REHABILITATION FOR A PATIENT WITH MULTIPLE SCLEROSIS

A Doctoral Project
A Comprehensive Case Analysis

Presented to the faculty of the Department of Physical Therapy
California State University, Sacramento

Submitted in partial satisfaction of the requirements for the degree of

DOCTOR OF PHYSICAL THERAPY

by

Kelley Kukis

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Department of Physical Therapy
Abstract

of

REHABILITATION FOR A PATIENT WITH MULTIPLE SCLEROSIS

by

Kelley Kukis

A 63 year old patient with multiple sclerosis was seen at an outpatient physical therapy clinic for eight visits over the course of eight weeks. She was found to have decreased dynamic balance during walking and stair tasks as well as decreased static standing balance with vestibular involvement and limited dorsiflexion passive range of motion. She received balance training, stair training, gait training, vestibular rehabilitation therapy, and patient education. The patient showed increased right ankle dorsiflexion passive range of motion and improved static standing balance. She showed improvements in functional testing of dynamic balance and stair negotiation. She was discharged to continue living at home with the support of her husband and adult daughter, and upon discharge she was independent in a home exercise plan.

_________________________________, Committee Chair
Lois Boulgarides, PT, DPT

_________________________________
Date
ACKNOWLEDGEMENTS

So many people have contributed to the completion of this project both directly and indirectly. I would like to acknowledge John “Jack” Corbett III for his expertise, advice, and supervision as my clinical instructor during this episode of care. I would also like to thank my committee members, Dr. Lois Boulgarides, Dr. Bryan Coleman-Salgado, and Dr. Edward Barakatt, for providing insightful feedback and direction through the writing and editing process. Without their expertise and patient guidance, the completion of this project would not have been possible. I owe thanks to my professors, Dr. Katrin Mattern-Baxter and Dr. Michael McKeough, for sharing just a small portion of their vast skills and knowledge of the treatment of neurological conditions. This would also not have been possible without the unending encouragement of my parents, Peter and Karen Kukis, for whom I am tremendously grateful. Finally, I would like to thank my partner, Jerry Yamashita, for being my sounding board and support through this journey.
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</tbody>
</table>
Chapter 1

General Background

Multiple sclerosis (MS) is a chronic autoimmune disease in which the activation of autoreactive T cells causes inflammation, progressive demyelination, and axonal loss of the neurons in the central nervous system.\textsuperscript{1-3} This disruption in neural transmission can cause vision changes, sensory loss, motor deficits, and balance impairments.\textsuperscript{1} Presentations fall into two main categories: relapsing-remitting and progressive.\textsuperscript{3}

Relapsing-remitting MS accounts for 85\% of those with the disease and is characterized by exacerbations followed by periods of remission, whereas progressive MS accounts for 10\% of those with the disease and is characterized by a steady disease progression.\textsuperscript{3}

In an analysis of 22 studies completed in multiple countries, the median incidence of MS was found to be 4.2 per 100,000, but this number ranged by geographical region from 0.8-12.0 per 100,000.\textsuperscript{4} The incidence is highest at age 30, and diagnosis is uncommon before age 15 or after age 50.\textsuperscript{4} The National MS Society states that there is no national registry for people with MS, so an exact prevalence is impossible to determine.\textsuperscript{5} However, by applying incidence rates to reported subgroups in the 2002 United States census, the national prevalence was estimated to be 400,000 individuals.\textsuperscript{5}

Female sex is a non-modifiable risk factor for MS; worldwide, the lifetime risk for women is 2.5\% compared to a 1.4\% lifetime risk for men.\textsuperscript{6} The female to male ratio of people with MS has been increasing over time and is currently about 3:1.\textsuperscript{7,8} Several genes have been identified to increase risk for MS, but current thought is that
Environmental factors play a significant role in onset of the disease. Latitude is a risk factor, though the correlation between higher latitudes and the prevalence of MS has been declining since 1980. Currently, each 10° increase in latitude is associated with a 15% increase in risk for women (down from 31% prior to 1980) and an 11% increase in risk for men (down from 54% prior to 1980). Several studies suggest that those who migrate prior to the age of 15 take on the risk of the latitude to which they have migrated, whereas those who migrate after the age of 15 retain the risk of their latitude of origin; however, other studies have found that this may not be the case universally or that the relationship between risk and age of migration may be more complicated than previously thought. Modifiable risk factors that are positively correlated with risk of MS are previous infection with the Epstein-Barr virus, smoking, and exposure to soil born lead. Modifiable risk factors that are inversely associated with the risk of MS include Vitamin D intake, hours of sunlight exposure, and exposure to soil born arsenic.

The overall natural course of both relapsing-remitting and progressive MS is decreasing mobility, increasing disability, and usually decreased life expectancy. One large study in Scotland found that 50% of those diagnosed with MS were moderately disabled 6 years after diagnosis, severely disabled (non-ambulatory) 18 years after diagnosis, and dead 30 years after diagnosis. Though the average duration of the disease is 25-30 years, on either side of this mean is a group that experiences early onset and short survival (malignant) and another group that experiences late onset and very slow progression (benign). Prognostic factors for decreased disability and mortality are
optic neuritis or other sensory deficits as a sole symptom, a lesion solely in the brainstem, a relapsing-remitting course at diagnosis, lack of a family history for MS, and a lack of disability 10 years after onset. Prognostic factors for increased disability and mortality are a polysymptomatic presentation; a short interval between the first two relapses; the presence of weakness or unsteadiness; a progressive course of the disorder at diagnosis; and pyramidal tract, spinal cord, or cerebellar involvement.
Chapter 2

Case Background Data

Examination - History

The patient was a 63 year-old woman who had been diagnosed with relapsing-remitting MS in 1998, 17 years prior to this episode of care. In the two years leading up to her diagnosis she had begun to experience blurred vision, fatigue, and dizziness. She self-referred to an outpatient physical therapy clinic to address concerns about her balance, which had begun to limit her usual activities.

At the time of the initial encounter, the patient’s chief complaint was a feeling of unsteadiness during dynamic activities such as transitioning from sit-to-stand and supine-to-sit, ascending and descending stairs, walking her dogs, and attending group yoga classes at her gym. She also complained of fatigue which she stated came on after 10-15 minutes of walking on a level surface with a walking stick or after ascending six stairs with a handrail and walking stick. The patient’s goals were to be able to walk her dogs, to increase her comfort with using the stairs at her church so that she could participate in functions held on the second level of the building, and to develop independence and consistency with a home exercise program (HEP).

Five years prior to the initial encounter, the patient reported experiencing two MS related seizures in 2010 which resulted in falls each time. The patient stated that she had not experienced any seizures or falls since then. Shortly following her diagnosis for MS, the patient was also diagnosed with depression for which she received treatment. She was
still receiving both counseling and pharmaceutical treatment for depression at the time of the initial encounter.

The patient reported that she lived with her husband and adult daughter and that her husband performed most household tasks, but she assisted as she was able. Her husband drove most places, but the patient reported that she was able to drive short distances during the day. She reported that she swam for exercise in her home pool during the summer. She belonged to a nearby gym, but she did not often utilize it because she tried a yoga class once and felt that it was too fast paced and challenging to her balance. The patient reported walking around her neighborhood on level pavement in 10-15 minute bouts a few times a week. Previously, she had walked her two small dogs, but she reported that she had not done so for the past two years because she felt unsteady while doing so. She attended church regularly and reported that there were events on the second floor which she was unable to attend due to lack of confidence in her ability to negotiate the flight of stairs.

The patient ambulated community distances with a walking stick but did not often do so without the supervision of her husband. She reported using glasses and bilateral hearing aids. She had grab bars in her shower and near her toilet. The patient stated that she had a walker and power wheelchair that were given to her but that she did not use either device.

**Systems Review**
The systems review showed impairments in the musculoskeletal and neuromuscular systems. Impairments to the musculoskeletal system included decreased dorsiflexion active and passive range of motion (PROM/AROM) bilaterally, and decreased right hip flexor and knee extensor strength compared to the left. Hoffman’s, Babinski, and clonus were negative bilaterally; light touch sensation was grossly intact bilaterally; and there was no detectable spasticity in the lower extremities as measured by a Modified Ashworth Scale. Cranial nerve testing revealed absence of ocular convergence, facial asymmetry with lower resting tone on the right side, and inability to hear a finger rub near the ears bilaterally. The cardiovascular system was not impaired; the patient’s blood pressure measured at 120/72 millimeters of mercury and her heart rate at 68 beats per minute with normal sinus rhythm. Her integument was intact per patient report, and her body mass index was 25.8. Communication was appropriate, and the patient was oriented times 4.
## Examination - Medications

### Table 1

### Medications

<table>
<thead>
<tr>
<th>MEDICATION</th>
<th>DOSAGE</th>
<th>REASON</th>
<th>SIDE EFFECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solifenacin (Vesicare)</td>
<td>5 milligrams (mg) daily</td>
<td>Overactive bladder</td>
<td>Dry mouth, constipation, stomach pain, nausea/vomiting, heartburn, dry eyes, blurred vision, extreme tiredness</td>
</tr>
<tr>
<td>Gilenya (Fingolimod hcl)</td>
<td>0.5 mg daily</td>
<td>Multiple Sclerosis</td>
<td>Headache, weakness, back pain, numbness, burning, or tingling in the hands or feet, depression, dry, peeling, or itchy skin, hair loss</td>
</tr>
<tr>
<td>Levetiracetam (Keppra)</td>
<td>1 tablet twice daily</td>
<td>Anti-convulsant</td>
<td>Drowsiness, weakness, unsteady walking, coordination problems, headache, pain, forgetfulness, anxiety, agitation or hostility, dizziness, moodiness, nervousness, numbness, burning, or tingling in the hands or feet, loss of appetite, vomiting, diarrhea, constipation, changes in skin color</td>
</tr>
<tr>
<td>Fluoxetine (Prozac)</td>
<td>60 mg daily</td>
<td>Depression</td>
<td>Nervousness, nausea, dry mouth, sore throat, drowsiness, weakness, uncontrollable shaking of a part of the body, loss of appetite, weight loss, changes in sex drive or ability, excessive sweating</td>
</tr>
<tr>
<td>Mirtazapine</td>
<td>15 mg daily</td>
<td>Depression</td>
<td>Drowsiness, dizziness, anxiousness, confusion, increased weight and appetite, dry mouth, constipation, nausea, vomiting</td>
</tr>
<tr>
<td>Multivitamin (nonprescription)</td>
<td>1 tablet daily</td>
<td>Nutritional</td>
<td>Upset stomach</td>
</tr>
</tbody>
</table>

- **MEDICATION**: Name of the medication
- **DOSAGE**: Recommended dosage
- **REASON**: Purpose of the medication
- **SIDE EFFECTS**: Common side effects
Chapter 3

Examination – Tests and Measures

Tests and measures were taken within all three levels of the International Classification of Functioning, Disability, and Health (ICF) model: body structure/function, activity, and participation. Standard goniometry was used to assess the PROM of the joints of the lower extremities. The Modified Clinical Test of Sensory Interaction and Balance (mCTSIB), which is an abbreviated version of the Clinical Test of Sensory Interaction and Balance (CTSIB), was used to test postural control under varied sensory conditions at the body structure and function level. The Dynamic Gait Index (DGI) was used at the activity level to assess gait function under eight varied conditions. The Dizziness Handicap Inventory (DHI) was used to assess how dizziness affected the patient at both the activity and participation levels. Participation was also measured by patient report.

Standard goniometry can be used as an outcome measure to assess changes in AROM and PROM. Joints are measured either actively or passively using a standard goniometer in degrees. The minimum detectable change at a 95% confidence level (MDC95) for dorsiflexion using a goniometer is 3.0.

The CTSIB was designed to identify which sensory components of balance (visual, somatosensory/proprioceptive, or vestibular) may be contributing to a balance deficit. The CTSIB, the mCTSIB, and instrumented versions of both tests (which quantify a subject’s amount of sway on a force plate) all measure tests a subject’s
ability to remain standing for up to 30 seconds on a firm surface with eyes open (condition 1 of the mCTSIB) or closed (condition 2 of the mCTSIB), or compliant surface with eyes open (condition 3 of the mCTSIB) or closed (condition 4 of the mCTSIB). The CTSIB additionally includes two conditions with a visual conflict dome. A shortened time that an individual is able to maintain each position indicates a static standing balance restriction. Condition 4 of the mCTSIB which is the same as condition 5 of the CTSIB, is thought to eliminate visual information, reduce reliable somatosensory and information, and force the subject to rely mostly on vestibular feedback, thus giving the tester information about a subject’s level of vestibular impairment. In an instrumented version of the test, loss of balance during condition 4 differentiated a known group of subjects with either a central or peripheral vestibular disorder from a control group with both a sensitivity (Sn) and specificity (Sp) of 0.80. Based upon this Sn and Sp the positive likelihood ratio is 4.0, and the negative likelihood ratio is 0.25. In addition to being diagnostic for vestibular impairment, the mCTISIB can be used as a test that is prognostic for future falls. Inability to maintain stability for at least 10 seconds on condition 4 was found to be predictive of both future single falls and future multiple falls in women over age 40 with odds ratios of 1.99 and 4.21, respectively. Because this patient’s chief complaints and goals centered on balance deficits, because of its ease of administration, and because it has been shown to identify vestibular impairments, the mCTSIB was selected as a diagnostic and prognostic test for this patient even though
more research is needed to determine its psychometric properties for the population of
patients with MS.

The DGI is scored on a 0-24 point scale with a lower score indicating a more
severe limitation. The test can be used as an outcome measure and as a prognostic
measure for fall risk. The test has excellent test-retest reliability in the population of
patients with MS with an intraclass correlation coefficient (ICC) of 0.85.\textsuperscript{31} The DGI
also has been shown to have excellent interrater and intrarater reliability (ICC=0.76-
0.98) when tested in patients with MS.\textsuperscript{32} In the population of people with MS, the
MDC\textsubscript{95} is 5.54 points, which means that a patient must change 6 points (since the
measure is not scored in fractions of points) to demonstrate true change that is not due
to possible measurement error.\textsuperscript{31} The minimal clinically important difference (MCID)
in community dwelling adults over age 65 for this measure is 1.90 points.\textsuperscript{33} Since the
MCID is lower than the MDC, the MDC should be utilized as the MCID. In patients
with MS a cutoff score below 12 points indicates that the patient has an increased fall
risk.\textsuperscript{34} This cutoff results in a Sn of 45\% and a Sp of 80\%, so the measure is more
effective at ruling in risk of fall than it is for ruling it out.\textsuperscript{34} Based on this Sn and Sp,
the positive likelihood ratio for this test is 2.25 and the negative likelihood ratio is
0.69. In populations with MS, the DGI has excellent to adequate concurrent validity
with the Berg Balance Scale, the Timed Up and Go, and the Activities-Specific
Balance Confidence Scale (Spearman coefficients= 0.78, -0.72, and 0.54,
respectively).\textsuperscript{31,34} A statistically significant mean difference of 3 points in DGI scores
(p=0.025) has been found between fallers and non-fallers in a sample of people with MS. This measure was selected because it has been tested extensively and has been found to be valid and reliable in the population of patients with MS. The DGI tested specific gait tasks that this patient identified as limited.

The DHI is a 25 question self-report questionnaire with scores ranging from 0-100 with higher scores indicating a higher perceived level of limitation and restriction. This instrument can be used as an outcome measure and has an MDC95 of 22.5 points for people with MS. In patients with MS, the DHI has excellent test-retest reliability (ICC=0.90, CI=95%) and excellent internal consistency (Chronbach’s alpha=0.91). No floor effect has been reported in patients with MS, and the ceiling effect is adequate at 1.9%. Because this instrument has been tested in the MS population and has been shown to have good psychometrics, it was selected as an outcome measure for participation for this patient.
Table 2

Examination Data

<table>
<thead>
<tr>
<th>Measurement Category</th>
<th>Test/Measure Used</th>
<th>Test/Measure Results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BODY FUNCTION OR STRUCTURE IMPAIRMENTS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Static standing balance</td>
<td>mCTSIB</td>
<td>Condition 1 (firm surface, eyes open): 30 seconds, minimal sway</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Condition 2 (firm surface, eyes closed): 30 seconds, minimal sway</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Condition 3 (foam surface, eyes open): 30 seconds, minimal sway</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Condition 4 (foam surface, eyes closed): 5.7 seconds (mean of 3 trials)</td>
</tr>
<tr>
<td>Passive range of motion</td>
<td>Goniometry</td>
<td>Joint</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R</td>
</tr>
<tr>
<td></td>
<td></td>
<td>L</td>
</tr>
<tr>
<td>Hip (flexion only)</td>
<td></td>
<td>110 degrees flexion with soft end feel (thigh approximation to abdomen)</td>
</tr>
<tr>
<td>Knee (extension/flexion)</td>
<td></td>
<td>0-150 degrees flexion with soft end feel upon flexion (calf approximation to thigh) and firm end feel upon extension</td>
</tr>
<tr>
<td>Ankle (dorsiflexion/ plantarflexion)</td>
<td></td>
<td>12-65 degrees with firm end feel in both dorsiflexion and plantarflexion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5-0-62 degrees with firm end feel in both dorsiflexion and plantarflexion</td>
</tr>
<tr>
<td><strong>ACTIVITY LIMITATIONS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dynamic standing balance</td>
<td>Dynamic Gait Index</td>
<td>16/24 points</td>
</tr>
<tr>
<td>Gait in open environments</td>
<td>Patient report</td>
<td>Patient reports being able to walk independently on a level surface with a walking stick for 10 minutes</td>
</tr>
<tr>
<td>Stair negotiation</td>
<td>Patient report</td>
<td>Patient reports being able to ascend/descend 6 stairs with supervision using 1 handrail on either side</td>
</tr>
<tr>
<td>Adherence to a home exercise program</td>
<td>Patient exercise log</td>
<td>Regular exercise consists of walking independently on level outdoor surface with walking stick an average of 10 minutes per day, 2 days per week</td>
</tr>
<tr>
<td>Measurement Category</td>
<td>Test/Measure Used</td>
<td>Test/Measure Results</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>------------------------------------</td>
<td>------------------------------------------------------------</td>
</tr>
<tr>
<td>Disability Due to Dizziness</td>
<td>Dizziness Handicap Inventory</td>
<td>46/100 points</td>
</tr>
<tr>
<td>Participation in the care of her dogs by walking them</td>
<td>Patient report</td>
<td>Patient reported not walking her dogs on a leash</td>
</tr>
<tr>
<td>Participation in events held on second story of church building</td>
<td>Patient report</td>
<td>Patient reported not participating in events held on the second story of her church building.</td>
</tr>
</tbody>
</table>
Chapter 4

Evaluation

Evaluation Summary

The patient was a 63-year-old woman 17 years post diagnosis of relapsing-remitting MS which, based on patient report, primarily affected her balance and fatigability. She was observed to ambulate independently using a walking stick but expressed that she often felt unsteady while walking her dogs or navigating stairs. Unsteadiness and fatigue, as reported by the patient, limited her ability to participate in activities that were held on the second story at her church and to independently care for her dogs by taking them on walks. The patient was found to have limitations in dorsiflexion PROM, as measured by goniometer, which was thought to have a muscular component due to a firm end feel. Her limited stance time during condition 4 of the mCTSIB suggested that her balance was limited by an impaired vestibular system. As measured by the DGI, the patient had limited dynamic balance during walking and stair activities.

Diagnostic Impression

The patient reported participation restrictions of not being able to walk her dogs or attend events on the second story of her church building. These restrictions were due to limitations in stair negotiation, dynamic balance, gait in open environments, and sufficient adherence to a HEP. Underlying these activity limitations were impairments at the body structure and function level of limited ankle dorsiflexion.
PROM, which limited her ability to utilize an ankle strategy for balance, and impaired vestibular function. These findings are consistent with a presentation of MS.

**G-Codes**

- Current with modifier: G8978+CL based on the DGI
- Goal with modifier: G8979+CI based on the DGI

**Prognostic Considerations**

A diagnosis of relapsing-remitting MS is prognostic for less disability than a diagnosis of progressive MS; therefore, this is a positive prognostic factor for this patient.36 There is evidence that patients with impaired standing static balance resulting from central vestibular dysfunction show improvements after vestibular rehabilitation therapy (VRT) but that VRT exercises must be continued in order for these gains to be maintained.37 Because of this, adherence to a HEP was expected to be vital to this patient’s improvement and maintenance of static standing balance. The patient was highly motivated to reach her goals. She took an active role in her physical and mental health by regularly seeing her mental health counselor and her primary care physician as well as consistently completing and logging physical activity. These behaviors showed it was likely that she would adhere to an appropriate HEP.

The patient was anticipated to be discharged to remain living at her home with a HEP after eight weeks of pro bono clinic. She had an excellent support system including a husband, who was very active in her care, and an adult daughter who also lived with her.
### Table 3

#### Evaluation and Plan of Care

<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>PLAN OF CARE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Limited dorsiflexion</strong></td>
<td><strong>Short Term Goals</strong> (Anticipated Goals) (4 weeks)</td>
</tr>
<tr>
<td>PROM</td>
<td>The patient will be independent with a daily home exercise program (HEP) that includes plantar flexor stretching</td>
</tr>
<tr>
<td></td>
<td><strong>Long Term Goals</strong> (Expected Outcomes) (8 weeks)</td>
</tr>
<tr>
<td></td>
<td>The patient will have -7 degrees of passive dorsiflexion on the right and 10 degrees of passive dorsiflexion on the left as measured by a goniometer in supine. (Increase of 5 degrees bilaterally)</td>
</tr>
<tr>
<td></td>
<td><strong>Planned Interventions</strong></td>
</tr>
<tr>
<td></td>
<td>Planned Interventions are Direct or Procedural unless they are marked:</td>
</tr>
<tr>
<td></td>
<td>(C) = Coordination of care intervention</td>
</tr>
<tr>
<td></td>
<td>(E) = Educational intervention</td>
</tr>
<tr>
<td></td>
<td><strong>Yoga Sequence</strong></td>
</tr>
<tr>
<td></td>
<td>• Modified Downward Dog: feet on the ground with straight legs, flexing at the hip with torso and arms straight and hands on chair holding for 10 seconds (gradually progressed to holding 60 seconds)</td>
</tr>
<tr>
<td></td>
<td>• Warrior I: legs in modified lunge position with back leg externally rotated and foot in contact with ground (gradually progressed to lengthen stance to increase stretch) for 10 seconds (progressed to 60 seconds)</td>
</tr>
<tr>
<td></td>
<td>• Contract/Relax stretching on stairs</td>
</tr>
<tr>
<td></td>
<td>• Heels off edge of step while holding handrail, patient contracted by pushing up onto toes for 10 seconds, relaxed and let heels hang off edge of step 30 seconds (2 sets with extended knees and 2 sets with flexed knees)</td>
</tr>
<tr>
<td></td>
<td><strong>HEP</strong></td>
</tr>
<tr>
<td></td>
<td>• Twice daily stretch gastrocnemius and soleus by leaning forward with back knee bent and back knee straight with hands on wall for support (hold 30 seconds each side)</td>
</tr>
<tr>
<td></td>
<td>• Yoga sequence 3 times/week</td>
</tr>
</tbody>
</table>
| Impaired static standing balance with vestibular system involvement | The patient will be independent with a daily HEP that includes vestibular adaptation exercises | Patient will be able to stand for >10 seconds during condition 4 of the mCTSIB (eyes closed, compliant surface) with supervision assist and no assistive device, which increases her score to above a cutoff value which is prognostic for a lower fall risk | Yoga Sequence
- Mountain Pose with comfortable stance (progressed to narrow stance) on firm surface (progressed to 1” thick foam mat) with arms at side (progressed to arms overhead) and face forward (progressed to looking overhead or eyes closed) holding for 10 seconds (progressed to 60 seconds)
- Forward Fold with comfortable stance (progressed to narrow stance) on firm surface (progressed to 1” thick foam mat) flexed at the hip with torso and arms hanging holding for 10 seconds (progressed to 60 seconds)
- Warrior I with comfortable stance (progressed to narrow stance) on firm surface (progressed to 1” thick foam mat) with arms at side (progressed to arms overhead) and face forward (progressed to looking overhead or eyes closed) holding for 10 seconds (progressed to 60 seconds)
- Tree Pose with toes on ground and heel on contralateral ankle (progressed to sole of foot on contralateral leg, then thigh) on firm surface (progressed to 1” thick foam mat) with arms at side (progressed to arms overhead) and face forward (progressed to looking overhead or eyes closed) holding for 10 seconds (progressed to 60 seconds)

Weight shifting exercises
- Self-imposed weight shifts (progressed to PT imposed perturbations) in sagittal plane (progressed to multiple planes) on firm surface (progressed to 1” foam mat to 6” foam square) with eyes open (progressed to eyes closed)
- Once patient progressed to 6” foam with eyes open, variations were added of picking up 6” cone
from floor, crossing midline, and placing cone on opposite side

Vestibular adaptation exercises
- 1 target viewing - patient focused on a letter posted on the wall and turned head right to left to beat of music at a speed of 1-2 hertz (Hz) while sitting (progressed to standing to walking) on firm surface (progressed to foam for standing and outdoor surface for walking)
- 3 target viewing - patient quickly turned head to focus on letters on left, center, and right to beat of music at a speed of 1-2 Hz while sitting (progressed to standing) on a firm surface (progressed to foam)

HEP
- Ball diagonals - patient held a ball at arm length with both hands. While maintaining focus on the ball, patient moved the ball down to knee, then up to opposite overhead diagonal 10 times and repeated on other side
- Weight shifting exercise on firm surface in sagittal plane in front of table with wall behind to facilitate ankle strategy

(E) Educated patient on yoga visualization strategy to improve balance during challenging tasks
(C) Found appropriate adapted yoga class for continued practice and progression following pro bono clinic

<table>
<thead>
<tr>
<th>ACTIVITY LIMITATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Limited gait in open environments</strong></td>
</tr>
<tr>
<td>Patient will walk outdoors with standby assist on varied surfaces (grass, up and down curbs, ramps, stepping stones) for 10 minutes with no supervision.</td>
</tr>
<tr>
<td>Patient will walk outdoors with supervised assist on varied surfaces (grass, up and down curbs, ramps, stepping stones) while receiving “dog leash”.</td>
</tr>
<tr>
<td>Stepping strategy practice</td>
</tr>
<tr>
<td>Patient held Theraband “dog leash” (progressed to noncompliant dog leash) as husband pulled in sagittal plane (progressed to multiple planes) in</td>
</tr>
</tbody>
</table>
| assistive device with no loss of balance | perturbations from husband (see intervention activity) for 20 minutes with no assistive device with no loss of balance  
Patient will show an improvement in DGI score of 6 points to a score of 22/24 points | standing (progressed to walking) on level indoor surface (progressed to varied outdoor surface) with a large enough force to cause patient to use stepping strategy  
HEP  
• Walked outdoors at self-directed pace for self-selected length of time (average 10-30 minutes) using walking stick as needed at least 3 times/week  

Limited stair negotiation | The patient will ascend and descend one flight of stairs (16 stairs) using handrail support with no assistive device using an alternating pattern with contact guard assist.  

Stair training  
• Patient ascended/descended one flight of stairs (16 stairs) with no assistive device holding 1 handrail (progressed to no handrail) with contact guard assist (progressed to supervised assist) one time (progressed to 4 times) | The patient will ascend/ descend one flight of stairs (16 stairs) with no assistive device using handrail support using an alternating pattern with supervised assist.  

Patient given written HEP with charting calendar  
(E) Patient education about importance of high repetitions of stretching and balance exercises to increase range of motion and static and dynamic balance  

Patient’s HEP does not include sufficient dosage or variety of exercises for increases in ankle dorsiflexion and static and dynamic balance | The patient will be completing and logging a prescribed HEP, which includes stretching, balance exercises, and walking at least 3 days per week  

Patient given written HEP with charting calendar  
(E) Patient education about importance of high repetitions of stretching and balance exercises to increase range of motion and static and dynamic balance | The patient will be completing and logging a prescribed HEP, which includes stretching, balance exercises, and walking at least 5 days per week  

Patient given written HEP with charting calendar  
(E) Patient education about importance of high repetitions of stretching and balance exercises to increase range of motion and static and dynamic balance  

PARTICIPATION RESTRICTIONS | The patient will participate in an activity on the second floor of her church building by ascending and descending one flight of stairs with contact guard assistance from her husband and using the handrail and her walking stick as needed.  

See above interventions for stair negotiation  
(E) Educated husband to provide contact guard assist on stairs | The patient will participate in at least 1 activity on the second floor of her church building by independently ascending and descending one flight of stairs using the handrail and her walking stick as needed.  

See above interventions for stair negotiation  
(E) Educated husband to provide contact guard assist on stairs |
| Unable to fulfill role as caretaker for her dogs by taking them on walks | The patient will stand on a level outdoor surface for 5 minutes using her walking stick and holding the leash of the dog she has identified as “calm” with supervision assistance from her husband. | The patient will go on a 10 minute walk on the sidewalk outdoors in neighborhood, using her walking stick and holding the leash of the dog she has identified as “calm” with supervision assistance from her husband. | See above interventions for gait in open environments (E) Educated husband to provide supervision assist during gait |
Plan of Care – Interventions

See table 3

Overall Approach

The overall treatment approach for this episode of care was twofold. Vestibular impairments were treated using the principles of adaptation and neuroplastic reorganization. Changing or diminished visual information, variable somatosensory and proprioceptive feedback, and changes in position to challenge the vestibular system were introduced to encourage adaptation and increased motor control. Activity level limitations were treated using task-specific training. Gait training and stair training were carried out with conditions that mimicked the patient’s self-identified functional balance challenges. All interventions were carried out with a high volume of repetitions and progressed appropriately as adaptation occurred. The patient was seen for one hour weekly for eight weeks and was given a daily HEP.

PICO question:

For a patient with MS who has complaints of both unsteadiness and fatigue (P), are balance exercises (I) more effective than strengthening and endurance exercises (C) to improve dynamic balance, particularly on stairs and with perturbations? (O)

In a 14-week, single-blinded, stratified blocked randomized controlled trial (level of evidence: 1b; Pedro Score: 8/10)35 Herbert et al (2011) studied the effects of vestibular rehabilitation compared to both general exercise and no exercise. Thirty-eight subjects aged 18-65 years of age with MS who were able to walk at least 100
meters, with or without an assistive device, and had limited standing balance participated in this study. Subjects were tested at baseline for fatigue, disability due to dizziness and disequilibrium, depression, and cardiorespiratory endurance. Subjects were assigned to either a vestibular rehabilitation group, an exercise group, or a wait-listed control group. The vestibular rehabilitation therapy program consisted of upright postural control and eye movement activities; the exercise program consisted of cycle ergometry and stretching, and both groups underwent treatment twice weekly for six weeks while the control group received their usual medical care. Following the treatment period, the group given vestibular rehabilitation therapy exercises showed significantly greater improvement over both the exercise group and the control group in fatigue (p=.024, .005), balance (p=.001, .003), and disability due to dizziness and disequilibrium (p=.018, .009). This study supported the use of vestibular/balance exercises to help address the patient’s chief complaints of unsteadiness and fatigue compared to a conditioning and strengthening program. The patient was similar to the participants of this study in age, ambulation ability, and use of assistive device; therefore, these findings were applicable to this patient.
## Table 4

### Outcomes

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Initial Details</th>
<th>Follow-up Details</th>
<th>Change Details</th>
<th>Goal Met (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OUTCOMES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>BODY FUNCTION OR STRUCTURE IMPAIRMENTS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ankle PROM</td>
<td>R: 12-65° plantarflexion L: 5-0-62° plantarflexion</td>
<td>R: 4-67° plantarflexion L: 0-61° plantarflexion</td>
<td>R: +8° dorsiflexion L: -5° dorsiflexion MDC&lt;sub&gt;95&lt;/sub&gt;: 3.0°</td>
<td>R: Y L: N</td>
</tr>
<tr>
<td>Static standing balance</td>
<td>mCTSIB (Condition 4): 5.7 seconds (mean of 3 trials)</td>
<td>mCTSIB (Condition 4): 17.4 seconds (mean of 3 trials)</td>
<td>mCTSIB (Condition 4): +11.7 seconds Cutoff Score: 10 seconds</td>
<td>Y</td>
</tr>
<tr>
<td><strong>ACTIVITY LIMITATIONS</strong></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Gait capacity in open environments</td>
<td>DGI: 16/24 points</td>
<td>DGI: 18/24 points</td>
<td>DGI: +2/24 points MDC&lt;sub&gt;95&lt;/sub&gt;: 5.54 points</td>
<td>N</td>
</tr>
<tr>
<td>Functional Testing of stair climbing capacity</td>
<td>Patient ascended/descended 6 stairs with one handrail and no assistive device with standby assist using alternating pattern on ascent and step-to pattern on descent</td>
<td>Patient ascended 16 stairs with alternating pattern and supervision assist using no handrail and no assistive device (x4) Patient descended 16 stairs with alternating pattern and standby assist using 1 handrail on either side and no assistive device (x4)</td>
<td>+10 stairs (x4) No handrail on ascent</td>
<td>Y</td>
</tr>
<tr>
<td>Variety and dosage of HEP</td>
<td>Patient logged 10 minutes of walking an average of 2 days per week</td>
<td>Patient logged exercise including walking, vestibular rehabilitation exercises, stretching, and yoga an average of 3 days per week</td>
<td>+1 day per week Increase in variety and specificity of exercises</td>
<td>N</td>
</tr>
</tbody>
</table>

### PARTICIPATION RESTRICTIONS
<table>
<thead>
<tr>
<th>Outcome</th>
<th>Initial</th>
<th>Follow-up</th>
<th>Change</th>
<th>Goal Met (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact of dizziness on participation</td>
<td>DHI: 46/100</td>
<td>DHI: 44/100</td>
<td>-2/100 MDC95: 22.5</td>
<td>N</td>
</tr>
<tr>
<td>Patient Report of participation in church events on the second story</td>
<td>Patient avoided events on second story of</td>
<td>Patient reported an event had not occurred</td>
<td>No change at participation level</td>
<td>N</td>
</tr>
<tr>
<td>floor of building (without elevator)</td>
<td>church</td>
<td>on the second story of her church during</td>
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<td></td>
<td></td>
<td>the last few weeks of clinic, so she</td>
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<td></td>
<td></td>
<td>had not attempted to ascend stairs</td>
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<td></td>
<td>independently. Functional testing showed</td>
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<td></td>
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<td>patient was able to ascend/descend 16</td>
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<td>stairs with one handrail and no assistive</td>
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<tr>
<td></td>
<td></td>
<td>device and supervision assist.</td>
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</tr>
<tr>
<td>Ability to participate in walking her dog on a leash</td>
<td>Patient did not bring her dogs on walks in</td>
<td>Patient reported she did not bring her</td>
<td>No change at participation level</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td>her neighborhood</td>
<td>dogs on walks in her neighborhood, but</td>
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<tr>
<td></td>
<td></td>
<td>functional testing with strong pulls on a</td>
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<tr>
<td></td>
<td></td>
<td>leash while walking over uneven surfaces</td>
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<tr>
<td></td>
<td></td>
<td>with supervision assist revealed the patient had the skills necessary to complete this task.</td>
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</tr>
</tbody>
</table>
Discharge Statement

The patient was seen at a physical therapy clinic for eight visits over eight weeks. Initially she was found to have decreased dynamic balance during walking and stair tasks as well as limited dorsiflexion PROM and impaired static standing balance with vestibular system involvement. She received balance training, stair training, gait training, vestibular rehabilitation therapy exercises, patient and family education, and a HEP. The patient showed increased right ankle dorsiflexion PROM and improved static standing balance as evidenced by goniometer measurements and increased time on condition 4 of the mCTSIB. She showed improvement in gait as evidenced by functional testing, though her improvement in the DGI did not reach the MDC. Her left ankle dorsiflexion PROM did not improve, and while the patient showed a slight improvement in the DHI, it did not reach the MDC. The patient reported that she did not reach her participation goal of attending functions on the second story of her church and walking her dogs, but functional testing during clinic revealed that she had developed the skills necessary to complete these tasks at the activity level, even though they were not attempted at the participation level. She was discharged to continue living at her home with the support of her husband and adult daughter, and upon discharge she was independent in her HEP and was planning to join a community adapted yoga class.

DC G-Code with modifier

G8980+CJ based on the DGI
Chapter 7

Discussion

The patient’s improved right ankle PROM, static standing balance, gait, and negotiation of stairs occurred, to a large part, because the patient was an active participant in her activities during clinic; was adherent to her HEP; created a strong support network of her husband, counselor, and physician; and was motivated to achieve her goals. This patient did not meet her participation goals during this episode of care, and improvement on the DHI did not reach the MDC. Based on patient-report, the final obstacles in attending an upstairs function at her church and walking her dogs seemed to be psychological rather than physical. The patient reported she had not had a reason to go upstairs in her church building during the eighth week of treatment and reported that she had not brought her dogs on her walk, though she did not give a clear reason. In clinic she demonstrated the physical ability to complete both of these tasks successfully, suggesting that her confidence level needed more time to match her physical skills, especially since this patient reported depression as a comorbidity. Likewise, an outcome measure like the DHI, which asks patients to self-rate broad patterns of activity and participation over time, may not be expected to change significantly in the limited period of time that this patient was seen.

In the future, I will use a very similar approach with a few changes. I will quantify the patient’s fatigue with an outcome measure such as the 6 Minute Walk Test. This patient’s fatigue was decreasing over the course of treatment as noted by
her ability to walk longer time periods and negotiate more stairs with similar Borg scale ratings. However, I did not have a validated endurance outcome measure and was unable to quantify how fatigue affected the patient at the activity and participation levels. In the future I will also consider how HEP instructions are structured visually and conceptually. I gave the patient of this case study a HEP and tracking form as a calendar, but she seemed more comfortable with tracking in list form. Though I did revise the format after receiving feedback from her, she still used her old HEP from a previous episode of care which had a more linear tracking form. I would also ask her about old exercises that she still liked doing and incorporate some of them into her new program rather than starting from scratch since she seemed to be incorporating a mix of current and past exercises on her own.

Many of the tests and measures and interventions used with this patient could be broadly applied to other patients with MS. Balance deficits are a common complaint in this population of patients, and vestibular rehabilitation therapy along with task specific activity level training could be utilized with a future patient with MS at a similar mobility level. These activities would not be as appropriate for a patient who was less mobile. Another consideration is that this patient was in good health with few comorbidities. She had a strong support system and a high level of motivation. If I were to encounter a patient with more comorbidities and/or less social support, I would need to modify goals and interventions.
In its comprehensive clinical guideline entitled *Management of Multiple Sclerosis in Primary and Secondary Care*, the United Kingdom based National Institute for Health and Care Excellence (NICE) reviewed and rated evidence available from 25 selected randomized controlled trials for non-pharmacological management of mobility in patients with MS as “very low” to “low” quality. The strongest recommendation was given for vestibular rehabilitation, but the evidence was still rated as “moderate.” Further investigation of effective interventions for patients with MS will be critical to determine best practices. As more evidence becomes available, physical therapists will be better equipped to choose appropriate and effective interventions for these patients.
References


