Considerations For Adding Alternative/Adjunctive Modalities to Facilitate Wound Healing

- Reduction in wound area 10-15%/week represents normal healing
- This rate of healing does not mandate a change in current wound healing strategy
- Consider alternative/adjunctive modalities if this level not met “consistently” on weekly basis

Indications for Exogenous Energies

- Debridement
- Decrease Bioburden
- Biofilm Disruption
- Facilitate Stalled Healing Processes
- Increased Blood Flow
- Edema Reduction

Electromagnetic Spectrum
- Electrical Stimulation
- Diathermy
- Ultraviolet
- Infrared

Mechanical & Acoustic
- Whirlpool (Rare Indications)
- MHz Ultrasound
- kHz Ultrasound

Positive Pressure
- Intermittent Pneumatic Compression
- Topical Hyperbaric Oxygen
- Hyperbaric Oxygen

Positive & Negative Pressure
- Pulsed Lavage w Suction
- NPWT

Electrical Stimulation (ES)

- One of the most cost effective, therapeutically efficacious modalities
- Used for more than 3 decades to accelerate the rate of chronic wound healing
- Strength of evidence rating for this modality was increased from Level B to Level A in 1999
- Reimbursement from CMS when documentation reflects wounds meets “chronic” definition


Pressure Ulcer Prevention and Treatment Following Spinal Cord Injury

- Published by the Paralyzed Veterans of America
- States electrical stimulation qualifies as a stand-alone intervention and no longer classifies it as an adjunctive therapy

(Clinical Practice Guideline: Pressure Ulcer Prevention and Treatment Following Spinal Cord Injury. Paralyzed Veterans of America, Washington, DC)
NPUAP Statement

• Consider the use of direct contact electrical stimulation (ES) in the management of recalcitrant Stage II as well as Stage III and IV pressure ulcers to facilitate wound healing

• Strength of Evidence (A)

Electrical Stimulation in Wound Healing

• Electrical current transfers energy to wound via electrodes to skin

• Evidence supports delivery of electrical current into wound tissue enhances wound healing

• Theory: How ES works
  • Related to “current of injury”

• ES mimics this “current of injury” to accelerate/“jump start” wound healing cascade

Courtesy Luther Kloth, PT, MS, CWS
**Cellular Processes & Physiological Responses**

- ↑ blood perfusion (FDA main label indication for treating wounds)
  - Cutaneous (microcirculatory)
  - Periwound
  - Arterial
- Stimulation of fibroblasts to enhance collagen & DNA synthesis
- ↑ number of receptor sites for growth factor interface
- ↑ migration and proliferation of cells at wound site
  - Neutrophils
  - Macrophage
  - Fibroblasts

**Cellular Processes & Physiological Responses-Con’t.**

- ↑ collagen deposition
- ↓ edema
- ↓ wound pain
- ↓ peripheral neuropathy pain
- Bactericidal effects
E-Stim Currents

- Electrical current may be delivered as:
  - Low-intensity direct current (LIDC)
  - High-voltage pulsed current (HVPC)
  - Transcutaneous electrical nerve stimulation (TENS)

- High voltage pulsed current (HVPG) - current used most often for wound treatments in last decade

Applications for Tissue Repair

- Exogenous (externally applied) electric currents that are delivered to the wound tissues via at least 2 electrodes which are placed:
  - Directly into the wound
  - Around the wound (periwound tissue)
  - By using a stocking or glove electrode garment to the affected limb.

Courtesy: Luther Kloth
Bioelectric Antimicrobial Wound Dressing

• Sustained electrical micro current
• Stimulates physiologic current of injury
• Induce, enhance, accelerate wound healing

Indications for ES

• Pressure ulcers
• Venous insufficiency ulcers
• Arterial ulcers
• Diabetic neuropathic ulcers
• Burns
• Dehisced surgical wounds
67 y/o with pressure ulcer, DM & PAD
Amputation L toes

**ABI=.51**

Treatment
- Debridement
- ES delivered stocking electrodes
- PDGF
- Infrared light

**NOTE**

- Electrical stimulation can be a first line or adjunct treatment and **should be used in combination with other moist wound therapy interventions**
What is Diathermy?

- Use of electromagnetic energy to produce heat within tissues
- Heats tissue 3-5 cm below surface of skin without overheating skin or subcutaneous tissues
- Treatment applied with specialized machine using coils that direct electromagnetic energy into tissue

Indications for Use of Diathermy

- Decreased joint ROM
- Accelerating healing
- Pain control
- Edema control
- Bone and nerve healing
Rationale for Use of Diathermy

<table>
<thead>
<tr>
<th>Thermal Effects</th>
<th>Non-thermal Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>– Current flows through treatment area</td>
<td>– Results from same electrical current as thermal effects</td>
</tr>
<tr>
<td>– Able to produce deep heat to tissues</td>
<td>– Low intensity and pulsed duration</td>
</tr>
<tr>
<td></td>
<td>• Does not allow heating of tissue</td>
</tr>
<tr>
<td></td>
<td>• Does increase blood flow to area</td>
</tr>
<tr>
<td></td>
<td>• Increased oxygen and nutrient availability</td>
</tr>
<tr>
<td></td>
<td>• Increases cell growth &amp; division</td>
</tr>
</tbody>
</table>

Non-Thermal Effects for Wound Healing (Pulsed Short Wave Diathermy)

- Increased cutaneous circulation
- Decreased inflammation
- Edema reduction
- Lymphedema reduction
- Accelerated wound healing
- Treatment wound related pain
- Decreased hematoma formation

Drum with cover off
Electrode Variations

- Air Space Electrodes
- Pad Electrodes
- Drum Electrode

Photo-therapy
- Laser
- Infrared
- UV Light
Infrared Light

Ultraviolet A, B, C Light

Photobiomodulation- Light Therapy

• A term that describes the regulating effects of light energy upon cellular components
• Photo energy is converted to chemical energy for a biological effect

photosynthesis
Low Level Laser Therapy

- Low level laser therapy or, low intensity laser therapy (LLLT or LILT)
- AKA:
  - Cold laser therapy
  - Photobiomodulation
  - Monochromatic infrared light therapy

Light Emitting Diodes
Outcomes of LLLT

• A summary of research and case studies revealed that irradiation with LLLT:
  1. Reduces pain and inflammation
  2. Turns on synthesis and repair of DNA & RNA
  3. Expands collagen production
  4. Proliferates nerve growth and sprouting

• Continued

Outcomes (Continued)

5. Facilitates neo-vascularization – granulation tissue formation
6. Releases/discharges lymphatic congestion
7. Induces a host of enzymatic reactions
8. Enhances the immune system
9. Diminishes scar tissue and adhesions formation
10. Increases ATP productions and more
Light Emitting Diodes Treatment
Ultraviolet (UV) Light Therapy

UV Light Properties

• Component to sunlight that encompasses wavelengths between 180 & 400 nanometers

• 3 spectral bands
  – UVA – produces most of the tanning effects
  – UVB – produces skin erythema, blistering and considered more carcinogenic
  – UVC – ionizing, bactericidal, virucidal

• UVC
  – bactericidal effects
  – Wound healing stimulation due to an aseptic inflammatory response in tissues
Ultraviolet Light

- UV light studies began for positive effects on wound healing in 1940s
- Pressure and venous ulcers treated with UV had enhanced healing rates
- Beneficial effects for producing a mild inflammatory response to help accelerate wound healing


UVC

- Adjunctive therapy for reducing and eliminating bacterial bioburden
- Consider as method for treating surface bioburden where conventional methods have failed
- Effective and safe for:
  - Combating a developing surface infection
  - Use with infected wounds where poor circulation reduces effectiveness of systemic antibiotics
  - Replacement for topical antibiotics
  - Treating antibiotic resistant species such as MRSA
UVC

- Beneficial effects for producing a mild inflammatory response to help accelerate wound healing
- UVC light therapy compatible with any concurrently administered systemic antibiotics
- Treatment is consistent with wound care best practice guidelines

Bactericidal Effects of UVC Light

<table>
<thead>
<tr>
<th>Bacteria</th>
<th>Exposure time to kill 99.9%</th>
<th>Exposure time to kill 100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>S. Aureus</td>
<td>5 seconds</td>
<td>45 seconds</td>
</tr>
<tr>
<td>MRSA</td>
<td>5 seconds</td>
<td>90 seconds</td>
</tr>
<tr>
<td>S. Pyogenes (group A strep)</td>
<td>4 seconds</td>
<td>Not eradicated with 180 second exposure</td>
</tr>
<tr>
<td>VRE</td>
<td>5 seconds</td>
<td>45 seconds</td>
</tr>
</tbody>
</table>

Mechanical & Acoustic

• Whirlpool
• Ultrasound
  – High frequency ultrasound=1-4 MHz
  – Low frequency ultrasound=20-120 kHz

Ultrasound in Wound Healing

• Ultrasound is a mechanical vibration of sound waves above the upper limit of human hearing
• Causes tissue molecules to oscillate or vibrate
• US has been used in wound care for over 50 years
### Traditional Ultrasound

- The physiological effects include:
  - ↑ mast cell degranulation
  - ↑ vascular permeability
  - ↑ release of mitogenic growth factors
  - ↑ migration of macrophages and fibroblasts
  - ↑ capillary density
  - ↑ calcium up-take in fibroblasts
  - ↑ collagen synthesis
  - ↑ tensile strength and elasticity of collagen

- Treatment is provided 3-5x/week, 1 minute for each cm² of treatment area, not to exceed 15 minutes.
Indications for LFU

- Locally infected wounds
- Wounds with impaired circulation
- Wounds with the need for debridement, irrigation, and topical treatment
- Pressure, diabetic, arterial and venous ulcers, post traumatic and surgical

Bacterial Killing by Low-Frequency Ultrasound

E. coli controls

E. coli insonified 60s at 100%
Staph. aureus - NLFU Treatment

After 2.5 minutes – 40k Magnification


Low Frequency (kHz) Ultrasound
FDA 510k Indications / Labels

<table>
<thead>
<tr>
<th>SonicOne™ Misonix, Inc.</th>
<th>Sonoca 180™ Soring, Inc.</th>
<th>Qoustic Wound Therapy System™ Arobella Medical</th>
<th>MIST™ Celleration® Inc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wound Debridement</td>
<td>Selective dissection and fragmentation of tissue at the operation site</td>
<td>Selective dissection &amp; fragmentation of tissues, wound debridement &amp; cleansing of the site for removal of debris, exudates, fragments and other matter through the use of ultrasonic energy and/or fluid irrigation.</td>
<td>Promotes wound healing through: cleansing and maintenance debridement by removal of slough, fibrin, tissue exudates &amp; bacteria</td>
</tr>
<tr>
<td>Surgical fragmentation</td>
<td>25.0 kHz</td>
<td>35.0 kHz</td>
<td>40.0 kHz</td>
</tr>
<tr>
<td>and aspiration of soft and hard tissues.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22.5 kHz</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Intermittent Pneumatic Compression

Sequential Compression Pumps Uses in Wound Care

- Compression mainstay of management for CVI and ulceration
- May also be used in lymphedema
Venous Insufficiency and Lymphedema Treatment

Pulsatile Lavage with Suction
Pulsed Lavage With Suction (PLWS)

- Initially used by surgeons in OR
  - Irrigation in surgical procedures
  - Cleanse wounds of debris
- Adopted physical therapists using low PSI in late 1980’s
  - Irrigation and debridement to cleanse and enhance healing of soft tissue wounds

PLWS

- Theory and Science of Therapy
  - Cleansing via gentle pulsatile lavage to stronger irrigation and debridement
  - Reduces bacteria and infection
  - Promotes angiogenesis - granulation and epithelialization
  - Theory: negative pressure of suction stimulates cells and granulation

BURN – OUT PATIENT

Pulsatile Lavage with Suction

• Eliminated need for whirlpools except in limited circumstances
• NOTE: WP contraindicated for CVI and DFUs

Courtesy: Dr. Harriett Loehne
Negative Pressure Wound Therapy

Negative Pressure Wound Therapy (NPWT)

• Common Definition:
The controlled application of subatmospheric pressure to a wound to intermittently or continuously convey pressure through connecting tubing to a specialized wound dressing to promote healing\(^1\)
Proposed Mechanism of Action

- Provide moist wound environment
- Edema reduction
- Increase in perfusion
- Decreased bioburden
- Microdeformations: stimulation of granulation tissue formation
- Removal of wound exudate
  - Decrease in bacterial colonization
- Enhanced epithelial migration


Negative Pressure Devices
What Do You Need the Energy to Do?

- Debride
  - Contact LFU
  - Non-contact LFU
  - Decrease Bioburden & Chronic Inflammation
    - ES
    - PLWS
    - LFU
    - Photo Therapy
    - NPWT
  - Decrease Edema
    - Compression
    - NPWT
  - Facilitate Stalled Wound Healing Processes
    - ES
    - LFU
    - Diathermy
    - Photo Therapy
    - NPWT
    - PLWS

Who Should Apply These Energies

- Should be directed by and under the supervision/management of a skilled licensed professional educated and trained in safe and effective selection, application, and monitoring methods
E-Stim References
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Ultraviolet Light Therapy References

- Sheffield, P, Smith A, Fife, C. Wound Care Practice, Chapter 32, Physical Therapeutic Modalities in Wound Healing, pp 607-630

Ultrasound References

- Morison MJ, Ovington LG, Wilkie K; Chronic Wound Care: A Problem-Based Learning Approach; By Mary Dyson, pp 129-141, Mosby, 2004
### NPWT References


#### Thank You