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Advances in Neuromodulation for Psychiatric Practice

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Interventional Psychiatrist
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Brent G Nelson, MD

wears multiple hats...

- Interventional Psychiatrist
- Chief Medical Information Officer





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- 71 bed inpatient - child / adol
- Residential – child / adol
- PHP - child / adol
- IOP - all ages
- Clinic - all ages
- TMS - adult

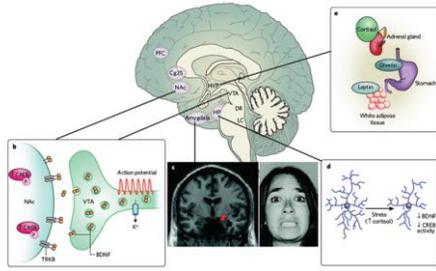


- 11 locations
- 180,000 visits per year
- All payors including Medicare and Medicaid



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Depression is Complicated!



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Adapted from Krishnan, V., & Nestler, E. J. (2008).

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Neuromodulation

The term "neuromodulation" encompasses a broad array of treatments, both electrical and chemical, targeting a variety of locations in the body to best achieve the desired outcome.

- International Neuromodulation Society

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Neuromodulation Types

- Psychopharmacology
- Psychotherapy
- **Brain Stimulation**
- Exercise
- Acupuncture
- Yoga
- Massage
- Nutrition

Many others...

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Induction



Michael Faraday (1831) - Qualitative

$$\nabla \times \vec{E} = -\frac{d\vec{B}}{dt}$$



"Faraday emf experiment" by Evatar Bach



James Clerk Maxwell (1860s) - Maxwell-Faraday Equation



http://commons.wikimedia.org/wiki/File:Faraday_emf_experiment.jpg

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Jacques-Arsène d'Arsonval
1896 (1851 - 1940)



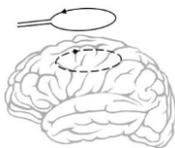
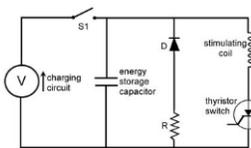
Silvanus P Thompson
1910 (1851 - 1916)



[\(George and Beltmaker, 2007\)](#)

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Induction in Action



<http://www.stimoptics.org/wiki/File:ASMAgagm05shenac02mk.jpg>

[Golstanirad et al., 2012](#)

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“Modern” Developments



1959 - Kolin et al use magnetic fields to induce muscle contractions in frogs

1965 - Bickford and Femming non-invasively stimulate human peripheral nerves via pulsed magnetic field

1976 - Anthony Barker develops first magnetic pulsing device: evokes human muscle contractions.

1982 - Polson et al use EMG to record magnetically induced motor jerks

1985 - Anthony Barker in England with the “Sheffield Magnet”



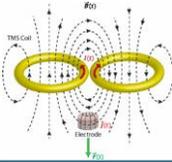
[Horvath et al., 2011]

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Progress



1988 - Shoogo Ueno develops figure 8 coil



1991 - Pascual-Leone et al report first speech arrest via rTMS



[Golubovskii et al., 2012]

[Horvath et al., 2011]

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MDD Circular and Figure 8

1995 - Kolbinger et al. undertake first proof-of-principle study with depression using flat, circular coil

1996 - First meeting of TMS safety consensus group

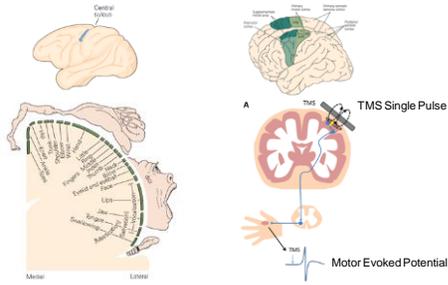
1998 - Wasserman publishes first TMS risk and safety guidelines



[Horvath et al., 2011] and BrainsWay

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Motor Threshold Mapping

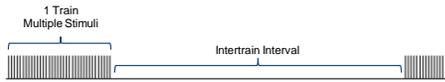


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Kandel et al. Principles of Neural Science, 5th edition

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Repetitive TMS (rTMS)



- High Frequency (>10Hz) Train - Stimulatory
- Low Frequency (<10Hz) Train - Inhibitory

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MDD Figure 8 Modified

2007 - O'Reardon et al publish depression study utilizing Neurostar system

2008 - FDA approves Neurostar device for MDD

2010 - NIMH Trial (OPT-TMS) is completed



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(Horvath et al., 2011)

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MDD H1 Coil



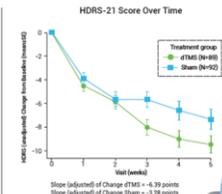
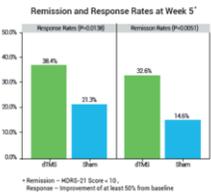
1996 - NIH begins development of H1 coil
 2001 - NIH Patents H1 coil
 2003 - Brainsway founded and licensed exclusively
 2013 - Brainsway is FDA approved for MDD



Images courtesy of BrainsWay

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Brainsway Trial



(Leikowitz et al. 2015)

Images courtesy of BrainsWay

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MDD Criteria For Treatment

Diagnoses:

- 296.23 Major depressive affective disorder single episode severe degree without psychotic behavior
- 296.33 Major depressive affective disorder recurrent episode severe degree without psychotic behavior

Criteria:

- Lack clinical response to 4 trials of pharmacological agents in the current episode. This means at least 2 different classes, at or above the minimum effective dose and duration. Make sure this includes at least 2 evidence-based augmentation therapies.
- OR
- Inability to tolerate 4 agents with distinct and documented side effects.
- OR
- A documented response to TMS in a previous episode.
- OR
- A documented response to ECT in a previous or current episode or inability to tolerate ECT and TMS is considered less invasive.

AND MUST HAVE THE FOLLOWING:

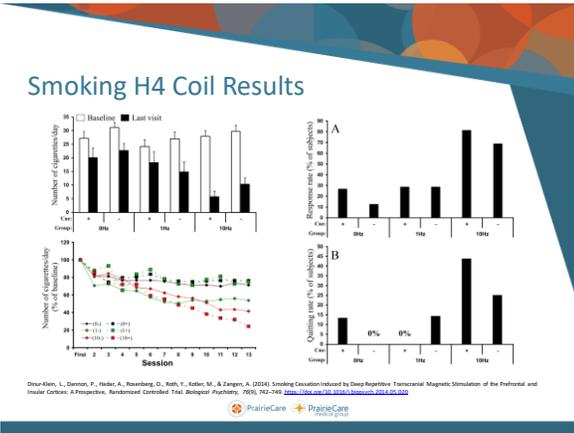
- A trial of an evidence-based psychotherapy with adequate frequency and duration without significant improvement in symptoms as documented by rating scales.



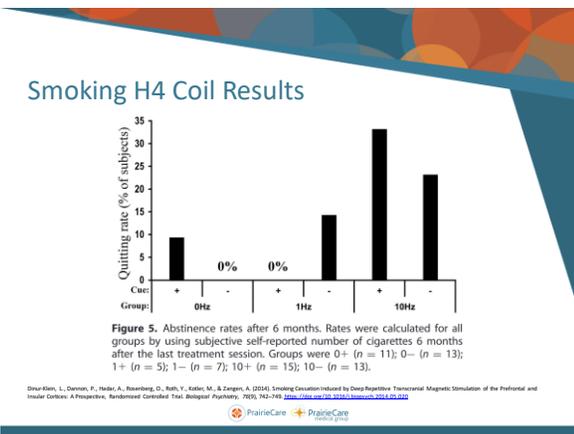
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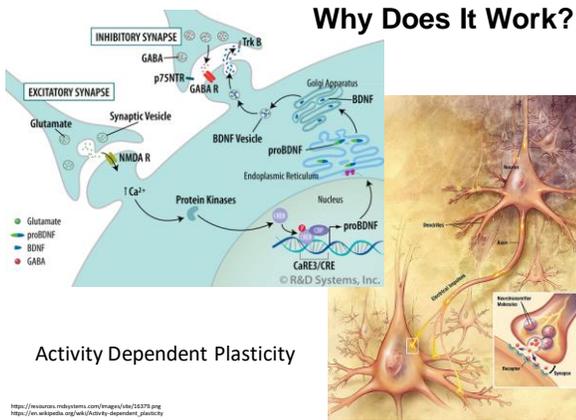
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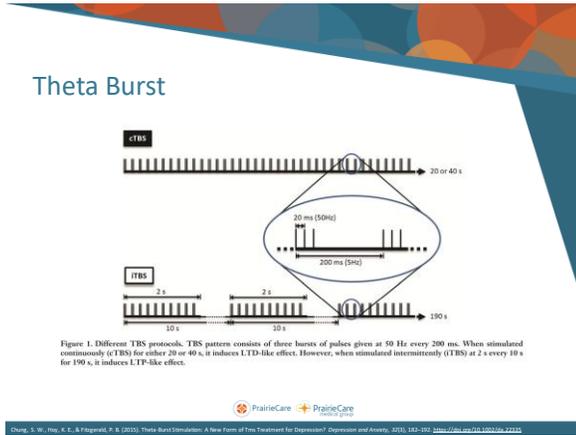
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Connectivity Stimulation

Resting-state connectivity biomarkers define neurophysiological subtypes of depression

nature medicine

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