINGS

Polyacrylate Dressings

- ➔ Polyacrylate core
- Affinity for protein molecules found in wound debris, necrotic tissue and micro-organisms
- ➔ 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



Courtesy MEDLINE Industries Inc.

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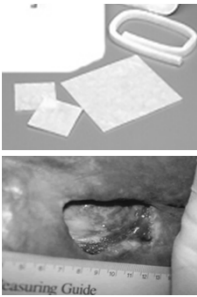
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WOUND DRESSINGS

Collagen

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

- Scarring



Measuring Guide

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WOUND DRESSINGS

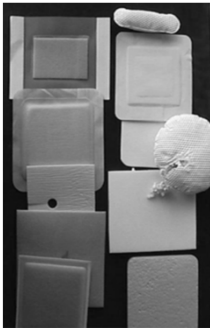
Foam

- Primary or secondary coverage

- Absorptive

- Oxygen permeable

- Partial and full thickness wound
- Infected or non-infected wounds
- Minimal trauma
- Facilitate autolytic debridement
- Not for use on dry eschar



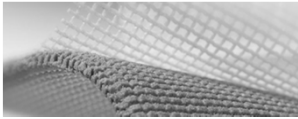
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ANTIMICROBIALS

Cadexomer Iodine

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



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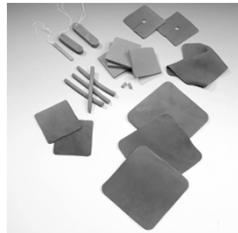
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ANTIMICROBIALS

Methylene Blue and Gentian Violet

- ➔ Polyvinyl alcohol sponge
- ➔ Bacteriostatic
- ➔ Open cell structure
- ➔ Trap and inhibit exudate and debris
- ➔ Absorb 12 x wt. in exudate
- ➔ Alter redox/oxidation potential of bacterial cell wall
- ➔ Not for use on 3rd degree burns



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ANTIMICROBIALS

Silver Misconceptions

- ➔ Silver dressings do not improve healing rates
- Silver reduces wound bioburden, treat localized 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

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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

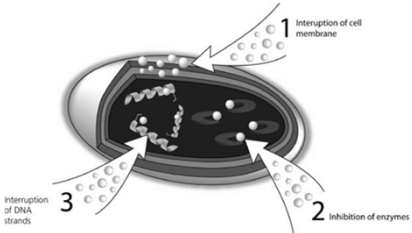


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ANTIMICROBIALS

- Ionic silver
- 3 pronged approach makes resistance less common



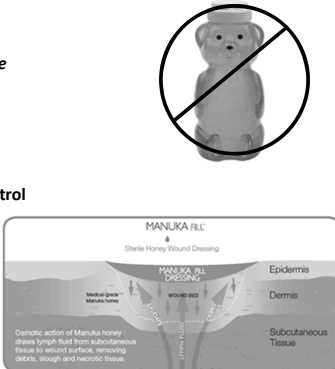
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ANTIMICROBIALS

Honey

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



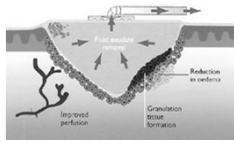
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WOUND DEVICE

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



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