If you are viewing this course as a recorded course after the live webinar, you can use the scroll bar at the bottom of the player window to pause and navigate the course.

This handout is for reference only. It may not include content identical to the powerpoint. Any links included in the handout are current at the time of the live webinar, but are subject to change and may not be current at a later date.
Using Gait Analysis to Drive Interventions for Gait Recovery in Patients with Neurological Disorder

Jill Seale, PT, PhD, NCS
Physicaltherapy.com
May 1, 2015

Objectives

• Use observational gait analysis and subjective gait measures to target impairments and activities for intervention.
• Integrate the concept of task specificity into therapeutic exercises to target gait deviations
• Appraise current best research evidence and apply to current practice
• Evaluate how the use of orthotic devices and assistive devices impact our gait retraining interventions
• Utilizing video patient cases, create appropriate plans of care for targeting gait recovery
Critical Ingredients in Gait Analysis

• Outcome measures across ICF
• Outcome measures that match goals
• Outcome measures that are as objective as possible
• Accurate observational analysis
• Hypothesis driven examination of impairments
• Attention to detail at all levels!
### Stance Limb

**Deviation**
- Absent or diminished heel strike
- Excessive DF in stance
- Excessive PF in stance

**Impairment**
- Tight or spastic PFs; weak DF; sensory dysfunction (not likely)
- Weak PF; hamstring contracture
- Tight, spastic, or weak PF; weak quads (if early); hip flexor contracture; quadriceps spasticity (not likely)

---

### Stance Limb

**Deviation**
- Knee hyperextension (thrust) during stance
- Knee wobble during stance
- Excessive knee flexion during stance

**Impairment**
- Tight, spastic, or weak PF; quad weakness (if early); hip flexor contracture
- Weak PF; weak quads (less likely); sensory dysfunction
- Weak PF; tight or spastic PF (less likely); hamstring contracture
Stance Limb

Deviation
• Trendelenberg
• Excessive hip external rotation
• Excessive lateral lean
• Excessive posterior lean
• Excessive hip and trunk flexion

Impairment
• Weak hip abductors
• Tight ERs; compensation for tight PFs
• Weak contralateral swing
• Weak contralateral swing
• Tight hip flexors; weak hip extensors

Stance Phase

Deviation
• Weightbearing on lateral border of the foot
• Weightbearing on medial border of the foot
• Vaulting

Impairment
• Foot/ankle instability; contralateral swing dysfunction
• Foot/ankle instability (less likely); compensation for tight PFs
• Contralateral swing dysfunction
Swing Phase

Deviation

• Decreased clearance during swing (tripping or dragging)
  – Decreased dorsiflexion during swing
  – Decreased knee flexion during swing
  – Decreased hip flexion

Impairment

• NOT JUST FOOT DROP
  • Tight or spastic PF; weak DF
  • TSt dysfunction; tight or spastic quads; weak hamstrings (least likely)
  • Weak hip flexors (or just slow); tight/spastic extensors (less likely)

Swing Phase

Deviation

• Excessive lateral lean
• Excessive posterior lean
• Excessive hip and trunk flexion
• Excessive hip external rotation
• Hip-hiking
• Circumduction

Impairment

• Compensation for weak swing
• Hip flexor tightness; weak hip/trunk extensors
• Tight ERs; weak IRs or psoas
• Compensation for weak swing
Swing Limb

**Deviations**
- Scissoring
- Absent or diminished heel strike

**Impairment**
- Tight/spastic abductors; sensory dysfunction
- Weak DF; lack of full knee ext at terminal swing
Rehabilitate all the Components

Muscle power

CV fitness

Functional walking

Neural control

Balance

Bowden, Embry, Gregory, 2011

Strength Training

- Moderate evidence to support improvement in gait efficiency
- Questionable transference of strength gains to function
- Training needs to be specific
- Fair to strong evidence supporting increased strength, gait speed, improved functional outcomes, and improved quality of life (without increase in spasticity)
Task Specificity

• Task-specific training can be defined as the **systematic** and **repetitive practice** of **functional tasks** that can be performed within the stroke survivor’s level of available voluntary motion
  – Weinstein et al, 2004

• But how do we apply task specificity to therapeutic exercise?
• Do we even need to?
• Is that possible?

Task Specificity in Therapeutic Exercise...

How to begin

• Analyze task and find deficits
• Hypothesize causative impairments for identified deficits
• Test out hypotheses to ID causative impairments
• What is the norm, in terms of motor activity, ROM, sensation, etc...?
Example:
Plantarflexors weakness in gait

- What is norm?
  - Peak firing from loading response through terminal stance
  - Type of contraction: Eccentric primarily
  - Position of limb is closed chain
  - Range of motion: from position of 5° plantarflexion to 10° dorsiflexion
  - Degree of difficulty: HIGH (long lever high, torque demand, controlling body weight)

So what would task specific ther-ex look like?

- Ther ex would match the key characteristics of the task:
  - Type of contraction
  - Range of motion
  - Training to fit demand: load, repetition, lever arm
How do we usually strengthen plantarflexors?

Plantarflexor Strengthening for Improving Gait
Example:
Stretching Plantarflexors

Example:
Dorsiflexor weakness in gait

- What is norm?
  - Firing from mid PSw through LR
  - Type of contraction: Concentric in swing, eccentric in LR
  - Position of limb is open chain in swing, closed chain in LR
  - Range of motion: from 15° plantarflexion to 0° dorsiflexion to 5° plantarflexion
  - Degree of difficulty: Moderate (short lever, mostly open chain, on for long period of time)
Does this work for us?

What else is necessary in addition to task specificity?
Number of Repetitions

Table 4: Frequency and Numbers of Repetitions in Categories and Subcategories, Pooled Across All Seven Sites

<table>
<thead>
<tr>
<th>Category</th>
<th>Sessions Observed, n</th>
<th>Sessions Observed, Percent</th>
<th>Repetitions, Mean n</th>
<th>95% Confidence Interval of the Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper extremity</td>
<td>119</td>
<td>73</td>
<td>54</td>
<td>41-68</td>
<td>76</td>
<td>1-541</td>
</tr>
<tr>
<td>Active exercise</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passive exercise</td>
<td>67</td>
<td>41</td>
<td>33</td>
<td>22-44</td>
<td>45</td>
<td>1-246</td>
</tr>
<tr>
<td>Sensory</td>
<td>29</td>
<td>18</td>
<td>13</td>
<td>9-19</td>
<td>16</td>
<td>1-71</td>
</tr>
<tr>
<td>Functional</td>
<td>83</td>
<td>51</td>
<td>32</td>
<td>20-44</td>
<td>56</td>
<td>1-420</td>
</tr>
<tr>
<td>Lower extremity</td>
<td>160</td>
<td>70</td>
<td>76</td>
<td>58-90</td>
<td>113</td>
<td>1-802</td>
</tr>
<tr>
<td>Active exercise</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Passive exercise</td>
<td>93</td>
<td>27</td>
<td>12</td>
<td>9-19</td>
<td>14</td>
<td>1-88</td>
</tr>
<tr>
<td>Sensory</td>
<td>10</td>
<td>4</td>
<td>10</td>
<td>4-15</td>
<td>8</td>
<td>1-25</td>
</tr>
<tr>
<td>Functional</td>
<td>20</td>
<td>7</td>
<td>6</td>
<td>2-10</td>
<td>10</td>
<td>1-34</td>
</tr>
<tr>
<td>Gait</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Episodes</td>
<td>193</td>
<td>94</td>
<td>6</td>
<td>5-6</td>
<td>5</td>
<td>1-39</td>
</tr>
<tr>
<td>Steps</td>
<td>193</td>
<td>94</td>
<td>357</td>
<td>286-418</td>
<td>432</td>
<td>3-2614</td>
</tr>
<tr>
<td>Stair climbing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Episodes</td>
<td>50</td>
<td>22</td>
<td>3</td>
<td>2-4</td>
<td>2</td>
<td>1-12</td>
</tr>
<tr>
<td>Steps</td>
<td>50</td>
<td>22</td>
<td>38</td>
<td>31-45</td>
<td>26</td>
<td>2-122</td>
</tr>
<tr>
<td>Transfers</td>
<td>219</td>
<td>70</td>
<td>11</td>
<td>9-13</td>
<td>12</td>
<td>1-78</td>
</tr>
<tr>
<td>Balance</td>
<td>147</td>
<td>47</td>
<td>27</td>
<td>19-35</td>
<td>48</td>
<td>1-432</td>
</tr>
</tbody>
</table>

All values rounded to the nearest whole number.

*Total number of observed sessions = 312. Denominators used to calculate percentage of observed sessions were as follows: upper extremity subcategories, n = 162; lower extremity subcategories, gait and stairs, n = 230; transfers and balance, n = 312; see Methods section for explanation.

Lang et al 2009

Intensity...
How do we manipulate it?

- Repetition
- Time in therapy
- Frequency of therapy
- Cardiovascular response
- RPE
- Functional
- Challenging
- Load
- Speed
But...how much is enough?

Does the dosage change the overall response?

**DOSE VS. RESPONSE?**

---

**Change intensity, change response!**

Results:

- **Conventional PT:**
  - Average # of steps during session: 886 steps
  - Average of 3,822 steps/day before conventional PT; **no change after intervention**

- **Locomotor Training:**
  - Average # of steps during session: 3,896 steps
  - Average of 5,560 daily steps after discharge from LT
  - Significant improvement in gait speed & gait efficiency

Moore et al, 2010
What about the P word?

- What is the best time frame for retraining function?
- Is recovery possible in chronic stages?
  - Teasell R et al, Top Stroke Rehabil, 2012
- What is a plateau?
  - Common in all areas of neuromuscular performance
  - Achieving an adaptive state
  - Stable training stimulus = stabilization of max performance
  - Not indication of diminished capacity for motor improvement
Breaking through the Plateau

• What can we do when patient plateaus?
  – Expect recovery
  – Periodization
• Adjust exercise delivery so that positive adaptations continue
• Modify intensity, session duration, changing routine, etc…
• Task specific, repeated practice protocols
• CHALLENGING exercise regimens

Task Oriented
Circuit Training

• Group setting training
• Beneficial for improving mobility
• Contradictory results:
  – More effective for improving walking distance, time, and speed compared to other exercise
  – Improvements in gait endurance, no changes in walking amount or rate; gains lost in 3 months
Target Endurance

- In sample of stroke survivors 1 year post stroke, only 50% could complete 6 minute walk
- Those who completed the walk did so at only 40% of predicted distance
- Strong relationship between endurance as measured by 6 minute walk and community integration
- Increasing endurance could reduce handicap

Balance
Becoming a Master Manipulator

Sherrington et al., 2008

Proposed model

Newell, 1991
Video Case 1

- Major gait deviations
- Likely causes
- How do we treat?
  - Strength
  - ROM
  - Endurance
  - Balance
  - Task specific function
Video Case 2

• Major gait deviations
• Likely causes
• How do we treat?
  – Strength
  – ROM
  – Endurance
  – Balance
  – Task specific function
Video Case 3

• Major gait deviations
• Likely causes
• How do we treat?
  – Strength
  – ROM
  – Endurance
  – Balance
  – Task specific function
Questions?

jiseale@utmb.edu