ELECTRICAL STIMULATION

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Note: This paper on electrical stimulation for wound healing has been excerpted from: Chapter 16, Sussman, C and Byl, N, Electrical Stimulation for Wound Healing, Wound Care Collaborative Practice Manual for Physical Therapists and Nurses, Sussman, C. And Bates-Jensen, BM, Aspen Publishers 1998.

DEFINITIONS:

Electrical stimulation is defined as the use of an electrical current to transfer energy to a wound. The type of electricity that is transferred is controlled by the electrical source. (AHCPR 94). Capacitatively coupled electrical stimulation involves the transfer of electric current through an applied surface electrode pad that is in wet (electrolytic) contact (capacitatively coupled) with the external skin surface and /or wound bed. When capacitatively coupled electrical stimulation is used, two electrodes are required to complete the electric circuit. Electrodes are usually placed over wet conductive medium, in the wound bed and on the skin a distance away from the wound.

When discussing electrical stimulation, it is important to distinguish the waveform used for the protocol. Although there are many waveforms available on electrotherapy equipment, the one that has the most thorough and consistent evaluation in vitro, in animal studies and in controlled clinical trials is monophasic twin peaked high voltage pulsed current (HVPC).The pulse width varies with a range from 20-200 microseconds. The HVPC devices also allow for selection of polarity and variation in pulse rates both of which seem to be important in wound healing. It is a very safe current because it's very short pulse duration prevents significant changes in both tissue pH and temperature. Therefore, the most tested and safe type of stimulation is the one recommended.

Other types of waveforms and have been tested in clinical trials but will not be discussed here due to limited space. They are discussed in the full chapter.

THEORY AND SCIENCE OF THE THERAPY

Acceptance of electrical stimulation for wound healing by the medical community has been a long and complex task. In 1994, the Agency for Health Care Policy and Research (AHCPR) panel issued Treatment of Pressure Ulcers, Clinical Practice Guideline, Number 15. The panel of pressure ulcer care experts used an explicit science-based methodology and expert clinical judgment to develop statements regarding pressure ulcer treatment. Extensive literature searches, critical review and synthesis were used followed by peer and field review to evaluate the validity, reliability and utility of the guideline in clinical practice. AHCPR panel issued a statement about use of electrical stimulation as an adjunctive therapy for pressure ulcers: “Consider a course of treatment with electrotherapy for Stage III and IV pressure ulcers that have proved unresponsive to conventional therapy. Electrical stimulation may also be useful for

recalcitrant Stage II ulcers. Strength of Evidence = B." The panel found that data from 5 clinical trials involving 147 patients to support the effectiveness of this therapy for pressure ulcers.

(Note: The complete chapter contains a review of some of the significant areas and observations of research used to develop protocols and support treatment of non-conforming wound healing with electrical stimulation. This an excerpt of that section.)

Bioelectric System

The body has its own bioelectric system. This system influences wound healing by attracting the cells of repair, changing cell membrane permeability ,enhancing cellular secretion through cell membranes and orientating cell structures. A current termed the "current of injury" is generated between the skin and inner tissues when there is a break in the skin. The current will continue until the skin defect is repaired. Healing of the injured tissue is arrested or will be incomplete if these currents no longer flow while the wound is open. A moist wound environment is required for the bioelectric system to function. A rationale for applying electrical stimulation is that it mimics the natural current of injury and will jump start or accelerate the wound healing process.

Research Wisdom:

Keeping a wound moist with normal (0.9%) saline (sodium chloride) maintains the optimal bioelectric charge because it is like the electrolytic concentration of wound fluid. Dressings such as amorphous hydrogels and occlusive dressings help promote the body's "current of injury" by keeping the wound moist.

Research Wisdom: Moist wounds promote the "current of injury "

Debridement and Thrombosis

Debridement is helped if the tissue is solubilized such as with enzymatic debriding agents. ES using negative current has been shown to solubilize clotted blood. Necrotic tissue is made up of coalesced blood elements. The negative pole has been used to begin treatment in all controlled clinical studies and most of the wounds have necrotic tissue. This research would lend support to that part of protocol. The positive electrode has been found to induce clumping of leukocytes and forming of thrombosis in the small vassals this was reversed with the negative electrode. (Gentzkow 91) This may explain a clinical observation that hematoma or hemorrhaging at the wound margin or on granulation tissue are dissolved and reabsorbed following application of HVPC with the negative pole. Hemorrhagic material goes on to necrosis if not dissolved and reabsorbed quickly.

Clinical Wisdom:

Clinical experience has repeatedly shown that treatment with the inflammation protocol, using negative polarity, promotes rapid absorption of hemorrhagic material, usually within 48 hours. (Sussman)

Clinical Wisdom: Absorption of Hemorrhagic Material

Clinical Wound Healing Studies

Early studies using direct current stimulation reported long treatment times of 20-40 hours per weeks. Four controlled clinical studies and three uncontrolled studies with HVPC report a mean healing time of 9.5 weeks with 45-60 minute treatment 5-7x/wk.

Summary of Scientific Rationale for Application

Electrical stimulation affects the biological phases of wound healing in the following ways:
Inflammation phase

- Initiates the wound repair process by its effect on the current of injury
- Increases blood flow
- Promotes phagocytosis
- Enhances tissue oxygenation
- Reduces edema perhaps from reduced microvascular leakage
- Attracts and stimulates fibroblasts and epithelial cells
- Stimulates DNA synthesis
- Controls infection (Note: HVPC proven bacteriocidal at higher intensities than use in clinic and may not be tolerated by patient)
- Solubilizes blood products including necrotic tissue

Proliferation phase

- Stimulates fibroblasts and epithelial cells
- Stimulates DNA and protein synthesis
- Increases ATP generation
- Improves membrane transport
- Produces better collagen matrix organization,
- Stimulates wound contraction

Epithelialization phase

- Stimulates epidermal cell reproduction and migration
- Produces a smoother, thinner scar

INDICATIONS FOR THE THERAPY

Use and application of the modality is not pathology dependent.

Types of wounds for which there is indication to use HVPC include:

- Pressure Ulcers Stage I through IV
- Diabetic ulcers due to pressure, insensitivity and dysvascularity
- Venous Ulcers
- Traumatic Wounds
- Surgical Wounds
- Ischemic Ulcers
- Vasculitic Ulcers
- Donor Sites
- Wound Flaps
- Burn wounds

PROCEDURE

The protocols change as the wound healing phase changes. Assessment and diagnosis of the wound healing phase determines the treatment protocol. The set up and protocols used by Sussman are the same regardless of wound pathogenesis.

Research Wisdom:

Research compared direct application of HVPC to the wound, using the whirlpool to conduct the current and whirlpool alone. Application of HVPC directly to the wound had best outcomes. Safety is also a concern because electrical leads can become tangled in the turbine of the whirlpool and HVPC stimulators have been known to fall into the water.

Research Wisdom - Best method for effective and safe HVPC treatment

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Protocol for treatment:

Wound Healing Phase Diagnosis: **Inflammation phase**

Expected outcomes:

- Wound progresses to the Proliferation phase

Change in Wound Healing Phase Diagnosis: **Proliferation phase**

Stimulator settings:

- Polarity - negative
- Pulse rate - 100 - 128 pps
- Intensity - 100-150 volts
- Duration - 60 minutes
- Frequency 5-7 x per week, once daily

Wound Healing Phase Diagnosis: **Proliferation phase**

Expected Outcomes:

- Wound progresses to Contraction and Epithelization phase.

Change in Wound Healing Phase Diagnosis: **Epithelialization phase**

Stimulator settings:

- Polarity - alternate every three days ie 3 days negative followed by 3 days positive
- Pulse rate - 64 PPS
- Intensity - 100-150 volts
- Duration - 60 minutes
- Frequency 5-7 x per week, once daily

Wound Healing Phase Diagnosis: **Epithelialization phase**

Expected Outcomes:

- Wound progresses to Remodeling phase

Change in Wound Healing Phase Diagnosis: **Remodeling**

Research Wisdom:

A saline based amorphous hydrogel, which has the ability to conduct electric current has been tested and the conductivity is comparable to saline. Whether the healing of the wound is improved when this product is used for conducting current and then left in the wound has not been tested. In the meantime, such a product may have the added advantage of being used as the wound dressing to keep the wound moist after the electrical stimulation treatment is completed.

Research Wisdom: Use of Amorphous Hydrogel for Conduction

Setting Up the Patient

1. Have supplies ready before undressing the wound.
2. Position patient for ease of access by staff and comfort of both.
3. Remove the dressing and place in an infectious waste bag.
4. Cleanse wound thoroughly to remove slough, exudate and any petrolatum products
5. Sharp debride necrotic tissue, if required, before HVPC treatment
6. Open gauze pads and fluff, then soak in normal saline solution, squeeze out excess liquid. An alternative is to use an amorphous hydrogel impregnated gauze. Hydrogel sheets can also be used to conduct current under the electrodes
7. Fill the wound cavity with gauze including any undermined/tunneled spaces. Pack gently.
8. Place an electrode over the gauze packing cover with dry gauze pad and hold in place with bandage tape.
9. Connect an alligator clip to the foil.
10. Connect to stimulator lead
11. Dispersive electrode placement:

- Usually placed proximal to the wound
- Place over soft tissues, avoid bony prominences
- Place a washcloth, wetted with water and wrung out, under the dispersive electrode
- Place against skin and hold in good contact at all edges with a nylon elasticized strap.
- If placed on the back, the weight of the body plus the strap can be used to achieve good contact at the edges
- Dispersive pad should be larger than the sum of the areas of the active electrodes and wound packing.
- The greater the separation between the active and dispersive electrode the deeper the current path. Use for deep and undermined wounds
- Dispersive and active electrodes can be close together but should not touch. Current flow will be shallow> Use for shallow, partial thickness wounds

Clinical wisdom:

All petrolatum products including enzymatic debriding agents such as collagenase, Santyl , and fibrinolysin, Elase , which are petrolatum-based products, must be removed before treatment or current will not be conducted into the wound tissues.

Clinical Wisdom: Remove Petrolatum Before Stimulation

Aftercare

After the electrical stimulation treatment is complete, slip the electrode out from between the wet and dry gauze. The wound can be left undisturbed. If saline soaked gauze is the conductive

medium, it should be changed before it dries or be covered with an occlusive dressing. If hydrogel impregnated gauze is the conductor, change BID. If additional topical treatments are required such as enzymatic debriding agents or antibiotics, then the packing will need to be removed, topical agent applied and redressed.

Research wisdom:

Frequent dressing changes are being discouraged because it disturbs the wound healing environment by removing important substances in wound exudate and cooling the wound. It takes three hours for a chilled wound to re-warm and slows leukocytic and mitotic activity

Research Wisdom: Avoid Wound Chilling

PRECAUTIONS

Signs of adverse effects were evaluated in the various clinical trials and none were found except some skin irritation or tingling under the electrodes in a few cases. Patients with severe peripheral vascular occlusive disease (PVD), may experience some increased pain, usually described as throbbing, in the leg after electrical stimulation.

Research Wisdom:

An alternative protocol with reported healing, by Kaada, calls for placing the active electrode on the web space of the hand between thumb and first finger instead of over the ulcer. This may be more comfortable for the patient with PVD.

Research Wisdom:

An Alternative protocol with reported healing of lower extremity ulcers , by Kaada, calls for placing the active electrode on the web space between the thumb and first finger instead of over or around the ulcer. This may be more comfortable for the patient with PVD.

Research Wisdom: Kaada Protocol for Wound Healing

CONTRAINDICATIONS

Contraindications for treatment with electrical stimulation include:

1. Placement of electrodes tangential to the heart
2. Presence of a cardiac pacemaker
3. Placement of electrodes along regions of the phrenic nerve
4. Presence of malignancy

5. Placement of electrodes over the carotid sinus
6. Placement of electrodes over the laryngeal musculature
7. Placement of electrodes over topical substances containing metal ions
8. E.I. povidone iodine and mercurochrome, unless thoroughly cleaned.
9. Placement of electrodes over osteomyelitis

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Medicare Reimbursement:

Medicare has been enjoined by the court to pay for electrical stimulation for wound healing if the treatment is medically necessary and appropriate and if it is effective. Individual Medicare carriers and contractors have the option to cover this service based on policies for reimbursement prior to July 14, 1997. Contact the American Physical Therapy Association, Government Affairs office at 1-800-999-APTA for more details about this coverage policy.

Reference sources:

The Role of Physical Therapy in Wound Care, C. Sussman, B.S. PT Chronic Wound Care: A Source book for Health Care Professionals , Krasner, Diane,RN, MS, CETN 1990 Health Management Publications

Wound Healing: Alternatives in Management, Kloth, McCulloch. , Feedar 2nd Ed. 1994

F.A. Davis. Clinical Wound Management, Gogia, P 1995 SLACK Inc.

AHCPR TREATMENT GUIDELINE FOR PRESSURE ULCERS U.S. Government Printing Office 1994
