USING THE PRINCIPLES OF NEUROPLASTICITY AND MOTOR LEARNING TO IMPROVE FUNCTIONAL OUTCOMES IN STROKE SURVIVORS: TRANSLATING THE EVIDENCE INTO PRACTICE

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INCIDENCE

• Each year, approximately 795,000 people suffer a stroke.
• On average, someone in the United States has a stroke every 40 seconds.
• Stroke is the third leading cause of death in the United States. More than 140,000 people die each year from stroke in the United States.
• Stroke is the leading cause of serious, long-term disability in the United States.
• Strokes can and do occur AT ANY age. Nearly one fourth of strokes occur in people under the age of 65.

(The Internet stroke center, 2015)
What is Neuroplasticity and how does it affect my treatment?

**WHAT IS NEUROPLASTICITY?**

- **Neuro:** Nerves and/or brain
- **Plasticity:** Moldable or changeable in structure

- Speaks to the adaptive capacity of the central nervous system
- Brain is not a static organ
- Brain changes throughout life and after injury
ANIMAL RESEARCH...

- Monkeys perform "monkey ADLs" bimanually
- Deafferented one of the two forelimbs
- Monkeys stopped using forelimbs
- Learned behavior? (no biologic correlate)
- Termed learned nonuse

ANIMAL RESEARCH (CONT’D)

- Apply operant conditioning to model behavior
  - Force use w. restraint of nondeafferented limb
- Monkeys begin using deafferented side
- Restraint removed – monkeys perform ADLs bimanually

MICHELLE MACK: THE IMPORTANCE OF REPETITION
IS THERE EVIDENCE THAT REPETITION BASED THERAPIES CHANGE THE BRAIN? (LIEPERT ET AL., 2001)

- TMS of the APB
- Learned nonuse before but not after
- Behavior -> plasticity
- This is one example; other strategies that have shown similar effects:
  - Certain types of estim
  - Mental practice
  - Modified CI Therapies
  - Certain types of robotics

BUT, CORTICAL "PLASTICITY" NOT DUE TO ONLY TO INCREASED MOTOR ACTIVITY...

Skill acquisition (Nudo et al., 1996)
No skill acquisition (Plautz et al, 2000; Kleim et al, 1998)

CHANGES IN THE LESIONED HEMISPHERE (NUDO ET AL., 1996)

No training
Training
MOTOR LEARNING INTEGRATES RESEARCH FROM:

- Psychology
- Neurology
- Physical Education
- Rehabilitation

PRINCIPLES OF TASK ORIENTED APPROACH

- Practice of a movement results in improvement in that movement
- Large amounts of practice are required to truly master a motor skill
- Learning requires problem solving, not rote repetition
- Learning does not happen in the absence of feedback
- Optimal learning occurs with high levels of motivation and engagement
- Variable practice conditions are optimal for learning and generalization
- Mass practice promotes better learning than distributed practice
- Whole task practice is more effective than partial task practice

PRINCIPLES OF EXPERIENCE DEPENDENT PLASTICITY

- Use it or lose it
- Use it and improve it
- Specificity
- Repetition matters
- Intensity matters
- Time matters
- Salience matters
- Age matters
- Transference
- Interference
HOW DO WE INTEGRATE THESE CONCEPTS INTO PRACTICE?

THE P.R.A.C.T.I.C.E. PRINCIPLES:
COMMON INGREDIENTS FOR EFFICACIOUS STROKE REHABILITATION

• Part whole practice
• Repetitive, task specific, and goal focused
• Activities should be meaningful to client
• Client driven – goals and content of practice
• Train in a practical way
• Emphasize accomplishments and awareness – copious, diverse feedback, self efficacy, home programs

Page & Peters, Stroke, 2014

INACTIVE AND ALONE

• Pts within 14 days after stroke
• Observed them for 2 consecutive days at 10-minute intervals between 8 AM and 5 PM
BERNHARDT ET AL, 2004 (CONT’D)

• 53% of the time, patients were resting, talking, or eating in bed.
• Patients were alone for 60.4% of the time.
• Patients were in or at beside for 88.5% of observations.
• 0.2% of time is spent in the therapy room.

ERRORLESS LEARNING VS ALLOWING ERROR

• Evidence shows that allowing for error increases the patient’s ability to carryover task completion.
***As therapists we need to learn to be quiet more and allow the patient to make mistakes.

ASSESSMENT OF MOTOR FUNCTION
THE NFL COMBINE APPROACH

• Observing functional, valued activities and timing, videotaping them
• B&B, ARAT, AMAT
• Quantifying quality of performance (0,1,2,3,...)$^*$
• Measuring distance walked, reached, etc.
• Self-reported/Other-reported skills: i.e. stroke impact scale, motor activity log
  Important: Train, Manualize

MOTOR ACTIVITY LOG

• Self report that measures perceived quality as well as quantity of use of affected limb
• A great way to measure changes in learned non-use

<table>
<thead>
<tr>
<th>Amount Scale (AS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 - Did not use my weaker arm (not used).</td>
</tr>
<tr>
<td>5 - Occasionally used my weaker arm, but only very rarely (very rarely).</td>
</tr>
<tr>
<td>4 - Sometimes used my weaker arm but did the activity most of the time (usually).</td>
</tr>
<tr>
<td>3 - Used my weaker arm about half as much as before the stroke (half pre-stroke).</td>
</tr>
<tr>
<td>2 - Used my weaker arm as much as before the stroke (same as pre-stroke).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>How Well Scale (HWS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 - The weaker arm was not used at all for that activity.</td>
</tr>
<tr>
<td>5 - The weaker arm was used during that activity but was not helpful (very poor).</td>
</tr>
<tr>
<td>4 - The weaker arm was of some use during that activity but needed some help from the other arm or moved very slowly or with difficulty (poor).</td>
</tr>
<tr>
<td>3 - The weaker arm was used for the purpose selected but movements were slow or were incorrect in some way (fair).</td>
</tr>
<tr>
<td>2 - The movements made by the weaker arm were almost normal, but were not quite as fast or accurate as normal (almost normal).</td>
</tr>
<tr>
<td>1 - The ability to use the weaker arm for that activity was as good as before the stroke (normal).</td>
</tr>
</tbody>
</table>
**FUGL MEYER**

- **Assesses motor function** – free and easy to use
- **Based on Brunstrom levels**

**Scoring:**
- 0 - cannot do movement
- 1 - can do partial movement
- 2 - can do full movement
OTHER ASSESSMENTS

• Box and Blocks

• Arm Mobility Arm Test (AMAT)

• Action Research Arm Test (ARAT)

INTERVENTION

An elderly woman at an ATM asked me to check her balance, so I pushed her over. Yup, she needs a walker.

• Occupational profile/ life history
  • What does the patient value?
  • What is frustrating them?
  • What do they want/need to do?
• Involve patient in their evaluation and goal setting
• Patient/family education
• Use it or lose it
WHEN IS THE LAST TIME YOU ASKED YOUR PATIENT WHAT THEY WANT TO WORK ON?

You know you are an OT when you can justify trips to the casino as a way to increase ROM, strength, cognition and social emotional well being.

- Door knobs
- Faucets
- Light switches

Because H.E.P. Doesn’t stand for “Hand ‘em Photocopies”!

CONSTRAINT-INDUCED MOVEMENT THERAPY (CIT)

- Components to induce repeated practice with the affected UE include:
  - 6 hour training sessions on 10 consecutive weekdays
  - Mitt 90% of all waking hours during same 2 weeks
  - Behavioral strategies (log; shaping; behavioral contract)
- Increases more affected UE use & function in subacute & chronic CVA pts.
MODIFIED CONSTRAINT-INDUCED THERAPY:
TRANSLATING “PRECLINICAL RESEARCH” TO CARE

• Therapy 3 times/week for ½ an hour
• Practice with the more affected arm for 5 hours/day 5 days/week
• Behavioral techniques (log, shaping)
• Reimbursement (acute and OP)
• Enough time (acute – 4 units of OT; OP – 2-3 units)
• Conditioning/no overtraining
• Compliance
• More UE reps = more opportunity for operant conditioning
• Distributed practice schedule

MENTAL PRACTICE

Therapy session structure

• 15 minutes – Supplemental or preparatory activities
  • Will assist with performance of designated functional task
• 15 minutes – Performance of designated functional task with challenge
• 15 minutes – Listening to mental practice recording of designated functional task
TECHNOLOGY IS CHANGING REHAB

TRANSCRANIAL DIRECT CURRENT STIMULATION

EMG ASSISTED MOVEMENT
TRANSCRANIAL MAGNETIC STIMULATION

HOW DO WE HELP PAST DISCHARGE?

CONSIDERATIONS

• Half of all stroke survivors report feeling abandoned by the healthcare system following discharge from the hospital.

• Relatives perceived that they needed more information and knowledge about stroke and care/medication/rehabilitation/support.

• They also needed to be more involved in goal-setting and in identifying patient needs.
EDUCATION IS KEY

• Stroke.org
• Strokengine.ca
• Local support groups
• Social media
• Community Resources

CLINICAL TRIALS

• www.clinicaltrials.gov
• Local Universities
• Neurologists offices

QUESTIONS???