AACPDM 2014, Non-Invasive Brain Stimulation in Congenital Hemiparesis, Instructional Course

Date: Friday, September 12, 2014, 4-6PM

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Objectives:

Learning Objective 1: To understand the electrophysiologic basis for non-invasive brain stimulation.

Learning Objective 2: To develop a thorough appreciation for the safety and limitations of the use of non-invasive brain stimulation.

Learning Objective 3: To discuss potential appropriate applications and protocols in the use of non-invasive brain stimulation.

Learning Objective 4: Evaluation of the benefit and challenges in use of this form of intervention in current research labs today.

Outline:

Gillick (4-4:30PM) Overview of Electrophysiology and forms of NIBS currently investigated in Children: TMS and tDCS. Review of current evidence in research in the application of NIBS in congenital hemiparesis.

I. Forms of NIBS researched in Congenital Hemiparesis
   - TMS as a test or cortical excitability assessment tool- mechanisms/dose/ assessment techniques
     - Electromagnetic Induction
       - Single Pulse
       - Paired Pulse
   - TMS as an intervention
     - Low Frequency (1 Hz) Inhibitory
     - High Frequency (> 5 Hz) Facilitatory
     - Priming
   - tDCS as an intervention (anodal/cathodal, neuromodulation, inhibition/facilitation) mechanisms/dose
     - Transcranial Direct Current Stimulation (tDCS)
       - Constant current
       - Anodal- “Excitation”
       - Cathodal – “Inhibition”
     - Oscillatory tDCS
       - Intensity fluctuates, polarity specific
     - Transcranial Alternating Current Stimulation (tACS)
       - Intensity fluctuates, non-polarity specific
Transcranial Random Noise Stimulation (tRNS)
- Random fluctuations in current intensity

II. Neurobiological Effects
a. tDCS
   i. Modulation of the Membrane Potential
   ii. Neural modulation without action potentials
   iii. Polarity Specific
      1. Anodal: inhibition of (GABA) neurotransmission
      2. Cathodal: inhibition of glutamate (Glu) neurotransmission

b. TMS
   i. Modulation of the Membrane Potential
      1. Neural modulation with depolarization or hyperpolarization
   ii. Modulate gene expression
   iii. Influence the expression of neurotrophins
   iv. Modify the release of neurotransmitters (including Glu and GABA)

c. Interhemispheric Inhibition

Current safety guidelines and adverse events profiles for non-invasive brain stimulation (NIBS) in people with congenital hemiparesis (presented by Friel)

I. Key features of a safe study with children with CP
   - Be sure participants fully understand and can comply with study protocol.
   - Inclusion/exclusion criteria to optimize safety.
   - Careful monitoring and assessment of safety during study.

II. Key concerns regarding the safety of NIBS in CP
   - There is currently no consensus regarding safety parameters of NIBS in CP.
   - Although safety profiles of NIBS are excellent, most safety outcomes are based on research in healthy adults.
   - Features of people with CP may impact safety (lesion size/location, smaller head size of children).
   - “Boldly go” forward, but with caution regarding safety.

III. Key safety issues regarding NIBS

TMS
- Seizure
- Syncope (fainting)
- Headache
- Dizziness
- Neck pain
- Back pain
- Scalp irritation

Which safety issues are most common, and how can they be minimized?
- Headache and neck pain: give frequent breaks and opportunities to stretch
- Dizziness: give breaks, provide snacks and juice
Incidence:
No seizures reported in congenital hemiparesis
Two cases of syncope in literature
Headache – in Friel lab, 8%
Neck pain – in Friel lab, 5%
Dizziness – in Friel lab

tDCS
- Seizure
- Syncope (fainting)
- Headache
- Dizziness
- Scalp burn/abrasion/tingling/itching

Which safety issues are most common, and how can they be minimized?
- Headache: minimize dose and duration of stimulation
- Scalp itching and tingling: minimize dose and duration of stimulation

Incidence:
No seizures reported
Headache – in Friel lab, 30%
Scalp itching – in Friel lab, 75%
No other common side effects in Friel lab

IV. Optimize safety of NIBS protocols
- Provide child-friendly education about study procedures and risks.
- Select enrollment criteria to minimize risk – age and cognitive capacity sufficient to understand and complete study, no active seizures, no metal implants, no prior unprovoked syncope.
- Monitor participant’s side effects and well-being during study. Offer breaks/snacks, look for nonverbal cues of discomfort (wincing, muscle tension).
- Have plan to quickly handle side effects and adverse events – a medical advisor is recommended, proximity to medical care if needed.

Are you using NIBS in your work with people with CP? We’re building a web-based repository of safety data, IRB protocols, and other helpful info. Email braininjuryclinic@med.cornell.edu to be a part of this effort!

REFERENCES


