EVIDENCE BASED PRACTICE RELATED TO GAIT TRAINING IN THE SCI AND CVA POPULATION

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ABOUT ME

• **Brett Rice PT, DPT, NCS**
  
  • Graduate of the University of Indianapolis Krannert School of Physical Therapy (Class of 2011)
  
  • Experience in stroke rehabilitation in both acute care and inpatient rehabilitation settings
  
  • Currently employed at Vanderbilt Stallworth Rehabilitation Hospital
    – Co-Chair of the Stroke Program
OBJECTIVES

• Understand the principles of motor control, motor learning, motor recovery and neural plasticity after stroke

• Identify characteristics and changes in gait following stroke

• Utilize evidence based treatment techniques for gait training in the patient with hemiparesis

• Explore clinically relevant barriers to evidence based practice available in the PT literature
LETS START WITH SOME THEORY
MOTOR CONTROL

• *Motor control* is defined as the ability to regulate the mechanisms essential to movement

• Controlled movement involves the interaction between the individual, task, and environment.

• Make a movement plan and execute

Shumway-Cook et al 2007
MOTOR LEARNING

• "An internal neurologic process that results in the ability to produce a new motor task"

• Fitts and Posner Three Stage Model of Motor Learning:
  - Cognitive
  - Associative
  - Autonomous.

• Measurements of Motor Learning:
  - Acquisition
  - Retention
  - Transfer of Skills

Magill 2011
PRACTICE MAKES PERFECT?

• Importance of Practice
  - Amount of Practice
  - Whole vs. Part Practice
  - Constant vs. Variable Practice
  - Mental Practice

Muratori et al 2013
MOTOR LEARNING

• Importance of Feedback
  – Intrinsic vs Extrinsic

  – Mode of Extrinsic Feedback
    • Composition
    • Frequency
    • Modeling
    • Manual Guidance

Muratori et al 2013
Skilled actions are those that demonstrate *consistency, flexibility and efficiency*.

Muratori et al 2013
NEURAL PLASTICITY
NEURAL PLASTICITY

- **Definition**: the ability of the central nervous system (CNS) to adapt in response to changes in the environment or lesions. (Sharma et al 2013)

“There is overwhelming evidence to indicate that the brain continuously remolds its neural circuitry in order to encode new experiences and enable behavioral change” (Kleim et al 2008)
TEN PRINCIPLES OF NEURAL PLASTICITY

1. Use It or Lose It
2. Use It and Improve It
3. Specificity
4. Repetition Matters
5. Intensity Matters

Kleim et al 2008
TEN PRINCIPLES OF NEURAL PLASTICITY

6. Time Matters
7. Salience Matters
8. Age Matters
9. Transference
10. Interference

Kleim et al 2008
HOW EARLY IS TOO EARLY

• AVERT TRIALS – Phase II
  – Safety and Feasibility
  – Patients at <24 hours after stroke
  – Standard Care vs Standard Care + VEM
  – Safety outcome was number of deaths at 3 months.
  – There was no significant difference in the number of deaths between groups

Bernhardt et al 2008

• AVERT TRIALS – Phase III
  – 2104 participants
  – Divided between Very Early Mobilization (VEM) and Usual Care (UC)
  – “This VEM protocol was associated with reduced odds of favourable outcome at 3 months cautioning against very early high-dose mobilisation.”

Langhorne et al 2017
GAIT TRAINING
WHAT IS OUR GOAL?

• Patient centered

• Restore automaticity / independence
  – “Community dwelling stroke subjects display the same level of automaticity of walking as elderly controls, but both elderly controls and stroke subjects are less automated than young controls” (Canning et al 2006)
  – 65% to 85% of stroke survivors learn to walk independently by 6 months post stroke, gait abnormalities persist through the chronic stages of the condition. (Wade et al 1987)

• Restore community required gait speed
FUNCTIONAL IMPAIRMENTS RELATED TO STROKE

- Motor impairments
- Somatosensory impairments
- Spasticity
- Motor coordination and balance

Wilson et al 2019
GAIT REHABILITATION PROGRAM

- muscle strength training
- task-specific gait training,
- treadmill training,
- electromechanical and robot-assisted gait training,
- functional electrical stimulations
- ankle foot orthoses (AFOs)
- virtual reality,
- mental practice with motor imagery
- botulinum toxin injection of spastic muscles

Verma et al 2012
Tenniglo et al 2014
Bevaert et al 2015
Hsu et al 2017
Jacinto et al 2018
Muscle strength training

Task-specific gait training

Treadmill training
MUSCLE STRENGTH TRAINING (INPATIENT)

• **Moreland et al:**
  - *Progressive resistance strengthening exercises after stroke.*
    - Inpatient conventional physical therapy versus conventional + resistive exercises with weights, 30 minutes, 3X/week.
    - No difference in 2 minute walk test or Disability Inventory

• **Badics et al:**
  - *Systematic muscle building exercises in the rehabilitation of stroke patients*
    - Rehabilitation which included leg extensor presses, arm presses (triceps) at 30–50% MVC, 3–5 sets of 20 repetitions.
    - 31%↑ in LE strength and 37%↑ in UE strength.
MUSCLE STRENGTH TRAINING (OUTPATIENT)

• Weiss et al:

• *High intensity strength training improves strength and functional performance after stroke*

  - 12 week, 2X/week resistance training for both LEs (leg press, knee extension, hip motions) at 70% 1 Repetition Maximum.
  - **No change gait speed.**
    - ↑ Motor Assessment Scale (lower limb score).
    - ↑ Berg balance score by 5 points.
MUSCLE STRENGTH TRAINING

“Although there is evidence that strength training alone can improve muscle strength, **further evidence** is needed to determine the carry-over effects of strength training to functional tasks in people with stroke” (Eng J 2004)

“Stroke survivors who had gained muscle strength or aerobic capacity during non-task specific training lost these improvements after the program was over” (Severinsen et al 2014)
COMPARISON OF OVER GROUND GAIT TRAINING TO BWS TREADMILL TRAINING
OVERGROUND GAIT TRAINING

• What is over ground gait training?
  – Real-time cueing of the patient’s gait by the use of manual, verbal, positional, or rhythmic cueing techniques
  – Practice of the walking pattern overground
  – Pregait activities such as step-up and step-down exercises, dynamic balance training, weight-bearing exercises to strengthen the lower extremities, and other exercises that require standing and weight-shifting

• Does not include high-technology aids such as functional electric stimulation or body weight support

States et al 2009
TREADMILL TRAINING PROTOCOL

- Body Weight support treadmill training protocol McCain et Al:

- Objective: To investigate the impact of locomotor treadmill training with partial body-weight support (BWS) before the initiation of over ground gait for adults less than 6 weeks poststroke.

- Setting: Inpatient Rehabilitation

McCain et al 2008
TREADMILL TRAINING PROTOCOL

Inclusion Criteria

• Males or females 16-80 years of age
• < 6 weeks post first time ischemic or hemorrhagic stroke
• Able to stand with or without assistance
• No significant therapeutic gait practice prior to start of study

Exclusion Criteria

• Bilateral stroke
• Non ambulatory prior to stroke
• Significant cognitive impairment
• Severe cardiac problems and/or recent MI (4 weeks)
• Able to complete 5 or more full heel raises with affected ankle in standing with knee extended with no more than 1-2 fingers on support surface at time of enrollment in treadmill group

McCain et al 2008
TREADMILL TRAINING PROTOCOL

**Amount of BWS**

- Initial amount of BWS is 30%
- Goal: reduce BWS in 5% increments
- BWS should be monitored and adjusted daily as well as adjustments in speed.

**Treadmill Speed**

- Initial treadmill speed: 0.7 mph
- Goal: increased treadmill speed by 0.1 mph increments
- Speed is increased when the participants can tolerate 2 consecutive bouts of 3 minutes at the same speed.

McCain et al 2008
TREADMILL TRAINING PROTOCOL

Amount of Assistance

• The participant is assisted by two people, one who assists the hemiparetic LE and one who assists with weight shift at the hips.

• Occasionally a third person is required for initial training sessions to achieve good mechanics on the less affected LE.

• Participants are **NOT** allowed to hold the treadmill bar at any time during training.

Duration of Treadmill Training

• Treadmill training continues throughout the rehabilitation stay until the participant can tolerate 10 consecutive minutes at 1.8 mph with no BWS and no assistance for LE or weight shift. The vest is still on for safety.

• Each training session is 30 minutes TOTAL.

McCain et al 2008
TRANSITION TO OVER GROUND WALKING

• Gait training over ground is initiated when the participant is able to tolerate 2 consecutive bouts of at least 3 minutes at < 10% BWS at 0.8 mph or greater with minimum assistance or less for LE advancement.

• Over ground training is done with the AFO and a single point cane.

• Once over ground gait begins, 20 minutes is spent on treadmill gait and 10 minutes on OG gait.

McCain et al 2008
RESULTS

• Recorded outcomes examined:
  – Gait symmetry
  – Gait velocity and endurance
  – Incidence of falls
  – Assistive device use

McCain et al 2008
RESULTS AT 6 MONTHS

• Symmetry values were superior in the research group compared to published values of symmetry in similar patients.

• All but 1 of the 18 participants had speeds adequate for community ambulation (0.8 m/s).

• The 6-MWT mean distance at the 6-month reassessment for all participants was 322.42 m (+/- 114.33), more than published values for persons with stroke.

• 10 of the 18 participants walked at home and in the community without any AD or AFO. Three persons used only an AFO, 4 used an AFO and STC, and 1 used only a STC.

• Only 28% reported falls (1 participant had 2 falls), whereas incidence of falls has been reported between 40-73% for community-dwelling persons 6 months post stroke.

McCain et al 2008
“Application of locomotor treadmill training with partial BWS before overground gait training may be more effective in establishing symmetric and efficient gait in adults postacute stroke than traditional gait training methods in acute rehabilitation” (McCain et al 2008)
Treadmill training and body weight support for walking after stroke (review) : Mehrholz J, Pohl M, Elsner B.

- “Overall, people after stroke who receive treadmill training with or without body weight support are not more likely to improve their ability to walk independently compared with people after stroke not receiving treadmill training, but walking speed and walking endurance may improve”

- “In practice, therapists should be aware that treadmill training may be used as an option but not as stand-alone treatment to improve the walking speed and endurance of patients who are able to walk independently. It appears that patients who are able to walk independently, but not patients who are unable to walk independently, may profit from treadmill training with and without body weight support to improve their walking abilities.”

Mehrholz et al 2014
BWS TREADMILL VS OVER GROUND GAIT TRAINING

• Treadmill training performed over 4 months showed significant walking improvements compared to over ground training (Ada et al 2013)

• Over ground gait training was more beneficial than body weight-supported treadmill training at improving self-selected walking speed for the participants in this study (Combs-Miller et al 2014)

• Significant walking function improvements occurred using over ground and treadmill training, but there were no significant differences between these groups. (Rensink et al 2009)
SO WHAT DOES THIS MEAN?

"Behavioral experience is the most potent modulator of brain plasticity"

• TASK SPECIFIC
• INTENSITY

Nudo 2013
REALE WORLD STATISTICS / CLINICAL IMPLICATION

• Vanderbilt Stallworth 2018 CVA Statistics
  – Average Length of Stay: 16.28 days
  – Discharge Location:
    • Community – 58%
    • SNF – 19%
    • Acute Care Transfer – 23%
  – Disease Specific Teams
  – CVA Joint Commission Certification

• Clinical Barriers
TAKE HOME MESSAGE

• Important to apply principles of motor learning and neural plasticity to treatment plans. “why am I doing this”

• The optimal training might be a combination of BWS treadmill with task-specific OG practice.

• TASK SPECIFIC! INTENSITY!

• Limited evidence that isolated LE strengthening has carry over to improvements in gait

• Research is not the real world....

• Gait is an ongoing goal across the acute care, inpatient and outpatient rehabilitation settings. Lifelong goal for patient.
DISCUSSION / QUESTIONS
REFERENCES


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