A DISCUSSION ON CURRENT RESEARCH ON DOSAGE

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THE MILLION DOLLAR QUESTION: HOW MANY REPETITIONS OF AFFECTED UPPER EXTREMITY MOVEMENT LEAD TO BETTER FUNCTIONAL OUTCOMES?
Disclosure

Neither the presenters nor Sheltering Arms have financial interests in the technologies, companies, or products discussed in this presentation.

For Presentation Handout:
www.shelteringarms.com/vota2014
SESSION OBJECTIVES

- The participant will be able to identify neuroplasticity principles and the recommended number of repetitions associated with cortical reorganization.

- The participant will be able to discuss current research trends regarding number of repetitions achieved in traditional therapy on average in inpatient rehabilitation settings.

- The participant will be able to identify the benefits of advanced technologies through the use of a Clinical Practice Guideline to address repetitions required for neurologic recovery.
“The various ways in which the nervous system can change its function as a result of training, or in response to injury” (Henson & Keogh, 2010, p. E54).

“Neural plasticity is believed to be the basis for both learning in the intact brain and relearning in the damaged brain that occurs through physical rehabilitation” (Kleim & Jones, 2008, p. S225).
WHAT DRIVES NEUROPLASTICITY?

- Extrinsic factors:
  - Motor learning
  - Motor relearning
  - Electrical stimulation
  - Pharmacological stimulation
  - Behavior

- Intrinsic factors:
  - Genotype
  - Stage of development
  - Age
  - Sex
  - Location of injury
  - Severity of injury
  - Time post injury
  - Prior experience

(Plowman & Kleim, 2010)
THE PRINCIPLES OF NEUROPLASTICITY
NEUROPLASTICITY PRINCIPLES

- Use it or lose it
- Specificity
- Time
- Intensity

- Use it and improve it
- Repetition
- Saliency
- Age
- Transference
- Interference

(Kleim & Jones, 2008)
Studied the effect that constraint-induced movement therapy (CIMT) paired with rehabilitation has on rats s/p an intracerebral hemorrhage (ICH)

- Completed with 67 rats
- Divided into four study groups
- Behavioral training and recovery assessments completed

(DeBow, Davies, Clarke, & Colbourne, 2003)
Subjects that received a combination of CIMT and rehabilitation illustrated:

- Improved motor recovery
- Smaller volume of tissue loss

(DeBow, Davies, Clarke, & Colbourne, 2003)
Study to determine the effect that skilled learning vs. strength training had on cortical reorganization

- Completed with 24 adult rats
- Divided into three study groups
- Movement analysis and electrophysiological mapping completed to gather data

(Remple, Bruneau, VandenBerg, Goertzen, & Kliem, 2001)
“Power Reaching and Control Reaching animals exhibited a significant increase in the proportion of motor cortex occupied by distal forelimb movement representations (wrist/digit) and a decrease in the proportion of proximal representations (elbow/shoulder)” (Remple, Bruneau, VandenBerg, Goertzen, & Kliem, 2001, p. 133).
Study to examine the functional outcomes and neuromorphological changes that occur after receiving therapy 5, 14, and 30 days post stroke:
- Conducted with 40 rats
- Five behavior assessments were completed
- Neuroanatomical procedures utilized to gather data

(Biernaskie, Chernenko, & Corbett, 2004)
Rehabilitation 5 days post stroke had marked improvements on the behavioral assessments as well as improved an overall improvement of the number and length of dendritic branches (Biernaskie, Chernenko, & Corbett, 2004).
Studied the effect of highly repetitive skilled vs unskilled tasks on the overall learning process, synapse number, and brain function in the mammalian brain

- Completed with 12 rats
- Divided into two groups
- 400 repetitions of reaches each session

(Kleim, Barbay, et al., 2002)
Engagement in highly repetitive skilled reaching tasks:

- Produces more successful reaches overall
- Contribute to significantly more movement representations within the caudal forelimb area (CFA) and significantly thicker cortices within the CFA
- Increase number of synapses/neurons within the CFA

(Kleim, Barbay, et al., 2002)
Two part study:

1- “To determine the effect of massed practice (MP) verses massed practice combined with somatosensory stimulation (MP+SS) on cortical plasticity and function in persons with incomplete tetraplegia” (Beekhuizen & Field-Fote, 2005, p. 33).

2- Discover if greater improvement will occur in massed practice when combined with somatosensory stimulation

- Completed with 10 human subjects
- Divided into two groups
- Completed two hour sessions, five days/week, three weeks total
This study indicated that it is possible to achieve additional functional gains even in the chronic stages of injury.

Results indicated that subjects in MP+SS group demonstrated improvements in pinch, grip, and the Wolfe Motor Functional Test.

Both groups demonstrated improvement in the Jebson Hand Function Test.

(Beekhuizen & Field-Forte, 2005)
Study on how many repetitions could be done in one hour and assess the benefit of highly repetitive training

- 13 human subjects diagnosed with chronic stroke
- Baseline assessments utilized
- Highly repetitive task-specific training

(Birkenmeier, Prager, & Lang, 2010)
Results indicated it is feasible to achieve hundreds of task-specific upper extremity repetitions in one hour sessions

- Average of 322 repetitions per session

- Improvement in outcomes noted

(Birkenmeier, Prager, & Lang, 2010)
Researched the relationship between engagement in skilled motor tasks and the plasticity of the sensorimotor cortex

- Competed with 26 rats
- Included reaching and grasping training

Results indicated an increase in synapse strength was noted after continual stimulation for a prolonged period of time

(Monfils & Teskey, 2004)
Study to investigate the possibility of delivering a highly repetitive, task-specific, individualized treatment training

- 15 human subjects
- Inpatient rehab setting
- Constraint induced movement therapy training

Results

- Average of 289 repetitions per session
- Forty-seven minutes of active training was achieved per session
- Functional improvements noted

(Waddell, Birkenmeier, Moore, Hornby & Lang, 2014)
Study to assess the effectiveness and use of the Hand Dance Pro gaming system with subjects s/p stroke greater than six months with hemiparesis

- 9 human subjects
- Outcome measures utilized
- Eight intervention sessions over a six week period

(Combs, Finley, et al., 2012)
The use of this gaming system is feasible and resulted in improvement in UE movement in chronic stroke individuals

(Combs, Finley, et al., 2012)
Study to determine if moving quickly has an effect on the performance of an impaired UE during a functional task

- 27 human subjects
- Outcome measure assessments utilized
- Trails completed for preferred speed
- Additional trails completed of same task at a fastest possible speed

(Dejong, Schaefer, & Lang, 2011)
“People with mild to moderate post stroke hemiparesis are able to increase their movement speed on request, and when they do, movement quality is improved. Reach paths are straighter, finger movements are more efficient, and fingers open wider” (Dejong, Schaefer, & Lang, 2011, p. 368).

Improvement was shown for both groups
NEUROPLASTICITY AND INPATIENT REHABILITATION
FACTORS FOR IDEAL REHAB

- DOSAGE
  - INTENSITY
  - VOLUME
  - FREQUENCY
  - DURATION
A study in 2009 reported the average length of stay for a patient diagnosed with a CVA was 14 days in an inpatient rehabilitation setting.

In addition, patients did not receive full “3 hours” of intensive therapy a day due to time spent setting up treatment, transportation, and medical needs.

(Krakauer, Carmichael, Corbett, & Wittenberg, 2012)
Additional studies indicated that task-specific training occurs in only about half of therapy sessions focused on the upper extremity (Lang, Reisman, et al., 2009; Bernhardt, Chan, Nicola, & Collier, 2007; Harris, Eng, et al., 2009).
USE OF ADVANCED TECHNOLOGY AND NEUROPLASTICITY
CATEGORIES OF “HIGH” OR ADVANCED TECHNOLOGY

- Robotics
- Arm Based Spring-Assisted Therapy
- Forearm Based Spring-Assisted Therapy
- Hand Based Spring-Assisted Therapy
- Arm Based Functional Electrical Stimulation
- Hand Based Functional Electrical Stimulation
- Virtual Reality
ROBOTICS

REO-Go

Armeo Power

http://www.motorika.com/?categoryId=65107
http://www.hocoma.com/products/armeo/armeopower/

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SPRING-ASSISTED TRAINING

SaeboFlex

http://www.saebo.com/products/saeboflex/

ArmeoSpring

http://www.hocoma.com/products/armeo/armeospring/

SaeboMAS

http://www.saebo.com/products/saebomas/

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FUNCTIONAL ELECTRICAL STIMULATION

Bioness H200

RT300

http://www.bioness.com/H200_for_Hand_Paralysis.php
http://www.restorative-therapies.com/products

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VIRTUAL REALITY

iPad apps, e.g. Puzzle Me”

http://www.nintendo.com/games/detail/1OTtO06SP7M52gi5m8pD6CnahbW8CzxE
http://www.mvrc.pitt.edu/facility_balance.html
http://www.hocoma.com/products/armeo/armeoboom/features-functions/

Wii Sports Golf

Medical VR Center, “Virtual Cave”

Armeo Boom

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**Benefits**
- Evidence-based
- Concrete stimuli
- Specific to desired tasks
- Repetitive and intense
- Multi-sensory experience
- Modifiable
- Safe errors
- Interactive
- Provide feedback
- Provide objective data
- Capability to guide and measure improvements

**Limitations**
- Cognitive requirement
- Visual component
- Contractures/Tone
- Pain if over-utilized
- Focus primarily on distal recovery

- Technological error
- Cost and accessibility
- Size of workspace
IREACH CPG

What is the purpose?

Why do we do it?

How is it implemented?

Is it effective?
IREACH CLINICAL PRACTICE GUIDELINE

- Utilizes advanced technology to better promote neuroplasticity principles
  - **High repetitions - High Intensity – Increased Treatment Time**
    - Advanced technology can provide significantly more repetitions than the therapist without getting tired!
  - **Task Specific Training**
    - Purposeful reaching/grasping/targeting facilitates better results than rote exercise or training of isolated movements
    - Goal oriented treatment gives patients a **reason** to move
  - **Novelty – Cognitive Challenge**
    - Advanced technology treatment is more exciting and stimulating than towel slides and passive range!
  - **Unilateral training– Multisensory treatment**
    - Increased awareness and focus on the affected extremity
CASE STUDY

Patient Information:
- **Diagnosis**: Right Pontomedullary ischemic CVA 8/6/14
- **54 Year old female**
- **Admitted to inpatient rehabilitation hospital on August 8th, 2014**
- **Social Environment**: Married, Worked Full time

Past Medical History: Significant for high blood pressure, obesity

Prior Level Of Function: Independent with all self care, IADLs
<table>
<thead>
<tr>
<th>Admission Functional Independence Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Eating- Supervision</strong></td>
</tr>
<tr>
<td><strong>Grooming- Minimal Assistance</strong></td>
</tr>
<tr>
<td><strong>Upper Body Dressing- Moderate Assist</strong></td>
</tr>
<tr>
<td><strong>Lower Body Dressing- Dependent</strong></td>
</tr>
<tr>
<td><strong>Bathing- Maximal Assist</strong></td>
</tr>
<tr>
<td><strong>Toilet Transfers- Moderate Assist</strong></td>
</tr>
<tr>
<td>Assessment</td>
</tr>
<tr>
<td>-----------------------------</td>
</tr>
<tr>
<td>Grip</td>
</tr>
<tr>
<td>9 Hole Peg Test</td>
</tr>
<tr>
<td>Box and Block</td>
</tr>
<tr>
<td>Fugl Meyer</td>
</tr>
</tbody>
</table>
Plan of Care:

- Occupational Therapy focus on high repetitions with the use of advanced technology
  - Reo
  - Bioness
  - Armeo
  - SAEBO MAS
  - SAEBO Flex
  - Weight bearing
<table>
<thead>
<tr>
<th>Activity</th>
<th>Admission FIMS</th>
<th>Discharge FIMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eating</td>
<td>Supervision</td>
<td>Supervision</td>
</tr>
<tr>
<td>Grooming</td>
<td>Minimal Assist</td>
<td>Modified Independent</td>
</tr>
<tr>
<td>Upper Body Dressing</td>
<td>Moderate Assist</td>
<td>Modified Independent</td>
</tr>
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<td>Lower Body Dressing</td>
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<td>Bathing</td>
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<td>Tub Transfers</td>
<td>Dependent</td>
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</tr>
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<td>Toilet Transfers</td>
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<td>Transfers</td>
<td>Maximal Assist</td>
<td>Modified Independent</td>
</tr>
<tr>
<td>Toileting</td>
<td>Moderate Assist</td>
<td>Modified Independent</td>
</tr>
<tr>
<td>Memory</td>
<td>Minimal Assist</td>
<td>Independent</td>
</tr>
<tr>
<td>Problem Solving</td>
<td>Minimal Assist</td>
<td>Independent</td>
</tr>
<tr>
<td>Social Interaction</td>
<td>Supervision</td>
<td>Independent</td>
</tr>
</tbody>
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## Outcome Measures

<table>
<thead>
<tr>
<th></th>
<th>Admission</th>
<th>Discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Assessment</strong></td>
<td>Right Left</td>
<td>Right Left</td>
</tr>
<tr>
<td><strong>Grip</strong></td>
<td>40 PSI 0 PSI</td>
<td>66 PSI 15.6 PSI</td>
</tr>
<tr>
<td><strong>9 Hole Peg Test</strong></td>
<td>47 Sec 999 Sec</td>
<td>36.3 Sec 126 Sec</td>
</tr>
<tr>
<td><strong>Box and Blocks</strong></td>
<td>42 Blocks 0 Blocks</td>
<td>54 Blocks 26 Blocks</td>
</tr>
<tr>
<td><strong>Fugl Meyer</strong></td>
<td>66 Points 9 Points</td>
<td>66 Points 42 Points</td>
</tr>
</tbody>
</table>
WHERE TO GO FROM HERE?

- Lack of repetition research in general
  - Abundance of animal vs human research
- Translating results of animal research
  - Utilization of clinical judgment/inferences with current research
- Magic number of repetitions still unknown
- Lack of research with subjects who have fully flaccid UEs
- Sheltering Arms current research project
QUESTIONS?


