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E-Stimulation: An Effective Modality to Facilitate Wound Healing

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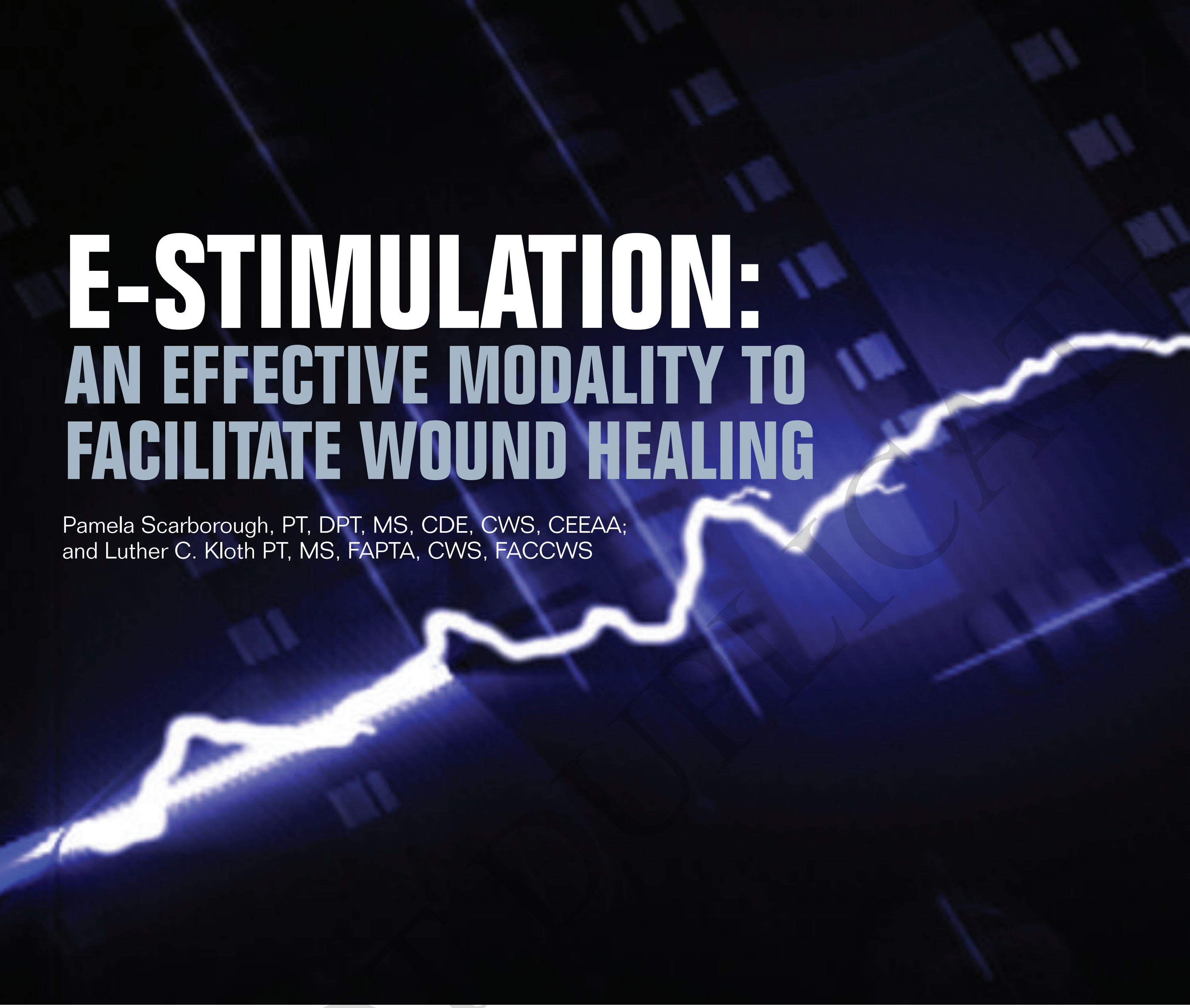

E-STIMULATION: AN EFFECTIVE MODALITY TO FACILITATE WOUND HEALING

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Every action in the body, from the cellular level to the level of gross motor function, begins as an electrical impulse. Exogenously applied electrical energy is something any wound care clinician should consider using to augment what is already a function of natural healing. When it comes to chronic wounds, electrical stimulation (ES), one of several biophysical technologies, is known by those healthcare providers who employ its use to be one of the most cost effective, therapeutically efficacious tissue repair and wound healing accelerators in the industry today.[1] By restoring the natural electrical potentials necessary for cellular activities that have become stalled, ES re-establishes and intensifies healing processes.[2,3]

There has been substantial research regarding the effects of ES on the cellular and physiological mechanisms that enhance wound closure and healing.[4] This article does not attempt to describe the evidence in detail; rather, the authors summarize the overall effects of ES on chronic wounds in an effort to familiarize clinicians with this underused efficacious treatment modality.

TYPES OF ELECTRICAL CURRENT

There are three types of electrical current that assist in wound closure and healing: direct current (DC), alternating current, and pulsed current (PC). The majority of clinical trials using ES currents for wound healing have used PC delivered in either monophasic- or biphasic-pulsed waveforms, whereby current is delivered to the wound via a number of pulses per second (pps).

There are three variations of PC that have been reported to augment chronic wound closure and healing. They are:

- high-voltage monophasic-pulsed current, frequently referred to as hi-volt pulsed current (HVPC);
- low-voltage monophasic-pulsed current; and
- low-voltage biphasic-pulsed current (LVBPC).

LVBPC is employed in transcutaneous electrical nerve stimulation (TENS)

Table1: Enhanced Cellular Motility/Electrotaxis in DC and PC Electric Fields[4]

Phase of Healing	Biological Effects	Cells	Cells Enhanced Motility to:
Inflammatory	Phagocytosis and autolysis	Macrophage Neutrophil Neutrophil Activated neutrophil	DC (+) DC (+) PC (+) DC (-)
Proliferative	Fibroplasia	Fibroblast Fibroblast Keratinocytes	PC (-) DC (-) DC (-)
Remodeling	Wound contraction Epithelialization	Myofibroblast Epidermal	PC (-) DC (-)

Adapted from Kloth L. Endogenous and Exogenous Electrical Fields for Wound Healing. In: McCulloch JM, Kloth LC, eds. Wound Healing: Evidence-Based Management. 4th ed. Philadelphia, PA: FA Davis Company; 2010:450-513.

devices, primarily for pain control.[4]

At present, HVPC is the current most supported by the evidence for wound healing and is most frequently used for this purpose in the US. HVPC devices provide choices for polarity and pulsed frequency, which are known to affect cell behavior in and near the wound bed.[4]

ES ACTION ON CELLS AND TISSUE

Chronic wounds become stalled somewhere between the inflammatory and proliferative phases, often requiring assistance to restore the wound to the beginning of the inflammatory phase (so as to proceed through the proliferative phase and on to the maturation phase). Functioning cells are required for granulation tissue formation, wound closure, and subsequent healing through the maturation phase. Neutrophils and macrophages clean the wound and help decrease bioburden to prevent infection. Fibroblasts are the "workhorse" cells that build granulation tissue, and keratinocytes resurface the wounds. Early in vitro studies[4-8] suggested cells involved in wound healing have their own inherent charge, and thus would be attracted to a treatment electrode having opposite polarity. More recent research has shown the motility of cells involved in wound healing can be enhanced by exogenously applied electrical fields; however, cell migration is not influenced in the same way that a charged particle (ion) is affected by electrical forces (Table 1).[4,9]

(For a sample of devices that deliver HVPC applicable for wound healing, visit www.todayswoundclinic.com beginning May 9. *Note:* This is a small sample and is not intended to be comprehensive regarding the devices available for sale and use.) Tables 2 and 3 describe the effects of ES on wound closure and healing, and the types of wounds that may benefit from ES application, respectively.

Table 2: Effects of ES on Wound Closure & Healing Fields

Electrical stimulation has multiple effects applicable to wound closure and healing. Research has demonstrated that application of ES energy:

- Upregulates insulin receptors on fibroblasts (Significance: If insulin is available to bind additional receptors, fibroblasts will significantly increase both protein and DNA synthesis.)[4]
- Results in upregulation of TGF–β[4,10]
- Increases angiogenesis[11]
- Decreases bacterial burden[12,13]
- Increases survival of grafts and flaps (in animal models)[4]
- Increases blood flow[4,14]
- Increases wound tensile strength[15,16]

Table 3: Wound Types That May Benefit From ES Application

There have been many clinical studies demonstrating the efficacy of ES energy to facilitate chronic wound closure and healing. Many, if not most, wound etiologies benefit from the application of ES energy. The types of wounds that have demonstrated improvement using ES include:

1. Pressure ulcers[3,4,17-19]
2. Venous insufficiency leg ulcers[20-22]
3. Arterial insufficiency ulcers[4,21,22]
4. Diabetic neuropathic foot ulcers[23,24]
5. Dehisced surgical wounds[4]
6. Failing flaps and grafts[4]

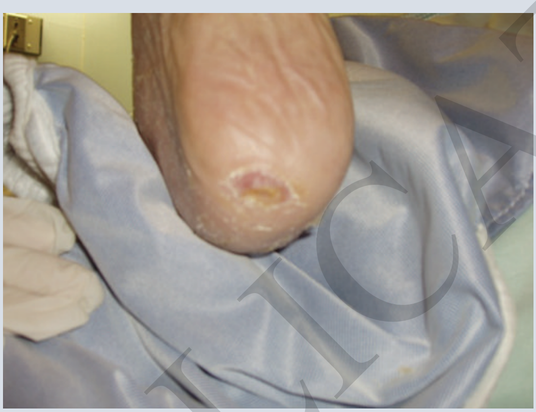
USING ES FOR WOUND CLOSURE[4]

Although several factors appear to affect cell movement in the wound bed using electrical currents, the choice of the polarity of the wound treatment electrode should be based on reports from clinical outcomes and best practice.

E-STIMULATION: CASE PRESENTATIONS

1) 67-year old male with 10-year history of diabetes. Presents with L-heel pressure ulcer due to immobility after hospital stay and transmetatarsal amputation L-foot (transmet wound not closing). Previous femoral popliteal bypass. ABI: .53. Goal: Prevent future amputations of L-foot, fitting of shoe for L-foot for functional home and community ambulation. Outcome: Complete closure heel and transmetatarsal site in 6 weeks using ES. Fitted with custom insert and shoes. Returns home from facility after rehabilitation.

PATIENT PRONE



PATIENT SUPINE

SLOW-HEALING AMPUTATION INCISION
SAME FOOT

ES STOCKING DELIVERY

2) 89-year-old female with 25-year history of diabetes. AKA L-leg, previous amputation of 2nd, 3rd, and 5th toes R-foot. Goal: Keep R-foot/leg for functional bed/wheelchair/shower-chair/commode transfers. ABI: .46. Wound closed 8 weeks with ES stocking delivery method.

(P. Scarborough)

When using ES, the clinician introduces the current into or near the wound by setting the parameters on the device to facilitate the outcomes desired. Many ES device manufacturers preset some of these parameters to simplify treatment application. The following suggestions relate to parameter selection:

Settings:

- Pulse frequency: 100 pps.
- Pulse duration: 20-100 µsec (usually fixed by the manufacturer).
- Polarity: A positive or negative polarity is introduced into the wound bed and is chosen by the clinician depending on wound healing phase and desired effects. In general, starting with negative polarity is recommended when the goal is to enhance granulation tissue formation in the wound bed and when re-epithelialization is desired. Positive polarity is chosen to enhance antimicrobial effects.
- Additional suggestions for polarity introduced into the bed of a non-infected wound:
  - o *Negative:* Begin with negative polarity as long as the wound shows improvement as evidenced by continued granulation tissue deposition, decrease in wound size, and decrease in exudate.
  - o *Positive*: If the wound stalls or regresses, change to positive polarity and continue as long as the wound shows improvement.
  - o *Negative:* Change back to negative polarity if there is no healing progress. Maintain negative polarity for 7-14 treatments, as long as healing progress continues.
- Treatment duration and frequency: 45-60 minutes, 5-7 days per week or at least 3 days per week if possible. Treat until wound closes.[4]

CONTRAINDICATIONS, PRECAUTIONS

There are several methods for introducing exogenous ES currents into the ulcer area, including:

- Direct or monopolar arrangement: The treatment electrode is placed directly into or over the wound; the non-treatment (dispersive) electrode is placed on intact skin.
- Indirect bipolar arrangement: Two electrodes straddle the wound area on intact skin.
- Stocking or glove electrode garment applied to the affected limb.

Although ES is appropriate for many wound etiologies, there are considerations that need to be made. For patients with intact sensation, the initial electrical current can be startling. Therefore, the clinician should alert the patient when starting the device and increase the intensity gradually, monitoring the patient's response until the desired intensity is reached. There have been reports of skin irritation under the non-treatment electrode. This irritation may occur when using a device with a continuous DC component. Skin irritation usually does not occur with PC. If skin irritation does occur, it is usually a transitory issue.[4]

Contraindications for ES include the presence of basal or squamous cell carcinoma in the wound or periwound tissues, or melanoma, as ES may increase cancer cell activity. Untreated osteomyelitis should not be treated with ES, as the wound may close while the infection is present. ES should not be placed over the pericardial area, carotid sinus, phrenic nerve, parasympathetic nerves, or ganglia; muscles of the larynx (an exception is VitalStim,® Therapy System, Empi, St. Paul, MN; used by speech-language pathologists for dysphagia); or any type of external or implanted electronic pacemaker device.[4] ES should not be placed directly over the pregnant uterus, as the effects on the fetus are unknown.

Studies have examined wound-related pain being modulated by ES currents including TENS, HVPC and interferential currents.[25,26] By primarily using the visual analogue scale, several investigators demonstrated a statistical improvement in wound-related pain reported by patients in these studies.[25] In addition, patients who have had ES used on their wounds frequently describe their wound pain as being a decrease from an anecdotal perspective. In 2000, the Paralyzed Veterans of America published a clinical practice guideline, *Pressure Ulcer Prevention and Treatment Following Spinal Cord Injury,*[18] which stated that ES qualified as a stand-alone intervention and was no longer classified as an adjunctive therapy. In addition, this energy has been recognized by the National Pressure Ulcer Advisory Panel as an adjunctive therapy for the treatment of recalcitrant category/stage III and IV pressure ulcers.[17] ■

Editor's Note: For coding, coverage, and payment information, please see Business Briefs on page 6.

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TWC Online Exclusive:
Examples of ES Devices that complement this article can be found online beginning May 9.

Visit: www.todayswoundclinic.com.

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