Modifications to Gait Training using a Motor Learning Approach: A Case Report

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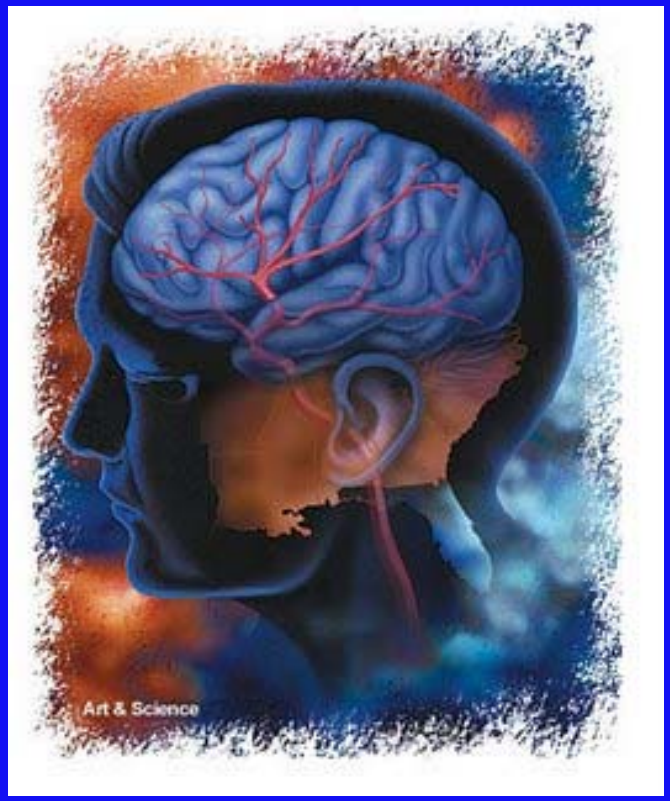
Introduction: Problem



- Stroke is a leading cause of serious, long-term disability in the United States Steinberger, 2007
- 700,000 people experience a stroke annually Steinberger, 2007
- 4.8 million stroke survivors in the United States DeJong, 2005

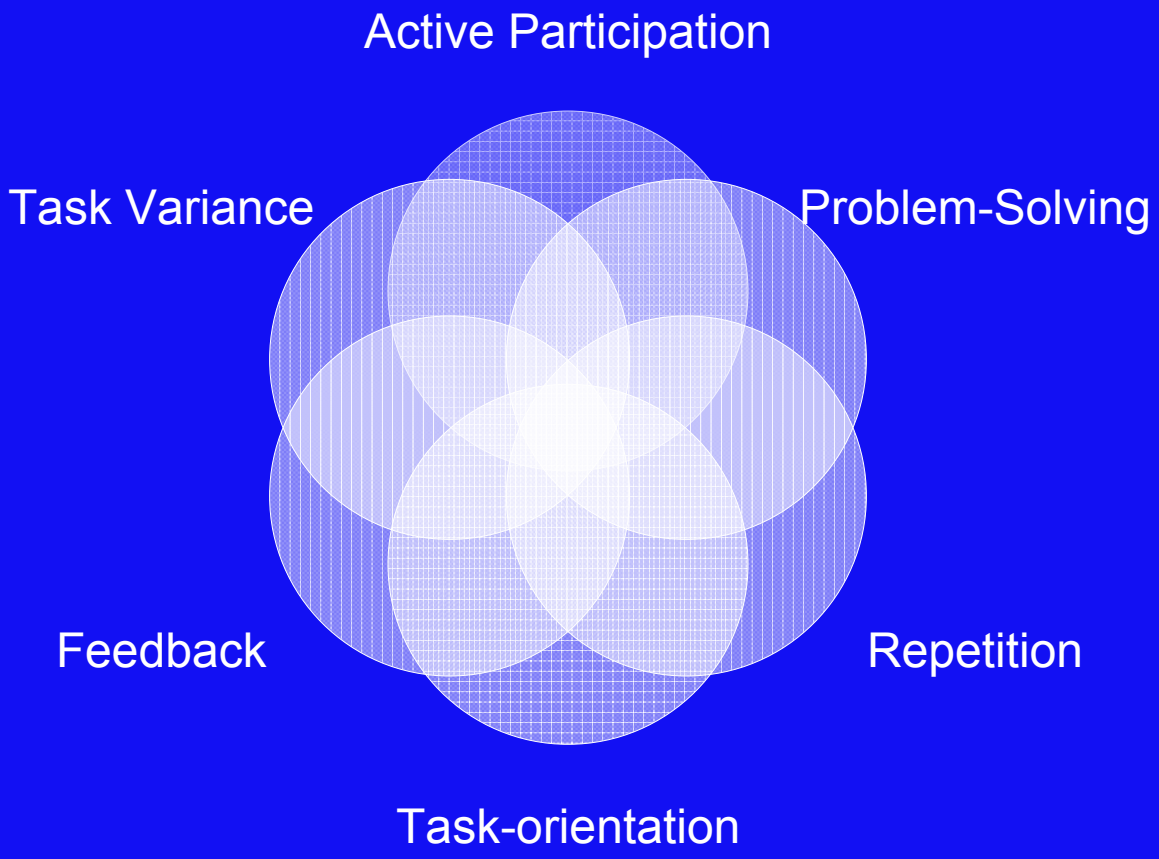
Introduction: Problem

- Physical Therapy is one of the most effective interventions for stroke
- Gait training is associated with better outcomes
- Motor Learning is an effective approach for stroke
- Lack of protocols for use of Motor Learning gait training for stroke

Introduction: Motor Learning

- Active practice of context-specific motor tasks with appropriate feedback Pollock, 2007
- Based on science, exercise physiology, and biomechanics Pollock, 2007
- Applicable to stroke rehabilitation Krakauer 2006
- Drives neuroanatomical changes resulting in motor recovery, retention, and transfer Jonsdottir 2007,Nudo, Pollock 2007, Krakauer 2006

Motor Learning



Motor Learning
Active Participation

Active involvement and the cognitive process of determining how to adapt movements in variable situations is considered the most important element of learning and retention Winstein,1999

Motor Learning
Feedback

- Feedback is one of the most powerful variables affecting motor learning

  Winstein,1994

- Infrequent augmented feedback is optimal for motor learning Winstein, 1994

Motor Learning
Repetition

- Time spent practicing a task is positively correlated to performance
- Repetitive locomotor activity optimizes sensorimotor stimulation and increases neuroplasticity Sullivan, 2002

Motor Learning
Task variance

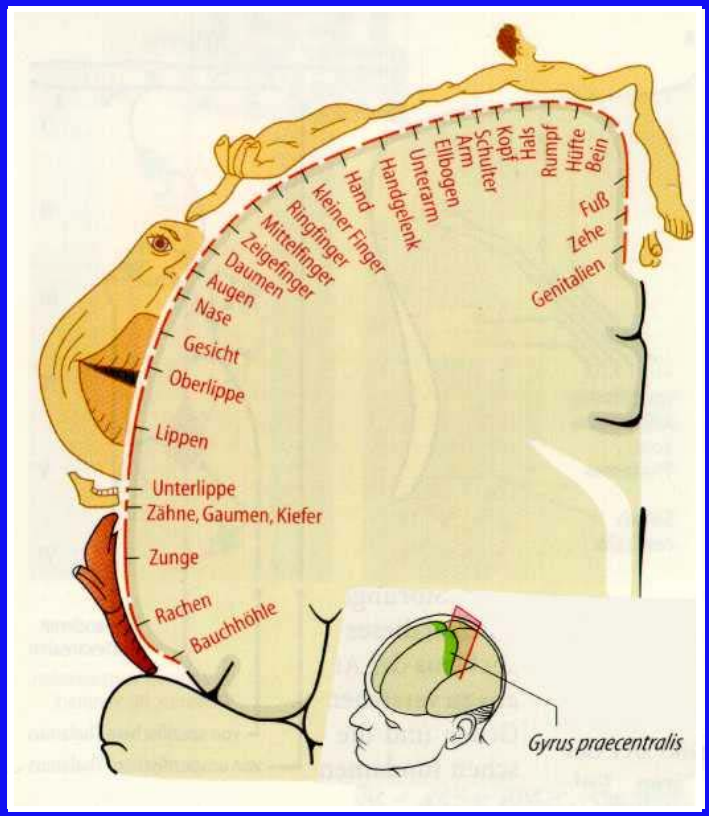
Variable practice and tasks increase development, retention, and generalizability of motor control

Jonsdottir 2007, Sullivan 2002,

Krakauer 2006

Motor Learning
Task-orientation

The topographic organization of the motor cortex is based on groupings of functionally related muscles Nudo



Introduction: Purpose

- To describe the examination and clinical problem solving for the use of a motor learning approach for gait training in a 34 year old female post stroke
- To describe changes in gait parameters observed during the course of treatment

Patient Description

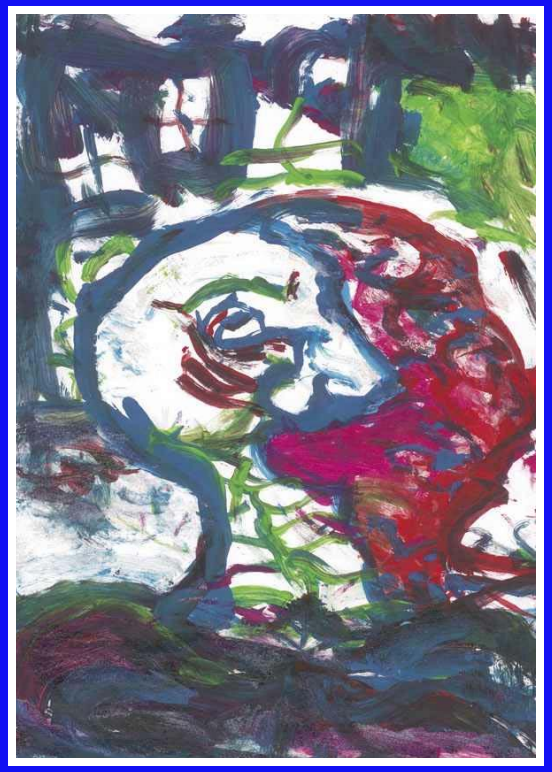
- 34-year-old female
- Lives with parents, sister, and nephews
- Prior function
  - Independent with ADL's
  - Employed as a housekeeper
- Patient signed HIPAA documentation and provided informed consent

Medical Management

- Admitted to acute facility with altered mental status
- Diagnosed with left middle cerebral artery ischemic infarct
- 10 days in acute facility
- Did not receive tPA
- Underwent clot retrieval surgery

Examination: Observation

- Alert and oriented
- Mild Broca's aphasia
- Right-sided neglect
- Right facial droop



Examination: Functional Mobility

- The FIM consists of a seven-point scale
- Shows level of independence for transfers, ambulation, wheelchair mobility, and stair climbing.
- A score from zero to seven is given for each mobility task
- Zero is unable to complete the task and seven is complete independence

Functional Task	Initial score
Bed transfer	**3**
Toilet transfer	**3**
Dry tub transfer	**3**
Wheelchair mobility	**2**
Ambulation	**0**

The interrater reliabililty for the motor scale of the FIM for a variety of populations is 0.96 Ottenbacher, 1996

Examination: Balance

- The Berg Balance Scale measures balance based on functional balance tasks
- Composed of fourteen tasks
- Each rated on a zero to four scale
- The total score possible: 56

The patient scored **5/56** on the Berg Balance Scale, indicating a **high fall risk**

The intrarater reliability of the BBS is high in patients with chronic stroke (ICC 0.98) Lih-Jiun Liaw, 2007

Evaluation: Muscle Performance

- Muscle strength was assessed through manual muscle testing
- MMT performed as described by Kendall
- Strength graded on a five point scale
- A score of zero indicates absence of muscle activation and five indicates normal strength

Hip flexion	2+
Hip extension	4
Knee extension	2+
Ankle dorsiflexion	0
Ankle plantarflexion	1
Ankle inversion	0
Ankle eversion	0

- The levels of agreement attained for intrarater reliability of MMT is very high, ranging from 96%-98%. Cuthbert

Evaluation: Gait Analysis

- Gait was analyzed using Observational Gait Analysis (OGA). Rancho Los Amigos
- Video gait analysis utilized to assess gait deviations before, during, and after BWSTT sessions

The patient was **unable to ambulate** secondary to limited balance, functional mobility, and strength

- Intra-observer reliability of observational push-off in stroke patients is high, ICC=0.89 McGinley, 2003
- Inexperienced clinician raters demonstrate an average intrarater reliability of 0.57 Brunnekreef, 2005

Evaluation: Gait Analysis

Weight Acceptance	• Foot flat contact • Excess knee flexion
Single Limb Support	• Backward lean • Excess knee flexion • Knee wobble
Swing Limb Advancement	•Limited hip and knee flexion • Foot drag

Problem List and Goals

Problem	**Short-term goal (1week)**	**Long-term goal (3 weeks)**
Dependence with transfers	Transfer with minimal assistance (FIM 4)	Transfer with modified independence (FIM 6)
Dependence with ambulation	Ambulate 150 feet, moderate assistance (FIM 3)	Ambulate >150 feet with supervision (FIM 5)
Decreased endurance	Participate in one hour of therapy	Ambulate 300 feet

Patient's goal: Independent ambulation

Plan of Care

- The patient spent 23 days in inpatient rehabilitation
- Total # of visits with a physical therapist: 16
- Total # of Progressive Resistive Exercise classes (PRE): 18
- Total hours of inpatient therapy: 34
- Total # outpatient visits: 3
- Patient self-discharged from outpatient

Intervention: Stage #1 - Early Mobility

Impairment	Task	Goal	Motor Learning Principle
Poor motor control	Wheelchair mobility training	Increased independence	• Problem-Solving • Task orientation
Decreased functional mobility	Transfer training	Increased independence	• Task variance • Problem-Solving
Limited right lower extremity strength	Progressive Resistive Exercise class	Increased strength	• Repetition

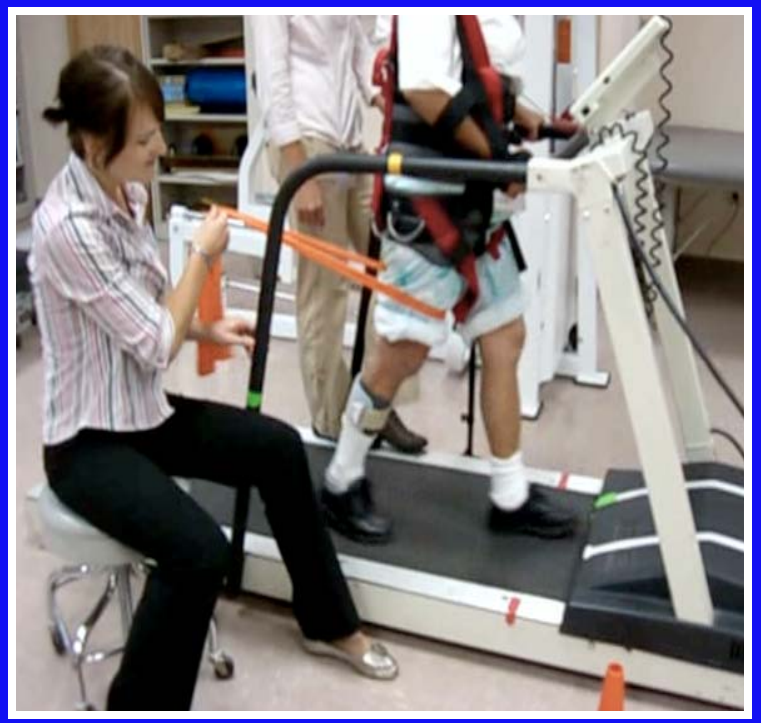
Intervention:

Stage # 2 - Functional Electrical Stimulation

Impairment	Task	Goal	Motor Learning Principle
Hypotonicity	• FES flexor withdrawl • FES over quadriceps	Increased tone	• Sensorimotor integration
Dependent gait	• Alternate FES stimulation	Increased stance stability and foot clearance	• Feedback • Task orientation

Intervention
Stage #3: BWSTT

Impairment	Decreased foot clearance
Task	Theraband-resisted hip flexion
Goal	Increase hip flexion power at initial swing
Motor Learning Principle	• Active Participation • Task variation



Intervention
Stage #3: BWSTT

Impairment	Task	Goal	Motor Learning Principle
Decreased stance stability	Kicking a soccer ball	Increase terminal knee extension	• Task variance • Problem-solving
Decreased foot clearance	Avoid foam	Increase balance reactions	• Task variance • Problem-solving

Intervention:
Stage #4 - Outpatient

Impairment	Task	Goal	Motor Learning Principle
Decreased gait velocity	Variable treadmill speed	Increase velocity	• Task orientation • Task variation
Occasional foot drag	• Resist theraband • Step over cone • Avoid foam	Increase foot clearance	• Task variation • Problem-solving
Decreased dynamic gait	Obstacle course	Increased dynamic gait	• Task variation • Problem-solving

Outcomes: Muscle Performance

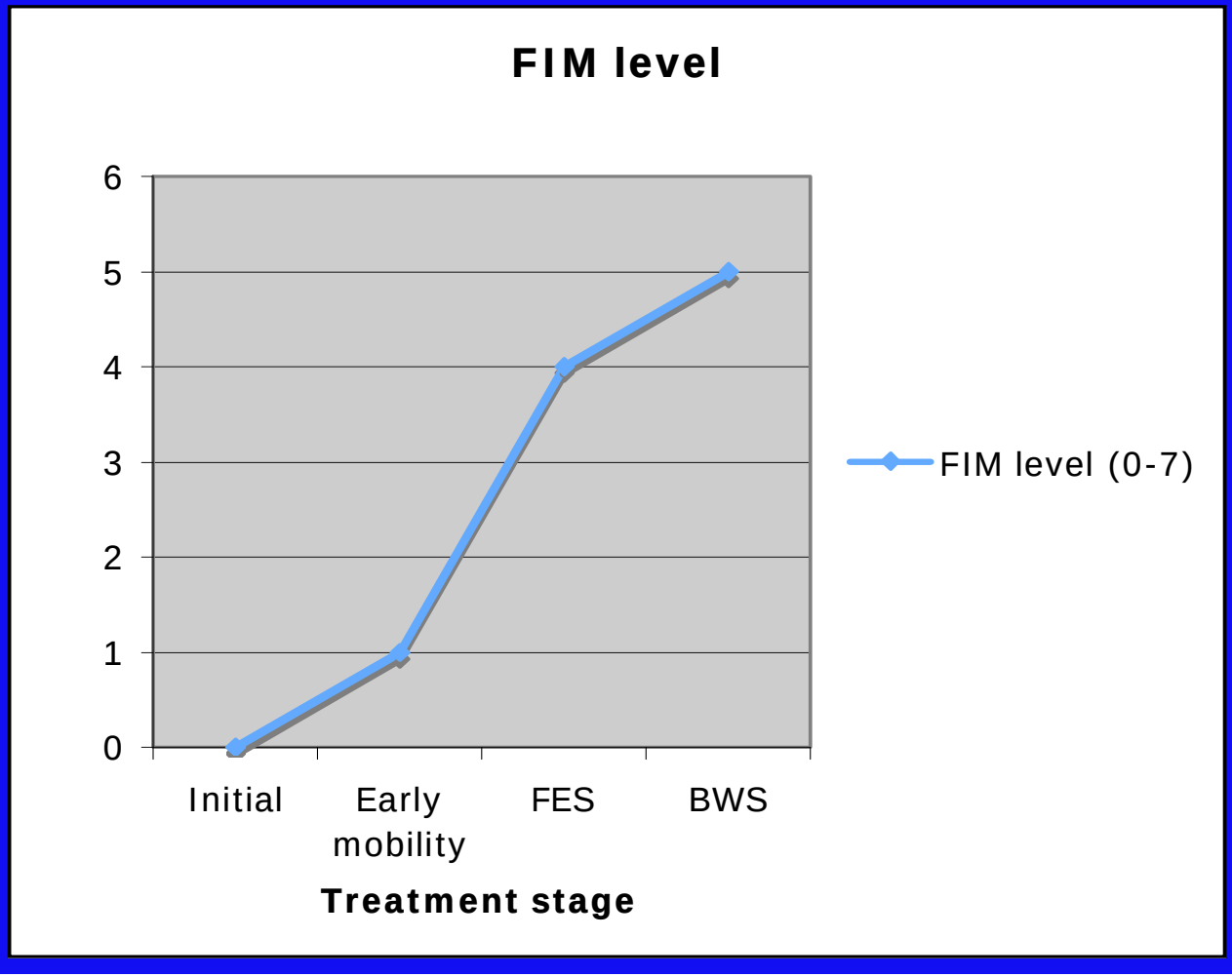
	Evaluation	Discharge from inpatient therapy
Hip flexion	2+/5	2+/5
Hip extension	4/5	4/5
Knee extension	2+/5	3/5
Ankle dorsiflexion	**0/5**	**3+/5**
Ankle plantarflexion	1/5	2-/5
Ankle inversion	0/5	1/5
Ankle eversion	0/5	1/5

Outcomes:
Functional Mobility and Balance

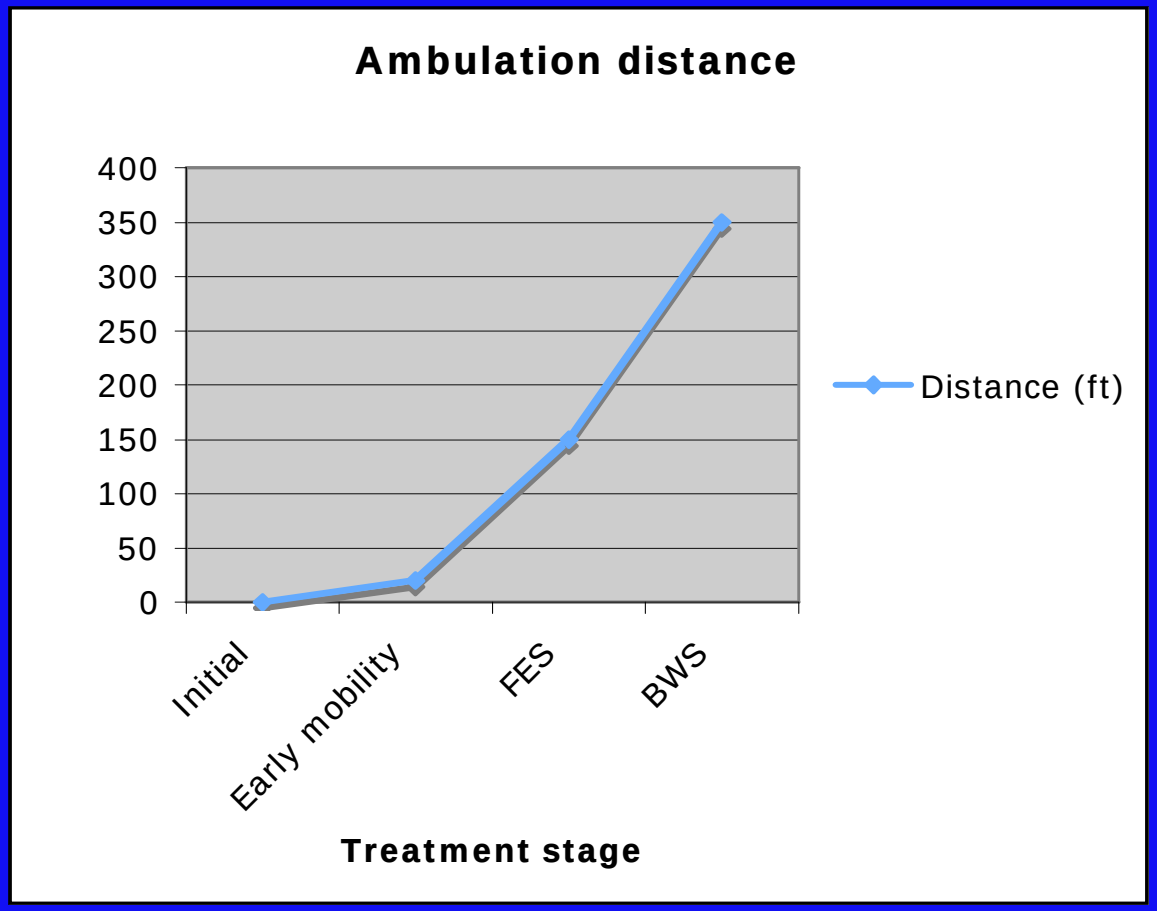
FIM level improved from **3** (moderate assistance) to **6** (modified independent) for all functional mobility

The Berg Balance Assessment score increased from **5/56** to **40/56**

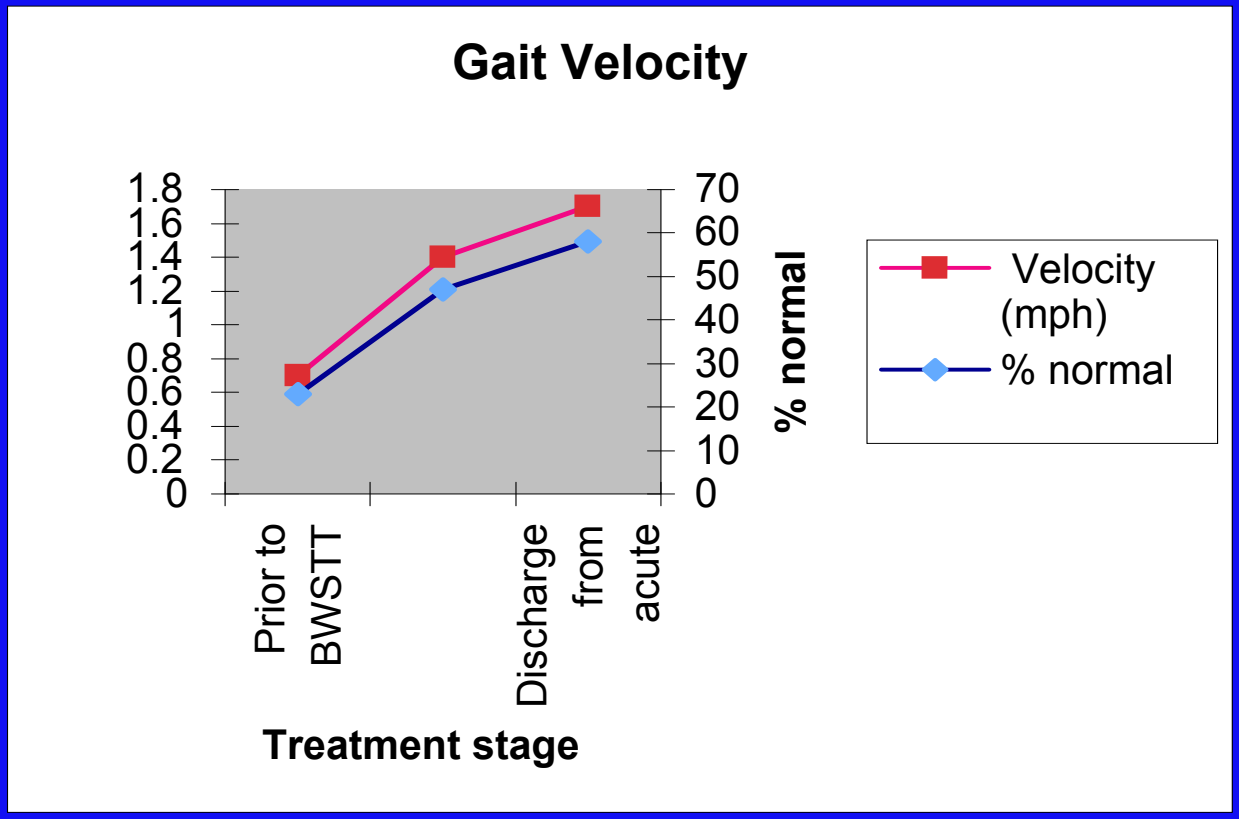
Outcomes: Gait Analysis FIM level



Outcomes: Gait Analysis Distance



Outcomes: Gait Analysis
Velocity



Outcomes: Gait Analysis
Observational

Gait Phase	Improvements	Unchanged
Weight Acceptance	• Heel contact • Adequate knee ext	
Single Limb Support	• Good trunk position	• Excess knee flexion • Knee wobble
Swing Limb Advancement	• Adequate foot clearance • Adequate hip flexion	

Discussion: Motor Learning

- Motor Learning principles can be applied to gait training throughout all stages of treatment
- Gait is functional and repetitive
- Augment feedback and vary the task
- Leads to active participation and problem-solving

Discussion: Recovery Explanations

- Spontaneous recovery due to biological healing process of damaged neurons
- Neuroplasticity:
  - Cortical repesentational maps altered
  - Morphological synapse changes
  - Growth of dendrites
  - Axonal trajectory changes
  - Neurotransmitter modulation
  - New neuronal differentiation occurs

Nudo et al

Discussion: Functional vs Strength Gains

- Spontaneous recovery occurs by undamaged brain recruitment to command same muscle Krakauer, 2006
- Compensation occurs by use of alternate muscles to accomplish tasks Krakauer, 2006
- Explained by patient's improved problem-solving ability to make appropriate compensations
- Motor Learning may explain dramatic improvements in function

Discussion: Who is appropriate?

- Physically able to endure challenges
- Requires capacity to learn
- Requires motivation
  - Trial and Error is frustrating
- Study of focal ischemia in rats
  - Rate of improvement similar before and after lesion
  - Motor improvement is mediated primarily by compensatory mechanisms

  Krakauer, 2006

Discussion: Guidelines for Treatment

- Break down treatment into stages
- Hold yourself back from assisting
- Maintain safe environment
- Analyze specific gait impairments
- Challenge impairments through various tasks
- Be Creative
- Make it fun

Discussion: Limitations

- Observational gait analysis assessed only pre and post BWSTT stage
- BWSTT training intervals, percentage body-weight-support, and speed was not recorded
- Lacks additional gait parameter assessment
- Lacks discharge data due to patient self-discharge

Future Work

- Any functional task can be modified to incorporate motor learning principles
  - Augment feedback
  - Vary task
  - Other components follow
- Motor Learning application to higher level training
  - Sport-Specific
  - Work-related

Conclusion

Given a patient with appropriate cognitive level and the capacity to learn, motor learning principles can be applied to a variety of physical therapy interventions in order to improve outcomes and increase functional level

Acknowledgements

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