UNDERSTANDING WOUNDS

- Differentiate between acute and chronic wounds
- Identify colonized vs. critically colonized wounds
- Determine best wound care based on wound type

NORMAL WOUND HEALING

- Hemostasis: Platelets, initial release of growth factors and fibrin
- Inflammation: Neutrophils, macrophages, Inflammatory cytokines
- Proliferation: Fibroblasts, granulation, Endothelial cells, angiogenesis
- Remodeling: MMPs and TIMPs, Fibroblasts

MMPs=matrix metalloproteinases; TIMPs=tissue inhibitor of metalloproteinases.
**PRIMARY ASSESSMENT OF TYPES OF WOUNDS**

- Identify the total etiology of wound
- Failure to do so will delay or prevent healing
- Pressure ulcer: See algorithm
- Neuropathic diabetic ulcers: Off-load
- Venous leg ulcers: Compress
- Diabetic Ulcer-Is there good blood flow to the toe?
- Arterial assessment of all wounds prior to debridement - correct hypoxia


**MANAGEMENT OF WOUNDS**

- Goal may not be complete restoration of defect, but may be getting the defect closed with the fastest method in order to gain the highest level of function in the shortest time while reducing the chance of recurrence
- Reconstruction now may be obtained using different tools during phases of wound healing using the team approach


**HISTORY OF MILITARY WOUND DEBRIDEMENT**

- WW1- Belgian Army surgeon Antoine DePage credited for full debridement of wounds to remove all contaminants and avoid gas gangrene.
- Carrell-Dakin Solution-Dr. Alexis Carrell (Major in French Army) & Henry Drysdale Dakin (English chemist) used rubber tubes interspersed in wounds infused with Dakin’s very messy on the bed!

LOCAL FACTORS AFFECTING WOUND HEALING

- Edema
- Perfusion
- Temperature
- Repetitive trauma
- Infection
- Presence of necrosis
- Callus
- Senescent cells
- Poor moisture balance
- Desiccation

SYSTEMIC FACTORS AFFECTING WOUND HEALING

Nutrition & Hydration
- Co-morbidities
- Diabetes
- PAD
- Inflammatory Diseases
- Anemia
- Hyper-hypotension
- COPD
- Incontinence
- CVA
- SCI
- Mental Status
- Radiation

PAD peripheral artery disease; SCI spinal cord injury; COPD chronic obstructive pulmonary disease; CVA cerebral vascular accident

HEALING WOUNDS

- Low levels of bacteria
- Low inflammatory cytokines
- Low proteases, ROR, RNA
- Intact functional matrix
- High mitogenic activity
- Mitotically competent cells

CHRONIC WOUNDS

- High levels of bacteria
- High inflammatory cytokines
- High proteases, ROS, RNA
- Degraded nonfunctional matrix
- Low mitogenic activity
- Senescent cells

ROS reactive oxygen species; RNA reactive nitrogen species

CONSIDERING ADVANCED WOUND CARE?

- Large prospective multicenter trial of diabetic patients with foot ulcers predicting the ability to heal
- Ability of 4-week healing rate assessed to see whether complete healing would take place
- Results of study including 203 patients: “Patients in whom ulcer size fails to reduce by half over the first four weeks of treatment are unlikely to achieve wound healing over a reasonable period”


BALANCING BACTERIA BIO BURDEN

- All wounds are colonized with microorganisms
- Granulation tissue pink
- Growth normal
- Exudate normal, serosanguineous
- Presence of bacteria high
- Bacteria compete with healthy tissue cells for oxygen and nutrients and produce toxins
- Increase inflammatory cytokines
- Swelling, pain, odor, erythema, increased exudate
Biofilms vs. Slough

**Slough:**
- Viscous yellow layer on wound bed
- Appears opaque may indicate biofilm

**Biofilms:**
- Complex microbial community of fungi & bacteria
- Synthesized & secrete protective slimy matrix
- Continuously changing and biofilm emits protective layer
- 60% of chronic wounds have biofilm structures

REDUCTION OF BIOFILM RECONSTRUCTION

- Wound cleansing products
- Polyhexamethylene biguanide polyhexanide (PHMB) –Prontosan surfactant properties aid in removal of debris and disturb biofilm
- Topical broad spectrum antibiotic
  - Silver
  - Iodine
  - Honey
  - PHMB


IDENTIFYING INFECTED WOUNDS

- N- Non-healing
- E- Exudate increasing
- R- Red friable tissue
- D- Debris
- S- Smell

Superficial critical colonization, if any three of NERDS are present treat topically. Consider fungal vs. bacterial infection.

SIGNS OF DEEP INFECTION

- **S-** Size of wound increased
- **T-** Temperature of surrounding tissue increased
- **O-** Osteomyelitis- probe to bone
- **N-** New areas of breakdown
- **E-** Exudate increased
- **E-** Erythema, Edema
- **S-** Smell

**DEBRIDEMENT & CONTROL OF BIOBURDEN**

- Debridement quickly removes bioburden
- Topical Antiseptics: Ag, betadine, hypochlorous acid, hydrogen peroxide, Dakin’s, povidine iodine, honey
- Topical Antibiotics: mupirocin, bacitracin, gentamycin
- Negative pressure wound therapy (NPWT)

**Autolytic vs. Enzymatic Debridement**

- Medihoney-Active Leptospermum Honey (ALH) aids in autolysis with moisture balance
- High osmolarity-sugar content helps deliver lymph fluid to wound increasing plasminogen
- Low pH reduces protease activity and reduce slough
- Cost less than 3.00

- Santyl-sterile enzymatic debridement agent from Clostridium histolyticum
- Digests collagen in chronic wounds/burns
- Optimal pH 6-8
- Cleansing with saline or Dakin’s
- Cost -200.00 per tube
- Co-pay assistance
**MEDIHONEY STUDIES**

- Claim to accelerate wound healing
- 25 RCTs & quasi-RCTs with total 2987 participants
- Acute-three trials on lacerations, abrasions, minor surgical wounds
- 12 trials on burns-show it may shorten time on some burns
- Results-insufficient evidence & uncertainty in replication & applicability of evidence
- Bias-some studies funded by competing company


**NEW THERAPIES WITH NEGATIVE PRESSURE**

- Instill
- Incision
- Prevena
- Continue to explore other companies with negative pressure wound therapy (NPWT) products
- Continue with KCI due to reliability of product

**WOUND BED PREPARATION-VAC THERAPIES**

- Debride the wound bed
- Advanced wound care with NPWT
  - New instill therapy
  - Technology allows liquid to be instilled into wound bed cleansing wound while using NPWT
- Reconstruct wound- bolster with NPWT
  - Biologics
  - Living cell
  - STSG/flap
PRODUCT OVERVIEW

New dressings have been designed for use with V.A.C. VeraFlo™ Therapy (V.A.C. VeraFlo™ and V.A.C. VeraFlo Cleanse™ Dressings).

Although similar to the V.A.C.® GranuFoam™ Dressing in composition (reticulated polyurethane foam), the V.A.C. VeraFlo™ Dressings are more hydrophilic for greater wetting of the foam during instillation; they also have greater tensile strength for use with solutions.

INSTILL THERAPY WITH NPWT

- Obtain culture-quantify bacteria
- Debride
- Irrigate
- Apply NPWT in O.R. with instill therapy
- Change dressing 3 times week instilling 10 minute soaks using Vashe, saline, or Dakin’s followed by 50 minute NPWT
- New studies have shown- 10 minute soak with 3.5 hours NPWT
- Reduce need to take back to OR for washout
An economic model was created to assess independently the potential cost savings of V.A.C. VeraFlo™ Therapy with instillation of silver nitrate solution when used on patients with infected wounds.

The model uses clinical outcomes reported in Gabriel’s two studies (2006, 2008). The model compares the costs of V.A.C. GranuFoam Silver® Dressings, and Moist Wound Therapy (MWT) with V.A.C. GranuFoam Silver® Dressings, and VeraFlo™ Therapy with instillation of silver nitrate, Negative Pressure Wound Therapy (NPWT) with silver nitrate, and Negative Pressure Wound Therapy (NPWT) with V.A.C. GranuFoam Silver® Dressings and VeraFlo™ Therapy with instillation of silver nitrate solution.

**Potential Cost Effectiveness of V.A.C. VeraFlo™ Therapy**

<table>
<thead>
<tr>
<th>Category</th>
<th>Average</th>
<th>Daily</th>
<th>Category</th>
<th>Average</th>
<th>Daily</th>
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**Prospective Case Study**

**Gabriel (2008) Background**

- **Patient Group:** Fifteen-patient, prospective case study of infected wounds treated with NPWT
- **Method:** Therapy was applied using:
  - V.A.C.® GranuFoam™ Dressings
  - V.A.C.® Instil™ Therapy Unit
  - Instillation of silver nitrate solution which consisted of repeated cycles of holding the silver nitrate solution in the wound for 30-45 seconds, followed by 2 hours of NPWT without instillation
- **Control Group:** Fifteen-patient, retrospective control group; treated similar infected wounds with moist wound therapy (MWT; wet-to-moist gauze)

*V.A.C. Instil™ Therapy Unit provides instillation therapy that is functionally equivalent to V.A.C. VeraFlo™ instillation therapy.*
**GABRIEL (2006, 2008) SUMMARY OF OUTCOMES**

<table>
<thead>
<tr>
<th>Clinical Outcome</th>
<th>NPWTi w/Silver Nitrate and GranuFoam™</th>
<th>NPWT w/GranuFoam Silver</th>
<th>MWT (Gabriel 2008, n=15, p&lt;0.001)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Days to Clear Infection</td>
<td>6.0</td>
<td>7.5</td>
<td>25.9</td>
</tr>
<tr>
<td>Average Days to Hospital Discharge</td>
<td>14.7</td>
<td>17.8</td>
<td>39.2</td>
</tr>
<tr>
<td>Average Treatment Duration</td>
<td>9.9</td>
<td>14.5</td>
<td>36.5</td>
</tr>
</tbody>
</table>

**INCISION TREATMENT AFTER VASCULAR SURGERY**

- Obesity
- Difficult to dress areas- groin
- Bolster wound after closure to reduce tension on incision
- Reduce edema
- Less risk of surgical site infection (SSI)
- Earlier hospital discharge with safe treatment
Matatov, et al. did study of 90 patients with 115 groin incisions after longitudinal or transverse femoral cutdown.
Prevena applied intra-operatively for 5-7 days.
52 incisions in 41 patients with Prevena with 3 (6%) Szilagyi grade I wound infection
Comparable non-Prevena 63 groin incisions in 49 patients 19 (30%) 10; grade I, 7 grade II & 2; grade III;

TOPICAL ANTIMICROBIALS-WHY?
- Inclusion to prevent critical colonization
- Aid in reduction of odor in chronic wounds
- If more than four bacteria identified wound healing impeded with bioburden
- Remove pseudomonas, staph and strep prior to closing with biologic of graft
- Early debridement

DAKIN’S SOLUTION BEFORE DEBRIDEMENT
PORCINE GRAFT

- OASIS® Wound Matrix is an intact matrix naturally derived from porcine small intestinal submucosa (SIS), indicated for the management of wounds.
- OASIS® Wound Matrix is indicated for the management of partial- and full-thickness wounds, draining wounds, and surgical wounds (donor sites/grafts, post-Mohs' surgery, post-laser surgery, podiatric, and wound dehiscence).

PORCINE GRAFT

- A 3-dimensional, bioresorbable extracellular matrix (ECM), OASIS® Wound Matrix is incorporated and absorbed into the wound.
- In a healthy body, the ECM is the structural component that surrounds cells and binds them in tissue.
- Incorporates into tissue.
- Remains on for 7 days.
VAC WITH OASIS GRAFT AFTER AMPUTATION

NECROTIC WOUND-STAGE IV

UNSTAGEABLE PRESSURE ULCER

Note the eschar with thick, hard, pressure ulcer. Careful fiber, MR, and ulna- no region avoiding a biopsy, unincorporated eschar on the head of the foot where the foot area has performed a vascular assessment.
OCCLUSIVE DRESSINGS

- Aquacel Ag surgical cover dressing (SCD) retrospective study of 903 patients using SCD applied in OR and remaining in place for 5 days
- Results - incidence of acute post-op joint infection (PJI) 0.4% (4/903)
- Control group standard dressing of sterile gauze secured with adhesive tape incidence of PJI 1.7% (15/875)

<table>
<thead>
<tr>
<th>Dressing Type</th>
<th>Incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard gauze dressing</td>
<td>1.71%</td>
</tr>
<tr>
<td>Aquacel Ag Hydrofiber dressing</td>
<td>0.44%</td>
</tr>
</tbody>
</table>

VASHE: Safety and Biocompatibility

- Non-irritating, non-sensitizing, non-mutagenic, non-cytotoxic, and shows no oral toxicity
- Safe for eyes, ears, and nose
- Tissue-friendly: pH-controlled so it is not cytotoxic and won’t sting or burn

<table>
<thead>
<tr>
<th>Safety Test</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin Irritation</td>
<td>No dermal irritation</td>
</tr>
<tr>
<td>Skin Sensitization</td>
<td>No skin sensitization</td>
</tr>
<tr>
<td>Primary Dermal Irritation</td>
<td>No dermal irritation</td>
</tr>
<tr>
<td>Acute Toxicity</td>
<td>No oral toxicity</td>
</tr>
<tr>
<td>Cell-Based Assay</td>
<td>Non-mutagenic</td>
</tr>
<tr>
<td>Cytotoxicity</td>
<td>Biocompatible with fibroblasts and keratinocytes</td>
</tr>
</tbody>
</table>
Mimicking the Human Body

WOUND CARE

- New rules for debridement and use of dressings in the new system means the wound care must include knowledge of the healing ability of the patient.
- Wound healing is a team effort.
- The patient is the center of the team.
- Expensive modalities may be used in order to close the wound and avoid re-hospitalization forSSI.
- Thank you!