

**BioElectric Stimulation Therapy (BEST) in Wound Healing :  
How Does it Work?**

**Cellular Migration (Electrotaxis)**

**BEST Mechanisms of Action**

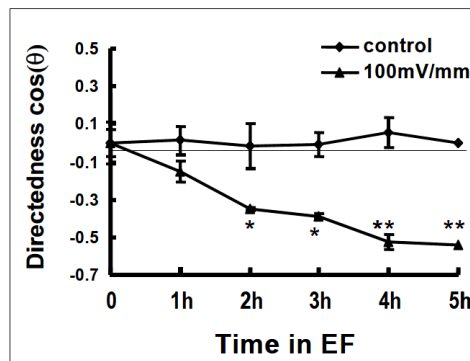
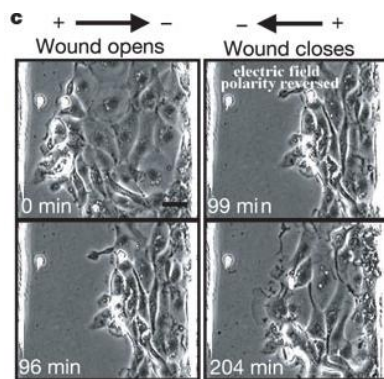
The directed movement of cells is a key mechanism in wound healing, with different cells active in the different stages of wound healing.

\*\* All the different cells depicted in this table have been shown to migrate in healing wounds under the influence of bioelectric signals [Kloth 2005]

Phase	Effects	Cells**
<b>Inflammatory</b>	Phagocytosis Debridement	Neutrophils Macrophages
<b>Proliferative</b>	Granulation tissue Angiogenesis	Fibroblasts Endothelial cells
<b>Maturation</b>	Collagen production Epithelialization Wound contraction	Fibroblasts Keratinocytes Myofibroblasts

In a recent Nature article, the mechanisms underlying electrotaxis have been elegantly explained [Zhao 2006]

Small electric fields (same magnitude as endogenous bioelectric current) cause asymmetric recruitment of key molecules responsible for activating cell movement



BioElectric signals direct cell migration in wound healing, as shown by movement of epithelial cells (left) and fibroblasts (right) [Zhao 2006].

In vivo studies have showed increased neutrophil counts in human skin exudates [Eberhardt 1986]. as well as faster epithelialization [Mertz 1993].

In conclusion, bioelectric signals are responsible for the directed movement of different cells throughout the phases wound healing. It is also one of the explanations why externally applied current (BEST) augments wound healing.

**References**

Kloth 2005 Electrical stimulation in und healing, in vitro, in vivo and clinical evidence *Low Extrem Wounds*, 2005;4(1),33-44.

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Mertz P et al. Electrostimulation:acceleration of soft tissue repair. *Wounds* 1993;5(3):153-9.

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**Antibacterial Effects**

**BEST Mechanisms of Action**

Several authors have reported inhibitory effects of BEST on bacterial cell populations, as the summary below shows:

Reference	Study	Pathogens	Polarity	Effect
Szuminsky et al, 1994	In vitro	<i>Staph aureus</i> <i>Pseudomonas aeruginosa</i>	Both poles	Bacteriostatic
Thibodeau et al, 1978	In vivo	Oral bacteria	Anode	Bacteriostatic
Laatsch et al, 1995	In vitro	Gram positive bacteria	Both poles	Bacteriostatic
Ong et al, 1994	In vitro	<i>Staph aureus</i> <i>Pseudomonas aeruginosa</i>	Anode	Bacteriostatic
Barranco et al, 1974	In vitro	<i>Staph aureus</i>	Anode	Bacteriostatic

Most publications refer to in vitro studies, whilst definitive clinical evidence is still lacking.

Conclusion : In addition to its direct wound healing effects, BEST can also play a useful antibacterial role. It should, however, NOT be seen as a replacement for standard therapy such as antibiotic treatment.

**Summary of BEST’s Mechanisms of Action in Wound Healing**

stage	1 <sup>0</sup> mediators	Cellular Migration	Angiogenesis	Fibroblast Activation
Inflammatory	TGF-β PDGF	Neutrophils Macrophages		
Proliferative	bFGF VEGF	Fibroblasts Endothelial cells	Fibroblasts Endothelial cells	Fibroblasts
Maturation	IGF-1 KGF	Fibroblasts Epithelial cells		Fibroblasts Myofibroblasts

TGF-β = tissue growth factor beta  
bFGF = basic fibroblast growth factor  
IGF-1 = insulin like growth factor

PDGF = platelet derived growth factor  
VEGF = vascular endothelial growth factor  
KGF = keratinocyte growth factor

**References**

Szuminsky N et al. Effect of narrow, pulsed high voltages on bacterial viability. *Phys Ther* 1994;74:660-7.  
 Thibodeau E et al. Inhibition of oral bacteria by silver ions generated with lowintensity direct current. *J Dent Res* 1978;57:922-6.  
 Laatsch L et al. In vitro effects of silver electrodes on select wound pathogens. *J Clin Electrophysiol* 1995;7(1):10-5.  
 Ong P et al. Antibacterial effects of microamperage direct current in vitro. *J Clin Electrophysiol* 1994;6(1):14-8.  
 Barranco S, Spadero J, Berger T, et al. In vitro effect ofweak direct current on *Staphylococcus aureus*.*ClinOrthop* 1974;100:250-5.