Electroceuticals in Pain Management

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Electric Stimulation for Pain Relief in Patients with Fibromyalgia: A Systematic Review and Meta-analysis of Randomized Controlled Trials

Effects of whole-body electromyostimulation on chronic nonspecific low back pain in adults: a randomized controlled study

Vagus nerve stimulation may reduce the symptoms of rheumatoid arthritis

The Problem with Electroceuticals...

- Frequency?
- Pulse width?
- Burst Mode?

https://www.fda.gov/medical-devices/products-and-medical-procedures

>6,000 devices
FDA database
Electroceuticals for Pain: Learning Objectives

• Provide an overview of and scientific basis for electroceuticals
• Review the mechanism and clinical efficacy of electroceuticals
• Summarize the rationale for incorporation of electroceuticals for specific pain states
• Discuss optimal clinical incorporation of electroceuticals in pain management
Electroceuticals / Neuromodulation Defined

• **Electroceuticals**: devices that treat ailments with electrical impulses
  • A component of the more general term Neuromodulation

• **Neuromodulation** is a technique that employs stimulating the nervous system via electric currents or a fluctuating magnetic field to modulate pain pathways.

• **Other terms**
  • Biostimulation
  • Bioelectronics
  • ElectroStimulation / E-Stim
  • Electrotherapy

• Electrical Nerve Stimulation
  • **Depth**: Transcutaneous (TENS) or Percutaneous (PENS)
  • **Location**: Tibial PTNS...

https://www.scientificamerican.com/article/electroceuticals/
? Can Neuromodulation be done with other stimuli?

• YES!
  • Acoustic / Vibration
  • Light
  • Sound
  • Temperature...
History of Electrotherapy

• 3100 B.C.E.
  • Stone carvings of Nile catfish (*malopterus electricus*) for pain (Sakkara, Egypt)

• 400 B.C.E.
  • Torpedo Fish used for gout & hemorrhaging

• 1745 storage battery

• 1752 Benjamin Franklin treats convulsive fits with 4 “shocks” morning and night

• 1965 Melzack and Wall published their gate control theory of pain reduction
A Brief History
AD 41. Scribonius Largus, physician to Emperor Claudius: “To immediately remove and permanently cure a headache, however long-lasting and intolerable, a live black torpedo is put on the place which is in pain, until the pain ceases and the part grows numb,”

New York Times, November 7, 2006
Acupuncture as earliest form of biostimulation

THERMOCOUPLE EFFECT OF KELVIN-THOMAS

• Create an electrical gradient along the length of a homogenous conductor when a temperature gradient is produced by the ends of the conductor at different temperatures.

3 microvolts
Neuromodulation: The premise

• Pain causes (and is caused by) Disruption in the electrical system of the body which goes onto to disrupt multiple systems (neurochemical, immune...)

• Biostimulation, in various forms, can provide a Restorative Signal to the body which can improve function and pain
Arthritic Degeneration ➔ Electrical Disruption

- Eraphy (EIP) signal around the knee have the potential for non-invasive diagnosis of knee osteoarthritis.


There were positive MRI findings in 64% of the patients.

Abnormal electrophysiological findings were recorded in 82% of the patients.

Postsynaptic Stimulus (PSTIM)

Mental Health Care Parity Signed Into Law; Starts in 2009

Health plans can decide what to cover.

After a 12-year fight led by mental health advocates, patients, families, clinicians, and a handful of members of Congress, some 113 million Americans will soon have equality of coverage between their benefits for physical health care and mental or behavioral health care.

The Paul Wellstone and Pete Domenici Mental Health Parity and Addiction Equity Act of 2008 was tucked into the massive financial rescue package passed by passage is “the recognition by the government of the United States that mental illnesses are real illnesses,” said Dr. Nabil Stotland, president of the American Psychiatric Association, in an interview.

The law also ensures that substance abuse treatment is specifically subject to the parity requirements.

The law will take effect Oct. 3, 2009, which means that benefit changes should be seen in health insurance policies that take effect in January 2010.

Medicare has already been instructed to eliminate the differ-
INTEGRATIVE PAIN MANAGEMENT

BODY
- Acupuncture
- Surgery Injection
- Medication
- Diet / Supplements

MIND
- Biofield Therapy
- Mindful Exercise
- MBSR
- Joie / Spirit

Integrate

Guided Imagery
- Visual Imagination
- Behavioral Therapy
- Group Support

Mind / Body / Spirit
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Neuromodulation Overview

Neuromodulation

Non-Invasive / Self Treatment
- TENS
- NMES
- IFC
- PEMF
- nVNS

Invasive / Clinic Treatment
- rTMS
- PENS/PTNS
- VNS
- DBS/SCS...

Others: Microcurrent, CES...

DBS: Deep brain Stimulation
Interferential Current (IFC)
NMES: Neuromuscular electrical stimulation
PEMF: Pulsed Electromagnetic Field Therapy
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rTMS: Repetitive transcranial magnetic stimulation
SCS: Spinal Cord Stimulation
TENS: Transcutaneous Electrical Nerve Stimulation
Stimulation-produced analgesia: acupuncture, TENS and related techniques

Alwyn Kotze
Karen H Simpson

Abstract
Stimulation-produced analgesia (SPA) is a term that describes many techniques, both non-invasive and invasive. These techniques relieve pain via both peripheral and central mechanisms. Simple antidromic conduction of non-painful stimuli (electrical or physical) and gate control of noxious impulses typically produce rapid analgesia of short duration. Longer-term effects are dependent on production of endogenous opioids at spinal cord and brain level and activation of non-opioid transmitter systems in the limbic system and at the spinal gate. There is no scientific evidence that metaphysical (without form or substance) energy pathways play any role in SPA. Methods of producing analgesia by nerve stimulation include non-invasive or minimally invasive techniques such as acupuncture, transcutaneous electrical nerve stimulation (TENS) and acupressure. Good evidence indicates that they are useful as a sole or supplementary analgesic technique for many painful conditions, both acute and chronic. Electronic stimulators may also be permanently implanted at peripheral nerves, into the epidural space or into the brain. These invasive techniques are useful for refractory pain conditions, mostly of neuropathic origin.
Stimulation Analgesia

- **High Freq. TENS**
  - Activate A-delta fibers

- **Low Freq. TENS**
  - Release of β-endorphins from pituitary

- **Brief-Intense TENS**
  - Noxious stimulation to active C fibers
Theories of Pain Modulation

- Gate theory
- Conditioned pain modulation (CPM)
  - Experimental measure of the endogenous pain inhibitory pathway
- Endorphin Theory
- ...

https://en.wikipedia.org/wiki/Gate_control_theory
Summary – Conditioned Pain Modulation

- Brainstem-mediated descending pain inhibition mechanism\(^1\)
- Stimulus must activate nociceptive fibers but can be below perceived pain threshold\(^2\)
- Stimulus must be remote from original pain location\(^3\)
- Global effect that last a few minutes beyond stimulation\(^3\)

\(^1\)Nir & Yarnitsky, 2015; \(^2\)Lautenbacher et al, 2001; \(^3\)Le Bars et al, 1979
Conditioned Pain Modulation

➢ Antinociceptive effects via descending serotonergic and noradrenergic pathways

➢ Via spinal nuclei, including cervical trigeminal complex

➢ Temporal and spatial effects suited to acute migraine treatment

Nir and Yarnitsky, 2015; Yarnitsky, 2010
Therapeutic Basis of Clinical Pain Modulation

- Placebo
- Endogenous Opioids
- Exogenous Opioids
- Opioid Receptors
- Vesicular Release of Pain Neurotransmitters
- Nociceptive Transmission
- Electrical Stimulation
- Galanin
- Glutamate Release
- Pain Modulation
- Dopamine
- Norepinephrine
- α2 Adrenergic Receptor
- 5-HT1A
- 5-HT1B
- 5-HT1D
- 5-HT2
- Serotonin
- Cannabinoids
- PGE2
- GABA
- CCK
- GABA
- CCK
E-Stim General Principles

- Hi Frequency (HF)
- Low Frequency (LF)
TENS / NMES / IFC General comparison

• Transcutaneous Electrical Nerve Stimulation (TENS)
  • Variable 1 Hz and 250 Hz
  • **Target**: sensory neurons; acupoints
  • **Indications**: chronic and acute pain; CPM

• Neuromuscular Electrical Nerve Stimulation (NMES)
  • ~25 Hz - 80 Hz with higher intensity
  • **Target**: Stimulate muscle with placement over motorpoints
  • **Indications**: muscle spasm, atrophy, **muscle** re-education, increase ROM

• Interferential Current (IFC)
  • High freq: ~ 3,000 Hz - 5,000 Hz
  • Target: deeper tissue, circulation
  • **Indications**: chronic and acute pain; edema reduction, increase circulation
TENS / NMES / IFC General comparison

**TENS**
- Reduce pain transmission
- Disuse Atrophy
- Swelling
- Active Muscle
- Gait / Muscular Retraining

**NMES**

**Interferential**
- Deeper Penetration
• 38 studies of ENS

• The overall results showed a significant decrease in pain with ENS therapy using a random-effects model (p < 0.0005).

• These results indicate that ENS is an effective treatment modality for chronic musculoskeletal pain and that previous, equivocal results may have been due to underpowered studies.
Which is Better?

- Groups A (conventional TENS), B (acupuncture-like TENS), and C (HVES) D (interferential) The least progress was recorded in group E (DD) and F (control).

- N=123; Selected electrical therapies (interferential current, TENS, and high voltage) appear to be effective in treating cLBP.

- ...Interferential current more improvement of functional ability

Assessment of the effectiveness of interferential current therapy and TENS in the management of carpal tunnel syndrome: a randomized controlled study.

- group I received splint therapy,
- group II TENS on the palmar surface of the hand and the carpal tunnel
- group III IFC therapy applied on the palmar surface of the hand and the volar surface of the forearm.
- 5x / weekly x 3 weeks

There was no statistically significant difference between TENS and splint therapy with respect to improvement in clinical scores, whereas IFC therapy provided a significantly greater improvement in VAS, mMDL, and mSNCV values than splint therapy.
• Five studies (across various neuropathic conditions) were suitable for pooled analysis of TENS versus sham TENS investigating pain intensity using a visual analogue scale. We found a mean difference in effect size favouring TENS of -1.58; n = 207

• 15 studies total;
• We found the quality of the studies overall to be low.
• We make recommendations with respect to future TENS study designs which may meaningfully reduce the uncertainty...
Transcutaneous Electrical Nerve Stimulation (TENS) reduces pain, fatigue, and hyperalgesia while restoring central inhibition in primary fibromyalgia

Dana L Dailey¹, Barbara A Rakel¹,², Carol GT Vance¹, Richard E Liebano³, Amrit S Anand⁴, Heather M Bush⁵, Kyoung S Lee⁵, Jennifer E Lee¹,², and Kathleen A Sluka¹,²

¹Department of Physical Therapy and Rehabilitation Science, Carver College of Medicine, University of Iowa, Iowa City, Iowa

• Pain and fatigue during movement, but not at rest, are reduced by a one-time 30 minute treatment with active TENS in individuals with fibromyalgia.

• The active TENS settings were 100 Hz, 200 μs at maximal tolerable intensity. The peak amplitude used in the active TENS treatment group was 39.93 mA

Moderate evidence from systematic reviews suggests that TENS is superior to placebo (no current) TENS for reducing analgesic consumption and improving pain, pulmonary function, and nausea and vomiting.

The Treatment of Upper Back Pain by Two Modulated Frequency Modes of Acupuncture-like TENS

Ching-Sung Weng\textsuperscript{1,2,*} Yuh-Show Tsai\textsuperscript{1} Shen-Hwa Shu\textsuperscript{1}

Chun-Chung Chen\textsuperscript{1} Mao-Feng Sun\textsuperscript{3}

\textsuperscript{1}Department of Biomedical Engineering, Chung Yuan Christian University, Chungli, Taiwan, 320, ROC
\textsuperscript{2}Chinese Medical Engineering Center, Chung Yuan Christian University, Chungli, Taiwan, 320, ROC
\textsuperscript{3}Department of Acupuncture, Chang Gung Memorial Hospital, Tao-Yuan, Taiwan, 333, ROC

Received 3 Mar 2005; Accepted 26 Mar 2005
Phase 2 Study of Acupuncture-Like Transcutaneous Nerve Stimulation for Chemotherapy-Induced Peripheral Neuropathy

• Bilateral acupuncture points included LI4 and LIV3, plus LI11 or ST36 were stimulated

• The results of this study suggests that ALTENS significantly reduces the mTNS scores and numbness in patients suffering from CIPN symptoms
PEMF
Pulsed electromagnetic field therapy
• Pulsed electromagnetic field therapy (PEMF), uses electromagnetic fields
• Initiated by pulsing high-frequency (>1000 times a second), low-energy electromagnetic signals into the nerves in the target tissue where pain is present.
Treating Chronic Pain Using the Oska Pulse Device

A double-blind clinical trial with placebo

By Joseph R. Shurman, MD, Brenda K Wiederhold, PhD, MBA, BCN, BCB, Roger Kasendorf, DO, John Qian, MD, Ian Miller and Mark D Wiederhold, MD, PhD, CPE, FACP, FACPE
UK Approves Wearable mHealth Device for Chronic Pain Management

The UK's National Health Service will reimburse physicians who prescribe the wearable mHealth device to help patients manage chronic pain.

• In 2017 PEMF Device was FDA 510k Cleared for "Adjunctive treatment of musculoskeletal pain related to: (1) plantar fasciitis of the heel; and (2) osteoarthritis of the knee"

• Postoperative Pain

• In 2019 PEMF Device was FDA Cleared for "Adjunctive treatment of postoperative pain".
Localized Percutaneous Stim

PENS

PTNS

PANS
Percutaneous Electrical Nerve Stimulation (PENS) for Pain
Reduction in pain and pain medications more sig in PENS group and noted for 1 mo. After 8 weeks of treatment and Diminished subsequently

Our results indicate that repeated PENS is more effective than TENS for chronic LBP but must be continued to sustain the analgesic effect.

PTNS Posterior Tibial Nerve Stimulation
Percutaneous tibial nerve stimulation (PTNS) efficacy in the treatment of lower urinary tract dysfunctions: a systematic review

Effectiveness of percutaneous tibial nerve stimulation in the treatment of overactive bladder syndrome

Randomized trial of long-term effects of percutaneous tibial nerve stimulation on chronic pelvic pain.

Auriculotherapy for Pain Management: A Systematic Review and Meta-Analysis of Randomized Controlled Trials

- ACP – 8 systematic reviews
  - ACP significant superiority over sham for back pain, knee pain, and headache
- Auricular - 17 Trials
  - 8 perioperative, 4 acute, 5 chronic pain
  - Superior to controls:
    - ↓ pain intensity ↓ analgesic use
Treatment of chronic migraine with transcutaneous stimulation of the auricular branch of the vagal nerve (auricular t-VNS): a randomized, monocentric clinical trial
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Case in Point:
Headache / Migraine
Treating Migraines: More Ways to Fight the Pain

https://www.fda.gov/consumers/consumer-updates/treating-migraines-more-ways-fight-pain

02/23/2017
Neuromodulation Therapies for Headache

Neuromodulation devices creates potential paradigm shift in headache medicine.

Umer Najib, MD, FAHS; Jessica Frey, MD; and David B. Watson, MD, FAHS, FAAN
<table>
<thead>
<tr>
<th>Mode</th>
<th>Device/Manufacturer</th>
<th>FDA-Approved</th>
<th>Migraine indication</th>
<th>CH indication</th>
<th>Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>nVNS</td>
<td>gammaCore/electroCore</td>
<td>YES</td>
<td>Acute treatment in adults age 18 and up</td>
<td>Acute treatment and adjunctive preventive treatment for adults &gt; age 18</td>
<td>Adjunctive treatment reduced frequency of CH and provided benefit for acute treatment of CH. For CM or high-frequency EM, 64% had pain relief with 40% of those achieving freedom from pain. For EM, nVNS superior to sham at 30 or 60 minutes, although not statistically different at 120 minutes.</td>
</tr>
<tr>
<td>sTMS</td>
<td>sTMSMini/eNeura</td>
<td>YES</td>
<td>Acute and preventive treatment in adults and adolescents &gt; age 12 years</td>
<td>In pivotal trial, 39% given active stimulation had pain relief vs 22% with sham stimulation; at 24 and 48 hours, 29% and 27% of people who had active stimulation, respectively, had continued relief vs 16% and 13% with sham stimulation. Active stimulation using a preventive protocol resulted in 2.75 fewer mean headache days per month.</td>
<td></td>
</tr>
<tr>
<td>eTNS</td>
<td>Multiple/Cefaly</td>
<td>YES</td>
<td>Acute and preventive treatment of migraine in adults age 18 and up</td>
<td>In prospective open-label study, 1 hour of treatment within 3 hours of treatment reduced pain by 57.1%, 2 hours of treatment reduced pain by 52.8%, and only 34.6% used rescue medication for following 24 hours.</td>
<td></td>
</tr>
<tr>
<td>PES</td>
<td>Nerivio Migra/Theranica</td>
<td>NO</td>
<td>Acute treatment in adults age 18 and up</td>
<td>Active stimulation for 20 minutes, soon after the migraine attack onset, resulted in 64% of the treated patients to have at least 50% pain reduction in more than half of their treated attacks, compared to only 26% of the participants in the sham group.</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: CH, cluster headache; CM, chronic migraine; EM, episodic migraine; eTNS, external trigeminal nerve stimulation; nVNS, noninvasive vagus nerve stimulation; PES, peripheral electrical stimulation; sTMS, single-pulse transcranial magnetic stimulation.
eTNS: External Trigeminal Nerve Stimulation
eTNS

• 20 minutes of active stimulation daily for 3 months resulted in reduced mean number of headache days with a 50% responder rate of 38.1% vs 12.1% for active vs sham stimulation.\textsuperscript{12,13}

• For acute migraine treatment, 1 hour of eTNS given in an outpatient clinic within 3 hours of onset resulted in 57.1% pain reduction after 1 hour and 52.8% after 2 hours.

• In addition, in the 24 hours after intervention, only 34.6% of patients had used rescue medication.

• \textsuperscript{~}May have muscle relaxing and sleep onset enhancing effect

https://practicalneurology.com/articles/2019-may/neuromodulation-therapies-for-headache
Spotlight On: Neuromodulation Devices for Headache

- nVNS: non-invasive Vagal Nerve Stimulation

FDA Clears Vagus Nerve Stimulator for Migraine Pain

*Cost-effectiveness of noninvasive vagus nerve stimulation for acute treatment of episodic migraine and role in treatment sequence strategies.*
nVNS: non-invasive Vagal Nerve Stimulation

• nVNS for acute self-treatment of 3 migraine attacks in a 3-week period, 64.6% of people with chronic migraine (CM) or high-frequency episodic migraine (HFEM) had pain relief within 2 hours, and 39.6% of responders had freedom from pain.

• Those with HFEM had more response than those with CM.6

• In a randomized sham-controlled study of 248 people with episodic migraine (EM) with or without aura, nVNS was superior to sham for acute treatment as early as 30 and 60 minutes after onset, although no there was no difference 120 minutes after pain onset.7

https://practicalneurology.com/articles/2019-may/neuromodulation-therapies-for-headache
Vagus nerve stimulation may reduce the symptoms of rheumatoid arthritis


The Effects of Noninvasive Vagus Nerve Stimulation on Fatigue and Immune Responses in Patients With Primary Sjögren's Syndrome.
After 10 sessions pain was reduced by 67%, especially regarding neuropathic components, while sleep disorders and fatigue also improved by 57–67%. The central sensitization inventory (CSI) score was reduced by 70%.

Repertitive Transcranial Magnetic Stimulation Therapy (rTMS) for Endometriosis Patients with Refractory Pelvic Chronic Pain: A Pilot Study

Neuromodulation Overview

Neuromodulation

Non-Invasive / Self Treatment

TENS  NMES  IFC  PEMF  nVNS

Invasive / Clinic Treatment

rTMS  PENS/PTNS  VNS  DBS/SCS...

Others: Microcurrent, CES...

DBS: Deep brain Stimulation
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SCS: Spinal Cord Stimulation
TENS: Transcutaneous Electrical Nerve Stimulation
Best Inventions 2019

Health Care

100 innovations making the world better, smarter and even a little more fun

Learning from Medical Mistakes
Surgical Safety Technologies Operating Room Black Box

Reducing False Diagnoses
Qlarity Imaging QuantX

Zapping Migraines
Theranica Nerivio

Relieving Sinus Pain
Tivic Health ClearUP Sinus Pain Relief

Microcurrent for Sinus Pain

- FDA cleared: To Treat Sinus Pain Associated With Allergic Rhinitis/Hay Fever

**Fig. 1** Microcurrent device and treatment path. The microcurrent device used in this study has a stimulation electrode at the tip and a return electrode built into the housing, comprising a monopolar design (a). Subjects were instructed to self-administer the device and follow a treatment path around the bilateral periorbital areas along the cheek, nose, and brow ridge (b). Subcutaneous fibers of trigeminal nerve branches V₁ (ophthalmic nerve) and V₂ (maxillary nerve) are targets of microcurrent stimulation (c).
• RDBPCT
• N= 71 with sinus pain
• After one treatment, 74% achieved sinus pain relief
• 82% preferred it over their current treatment.


• Significantly reducing moderate sinus pain for up to 6 hrs and significantly reducing pain and congestion over 4 weeks of daily use.
• Minor side effects that resolved without intervention
REN: Remote Electrical Neuromodulation

- FDA approved May 2019
- Indicated: acute treatment of migraine with or without aura in patients ≥ 18 years of age
- Based on Conditioned Pain Modulation (CPM)
- Applied to upper arm at onset of a migraine attack
- Controlled via smartphone App
### REN vs TENS

<table>
<thead>
<tr>
<th></th>
<th>REN - CPM</th>
<th>TENS – Gate Theory</th>
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</thead>
<tbody>
<tr>
<td><strong>MOA</strong></td>
<td>Descending Pain Inhibition</td>
<td>Ascending Pain Inhibition</td>
</tr>
<tr>
<td><strong>Nerve Fibers</strong></td>
<td>C and Aδ Fibers</td>
<td>Aβ Fibers</td>
</tr>
<tr>
<td><strong>Stimulated sensation</strong></td>
<td>Nociceptive</td>
<td>Touch</td>
</tr>
<tr>
<td><strong>Location</strong></td>
<td>Remote from Pain Location</td>
<td>At Pain Location</td>
</tr>
<tr>
<td><strong>Typical Pulse Frequency</strong></td>
<td>100 - 120 Hz</td>
<td>40 - 80 Hz</td>
</tr>
<tr>
<td><strong>Typical Pulse Width</strong></td>
<td>50 - 300 μS</td>
<td>400 μS</td>
</tr>
<tr>
<td><strong>Impact</strong></td>
<td>Global</td>
<td>Local</td>
</tr>
</tbody>
</table>
Remote Electrical Neuromodulation (REN) Relieves Acute Migraine: A Randomized, Double-Blind, Placebo-Controlled, Multicenter Trial

- N = 252 from 12 HA clinics
- Criteria: 2-8 migraine HAs/Mo
- Randomized in a 1:1 ratio to active or sham stimulation
- A smartphone-controlled wireless device was applied for 30-45 minutes on the upper arm within 1 hour of attack onset; electrical stimulation was at a perceptible but non-painful intensity level.

- At 2 hrs:
  - Pain relief: 66.7% vs 38.8%
  - Pain-free: 37.4% vs 18.4% (P = .003)
  - Symptom relief: 46.3% vs 22.2%, P = .0008)
- The pain relief was sustained 48 hours post-treatment
- Adverse events was low:
  - 4.8% vs 2.4% (P = .499)

Remote electrical neuromodulation (REN) in the acute treatment of migraine: a comparison with usual care and acute migraine medications

Alan M. Rapoport¹, Jo H. Bonner², Tamar Lin³, Dagan Harris³, Yaron Gruper³, Alon Ironi³ and Robert P. Cowan⁴
sTMS Single Pulse Transcranial Magnetic Stimulator

• This is a magnet placed on the back of the head and turned on for a split-second pulse.
• Two pulses of the magnet stopped migraine with aura in around 40% of patients

• ...rTMS improves the efficacy of conventional medical treatment in chronic pain patients...not associated with any direct adverse effects...duration and frequency of rTMS therapy is presently highly variable and needs standardization.
Longlasting antalgic effects of daily sessions of repetitive transcranial magnetic stimulation in central and peripheral neuropathic pain
Three-minute version of brain stimulation therapy effective for hard-to-treat depression

https://thebrainstimulator.net/brain-stimulation-comparison/
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- SCS: Spinal Cord Stimulation
- TENS: Transcutaneous Electrical Nerve Stimulation
Can Neuromodulation be done with other stimuli?

- YES!
  - Acoustic / Vibration
  - Light
  - Sound
  - Temperature...
Shock wave as biological therapeutic tool: From mechanical stimulation to recovery and healing, through mechanotransduction

- Reduced expression of metalloproteinases and inflammm interleukins
- Positive expression of anti-inflammatory cytokines
- Up regulation of PCNA, TGF-beta1 gene expression, NO release and TGF-beta1 protein → collagen synthesis
- Enhancing activation of tenocytes (proliferation and migration), → tendon healing
- Increased expression of lubricin (Proteoglycan 4) a proteoglycan encoded by PRG4 gene acts as a joint lubricant
Long-term results of radial extracorporeal shock wave treatment for chronic plantar fasciopathy: A prospective, randomized, placebo-controlled trial with two years follow-up
The Future…

FDA NEWS RELEASE

FDA permits marketing of first medical device for treatment of ADHD

For Immediate Release: April 19, 2019
3D Motion Detection

A 3-axis gyroscope and accelerometer are embedded in the Stimulator to monitor user movement in all three kinematic planes and deploy stimulation in 0.01 seconds of detecting a valid gait event.

Through an adaptive, learning algorithm, the L300 Go detects gait events, providing stimulation precisely when needed making it easier for users to clear their foot at different walking speeds, on stairs, ramps, and while navigating uneven terrain.
Multi-Channel Stimulation

Independent adjustment of medial/lateral stimulation intensity allows clinicians to precisely control dorsiflexion and inversion/eversion - with a single cloth electrode. Optimizing gait dynamics is now fast and efficient.
Home User App

The myBioness™ mobile app allows users to control their L300 Go, set goals, monitor activity and see how far they’ve come, allowing the gains made in therapy to continue.
Vagus nerve stimulation may reduce the symptoms of rheumatoid arthritis

Electrostimulation of the vagus nerve may be key to reducing the symptoms of rheumatoid arthritis, according to findings that scientists presented at the Annual European Congress of Rheumatology in Madrid, Spain.
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TENS: Transcutaneous Electrical Nerve Stimulation
What Electroceutical? Need to be an individualized

• Electrotherapy is not one size fits all…
• To Find the best electroceutical (Restorative Signal) need to recognize the **electrical disruption**
  • Pain is local / neuropathic → TENS
  • Pain is cortical / central → ALTENS / PANS / REN / rTMS
  • Pain is acute → High freq
  • Pain is chronic → Low freq / rTMS
  • Pain is deep → Interferential / PENS / PEMF
  • Pain associated with weakness → NMES…
  • Head and Facial pain / Migraine → REN, nVNS, eTNS
  • Pelvic pain → PTNS
Who?
• Preference
• Experience / Education
• Compliance
• Tolerance ...
Using TENS for pain control: the state of the evidence

- TENS success is optimized when new TENS users have realistic expectations from treatment and are provided with strategies to enable them to sustain motivation to self-administer treatment and troubleshoot declining response.
  - 20-30 min 2x/day
  - Placement:
  - Setting:
  - Expectations:
  - Care of equipment/pads:

Previous studies show the greatest analgesic effect of TENS with the highest tolerable intensities: ‘strong, tolerable and non-painful’
When, Where & How: The Prescription

• Type of Biostimulation
• Frequency
• Intensity
• Duration
• Mode
• Positioning
  • Local, dermatomes, myotomes, nerve roots, trigger points, acupuncture points...
Safety

- Rare skin irritation
- Use hypoallergenic pads
- Avoid prolonged use
- Avoid with implantable devices*
- Pregnancy
CPWH guidance on the safe use of Transcutaneous Electrical Nerve Stimulation (TENS) for musculoskeletal pain during pregnancy

Resources

- WWW.Electrotherapy.org
- Electrotherapy: evidence-based practice (Physiotherapy Essentials)
  - Tim Watson (Editor)
Transcutaneous electrical nerve stimulator (TENS)

How does TENS work?

A transcutaneous electrical nerve stimulator (TENS) sends electrical pulses through the skin to start your body's own pain killers. The electrical pulses can release endorphins and other substances to stop pain signals in the brain.

TENS can reduce pain. It works best when used during activities such as walking, doing chores, or exercise. The video below shows how TENS can reduce pain and demonstrates how to use a TENS unit.

https://uihc.org/health-topics/transcutaneous-electrical-nerve-stimulator-tens
Conclusions – Electroceuticals

• What is *New* in medicine is often a retelling of a therapeutic story told through a modern filter...

• An attempt to correct *disruption* with a *restorative signal*

• Great reverence for the history that made today’s medicine possible

• Great hope for future options to improve pain management
Electroceuticals in Pain Management

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CODES

• General ESTIM = 97032
• PENS = (Electroacupuncture)
  • Code: 97813 97814
• 64999 Unlisted procedure, nervous system