# Improving Mobility Through Specificity and Intensity

## Sensorimotor Interventions for Older Adults

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## Principles of Neuroplasticity

<table>
<thead>
<tr>
<th>Principle</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Use it or Lose it</td>
<td>Failure to drive specific brain functions can lead to functional degradation</td>
</tr>
<tr>
<td>2. Use it and Improve it</td>
<td>Training that drives a specific brain function can lead to an enhancement of that function</td>
</tr>
<tr>
<td>3. Specificity</td>
<td>The nature of the training experience dictates the nature of the plasticity</td>
</tr>
<tr>
<td>4. Repetition Matters</td>
<td>Induction of plasticity requires sufficient repetition</td>
</tr>
<tr>
<td>5. Intensity Matters</td>
<td>Induction of plasticity requires sufficient training intensity</td>
</tr>
<tr>
<td>6. Time Matters</td>
<td>Different forms of plasticity occur at different times during training</td>
</tr>
<tr>
<td>7. Salience Matters</td>
<td>The training experience must be sufficiently salient to induce plasticity</td>
</tr>
<tr>
<td>8. Age Matters</td>
<td>Training-induced plasticity occurs more readily in younger brains</td>
</tr>
<tr>
<td>9. Transference</td>
<td>Plasticity in response to one training experience can enhance the acquisition of similar behaviors</td>
</tr>
<tr>
<td>10. Interference</td>
<td>Plasticity in response to one experience can interfere with the acquisition of other behaviors</td>
</tr>
</tbody>
</table>
SPECIFICITY

CASE STUDIES

What Is Backward Disequilibrium and How Do I Treat it?: A Complex Patient Case Study

Patricia L. Scheets, PT, DPT, NCS, Shirley A. Sahrmann, PT, PhD, FAPTA, Barbara J. Norton, PT, PhD, FAPTA, Jennifer S. Stith, PT, PhD, LCSW, and Beth E. Crowner, PT, DPT, NCS, MPPA

Background and Purpose: Postural vertical refers to a component of an individual’s perception of verticality that is derived from information about the direction of gravitational forces. Backward disequilibrium (BD) is a postural disorder observed in some older adults who have a distortion in their perception of postural vertical. Individuals with BD sustain their center of mass (COM) posterior to their base of support and resist correction of COM alignment. The purposes of this case study are to describe a patient with BD and propose a physical therapy management program for this condition.

and employing the specific intervention we have proposed. We believe that failure to recognize and manage our patient’s condition appropriately would have led to nursing home placement.

Video Abstract available for more insights from the authors (see Supplemental Digital Content 1, http://links.lww.com/JNPT/A94).

Key words: backward disequilibrium, diagnosis, movement system, physical therapy, psychomotor disadaptation syndrome

(JNPT 2015;39: 119–126)
SUBJECTIVE VERTICAL

- Perception of upright orientation
- Under normal conditions, subjective vertical aligns with physical vertical through implicit representation of verticality
- Internal representation of vertical established through
  - Visual-Vertical
  - Visuovestibular information
  - Haptic (Touch) Vertical
  - Touch and pressure receptors
  - Postural Vertical
  - Graviceptive—somaesthetic information
**Postural Vertical**

**Psychomotor Disadaptation Syndrome**

- Geriatric Syndrome
- Backward Disequilibrium
- Cautious Gait – Retropulsive Behavior
- Fear of Falling
- Fear with Sit to Stand
- Reactive Hypertonicity
**Backward Disequilibrium**

- COM Posterior to BOS
- Posterior Postural Tilt in Standing and Sitting
- Exposes Patients to Backward Falls
- Insufficient Shift of COM Forward During Sit to Stand
- Altered Perception of Postural Vertical Similar to Patients with Contraversive Pushing Behavior

**Mechanism**

- White Matter Signal Abnormalities
  - Parietal-Occipital area
  - Peri-ventricular frontal
- Redistribution of Functional Reserves
  - Critical threshold
  - Can no longer compensate
- Loss of Postural Reserves
  - Cumulative
  - Similar to acute stress fx
MEASUREMENT

- Mini-Motor Test

- Backward Disequilibrium Scale

MINI MOTOR TEST

- 20 items
  - In bed
  - Sitting position
  - Standing position
  - Gait

- Dichotomous scale
- Inter-rater reliability- r =0.956
### Mini-Motor Test

<table>
<thead>
<tr>
<th>Category</th>
<th>Items</th>
</tr>
</thead>
</table>
| **In Bed** | 1. Able to roll into one side  
2. Able to rise from lying to sitting position |
| **Sitting** | 3. No retropulsion of the trunk  
4. Able to bend trunk forward  
5. Able to rise from a chair |
| **Standing** | 6. Possible  
7. Without assistance  
8. Able to stand on 2 legs with closed eyes  
9. Able to stand on 1 leg  
10. No retropulsion  
11. Reactive postural responses  
12. Protective reactions of upper limbs  
13. Stepping reactions forwards  
14. Stepping reactions backwards |
| **Gait** | 15. Possible  
16. Without assistance  
17. Normal heel-strike  
18. No knee flexion  
19. No retropulsion  
20. Harmonious turn round |

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### Backward Disequilibrium Scale

- 5 items  
  - Maintaining Sitting  
  - Maintaining Standing Feet Together – EO  
  - Maintaining Standing Feet Together – EC  
  - Sit to Stand  
  - Stand to Sit  
- Each item scored 0-3  
  - 0 = No BD  
  - 1 = Slight BD; no difficulty with task  
  - 2 = Moderate or intermittent BD; difficulty with task but no help needed  
  - 3 = Severe BD compromising task
**Backward Disequilibrium Scale**

- Normal = $\leq 2$
- Moderate BD = 3-7
- Severe BD = $\geq 7$

- Inter-rater reliability Spearman CC = 0.99
- Intra-rater reliability Spearman CC = 0.89

**Intervention**

- Recommendations in the Literature
  - 45 min/day
  - Rolling
  - Sit to/from Supine
  - Sit to/from Stand
  - Gait
PROPOSED INTERVENTION PROTOCOL

• Sit to Stand
• Stand to Sit
• Standing Back Against Wall Heels Touching
• Continuous Stepping
• Backward Stepping

SIT TO STAND

• Without UE support
• If must use UE do so for initiation only
• Provide manual block to posterior displacement of tibia
• Provide assistance with anterior translation of tibia
• Provide encouragement and support related to fear of falling
**STAND TO SIT**

- Without UE support
- If must use UE do so only in last part of execution
- Initiate with knee flexion
- Sit at the front of the chair
- **Avoid** teaching to reach back for the chair
- **Avoid** teaching to step back until back of knees touch the chair

**STANDING BACK AGAINST WALL**

- Heels against wall - no resistance
- Use UE support to assume position if needed
- Increase time standing
- UE movements without changing BOS
- Produce active sway forward
- Practice walking and/or sit to stand after
CONTINUOUS STEPPING

- Eliminate stopping and starting
- Maintain forward progression
  - Pull rolling walker forward
  - Harness support over a treadmill or over ground
  - Assist with weight shift and limb advancement as needed
BACKWARD STEPPING

- Anterior sway prior to stepping  
- Controlled – does not have to be continuous  
- Practice switching between forward and backward stepping

PATIENT EXAMPLE #1

- 87 year old female  
- 4 months s/p fall with right hip fracture with hemiarthroplasty  
- 14 weeks of PT and OT in SNF  
- Discharged to apartment in ALF  
- Home Health referral

Scheets et al. JNPT. 2015;39:119-126
• **PMH**
  - IDDM, HTN, CAD with previous MI, CHF, CVA without residual, hearing loss

• **Prior Level of Function**
  - Min assist with bathing and LE dressing
  - Walker or quad cane independent in apartment; w/c for long distances

• **Current Level of Function**
  - Assistance of 2 with all ADLs
    - “does not know where her feet are,” and “falling backward in bed”
  - Full-time use of w/c

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**EXAMINATION**

<table>
<thead>
<tr>
<th>Test</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mini Motor Test</td>
<td>1/20</td>
</tr>
<tr>
<td>BD Scale</td>
<td>15 (Severe)</td>
</tr>
<tr>
<td>POMA</td>
<td>3/28</td>
</tr>
<tr>
<td>SPPB</td>
<td>0/12</td>
</tr>
<tr>
<td>Gait Speed</td>
<td>0 m/s</td>
</tr>
</tbody>
</table>
EXAMINATION

<table>
<thead>
<tr>
<th>Joint Limitation</th>
<th>DF to 90°</th>
<th>DF to 90°; hip abduction 25°</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strength (MMT):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Hip flexion</td>
<td>3+</td>
<td>3-</td>
</tr>
<tr>
<td>• Hip extension</td>
<td>2+</td>
<td>0</td>
</tr>
<tr>
<td>• Hip abduction</td>
<td>2+</td>
<td>0</td>
</tr>
<tr>
<td>• Knee extension</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>• DF</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Muscle Fatigue</td>
<td>Present in UE and LE</td>
<td>Present in UE and LE</td>
</tr>
<tr>
<td>JPS</td>
<td>Absent at ankle</td>
<td>Absent at ankle</td>
</tr>
</tbody>
</table>

EXAMINATION

Quiet sitting
Able to sit with feet supported without UE support once placed; decreased weight bearing on right; assistance needed to shift trunk forward to a vertical position

Sit to stand
Initiation: Maximal assistance without UE support; pulls up using walker with moderate assistance
Execution: Posterior translation of tibia relative to the foot early in the execution phase bilaterally; narrow BOS; decreased weight bearing on right; increased posterior displacement of COM relative to BOS; resisted correction of COM forward
Termination: Unable to find stable position; COM posterior to BOS; sustained right hip and knee flexion

Quiet standing
Unable to find a stable standing position; right hip and knee flexion

Gait
2-3 steps with rolling walker; COM posterior to feet supported in standing by therapist; resisted correction of COM alignment; variable foot placement; both feet cross midline with advancement; right hip flexion and adduction with right stance
MOVEMENT SYSTEM DIAGNOSES

- PSD with BD
- Postural Vertical Deficit in Sagittal plane
- Sensory Detection Deficit
- Force Production Deficit

Scheets et al. Phys Ther. 2007;87:654-669

PROGNOSIS FOR IMPROVEMENT IN IMPAIRMENTS

- Improvement in Impairment Syndromes
  - Poor
    - Sensory Detection Deficit
  - Fair to Poor
    - Postural Vertical Deficit
    - Force Production Deficit

- Improvement in Activity Limitations
  - Fair
    - 50% of Baseline
INTERVENTION

- 5 times/week for 2 weeks
- 4 times/week for 2 weeks
- 3 times/week for 11 weeks
- 2 day hospital admission in week 7

INTERVENTION

- **Bilateral AFOs**
  - Visit 2
  - Casted for custom AFOs week 3

- **Visual Guide Line with Ambulation**
  - Initiated end of week 1
  - Discontinued during week five because no longer needed
**INTERVENTION**

- **Continuous Stepping**
  - Initiated during first week
  - Progress slow due to proximal weakness
  - Week 2 – 5 ft with continuous steps; Week 4 5-7 ft; Week 8 40 ft; week 12 50 ft with continuous steps with sustained forward progression

- **Backward Stepping**
  - Initiated at end of week 3; failure
  - Attempted intermittently from week 3 to 11
  - Week 14 – 10 feet without excessive posterior sway or loss of balance; immediate loss of balance of coupled with sitting down

- **Strengthening**
  - Initiated week 4
  - Progressing loading in standing
  - Sitting knee extension
  - Stationary bike

- **Sit to Stand**
  - Initiated visit 2; required UE for initiation
  - End of week 2 – forward translation of tibia during 1st half of execution
  - End of week 4 – consistently SBA standing to walker
  - End of week 6 – consistently min assist with all transfers with facility staff

- **Stand to Sit**
  - Initiated visit 2; significant manual and verbal cues
  - Variable performance without cueing; unable to verbalize correct strategy
  - Limited change with practice
INTERVENTION

- **Standing with Back Against Wall**
  - Best initial performance standing heels 2-3 inches from wall holding onto walker 1 min.
  - Improved from max assist to min assist with STS
  - Able to stand with walker without other support 30 sec immediately after
  - Continued throughout course
  - Instructed care givers
# Intervention Time Course

Table 3. Time at Which Interventions for BD Were Implemented and Indication of Rate of Observable Improvement

<table>
<thead>
<tr>
<th>Component</th>
<th>Wk 1</th>
<th>Wk 2</th>
<th>Wk 3</th>
<th>Wk 4</th>
<th>Wk 5</th>
<th>Wk 6</th>
<th>Wk 7</th>
<th>Wk 8</th>
<th>Wk 9</th>
<th>Wk 10</th>
<th>Wk 11</th>
<th>Wk 12</th>
<th>Wk 13</th>
<th>Wk 14</th>
<th>Wk 15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stand Back Against Wall</td>
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<td>Sit to Stand</td>
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<tr>
<td>Stand to Sit</td>
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<tr>
<td>Continuous Stepping</td>
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<tr>
<td>Backward Stepping</td>
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</tbody>
</table>

Key:
- Light gray: Initiation to time of 1st improvement
- Dark gray: Time of 1st improvement to time of 2nd improvement
- Medium gray: Time of 2nd improvement to time of 3rd improvement
- Black: Time of 3rd improvement to time of 4th improvement
- Darker gray: Time of 4th improvement to time of 5th improvement
# Outcome

<table>
<thead>
<tr>
<th>Test</th>
<th>Initial Result</th>
<th>Final Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual Muscle Test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hip flexion</td>
<td>3+</td>
<td>4</td>
</tr>
<tr>
<td>Hip extension</td>
<td>2+</td>
<td>3+</td>
</tr>
<tr>
<td>Knee extension</td>
<td>4</td>
<td>4+</td>
</tr>
<tr>
<td>Mini Motor Test</td>
<td>1/20</td>
<td>7/20</td>
</tr>
<tr>
<td>BW Disequilibrium Scale</td>
<td>15 (Severe)</td>
<td>11 (Severe)</td>
</tr>
<tr>
<td>Sit to stand</td>
<td>Maximal assistance</td>
<td>SBA</td>
</tr>
<tr>
<td>Amputation</td>
<td>Maximal assistance with rolling walker a few steps</td>
<td>SBA with rolling walker 50 feet</td>
</tr>
<tr>
<td>POMA</td>
<td>3/28</td>
<td>14/28</td>
</tr>
<tr>
<td>SPPE</td>
<td>0/12</td>
<td>1/12</td>
</tr>
<tr>
<td>OASIS ADL Items</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Gait speed</td>
<td>0.0 m/s</td>
<td>0.11 m/s</td>
</tr>
</tbody>
</table>

*MMT = manual muscle test; SBA = standing assistance; POMA = Performance Oriented Mobility Assessment; OASIS = Outcome and Assessment Information Set; ADL = activities of daily living; m/s = meters/second*

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## Patient Example #2

- 94 year old female
- History of repeated falls with injury
- Recently moved from her home to ALF

- **PMH:** a-fib (coumadin), HTN, multiple fractures, osteoporosis, arthritis
EXAMINATION

<table>
<thead>
<tr>
<th>Test</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mini Motor Test</td>
<td>7/20</td>
</tr>
<tr>
<td>BD Scale</td>
<td>10 (Severe)</td>
</tr>
<tr>
<td>Berg Balance Scale</td>
<td>22/56</td>
</tr>
<tr>
<td>SPPB</td>
<td>5/12</td>
</tr>
<tr>
<td>Gait Speed</td>
<td>0.3 m/s</td>
</tr>
</tbody>
</table>

MOVEMENT SYSTEM DIAGNOSIS

- Movement Pattern Coordination Deficit with Backward Disequilibrium
INTERVENTION

- **Standing Back Against Wall**
  - Able to do independently after a few visits
  - Home program

- **Sit to Stand**
  - Manual guidance for anterior translation of tibia and toe flexion
  - Task specific strengthening

- **Stand to Sit**
  - “Bend knees to sit”

---

INTERVENTION

- **Continuous Stepping**
  - Hand hold initially
  - Running
  - Coupled with bouts of speed training

- **Backward Stepping**
  - Over an obstacle
  - Opening doors
### OUTCOME

<table>
<thead>
<tr>
<th>Test</th>
<th>Initial</th>
<th>Discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mini Motor Test</td>
<td>7/20</td>
<td>14/20</td>
</tr>
<tr>
<td>BD Scale</td>
<td>10 (Severe)</td>
<td>5 (Moderate)</td>
</tr>
<tr>
<td>Berg Balance Scale</td>
<td>22/56</td>
<td>36/56</td>
</tr>
<tr>
<td>SPPB</td>
<td>2/12</td>
<td>5/12</td>
</tr>
<tr>
<td>Gait Speed</td>
<td>0.3 m/s</td>
<td>0.5 m/s</td>
</tr>
</tbody>
</table>

2 times/week; 8 weeks

### SPECIFICITY & INTENSITY
**Task-Oriented Training**

**Skill Acquisition**

- **Consistency**
  - Performance over multiple trials or sessions

- **Flexibility**
  - Performance under a variety of conditions

- **Efficiency**
  - Performance with a certain level of energy expenditure

**Task-Oriented Training Defined**

**What is a Task?**
- Space between Body Structure/Function and Activity
  - Body Structure/Function = muscle performance, timing, and balance
  - Activity = walking from the living room to the kitchen for dinner

**What is Task-Oriented Training?**
- Goal directed
- Coordinated movements and/or sustained postures
- Replicate some component of daily activities

**International Classification of Disability, Functioning, Health (ICF)**
- Health Conditions
- Impairments in Body Structures and Functions
- Activity Limitations
- Participation Restrictions
- Contextual Factors
  - Personal Factors
  - Environmental Factors
**Task-Oriented Training Continuum**

- **Impairment**
  - Hip Abductor Weakness
  - Impaired Spatial Organization

- **Task Space**
  - Stair Tap
  - Containers and Lids

- **Activity Limitation**
  - Walk down steps and transfer into senior citizens’ van
  - UB grooming and dressing

---

**Principles of Task-Oriented Training**

- Task Selection
- Meaning and Fit
- Targeted to Impairment
- Applicable to the Patient
- Goal Directed
- Sufficient Challenge
- Intensity
PRINCIPLES OF TASK-ORIENTED TRAINING

Task Delivery

Set the Task Parameters

Focus on the priority impairment

Remediation or Compensation

Monitor Response

Tasks Need to Be Practiced

Progress the Challenge

DOSAGE
**Task Selection**

Planning and Preparation

Specific to Patient

**Examples of Lower Extremity “Go-To” Tasks**
SIT TO STAND

- Task used in wide range of activities
- Task demands:
  - Force production at *initiation*
  - Control of inter-segmental movement and shifting COM during *execution*
  - Ability to stabilize in a new position at *termination*

COM 25 cm forward — 8.1 cm from trunk flexion
13.9 cm from tibia forward over foot
CARDIAC PUMP FAILURE

Task Parameters
- Raise seat height to decrease demand on initiation
- Larger number of lower intensity reps
- Endurance paradigm

LUMBAR EXTENSION SYNDROME

Task Parameters
- Focus on strategy at termination
- Timing of abdominals with hip and knee extension
- Raise seat height to decrease demand on initiation
- Use of external cue for motor learning
**MOVEMENT PATTERN COORDINATION DEFICIT**

<table>
<thead>
<tr>
<th>Task Parameters</th>
<th>On foam/compliant surface</th>
</tr>
</thead>
</table>

2-3 trials interspersed with other activities

Balance paradigm

**GROUP QUESTION - SIT TO STAND TASK**

- **Musculoskeletal**
  - TKA – Quad weakness
  - Force Production Deficit

1. Which phase of the task has the greatest strength demand?
2. What surface height is most appropriate to encourage quad recruitment? High, Medium or Low?
3. Will you allow UE support, Yes or No?
4. What will you monitor?
5. How will you progress the task?
**STAIR TAP**

- Preparation for obstacle negotiation, stairs, and change of direction during ambulation
- Task demands:
  - Stance limb: force production (isometric) of extensors and balance
  - Swing limb: force production of hip flexors and timing to place foot on step

**PATIENT PROFILE – STAIR TAP**

- **Cardiac Pump Failure**
  - Adjust step height
  - Alternate sides
  - Endurance Paradigm

- **Lumbar Extension Syndrome**
  - Adjust step height
  - Fewer repetitions
  - Cues for trunk stabilization
  - Sit between sets

- **Movement Pattern Coordination Deficit**
  - Alternate sides
  - Cues for postural adjustments
  - Compliant surface
MORE LE TASK IDEAS

Step Over

Step Up / Up; Down / Down

Water Carry

UE TASKS

- Variability in what we do with our hands
  - Reach
  - Grasp & Release
  - Manipulate
  - Carry

- Can be practiced in standing or sitting
OBJECT TRANSPORT

- Element common across many ADL/IADLs
- Task demands:
  - ROM and strength proximally (including trunk)
  - Isolated movement distally
  - Cardiopulmonary demand with repeated UE movement
  - Milk jug filled with water to increase strength demand
  - Problem solving
- Could be done in sitting
MORE UE TASK IDEAS

Folding

Tape to Target

Pouring

Catch the Noodle

DOCUMENTING CHANGES IN TASK PERFORMANCE

<table>
<thead>
<tr>
<th>CONSISTENCY</th>
<th>FLEXIBILITY</th>
<th>EFFICIENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMPROVEMENTS IN TASK PERFORMANCE</td>
<td>ONGOING DEFICITS IN TASK PERFORMANCE</td>
<td></td>
</tr>
</tbody>
</table>

CONSISTENCY

Because
- larger / faster arm movement
- postural adjustment
- larger / faster coordination
- larger / faster postural response
- patient is getting stronger
- maintain attention
- primary task
- allowing more time for movement preparation and planning
- able to report intrinsic feedback

FLEXIBILITY

Because
- fluctuating medical condition limits opportunity for repeated practice
- lack of intrinsic feedback to guide movement performance
- performance within a session improving but needs more practice for learning
- deficits in movement timing which are changing but still insufficient for all tasks
- deficits in movement timing which are not changing with practice

EFFICIENCY

Because
- fluctuating medical condition limits opportunity for extended practice
- primary medical condition limits practice for extended practice
- poor prognosis for improvement in impairments
Incorporating Large Amplitude Movement into Task Training

**Large Amplitude Movement Training**

<table>
<thead>
<tr>
<th>“LOUD”</th>
<th>Derived from Lee Silverman Voice Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Amplitude Movements</td>
<td>Multiple repetitions</td>
</tr>
<tr>
<td></td>
<td>High intensity and increasing challenge (80% of maximal energy every repetition)</td>
</tr>
<tr>
<td>Sensory Calibration</td>
<td>Improve movement perception</td>
</tr>
<tr>
<td></td>
<td>Recalibrate disturbed scaling of movement amplitude</td>
</tr>
<tr>
<td>Self-cueing</td>
<td>Carry-over into routine tasks</td>
</tr>
</tbody>
</table>
**LARGE AMPLITUDE MOVEMENT TRAINING**

<table>
<thead>
<tr>
<th>Standard Protocol</th>
<th>16 1-hour sessions; 4x per week x 4 weeks</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>1:1 sessions; intensive motivation and feedback</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Improvements in Motor Scores</th>
<th>60 subjects; LSVT BIG or Walk or Home</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>LSVT BIG superior to other two groups in improvement in UPDRS motor score (especially bradykinesia) and TUG scores</td>
</tr>
<tr>
<td></td>
<td>Study ½ protocol didn’t show same result</td>
</tr>
</tbody>
</table>

**HOW-TO’S**

**TRAINING AMPLITUDE IN VOICE AND MOVEMENT**

<table>
<thead>
<tr>
<th>High Effort</th>
<th>“On a scale of 1-10, with 10 being a lot and 1 nothing at all, how much effort was that? Try to get as high on the effort scale as you can each time.”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensory Calibration</td>
<td>“How do your limbs feel? Do you hear how loud you can be? What you are feeling produces sound (or movement) that is normal. Repeat that feeling each time.”</td>
</tr>
<tr>
<td>Shape Quality</td>
<td>Manual and verbal cues to improve quality of movement and sound each time. “Do what I do.”</td>
</tr>
<tr>
<td>Homework</td>
<td>Incorporate therapy activities into functional activity. Do every day.</td>
</tr>
</tbody>
</table>
BIG EXERCISES

**Floor to Ceiling - Sustained**
1. Big hands. Sustain.
2. Floor.
3. Ceiling.

**Floor to Ceiling for Sit to Stand**
1. Feet in stride position (one foot forward of the other). Big hands.
2. Toward floor to sit; back from chair. Stand.

**Side to Side - Sustained**
1. Big hand to side. Sustain.
2. Reach across body. Push with foot.

**Side to Side - Functional Activity**
1. Big hand to side.
2. Reach and retrieve object.

---

**BIG EXERCISES**

**Rock and Reach - Forwards and Backwards**
1. Reach forward.
2. Rock back.

**Front View**

**Twist and Reach**
1. Start with side stance.
2. Twist and reach to look behind you.

**Large Amplitude Walking**
Big arms and steps.
Step around object.
INCORPORATING CUES INTO TASK TRAINING

STUDIED IN A NUMBER OF HEALTH CONDITIONS

- PD
- Stroke
- Huntington’s Disease
- Multiple Sclerosis
- SCI
- Brain Injury
**Frequency & Duration**

- 30-60 minute sessions
- Minimum of 3 days/week; generally 5 days/week
- Generally 4 – 6 weeks

**External Cues**

**Visual**
- Regular lines on the floor
- Improve step length, velocity, heel strike
- Spaced every 50 – 60 cm (20 – 24 inches)
- Use for turning
- Set visual targets for large amplitude lunges or step-up
- Portable visual displays

**Auditory**
- Rhythmic Auditory Stimulation (RAS)
- Metronome – fixed vs interactive
- “High Groove” Music
- Improve step length, velocity, cadence
- Variable pacing
- 80% of self-selected
- 25% faster than fastest speed
- 133% faster than preferred pace

**Cognitive**
- Internal prompting or self-instruction
  - BIG is an example
- Swing arms, walk and count, large steps, walk fast
- Improve step frequency, step length, arm swing
- Some cues more effective for some subjects
MECHANISM

**Accelerated Motor Learning**
- Movement is "regularized" and therefore practiced more similarly each time
- Pattern repetition especially with music
- Enough practice of cues movements leads to improvement in non-cued movements

**Qualitatively Different Motor Learning**
- Auditory cues take advantage of connectivity between auditory and motor areas
- Rich environment for learning

**Acquiring Temporal Skills**
- Increases perceptual skills
- Overlap with neural circuits for cognition and rhythm perception
- Increases attention

**Motivation**
- Emotional engagement
- Especially a factor with music
### Cue Training

| For speed      | • Visual cue – lines 20 – 24 inches apart; “Step on (or over) the lines.”
|                | • Auditory cue – 10% above baseline; “Match your movements to the beat.”
| For amplitude  | • Visual cue – lines 20 – 24 inches apart
|                | • Auditory cue – 10% below baseline (especially for patients who freeze);
| For freezing   | • Visual cue – lines 18 – 22 inches apart where likely to freeze; “Use to cue to remind you to take a bigger step to prevent freezing.”
| and turning    | • Auditory cue – baseline or 10% below; “Use the cue to maintain stepping movements.”
|                | • Stepping through strategy – keep stepping through the tricky spots; all directions
|                | • Approach doorway by aiming for the wall to the side of the door handle to allow room for door to open
| For dyskinesia | • Visual cue – lines 20 – 24 inches apart; lines indicating step width for lateral deviations
|                | • Auditory cue – 10% above baseline

---

[http://rescueprojects.org/pubs/info_sheets.htm](http://rescueprojects.org/pubs/info_sheets.htm)
High Intensity Stepping Training (HIT)
Part 1
Infinity Mountain Symposium
April 22, 2017

Patrick Hennessy, PT, MPT NCS
Patty Scheets, PT, MHS, DPT, NCS

Adapted content from original lectures by T George Hornby, PT, PhD
Additional contributions from Carey Holleran PT, MPT, NCS, Abigail Leddy, DPT, NCS

Current HIT pilot

- Determining the effectiveness, feasibility, safety risks, barriers, and cognitive-behavioral impact in 25-30 SNF patients.
- Including all patients with ambulation goals except weight bearing restrictions, amputation, chronic wounds, active infection, progressive neurological disorders, active cancer, or otherwise medically restricted. *Patients with PD and TJR will be tracked separately.*
- Primary and secondary outcomes will be compared with site and company averages then expand as effectiveness and safety are determined
- “Train the trainer” model to promote sustainability
- Quality Implementation Specialist onsite to serve as knowledge broker throughout pilot phase as part of knowledge translation framework.
PRINCIPLES OF NEUROPLASTICITY | HIGH INTENSITY STEPPING PROTOCOL | PRINCIPLES OF EXERCISE PHYSIOLOGY
---|---|---
Specificity | Walking | Type
Repetition | 40 min per session ≥25% FFW ≥4/wk | Frequency, Time
Intensity | 60-80% HRR 15-18RPE | Intensity
Variability (Salience, Interference, Transference) | Trial and error practice, variable task and environments | Type

See quick reference and appraisal form

### Principles of Neuroplasticity

<table>
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<tr>
<th>Principle</th>
<th>Description</th>
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<tbody>
<tr>
<td>1. Use it or Lose it</td>
<td>Failure to drive specific brain functions can lead to functional degradation</td>
</tr>
<tr>
<td>2. Use it and Improve it</td>
<td>Training that drives a specific brain function can lead to an enhancement of that function</td>
</tr>
<tr>
<td>3. Specificity</td>
<td>The nature of the training experience dictates the nature of the plasticity</td>
</tr>
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<td>4. Repetition Matters</td>
<td>Induction of plasticity requires sufficient repetition</td>
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<tr>
<td>5. Intensity Matters</td>
<td>Induction of plasticity requires sufficient training intensity</td>
</tr>
<tr>
<td>6. Time Matters</td>
<td>Different forms of plasticity occur at different times during training</td>
</tr>
<tr>
<td>7. Salience Matters</td>
<td>The training experience must be sufficiently salient to induce plasticity</td>
</tr>
<tr>
<td>8. Age Matters</td>
<td>Training-induced plasticity occurs more readily in younger brains</td>
</tr>
<tr>
<td>9. Transference</td>
<td>Plasticity in response to one training experience can enhance the acquisition of similar behaviors</td>
</tr>
<tr>
<td>10. Interference</td>
<td>Plasticity in response to one experience can interfere with the acquisition of other behaviors</td>
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</table>
**FITT Guidelines for Exercise Prescription.**

- **Frequency:** number of times per week / total duration
- **Intensity:** work load / challenge
- **Time:** per session
- **Type:** task-specific

---

**Task Specificity & Repetition**

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*See quick reference and appraisal form*
What is Task-Specific Walking?

- Walking is a continuous task, whole practice should be provided,
- Pre-gait activities may not translate to improved walking,
- Task-specific practice is thought to mediate activity-dependent neuroplasticity
- Weight-bearing, stepping, efficiency and balance can be retrained SIMULTANEOUSLY during locomotor training.

Providing Substantial Amounts of Practice

- Animal and human studies of motor learning
  - Thousands of steps,
- Barriers to providing sufficient practice during therapy sessions
  - Limited time, equipment, available assistance, burden of care, etc.
  - Variations in education/theoretical frameworks for what should be done in rehabilitation
- Observed practice in patients post-stroke
  - Single center studies,
  - Multicenter study,
What has been observed in the clinic?

![Pie chart showing distribution of activities in the clinic](image)

<table>
<thead>
<tr>
<th>Category</th>
<th>Repetitions (mean)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UE Functional</td>
<td>32</td>
</tr>
<tr>
<td>LE Functional</td>
<td>6</td>
</tr>
<tr>
<td>Steps</td>
<td>357</td>
</tr>
<tr>
<td>Stairs</td>
<td>38</td>
</tr>
<tr>
<td>Transfers</td>
<td>11</td>
</tr>
<tr>
<td>Balance</td>
<td>27</td>
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(Moore, 2010) (Lang, 2009)

Outpatient research intervention—walking outcomes

- **Grouped Data - Daily and training stepping activity**
  - Per day prior to, during and following training (post and follow-up)
  - Stepping activity during training (ave = 2873 per session)

![Graph showing stepping activity over weeks of training](image)

(Moore et al 2010)
Stepping dose-response effects

- Significant relationship between:
  - **Dose** (stepping practice during training)
  - **Response** (Δ daily stepping following training)

(Hornby et al, 2015)

Dose-response effects in the clinical setting

(Figure 2. Relation between steps per day and discharge 6MWT (A) and 6MWT (B) in patients who required different levels of assistance (LoA) at discharge (LoA of 1 = red; 2 = orange; 3 = yellow; 4 = green; 5 = blue).

**Abbreviation**: 6MWT, 6-minute walk test.

(Hornby et al, 2015)
“What is better, the treadmill or overground training?”

<table>
<thead>
<tr>
<th>Treadmill with harness</th>
<th>Overground</th>
</tr>
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<tbody>
<tr>
<td>Safety</td>
<td>Task specificity</td>
</tr>
<tr>
<td>Larger or dependent patients</td>
<td>Allows for more variability</td>
</tr>
<tr>
<td>Earlier gait training</td>
<td>Task can be more salient and motivating</td>
</tr>
<tr>
<td>Speed pacing</td>
<td>Quicker setup and breakdown</td>
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<tr>
<td>Allows for increased practice</td>
<td></td>
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<tr>
<td>Increased speed during training</td>
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<tr>
<td>Cardio respiratory conditioning</td>
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Task Specificity & Repetition

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See quick reference and appraisal form
## Intensity

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**Increased time of activity per given workload or speed**

**Increased speed of activity per given time or workload**

**Replication**

**Workload**

**Intensity** *(Heart Rate or RPE)*

- Increased reps per given time or workload
- Added resistance per given time or number of reps

- **Time**

- **Speed**
**Monitoring Intensity and Exercise Response**

- **Heart Rate Reserve (HRR)**
  - Training heart rate = \([\text{HRmax} - \text{HRrest}] \times \%\text{training intensity}\) + \text{HRrest}
- **HRmax**
  - \(220 - \text{age}\)
  - \([208 - (0.7 \times \text{age})]\) = Tanaka formula
  - All prediction equations often reveal large inaccuracies in some patients (> 10 beats/min)
- **HRmax does not consider resting HR**
- Significant inter-individual variability with both, but less with HRR
- **Borg RPE** - ratings of “exertion” vs “difficulty”

**Considerations for Adjusting HR**

- **Chronotropic Incompetence (CI)**
  - Reduced exercise capacity (max HR and Vo2 uptake) and lower or unstable HR with exertion
  - Delayed recovery after exertion
  - “Blunted HR response” to exercise
  - **ANY patient on beta blockers**
  - Potentially patients on Calcium channel blockers
  - Common in patients with systolic HF, SSS, CAD, AV block
  - Potential indicator of future morbidity/mortality
  - **Exercise can improve lower resting HR, recovery time, higher exercise capacity (max HR and activity tolerance)**
### Common Prescribed Meds

<table>
<thead>
<tr>
<th>Beta Blockers</th>
<th>Ca Channel blockers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acebutolol (Sectral)</td>
<td>Verapamil (Covera, Verelan)</td>
</tr>
<tr>
<td>Atenolol (Tenormin)</td>
<td>Diltiazem (Cardizem)</td>
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<tr>
<td>Bisoprolol (Zebeta)</td>
<td>Amlodipine (Norvasc)</td>
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<td>Metoprolol (Lopressor, Toprol)</td>
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</tr>
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<td>Nadolol (Corgard)</td>
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<td>Nebivolol (Bystolic)</td>
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**Common Prescribed Meds**

- **Beta Blockers**
  - Acebutolol (Sectral)
  - Atenolol (Tenormin)
  - Bisoprolol (Zebeta)
  - Metoprolol (Lopressor, Toprol)
  - Nadolol (Corgard)
  - Nebivolol (Bystolic)
  - Propranolol (Inderal, InnoPran)

- **Ca Channel Blockers**
  - Verapamil (Covera, Verelan)
  - Diltiazem (Cardizem)
  - Amlodipine (Norvasc)
**Clinical Bottom Line**

- If patient is on beta blockers, Borg RPE may be used as primary measure and **subtract 10bpm from target HR zone**
- HR should be continuously monitored during training (target every 5min)
- Recommended training parameters and contraindications and are not intended to replace clinical decision making
- **See ACSM, AHA, and Infinity recommendations for absolute and relative contraindications to exercise**
- Distinguish between deconditioned vs adverse response to exercise
- Balance between building activity tolerance (time spent in walking bouts) and reaching target intensity (time spent in target HR/RPE)
Building Treatment Tolerance and Endurance

• Patients may need to build endurance to tolerate target training intensity or time
• Target longer bouts of exercise, shorter and less frequent rest breaks, longer total time
• Target rest breaks only when HR exceeds training zone
  • Allows for vitals monitoring
  • Patient may reach true muscular fatigue before achieving target HR
• Document amount of active vs rest time to track progress

Intensity

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See quick reference and appraisal form
**Patient Case Application of Intensity Principles**

- Pt is a 77yo fm who was found down by family brought to the ED with new confusion and L sided weakness and incoordination. MRI revealed a 1cm acute infarct of the posterior limb on the R internal capsule, atrophy and white matter ischemic changes.
- Past Medical Hx includes: HTN, heart murmur, chronic dementia, cleft palate repair, hysterectomy
- Medications: (+)beta blockers, (+)Ca channel blockers
- **Considerations?**

---

**Patient Case Application: Calculating Target HR**

**OPTION 1**

- 60-80% Heart Rate Reserve (HRR)
- \[ \text{HRR} = \text{HR}_{\text{rest}} + [(\text{HR}_{\text{Max}} - \text{HR}_{\text{rest}}) \times (60\%-80\%)] \]
- \[ \text{HR}_{\text{Max}} = 208 - (0.7 \times \text{age}) \]
- \[ \text{HR}_{\text{Max}} = 208 - (0.7 \times 77) = 154.1 \]
- \[ 60\%\text{HR}_{\text{R}} = 91 + [(154.1 - 91)] \times (0.6) = 128.86 \]
- \[ 80\%\text{HR}_{\text{R}} = 91 + [(154.1 - 91)] \times (0.8) = 141 \]
- **Training Zone = 129-141 bpm**
- **If using Beta blockers = 119-131**

---

**OPTION 2**

Use HR calculator on desktop
Patient Case Application: Assessing Exercise Response

Initial Evaluation

- Resting VS: 91bpm (sitting rest) 96%02
- With Activity: 111bpm after 6MWT, 98% 02
- Unable to report RPE

First two training sessions

- Session 1
  - Resting: HR 113bpm BP 112/64
  - With activity: 118-134bpm, 98%02
- Session 2:
  - Resting: BP 112/82, HR 84bpm
  - With activity: 112-130bpm

Considerations?

References

9. American Heart Association www.americanheart.org
**HIT program**

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Motor learning.

Individual, Task, Environment

Motor Learning
Kinds of variability

• Kinematic variability
  – Trial and error practice
  – Allowing exploration of various movement solutions to accomplish a task

• Environmental variability
• Task variability

Trial and error practice is fundamental to motor learning
Practice with and without errors

• Trial and Error practice is fundamental to motor learning (including walking skills).
• Errorless learning has less retention than trial and error practice.
• Errorless learning may ‘look better’ immediately.
• Immediate performance ≠ long-term performance

Important terminology.

• Sensory prediction error- difference between the brain’s predicted outcome of the movement and the observed outcome
• Adaptation- modification of a movement from trial-to-trial based on error feedback
• Aftereffect- when the new parameters are removed, movements are performed according to recalibrated internal model
Errors contribute to long term learning

- **Adaptations**
  - Gradual change in behavior that results from experience ("feedback strategies")
  - Driven by demands that exceed "current state", minimize cost

- **Learning**
  - Relatively permanent changes
  - Resulting from repeated exposure (adaptation may be a precursor)

- **Transitions**
  - Immediate change in behavior
  - Driven by prior experience and the ability to predict that new demands will exceed "current state" (feed-forward strategies)
  - New motor plan

(Kastian, 2008)

Kinds of variability

- **Kinematic variability**
  - Trial and error practice
  - Allowing exploration of various movement solutions to accomplish a task

- **Environmental variability**
- **Task variability**
Kinds of variability

• Kinematic variability

Environmental variability- More salience in training over-ground and mixed environments vs treadmill alone,
Kinds of variability

• Task variability
  – Stepping in multiple directions
  – Variability in practice schedule
  – Recommendation for 3-5 tasks per session

• Transfer to other tasks?
  – Leap–frog hypothesis or “reverse transfer”
    – Training harder task to make an easier task easier
    – Driven by biomechanical demands and complex motor planning (ex stairs vs sit to stand)

Clinical bottom line

• An adaptation is required to have an after effect.
• Pt must be able to detect their error and recalibrate in order to benefit from trial and error practice.
• Severe perceptual or sensory deficits require more guidance
• Patients with advanced dementia/alzheimers or severe memory deficits will likely benefit from less task and kinematic variability, but still benefit from high repetition, intensity, and specificity of practice
• Trial variable practice with all patients in HIT program and look for training adaptations to determine appropriateness
**HIT program**

<table>
<thead>
<tr>
<th>PRINCIPLES OF NEUROPLASTICITY</th>
<th>HIGH INTENSITY STEPPING PROTOCOL</th>
<th>PRINCIPLES OF EXERCISE PHYSIOLOGY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specificity</td>
<td>Walking</td>
<td>Type</td>
</tr>
<tr>
<td>Repetition</td>
<td>40 min per session</td>
<td>Frequency, Time</td>
</tr>
<tr>
<td></td>
<td>≥25% FFW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>≥4/wk</td>
<td></td>
</tr>
<tr>
<td>Intensity</td>
<td>60-80% HRR</td>
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</tr>
<tr>
<td></td>
<td>15-18RPE</td>
<td></td>
</tr>
<tr>
<td>Variability (Salience, Interference, Transference)</td>
<td>Trial and error practice, variable task and environments</td>
<td>Type</td>
</tr>
</tbody>
</table>

See quick reference and appraisal form

**Variability “how to”**

- Increase assistance or “strategies to promote minimal requirements” only as needed to ensure successful task completion
- Use of error augmentation or “strategies to challenge stepping” to progress difficulty of task completion
- **What is successful task completion?**
Subcomponents of walking

**Biomechanical subcomponents of walking**

- Limb swing advancement
- Propulsion
- Stance control
- Lateral/frontal stability

**Defining Successful walking**

- Positive step length
- Directional advancement
- Preventing limb/trunk collapse
- Maintain upright

*Success = Continuous stepping*

*Failure = 3-5 consecutive errors*

*Minimal focus on normalizing movement during gait*

(Holleran et al, 2014 online appendix)
Addressing subcomponents:
Use HIT short reference form

<table>
<thead>
<tr>
<th>GAIT REQUIREMENTS</th>
<th>GUIDANCE</th>
<th>ERROR AUGMENTATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subcomponent</td>
<td>Minimal requirement</td>
<td>Strategies to enhance stepping</td>
</tr>
<tr>
<td>Stance control</td>
<td>Preventing limb collapse</td>
<td>HHA or BWS, Bracing (knee immobilizer, AFO, etc) AD</td>
</tr>
<tr>
<td>Propulsion</td>
<td>Directional advancement</td>
<td>Stabilizing straps, Slower speeds, HHA or BWS</td>
</tr>
<tr>
<td>Limb Swing</td>
<td>Positive step length</td>
<td>Manual assistance, Elastic assistance</td>
</tr>
<tr>
<td>Lateral Stability/Balance</td>
<td>Maintain upright</td>
<td>Anterior/lateral pelvic straps, HHA or BWS</td>
</tr>
</tbody>
</table>

Successful task completion:
Subcomponents of walking

Positive step length
Prevent trunk/limb collapse
Directional advancement
Stability/ balance
HIT Program

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See quick reference and appraisal form

Patient Case Application

- Pt is a 77yo fm who was found down by family brought to the ED with new confusion and L sided weakness and incoordination. MRI revealed a 1cm acute infarct of the posterior limb on the R internal capsule, atrophy and white matter ischemic changes.
- Past Medical Hx includes: HTN, heart murmur, chronic dementia, cleft palate repair, hysterectomy
- Cognition: Oriented to person only, requires mod A and verbal/tactile cues to follow simple 1step command, poor safety awareness and learning capacity, pleasantly confused
- ASHA NOMS= 3/7 spoken language comprehension
- SLUMS=1/30

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**Patient case application: PT evaluation**

- SPPB 1/12
- Gait speed=0.85ft/.sec
- CARE mobility= 38/84 (46/100)
- Bed mobility=25%
- Transfers and gait=40% assist
- Stairs=70-89% assist
- Unable to complete BBS (cog)
- Unable to complete 6MWT (assist)
- Impairments: Impaired L gross motor coordination
- LLE strength WFL except L hip flexion= 3/5, L ankle DF=2/5
- Sitting balance: static SBA, dynamic sitting CGA
- Dynamic sitting 25%, standing 40% with L side LOB
- **Gait**

**Patient case application: PT evaluation**

- Gait Pattern: “The patient exhibits the following characteristics during gait: ataxic gait, broad stride length at times and at other times is close to scissoring and deficits during turning especially with the LLE. When she's distracted her gait/turns need even more assist to maintain balance”.
- Fall Predictors: Inadequate ankle dorsiflexion, inadequate postural control and reduced insight for unsafe situations
References


11. Van de Brand 2012


Development Plan

[Diagram of a development plan with two sections:
  - New Things I Learned
  - My Plan for Implementing the New Things I Learned]
<table>
<thead>
<tr>
<th>NEW THINGS I LEARNED</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<table>
<thead>
<tr>
<th>NAME:</th>
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<table>
<thead>
<tr>
<th>INDIVIDUAL DEVELOPMENT PLAN</th>
</tr>
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<tbody>
<tr>
<td>DATE:</td>
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<tr>
<td>-----------------------------</td>
</tr>
<tr>
<td>-----------------------------</td>
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<tr>
<td>-----------------------------</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>MY PLAN FOR IMPLEMENTING THE NEW THINGS I LEARNED</th>
</tr>
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<tbody>
<tr>
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</tbody>
</table>
## Backward Disequilibrium (Postural Vertical Deficit)

1) **Standing with the back against the wall**
   - Heels against wall; relax in position; use assistive device if needed
   - Increase amount of time standing without resisting
   - Produce active sway forward so that COM moves toward forward limits of stability
   - Practice walking and/or sit to stand after
   - Progress to wedge training with ankles in DF

2) **Sit to Stand**
   - Without UE support if possible; raise the surface height to accommodate for weakness during initiation
   - If must use UE do so only during initiation then have the patient let go; push and let go
   - Provide a manual block to posterior translation of the tibia during execution
   - Provide assistance with anterior translation of the tibia relative to the foot
   - Provide encouragement and support related to fear of falling

3) **Stand to Sit**
   - Initiate by flexing the knees keeping the COM over the BOS during the first half of execution
   - Avoid teaching to initiate sitting down by reaching back for the chair
   - Avoid teaching to step back until the back of his knees touch the chair before sitting down
   - Use UE to compensate for weakness during the last half of execution

4) **Ambulation with continuous stepping**
   - Emphasis on forward progression

5) **Backward stepping**
   - Keep COM over BOS; don’t let COM get behind BOS
### Improvements in Task Performance

<table>
<thead>
<tr>
<th>Consistency</th>
<th>Flexibility</th>
<th>Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Because</td>
<td>Because</td>
<td>Because</td>
</tr>
<tr>
<td>▪ larger / faster associated postural adjustments</td>
<td>▪ rapid access to best movement strategy</td>
<td>▪ improved vital sign response during activity</td>
</tr>
<tr>
<td>▪ larger / faster corrective postural responses</td>
<td>▪ able to change strategy relative to situational demands</td>
<td>▪ decreased energy expenditure associated with fear or instability</td>
</tr>
<tr>
<td>▪ larger / faster protective postural responses</td>
<td>▪ able to shift attention from one aspect of task performance to another</td>
<td>▪ decreased co-contraction in order to complete task or activity</td>
</tr>
<tr>
<td>▪ patient is getting stronger</td>
<td>▪ able to maintain primary task performance during performance of a secondary task</td>
<td>▪ improved speed of movement</td>
</tr>
<tr>
<td>▪ maintain attention to primary task</td>
<td>▪ allowing more time for movement preparation and planning</td>
<td></td>
</tr>
<tr>
<td>▪ ability to report intrinsic feedback</td>
<td>▪ ▪</td>
<td></td>
</tr>
</tbody>
</table>

### Ongoing Deficits in Task Performance

<table>
<thead>
<tr>
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<th>Flexibility</th>
<th>Efficiency</th>
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</thead>
<tbody>
<tr>
<td>Because</td>
<td>Because</td>
<td>Because</td>
</tr>
<tr>
<td>▪ fluctuating medical condition limits opportunity for repeated practice</td>
<td>▪ deficits in movement amplitude which are changing but still insufficient for all tasks</td>
<td>▪ lack of intrinsic feedback to guide movement performance</td>
</tr>
<tr>
<td>▪ lack of intrinsic feedback to guide movement performance</td>
<td>▪ deficits in movement amplitude which are not changing</td>
<td>▪ inability to develop effective strategy without extrinsic feedback</td>
</tr>
<tr>
<td>▪ performance within a session improving but needs more practice for learning</td>
<td>▪ weakness which is improving but will require ongoing resistance training</td>
<td>▪ fear or anxiety with new activities</td>
</tr>
<tr>
<td>▪ deficits in movement timing which are changing but still insufficient for all tasks</td>
<td>▪ weakness which is not changing</td>
<td>▪ agitation which limits opportunity for practice</td>
</tr>
<tr>
<td>▪ deficits in movement timing which are not changing with practice</td>
<td>▪ deficits in placement of attentional resources</td>
<td>▪</td>
</tr>
<tr>
<td></td>
<td>▪ agitation which limits opportunity for repeated practice</td>
<td>▪</td>
</tr>
</tbody>
</table>

**Flexibility**

Because

- fluctuating medical condition limits opportunity for repeated practice
- primary medical condition limits practice for extended practice
- poor prognosis for improvement in impairments
Floor to Ceiling - Sustained

1. Big hands. Sustain.
2. Floor
3. Ceiling
Floor to Ceiling for Sit to Stand

1. Feet in stride position (one foot forward of the other). Big hands.

2. Toward floor to lift buttocks from chair. Stand.
Rock and Reach – Forwards and Backwards

1. Reach forward

2. Rock back

Front View
Twist and Reach

1. Start with side stance.

2. Twist and reach to look behind you.

3. Repeat to both sides.
Side to Side - Sustained

1. Big hand to side. Sustain.  
2. Reach across body. Push with foot

Side to Side – Functional Activity

1. Big hand to side.  
2. Reach and retrieve object
Large Amplitude Walking

Big arms and steps.
Step around object.
## Training Amplitude in Voice and Movement

<table>
<thead>
<tr>
<th>High Effort</th>
<th>“On a scale of 1-10, with 10 being a lot and 1 nothing at all, how much effort was that? Try to get as high on the effort scale as you can each time.”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensory Calibration</td>
<td>“How do your limbs feel? Do you hear how loud you can be? What you are feeling produces sound (or movement) that is normal. Repeat that feeling each time.”</td>
</tr>
<tr>
<td>Shape Quality</td>
<td>Manual and verbal cues to improve quality of movement and sound each time. “Do what I do.”</td>
</tr>
<tr>
<td>Homework</td>
<td>Incorporate therapy activities into functional activity. Do every day.</td>
</tr>
</tbody>
</table>

## Cue Training

| For speed | Visual cue – lines 20 – 24 inches apart; “Step on (or over) the lines.”  
| For amplitude | Visual cue – lines 20 – 24 inches apart  
| | Auditory cue – 10% above baseline; “Match your movements to the beat.” |
| For freezing and turning | Visual cue – lines 18 – 22 inches apart where likely to freeze; “Use to cue to remind you to take a bigger step to prevent freezing.”  
| | Auditory cue – baseline or 10% below; “Use the cue to maintain stepping movements.”  
| | Stepping through strategy – keep stepping through the tricky spots; all directions  
| | Approach doorway by aiming for the wall to the side of the door handle to allow room for door to open |
| For dyskinesia | Visual cue – lines 20 – 24 inches apart; lines indicating step width for lateral deviations  
| | Auditory cue – 10% above baseline |
Selected References


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Schaefer SY, Patterson CB, Lang CE. Transfer of training between distinct motor tasks after stroke: implications for task-specific approaches to upper-extremity neurorehabilitation. Neurorehabil Neural Repair. 2013 Apr 2 [Epub ahead of print].


