TIMELINE

- Technology and tools in neurologic rehabilitation
- Measurement and psychology in neurologic rehabilitation
- Interventions in neurologic rehabilitation: MOTOR

TIMELINE

- Interventions in neurologic rehabilitation: SENSORY
- Intervention in neurologic rehabilitation: COGNITIVE
- Case studies in neurologic rehabilitation
- Summary and discussion, questions
Outline and objectives

Participants will be able to:

- Be aware of recent evidence-based advances in neurologic rehabilitation
- Identify psychological principles involved in motivation and measurement in neuro-rehabilitation
- List 4 essential variables for promoting neuroplasticity in neurologic rehabilitation

Outline and objectives

Participants will be able to:

- Describe available resources OUTSIDE of the nervous system for stroke recovery
- Describe modalities for and interventions designed for sensory neuroplasticity
- Improve patient outcomes.

Neuroplasticity: The laws of demand and supply

The rules have changed. We must consider the brain changeable under and condition and any time frame until proven otherwise.

The brain has potential to change at any stage in life. Attention to new information stimulates neuronal branching.

YOU can change a patient’s brain in 10 min!

The brain must see a need to...

Survive, protect, compete, improve...

If there is no challenge
If there is no chance
If there is no expectation
If there is no success

There is no stimulus to continue to improve…
Manipulation of (4) key practice variables appears to be critical for evoking neural plasticity and behavioral recovery.

- Task Complexity
  - Jones et al., 1998
- Task Difficulty
  - Plautz, Milliken, and Nudo, 2000
- Task Specificity
  - Nudo et al., 1997
- Task Intensity
  - Sullivan et al., 2002
  - Van Pragg et al., 1999

**WHAT DO WE MEAN BY INTENSITY?**

Intensity defined in general
- Webster’s: “the quality of being intense, specifically, extreme degree of anything”.

The term intensity...
- “Several animal studies have shown that neurorecovery and functional performance are enhanced after cortical infarction when postinjury training incorporates motor tasks of greater complexity and higher-intensity demands than training conditions that do not.” (Sullivan, 2002)
The term intensity...

- “…the majority of evidence then indicates that functional improvement through the use of CIMT is attributable to the intensity of training...” (Wolf, 2007)
- “Repetitive task practice combines elements of both intensity of practice and functional relevance.” (French, 2007)

DOSAGE

Intensity (amount of weight)

Frequency (# sessions/week)

Duration (length of each training session)

Volume (sets x reps)

Resistance training prescription
For the purpose of changing muscle.
DOSAGE PRESCRIPTION FOR NEUROLOGIC REHAB?

And what is the purpose?

• Optimal dosage for our patients to make functional changes?
• Or to make neuroplastic changes?
• Or both?
• What are we measuring?

Define our DOSAGE terms in neurologic rehab, specifically the term INTENSITY.

Intensity defined

• Defined as number of repetitions provided
  – Repetitions-COMPONENT OF VOLUME
Intensity defined

- Defined in terms of number of hours of consecutive therapy. (Page, 2003)
- Number of repetitions within a set duration. (Dromerick, 2000, 2010)
  - DURATION
  - DURATION AND COMPONENT OF VOLUME

Intensity defined

- Defined as the average hours of therapy provided per day across the entire length of stay. (Jette, 2005)

Intensity defined

- GRADING of activity/task
  The effort or the load of the task being performed. (Sullivan, 2002)
- Step training at speeds faster than an individual's known capability over ground.

Untapped resources

STROKE, BRAIN INJURY, AND DEGENERATIVE DISEASES

When we focus on resources OUTSIDE of the nervous system...does this necessarily mean compensation?
RESOURCES in and outside the nervous system impact participation

CAPACITY

Impact

CAPABILITY

Activity

Nudo & Dancause (2007)

PERIPHERAL REHABILITATION POTENTIAL = untapped resources

- Muscular strength
- Muscular endurance
- Cardiovascular endurance
- PSYCHOLOGICAL

Point by point... how you intervene

- Muscular strength:
  - Resistance tolerated 8-12 reps
  - 3-4 days/week
  - 2-3 sets
  - “Expect soreness”

Are we INTENSE enough in these arenas?
Point by point…how you intervene

- Muscular endurance
  - Resistance 15-20 repetitions
  - 3-4 days/week
  - Multiple sets

- Cardiovascular endurance
  - Sustained activity, whole body as able
  - 30 minutes
  - 10 minutes, 3+/day acceptable (cumulative)
  - 4-7 days/week

Point by point…how you intervene

- Muscular strength:
  - Muscular endurance
  - Cardiovascular endurance
  - Somatosensory neuroplasticity
  - Motor control neuroplasticity
  - PSYCHOLOGICAL

Point by point…how you intervene

- PSYCHOLOGICAL
  - Understand that the brain can change
  - Understand that I can improve
  - SEE that I have improved
  - Know that challenge = opportunity to improve
  - Use MEASUREMENTS to prove potential
Example: recovery 4 years post CVA
Reversing the secondary changes of:

- Deconditioning (*strength*)
- Deconditioning (*endurance*)
- Sensory nonuse (*visual dependence*)
- *Imbalance* from fear and deconditioning
- *Flexibility*-led biomechanical impairments

Measurement and psychology in neurologic rehabilitation

- Video Case Example
- Patient evaluation + discussion

Interventions in neurologic rehabilitation: MOTOR

- Are direct motor control improvements in the face of CNS lesion considered RESTORATIVE or COMPENSATORY?
- Are we actually restoring the same connections that were lost?

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Point by point... how you intervene

- Motor control neuroplasticity
- As discussed – demand and supply
- Task specific
- Repetition-based
- MUST be challenged…and see progress
- RIPE – a model to structure your intervention

Neurologic rehabilitation

- ANY patient can improve ANYTIME
- Measurement priority
- Requires consistency and intensity
- RIPE

Neurologic rehabilitation

- ANY patient can improve ANYTIME
- Consider peripheral resources
- Measurement priority
- Requires consistency and intensity
- RIPE

Neurologic rehabilitation

- ANY patient can improve ANYTIME
- Measurement priority
- Consider the psychological effects of seeing yourself improve
- Requires consistency and intensity
- RIPE
Neurologic rehabilitation: RIPE

- **Repetitions**: The nervous system requires a consistent and frequent opportunity to see what changes can and should be made. Exposure incentivizes the system to improve so that the same error is not repeated again.

- **Intensity**: Requiring an individual to push and explore their limits of performance in the form of speed, balance, resistance, accuracy/skill, or cognition. MAY NOT require an increase in heart rate or extended practice without rest.

- **Promise**: Task-specific practice revealing the possibility of a higher level of function than the learner currently operates. (Adjusting task difficulty enough to provide the learner with some level of success)

- **Error**: Tasks that are too hard give no hope for improvement and no reason for change
Neurologic rehabilitation: RIPE

- Error: Systematically grading tasks to increase difficulty in an effort to reveal a fundamental need for change.

Loss of balance, need for assistance, speech fluency, missed button in dressing, etc. 
*Tasks that are too easy do not require change.*

RIPE: preparing the nervous system

Providing frequent reality-based and challenging practice in a safe situation where the learner can make and see errors without consequence of injury or complete failure

Applications to mobility, ADL, communication,

Interventions in neurologic rehabilitation: SENSORY

- Does sensory neuroplasticity occur in response to CNS lesion?

- Are the mechanisms similar?

Manipulation of (4) key practice variables appears to be critical for evoking neural plasticity and behavioral recovery

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Somatosensory reweighting: \textit{WHY} to improve sensation

- Patients become dysfunctionally dependent on faster and more accurate stimuli
- Sensory “learned nonuse”
- Systematically removing strong/dependent sensory stimuli
- Force the brain to improve accuracy
- Improve timeliness and accuracy

Point by point...how you intervene

- Sensory neuroplasticity
- Remove sensory strengths
- Vision
- Somatosensation
- Daily +

Brainstem/cerebellar + Parietal stroke rehabilitation: Sensory neuroplasticity

- Sensory reweighting
- Adaptive training with visual conflict and head motion

Videotape examples

- Sensory neuroplasticity
- Remove sensory strengths
- Vision
- Somatosensation
- Daily +
Somatosensory reweighting: **HOW** to improve sensation

- Patients become dysfunctionally dependent on faster and more accurate stimuli
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Intervention in neurologic rehabilitation: COGNITIVE

- Should PT be involved and attempt to intervene to remediate cognitive impairments?
- Billable?
- Functional?
- Qualified?
- Are the mechanisms for cognitive recovery similar to those in sensory and motor?

Complication: Cognitive impairment in the stroke patient

Pushing for more attention, challenging the brain

If we can demand it, can the brain supply it? INTENSITY, SPECIFICITY, DIFFICULTY, COMPLEXITY = neuroplasticity

When and how to challenge attention...

Learning DEMANDS attention!

How can we acquire and SUSTAIN a patient’s attention?
1) Interest
2) Testing
3) Challenge (patient competition)/dual tasking
4) Self monitoring expectations
5) Patient predictions
Rehabilitating Attention: Interest

Consistent with the ICF model

- Know the PERSON you are working with -
- Capture THEIR interest - tie to premorbid.

“A person’s attention is only as good as their interest.”

Rehabilitating Attention: TEST

Nothing captures a person’s attention like the word…

Rehabilitating Attention: Challenge

Consider patient personality
- Confidence
- Self efficacy

Competing against themselves, you, another patient or an issued “challenge”

Rehabilitating Attention: Patient Predictions

Patients estimate their abilities, become invested in the outcome: Ask them to predict:

“How much help will you need?”
“How much time will it take you?”
“How many times will you lose your balance?”
Rehabilitating Attention: Patient Predictions

Reinforcing learning from previous efforts
Advancing patient awareness
Fewer cues or “logic” from therapists

Pre task delivery with post task review
“How will I do next time?”

Rehabilitating Attention: Goals

Recognize when safety is compromised:
requires awareness

Accommodation/habituation: handle more complex and distracting environments

Error Estimation

<table>
<thead>
<tr>
<th></th>
<th>Underestimates</th>
<th>Overestimates</th>
<th>Accurate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient gains awareness of their impairment, is pleasantly surprised by their performance + benefits from this experience</td>
<td>Therapist obtains information about patient awareness. Patient gains insight about the amount of assistance needed. Sets a more realistic goal + strives to meet the previous goal</td>
<td>Therapist notes patient awareness is accurate for this trial. Patient is pleased with their performance</td>
<td></td>
</tr>
</tbody>
</table>

Challenging the brain - allowing errors to promote self-awareness

Systematic cueing strategy

We allow patients to struggle in transfers, in ADLs, why not in problem solving?
Dual task testing: An objective measure of attention?

Combine a standardized or objective measure with everyday distracters

Compare performance with/without distracter

Compare performance pre/post intervention

The result is your functional attention cost

Dual tasking: Returning automaticity to gait

Remember: DEMAND yields SUPPLY

- If you do not challenge dual-task attention, the brain will not supply it…

Learning with a neurologic impairment: summary

Capture attention - meaningful tasks!
Sufficient stimuli - recognizable goal/error
STAY QUIET and HANDS OFF if possible
Overt or subtle retention testing
Follow the steps for awareness rehabilitation
Value silence: “Say less, mean more”
More active patient involvement – providing feedback
Introduce dual tasking at the right time
Measure your results!
Dosage: Dual task training

- ~70% success rate (pathway deviation, LOB, timed testing, etc.)
- Cognitive vs manual
- Random vs blocked
- Focus on primary vs secondary task
- Pre-cued for allocation of attention?

Intensity: Dual task training

- Focus on adding more demands to enable the learner to make the primary task (functional mobility, swallowing or ADLs) automatic

Dual task training

<table>
<thead>
<tr>
<th>Mobility</th>
<th>Manual</th>
<th>Cognitive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walking</td>
<td>Carry water</td>
<td>Remember a fact/word during mobility</td>
</tr>
<tr>
<td>Standing w/ eyes closed</td>
<td>Pour water</td>
<td>Read from a magazine</td>
</tr>
<tr>
<td>Walking up stairs</td>
<td>Pull things out of a bag</td>
<td>Object recognition</td>
</tr>
<tr>
<td>Walking on uneven surfaces</td>
<td>Turn pages of a magazine</td>
<td>Alphabet backwards</td>
</tr>
<tr>
<td>Propel a w/c</td>
<td>Dial a phone</td>
<td>Recite a phone number</td>
</tr>
<tr>
<td>Get in/out of a chair rapidly</td>
<td>Write a note</td>
<td>Hold a conversation, keep eye contact</td>
</tr>
<tr>
<td>Walking backwards</td>
<td>Button a shirt</td>
<td>Count backwards by sevens</td>
</tr>
<tr>
<td>Avoiding obstacles</td>
<td>Thread a belt</td>
<td>Think of things you need to do this month</td>
</tr>
</tbody>
</table>

Functional Dual Task Testing

Case study
Practice variables remain for cognition

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Case Studies: More applications!

Video examples, case studies

- Case studies in neurologic rehabilitation
- Forcing LE motor pattern and skill change
- Forcing core engagement
- Forcing LE motor recruitment and force

Therapist

- Task specificity
- Task complexity
- Task difficulty
- Task intensity

Patient

- I want to be able to do this
- I trust my therapist
- I will be able to do this
- This is worth the struggle
Making a MATCH

Demand
And
Supply

A balance of allowing the patient to struggle enough during safe practice that the nervous system sees a need to make a change. This takes into consideration patient awareness, personality and their current levels of physical abilities.

Case Studies: Make a MATCH

 Meaning – for the learner, not the therapist
 Active – learner driven and evaluated
 Task specific – real world, not contrived
 Challenge – demanding more from the system
 Hope – within reach

WARNING

- The following case studies are to be viewed at your own discretion. Some footage may be contrary to your current approach to practice and may involve patients being challenged – intensively.

- If you are averse to watching a patient struggle – please do not open your eyes.

Technological advances in neurologic rehabilitation

- Body-weight supported treadmill training
- Robot aided therapy
- Electrical Stimulation
- Motor Learning – lesion specific
Body Weight Supported Treadmill Training (BWSTT)

- Central Pattern Generator (CPG)
- Medial Reticulospinal Tract
- Weight support: effects on compensation
- Neuromuscular intensity
- Reduced cardiopulmonary workload
- Carryover, posture, speed
- Reducing patient fear

Learned non use and dysfunctional neuroplasticity

- Overcoming “the bad habits” with intensity and a forced-use approach
- One of the MAIN reasons why YOU can help ANY stroke patient improve

Task specific circuit training

- Sit to stand repetitions
- Standing without UE support or vision - compliant surface
- Ascending stairs with the affected LE
- Sit to supine repetitions
- High speed or weighted LE efforts BWSTT
- More…

Resources in and outside the nervous system:

CAPACITY

- Impairment

CAPABILITY

- Activity

Participation

Nudo & Dancause (2007)
Misconceptions about the frail and very elderly “neuro” patient

- Memory decline is normal
- Endurance, strength decrease with age
- Falling is a part of aging
- People can maintain, but not GAIN strength
- Dizziness is a part of aging

The frail and very elderly “neuro” patient

- Memory decline is a factor of attention – and limited stimulation in routine environments
- People can make endurance, strength improvements at any age
- Falling is often a “Use it or lose it” problem of balance or a person to task mismatch. This may be in the form of physical or cognitive.

The frail and very elderly “neuro” patient: MEASUREMENT

- Objective recordings that can be reproduced to prove real changes within a patient’s case
- Bed mobility
- 5x sit to stand
- Unassisted sit to stand height
- 10’ w/c propulsion
- Standing endurance

The frail and very elderly “neuro” patient

- Measurement is critical
- HOW do I measure the frail patient?
- Frail patient considerations…
Frail patient considerations

- Psychology of rehabilitation
- Nutritional considerations
- Evidence and recommendations: ACSM
- Provide body weight support to allow for endurance improvements
- Build RESOURCES, then function

Summarize the potential

- Enable a patient to improve through intensity
- Force the brain and body to improve
- Read a patient to dose intensity
- Less from the therapist, more from THEIR brain
- Use measurements to motivate
- The more you cue, touch, help them...the more they need you

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