5-2021

Outpatient Physical Therapy Management of a Patient with relapsing-remitting multiple sclerosis.

Lydia Jacobson

OUTPATIENT PHYSICAL THERAPY MANAGEMENT OF A PATIENT WITH RELAPSING-REMITTING MULTIPLE SCLEROSIS

by

Lydia Jacobson

Bachelor of General Studies
University of North Dakota, 2019

A Scholarly Project Submitted to the Graduate Faculty of the

Department of Physical Therapy

School of Medicine and Health Sciences

University of North Dakota

in partial fulfillment of the requirements for the degree of

Doctor of Physical Therapy

Grand Forks, North Dakota
May
2021

This Scholarly Project, submitted by Lydia Jacobson in partial fulfillment of the requirements for the Degree of Doctor of Physical Therapy from the University of North Dakota, has been read by the Advisor and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

Emily Henneman, PT, DPT
(Graduate School Advisor)

David Kelly
(Chairperson, Physical Therapy)

PERMISSION

Title OUTPATIENT PHYSICAL THERAPY MANAGEMENT OF A PATIENT WITH RELAPSING-REMITTING MULTIPLE SCLEROSIS

Department Physical Therapy

Degree Doctor of Physical Therapy

In presenting this Scholarly Project in partial fulfillment of the requirements for a graduate degree from the University of North Dakota, I agree that the Department of Physical Therapy shall make it freely available for inspection. I further agree that permission for extensive copying for scholarly purposes may be granted by the professor who supervised my work or, in Emily Henneman absence, by the Chairperson of the department. It is understood that any copying or publication or other use of this Scholarly Project or part thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and the University of North Dakota in any scholarly use which may be made of any material in this Scholarly Project.

Signature Lydia Jacobson

Date 10/14/20

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

This case study would not have been possible without my endless support systems. My wonderful classmates, especially Jayce Turner, McKinley Bender, Megan Siebert, and Ellie Hagen, have given their time to countless peer reviews and feedback along the way. Assistant Professor Emily Henneman PT, DPT has been instrumental with her thoughtful guidance throughout developing this case study as well as the rest of physical therapy school. Finally, my wonderful family has always believed in me and cheered me on throughout my educational career.

ABSTRACT

Background and Purpose. Multiple sclerosis is a progressive autoimmune disease that affects the central nervous system. This case study discusses the clinical decision-making and the effectiveness of treatment of physical therapy for a patient with relapsing-remitting multiple sclerosis. **Case Description**. This case study describes an 8-week outpatient physical therapy episode of care for a 52-year-old patient with relapsing-remitting multiple sclerosis. The patient presented to physical therapy secondary to balance deficits and muscles spasms in her thoracic spine. Physical therapy interventions included resistive, balance, endurance, and gait exercises. **Outcomes.** Following 8 weeks of physical therapy the patient's balance, endurance, gait, and strength improved. She had no recent falls or muscle spasms since starting physical therapy. Outcomes were measured with manual muscle testing, 30-second chair test, single leg stance, and ambulating around a track. **Discussion.** This study aligns with current evidence that physical therapy can positively affect patients with multiple sclerosis. A limitation of this study is the absence of standardized tests and measures. Fatigue and quality of life should be measured through a self-report questionnaire.

CHAPTER I

BACKGROUND AND PURPOSE

Multiple sclerosis (MS) is a progressive autoimmune disease that affects the central nervous system (CNS).[1] MS causes both acute and chronic symptoms that may result in significantly impaired body structure/function, activity and participation limitations, and diminished quality of life. Symptoms of MS affect endurance, strength, sensation, pain, coordination, balance, vision, and cognition.[2]

The central nervous system (CNS) integrates sensory information from the peripheral nervous system and responds accordingly. The CNS consists of the brain, spinal cord, and optic nerves. Multiple sclerosis causes inflammation within the CNS that damages the myelin, oligodendrocytes, and nerve fibers.[3] Myelin is a protective coating that surrounds the nerve fibers, and oligodendrocytes are the cells that produce myelin. Damage to the myelin or nerve fibers results in messages within the CNS being altered or stopped completely. This damage is what causes the symptoms of MS. The areas damaged develop scar tissue, which is how multiple sclerosis developed its name – multiple areas of scarring.[4]

MS affects approximately 400,000 persons in the United States and 2.1 million worldwide.[2] The typical onset of MS is between ages 20 to 30 years of age, and it is more prevalent in women than men (2:1).[6] There is a higher incidence of MS in Caucasian populations than other ethnicities. The disease is not hereditary, however

there is an increased risk of MS in persons with an affected family member. This may be due to an inherited genetic susceptibility to immune system dysfunction.[2] The risk of MS is increased with vitamin D deficiency and smoking. That being said, there is a higher correlation of MS in the northern populations, which may be due to the lack of sunlight throughout part of the year.[2]

Multiple sclerosis is diagnosed through a series of medical history, neurologic exams and various tests (MRI, spinal fluid analysis, blood tests). There is no single symptom, physical finding, or laboratory test that determines the diagnosis of MS.[4] More so, there is a long-established criterion that must be met, and all other causes must be excluded before MS is diagnosed. In order to make a diagnosis, the physician must find evidence of damage to the CNS in at least two separate areas, evidence that the damage occurred at different points in time and rule out all other possible diagnoses.[4]

Symptoms of MS vary from person to person and vary throughout the disease process. Initial symptoms of MS typically include fatigability, weakness, minor visual disturbances, and paresthesia. As MS progresses, more symptoms will present. These symptoms may develop rapidly (in a matter of minutes or hours) or insidiously (over a period of weeks or months) and are dependent on where the lesions are within the central nervous system. Symptoms may affect many different functions and areas of the body as noted in Table 1 below.[2] The most common symptoms of MS are weakness or numbness in one or more limbs, optic neuritis, tremor and ataxic gait, double vision, dysarthria or dizziness, and fatigue.[6] These symptoms of MS can contribute to an increased fall risk among individuals with MS. The effects on strength, sensation, cognition, vision, and coordination all contribute to decreased balance and increased fall

risk. Approximately 50 to 60% of individuals with MS fall 1 or more times over 3 to 12 months.[7]

Table 1: Common Symptoms of MS[2]

Sensory Symptoms:	Cognitive Symptoms:
- Hypoesthesia, numbness	- Short-term memory deficits
- Paresthesia	- Difficulty multi-tasking
Pain:	- Diminished attention
- Paroxysmal limb pain	- Diminished executive functions
- Headache	- Diminished information processing
- Optic or trigeminal neuritis	- Diminished visual-spatial abilities
- Lhermitte's sign	Affective Symptoms:
- Hyperpathia	- Depression
- Chronic neuropathic pain	- Anxiety
Visual symptoms:	- Fatigue
- Blurred or double vision	- Spasticity, spasms
- Diminished acuity/loss of vision	- Ataxia
- Nystagmus	- Postural Tremor
- Lateral gaze palsy	- Impaired balance and gait
Speech and Swallowing Symptoms:	Bladder and bowel symptoms:
- Dysarthria	- Spastic bladder
- Diminished verbal fluency	- Flaccid bladder
- Dysphonia	- Diarrhea and incontinence
- Dysphagia	- Constipation

Multiple sclerosis is the result of an acute inflammatory response from an unknown trigger. This response causes an abnormal immune-mediated response attacking the myelin nerve coatings, oligodendrocytes, and the nerve fibers within the CNS.[3] Myelin is an insulator that increases the speed of conduction along the nerve fibers and conserves energy during depolarization. Demyelination slows neural transmission and causes the nerves to fatigue easily.[2] This acute inflammatory attack will subside in time, however there are different fluctuations of re-inflammation and the remission of the inflammatory attack. These fluctuations are what characterizes the different courses (or types) of the disease. There are four predominant courses of MS: clinically isolated syndrome, relapsing-remitting, secondary-progressive, and primary-

progressive. Clinically isolated syndrome (CIS) is the first episode of neurologic symptoms. Not everyone that has a CIS will develop MS. If CIS is accompanied by lesions to the brain, there is a high likelihood the individual will develop MS.[4] Relapsing-remitting MS (RRMS) is the most common disease course (approximately 85 percent of the people with MS). Secondary-progressive MS (SPMS) is progressive worsening of neurologic function over time. Fifty percent of people with RRMS will transition to SPMS within 10 years, and 90 percent will transition within 25 years.[4] Primary-progressive MS (PPMS) is characterized by worsening neurologic function from onset of symptoms. Roughly 15 percent of people with MS have PPMS.[4] This case report will focus on relapsing-remitting multiple sclerosis.[2]

Relapsing-remitting multiple sclerosis (RRMS) is the most common course of MS. It is characterized by attacks (or relapses) with new or increasing neurologic symptoms followed by periods of remission with partial or complete recovery of symptoms. MS relapses are defined as new and recurrent MS symptoms that last more than 24 hours (although usually longer duration) and are unrelated to another etiology. RRMS can be characterized as either active (with relapses and/or evidence of new lesions in an MRI) or not active; and worsening (confirmed increase in disability following a relapse) or not worsening as depicted on Figure 1.[4] This figure displays how following a relapse, symptoms may resolve completely or partially resolve (resulting in worsening MS). New MRI activity is an indicator of "active" MS. This typically occurs during a relapse, but it can also occur when symptoms are not present.[4]

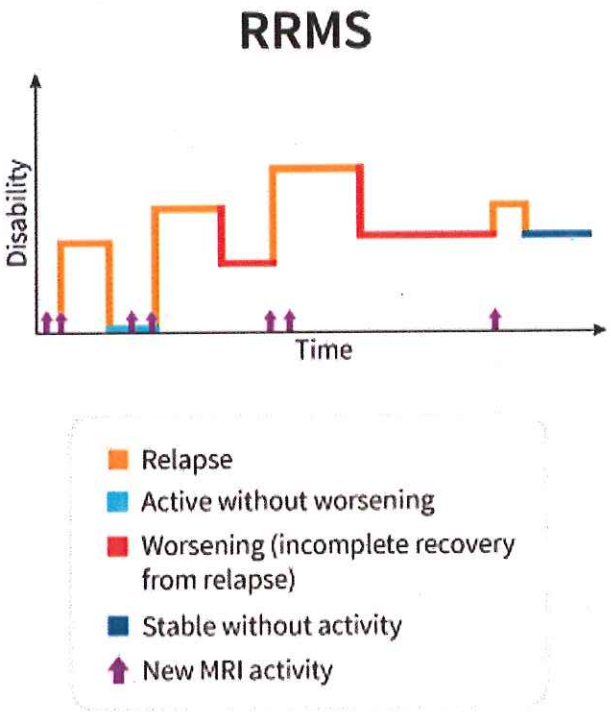

Figure 1: Relapsing-remitting Multiple Sclerosis

The prognosis of MS differs between the different courses of the disease and person to person. It is seldom fatal and life expectancy is only a few months shorter than average.[8] However, it is estimated that 50 percent of patients with MS will walk independently for 15 years following disease onset.[9] After 15 years of MS onset, roughly 20% of the patients will be unable to ambulate and institutionalized, 20% require an assistive device to ambulate, and 60% continue to ambulate without an assistive device and little deficit.[8] Females usually have a more positive prognosis compared to males.[9] The average life span is 25 to 35 years after the diagnosis of MS. The most common cause of death in patients with MS are due to secondary complications such as immobility, chronic urinary tract infections, compromised swallowing and breathing.[9] Additionally, the frequency of death by suicide is 7.5 times higher for patients with MS.[9] Although this is a life altering diagnosis, as many as 1/3 of patients with MS will suffer

only intermittent, transient relapses and live without any persistent functional limitation throughout most of their life.[8]

There are several known exacerbating factors that may affect when a relapse occurs. Factors include viral or bacterial infections, disease of major organ systems, major or minor stresses, new medications, or physical overuse/over-activity.[2,9] Major stresses may be divorce, job loss, or trauma. Minor stresses may be exhaustion, dehydration, malnutrition, or sleep deprivation.[2] Individuals with RRMS may also experience pseudo-exacerbation/pseudo-attack. A pseudo-exacerbation/pseudo-attack is a transient worsening of symptoms that comes and goes within 24 hours and is typically due to an external factor.[2,9] A true relapse/exacerbation will last for at least 24 hours and is due to new MS lesion in the brain or spinal cord.[9] The majority of individuals with MS experience an adverse reaction to heat. The source of heat can be either external (sun exposure, hot environmental temperature, etc.) or internal heat (fever). Heat can cause immediate and dramatic reduction of function and increased fatigue. It is important to avoid these factors in order to optimize function.[2]

As there are exacerbating factors, there are also factors that can greatly improve function of an individual with MS. Frequent exercise is crucial for individuals with MS. Exercise has been shown to improve overall function, produce meaningful physiological and psychological changes, and improve quality of life.[2] Patient's with a loss in proprioceptive feedback will have decreased motor control and motor learning. Incorporating proprioceptive loading with light resistance bands, weights, tapping, and/or biofeedback are effective techniques to increase proprioceptive awareness.[5] Individuals with MS will all respond differently to exercises. Physical therapy is where

individuals with MS can receive exercise prescriptions (as well as education, assistive devices, and more) catered to their individual needs. The focus and pace of therapy must be readjusted for each individual and throughout each individual's treatment session.[2] Ultimately the role of physical therapy is to inspire hope, resilience, and happiness through movement.[11]

The purpose of this case study is to discuss and review the effect and clinical decision-making of physical therapy for an individual with relapsing-remitting multiple sclerosis in the outpatient setting. This case report will demonstrate that physical therapy can improve endurance, strength, gait pattern, and most importantly quality of life of an individual with multiple sclerosis.

CHAPTER II

CASE DESCRIPTION

The patient is a 52-year-old female who presented to physical therapy secondary to balance deficits and muscle spasms in her thoracic spine. She has relapsing-remitting multiple sclerosis (MS) which was diagnosed at age 35 years old. Her last relapse was 4 months prior to the initial evaluation and lasted roughly 4 weeks. During her relapse she was unable to ambulate independently and required a four wheeled walker for ambulation around the house and a powered scooter for ambulation in the community. Her previous relapse was spring of 2011. During remission, she was able to ambulate independently with a hemiplegic gait.

The patient presented to outpatient physical therapy with muscle spasms in her thoracic spine and balance deficits that caused her to fall 5-6 times a month. Her thoracic muscle spasms happened randomly, and she had not been able to determine what the cause was. These spasms lasted from hours up to several days. She stated that the spasms wrapped around her chest and made it very difficult for her to breath. Position changes did not alter the spasms and movement seemed to make them worse. The patient's balance deficits resulted primarily from weakness on her left side, decreased sensation, and fatigue. Her symptoms from MS were primarily on her left side and consisted of paresthesia, diminished visual-spatial abilities, fatigue, spasticity, ataxia, and impaired balance and gait. These symptoms caused her to frequently trip

over her left toe or for her left knee to buckle and give out, both being a regular cause of falls.

The patient worked part-time as a competitive horseback riding instructor and part-time for an insurance company. In the last 17 years since her MS diagnosis, she had to reduce the number of her clients by 50% due to her mobility and balance challenges. Horseback riding instructing required her to be able to move around frequently and to be able to ride a horse. She stated that she was still able to ride a horse for short periods of time but had to do most of her instructing from a chair. Horseback riding instruction was this patient's passion and was a great motivator for her throughout physical therapy.

The patient lived in a multi-level home with her husband. She stated that her husband was very supportive but did not always understand the frustrations that MS entails. This can be very common among spouses of individuals with MS. One study found that nearly 21% of marriages with a woman having MS end in divorce.[10] The patient had two adult daughters that lived nearby and were very supportive. She attended a monthly MS support group and stated that she had no history of psychological disorders. She was a very positive and hardworking individual that was motivated to not let MS hinder activities throughout her life.

Current and previous treatments for this patient included both medication and physical therapy. The patient currently received injections of medication 1x per month to control spasticity and reduce the number of new lesions to neural tissue. The patient also has had several rounds of physical therapy in the past. She stated that her last physical therapy appointment was roughly 4 years prior and only made minor

improvements to her function. She stated that physical therapy previously did not challenge her at all. The patient's goals for physical therapy were to decrease the frequency and intensity of thoracic muscle spasms, improve balance in order to decrease the number of falls, and improve endurance and gait.

Throughout the history a brief review of systems was collected. The patient's integumentary system was intact with no abrasions to the skin. The cardiopulmonary system was reviewed with a walking endurance test. She was able to ambulate 500 ft but was very fatigued following ambulation. The patient's neuromuscular and musculoskeletal systems were impaired. These systems will be discussed later throughout the paper.

This patient was a candidate for physical therapy due to her motivation and willingness to work hard. Also, physical therapy is a crucial component of the management of MS. Physical therapy will offer education, thorough examination and evaluation to establish baselines and realistic goals, as well as an exercise and activity prescriptions.[11]

Examination

The patient was referred to outpatient physical therapy by her doctor for thoracic muscle spasms. The examination began with observation of the patient when she first arrived in the clinic. She was able to ambulate independently in the clinic with a hemiplegic gait pattern. Then the patient's medical history, home environment, personal factors, and goals were obtained through questions. Next, the physical therapist led the patient through a series of tests and measures to assess her strength, balance,

endurance, and gait. The purpose of tests and measures was to identify movement-related disorders and identify the potential benefit of physical therapy management.[9] The examination plan was based on O'Sullivan's *Physical Rehabilitation* evaluation on multiple sclerosis.[2] A physical therapy examination should consist of a patient history (demographic information, social history, occupation, living environment, general health status, social and health habits, family history, medical history, current complaints, medications, functional status and activity level) and tests/measures (aerobic and muscle performance, balance, assistive devices, circulation, communication, nerve integrity, gait, integumentary integrity, joint integrity, alignment and mobility, mental and motor functions, neuromotor control, pain, motivation, ROM, and work, community, and leisure activities).[2] The results of the examination and evaluation were then utilized to select an appropriate diagnosis, prognosis, and intervention approach.

The physical strength was assessed through manual muscle testing (MMT) of hip flexion, knee extension, and knee flexion and 30-second chair stand test. The MMT is used to assess the strength of specific muscles groups, versus the 30-second chair stand test is used to assess functional lower body strength.[11] The sensitivity of MMT is 0.35, specificity is 0.90, and positive likelihood ratio is 3.5.[13] This indicates that the test has a low ability to correctly identify those with muscle weakness (true positive), but a high ability to correctly identify those with proper muscle strength (true negative). Refer to the Table 2 below for the patient's initial MMT scores. The results of MMT showed proximal muscle weakness and greater weakness on the left than right.

Table 2: Initial Manual Muscle Test

	RIGHT	LEFT
HIP FLEXION	3/5	2/5
KNEE EXTENSION	4/5	3/5
KNEE FLEXION	4/5	3/5

The 30-second chair test measures the number of times the patient can stand up from a chair with no assistance in 30 seconds. The chair is 17 inches of height, has no arms, and is placed against the wall for stability. The sensitivity of the 30-second chair test is .66, the specificity is .67, and the positive likelihood ratio is 2.1.[13] This indicates a fairly reliable outcome measure for functional lower body strength. Upon initial evaluation, the patient was able to complete 8 sit-to-stands. One limitation of this test is due to the fact that the normative data for 30-second chair test does not include the patient's age. The current normative date for this test ranges from ages 60 to 94 years old. The patient is 52 years old but was categorized into the 60-64 years old range due to this limitation. The normative data for ages 60-64 years old is 15 sit to stands in 30 seconds, therefore the patient falls below the norm indicating that she had weak functional lower body strength. Refer to Table 3 for the normative data of the 30-second chair test.[13]

Table 3: Normative Date for 30-Second Chair Test

AGE	60-64	65-69	70-74	75-79	80-84	85-89	90-94
WOMEN	15	15	14	13	12	11	9
MEN	17	16	15	14	13	11	9

Balance was assessed through a single leg stance (SLS) test. For this test, the patient stands on one leg unassisted and is timed in seconds from the time the opposite leg is flexed off the floor to when it touches the floor or the standing leg. The test is

performed with eyes open and hands on hips. If the patient is unable to stand on one leg for at least 5 seconds, they are at increased risk for falls.[14] The sensitivity of the SLS is .75 and specificity is .74.[14] The high sensitivity and specificity indicates a reliable test for assessing a true positive (the patient has balance deficits) as well as ruling out a true negative (the patient does not have balance deficits). The patient was unable to stand on the left leg for more than 5 seconds, which indicated that she had an increased risk for falls. Refer to Table 4 for initial SLS scores.

Table 4: Initial Single Leg Stance

	RIGHT	LEFT
TIME (IN SECONDS)	20	4

Endurance and gait were both assessed by skilled observation of ambulation around the track within the physical therapy gym until the patient was fatigued and needed a rest break. She was able to ambulate 500 feet until she needed to sit down and rest. The patient reported that her "legs were jelly" at that point. The gait deviations that this patient presented with were circumduction on left, foot drop on left, left knee recurvatum/hyperextension, and left knee buckling. These deviations did not occur all at the same time but were present at different times throughout the 500 feet ambulation. As the patient fatigued, the deviations in gait became even more significant.

Evaluation, Diagnosis and Prognosis

The initial examination identified movement-related disorders that had the potential to benefit from physical therapy. Through the examination a problem list (as shown on Table 5 below), physical therapy diagnosis, goals and expected outcomes, and prognosis were determined. The most significant problem the patient faced was

impaired balance. This impairment had the potential to lead to more serious impairments and injuries in the future, if not addressed. Decreased endurance, strength, and hemiplegic gait were also identified. Due to these impairments, the patient's activity and participation were affected. She was unable to ambulate far distances, fell frequently, and required a handrail to ambulate up stairs. The patient's participation was affected because she had to reduce the number of clients for horseback riding instruction and she was unable to ride a horse competitively.

Table 5: Problem List

PROBLEMS
▪ Impaired balance
▪ Frequent falls
▪ Hemiplegic gait
▪ Impaired endurance
▪ Impaired strength
▪ Unable to ambulate far distances
▪ Requires handrail to ambulate stairs

The movement dysfunctions that this patient faced were secondary to her diagnosis of multiple sclerosis. The demyelination of her central nervous system was the cause of her impaired balance, strength and endurance, which resulted in impaired gait pattern. That being said, the clinical impression of this patient aligned with the diagnosis of MS. Physical therapy is not able to reverse the effect of the multiple sclerosis, but it can reduce the impairments through education, strengthening, balance exercises, and endurance training. This case correlated with the practice patterns 5A: Primary Prevention/Risk Reduction for Loss of Balance and Falling, and 5E: Impaired Motor Function and Sensory Integrity Associated with Progressive Disorders of the Central Nervous System.[12]

The expectation was to re-examine and evaluate the patient following 8 weeks of physical therapy. The patient's short-term goal was to ambulate 750 feet (500 feet – 750 feet) with a reduced hemiplegic gait in order to increase endurance at work. This goal was to be met in 4 weeks. The patient's long-term goal was to be able to stand on her left leg for 15 seconds (5 secs – 15 secs) in order to reduce the number of falls per month. This goal was to be met in 8 weeks. These goals were attainable, but a joint effort from the patient and physical therapist were needed in order to achieve these goals.

Although relapsing-remitting multiple sclerosis is a lifelong progressive disease that is unpredictable, fluctuating, and has no "fixed deficit" the patient's prognosis was good.[11] The barriers that this patient faced were common and affected her potential outcomes. They included fatigue, weather (she lived in a warm and dry climate), and time commitment. As mentioned above, the role of physical therapy is to inspire hope, resilience, and happiness through movement. Therefore, physical therapy can improve functional mobility with education, physical activity, and exercise.[11] The patient's potential to improve functional mobility through physical therapy was good due to her positive attitude, willingness to work hard, and commitment from her physical therapist.

CHAPTER III

INTERVENTION

The interventions were chosen based off of clinical experience, O'Sullivan's *Physical Rehabilitation* interventions on multiple sclerosis[2], and patient's response to treatment. The treatment strategy was to fatigue the patient through different strengthening and resistive exercises, and then practice balance and gait when the patient was fatigued.

The patient was seen once a week for 40-60 minutes for 8 weeks. Interventions involved strengthening, balance training, and education. The first session consisted of terminal knee extension (3 sets of 10 reps with a blue band around the back of the knee), sit-to-stands (3 sets of 10 reps with a chair at 20 inches high), and low rows (2 sets of 10 reps with 10 lbs.), which were all utilized for strengthening. The patient fatigued quickly following exercises and required frequent breaks. Balance training consisted of 30 sec tandem standing (3 reps without UE support), 30 sec single-leg stance with manual cuing to not buckle the knee (3 reps with UE support), and toe taps (3 sets of 20 reps with UE support). Her balance decreased significantly once she fatigued, requiring her to take several minute breaks between sets. The patient was also given a home exercise program (HEP) to complete daily. The patient was very compliant with the HEP, which consisted of sit-to-stands (2 sets of 10 repetitions),

terminal knee extension (3 sets 10 reps with blue band), and tandem standing (3 sets of 30 seconds).

The second- and third-week sessions consisted of the same exercises as listed above but with the addition of 3 minutes of low resistance biking at the beginning of the sessions. The biggest challenge throughout the sessions was the extent of her fatigue. The patient's balance decreased significantly once she fatigued, however, following a few minutes of rest, she was able to continue with therapy. During the third week of therapy interventions, hurdles were incorporated for gait training at the end of the session. The hurdles were 8 inches high and placed 1 foot apart as seen in Figure 2. Step-to and step-through gait patterns were practiced in order to try to reduce the circumduction and knee hyperextension gait patterns. The patient completed 4 sets of stepping over 6 hurdles.

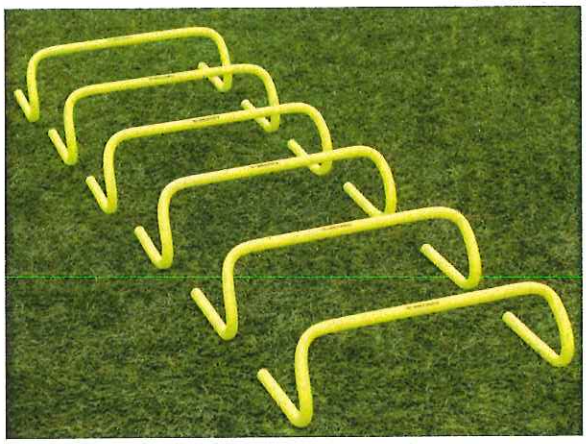

Figure 2: 8-inch Hurdles[18]

By the fourth week of therapy, the intervention strategies for the patient were progressed. Therapy began with 5 minutes of sit-to-stands (30 seconds on, 30 seconds of rest) followed by balance activities and gait training. Balance activities included toe taps (3 sets 1 minute on/1 minute off), terminal knee extension (3 sets of 20 reps), and

single leg stance (2 sets of 30 seconds). Gait training was consistent with last week with the hurdles (4 sets of 6 hurdles). The patient stated that her husband and clients have noticed that her balance and gait have been more coordinated the previous week.

The fifth week of therapy consisted of strength, balance, and gait training. Strength training consisted of wall sits (4 sets of 30 seconds). Balance training followed with bosu ball step up, emphasizing flexing her knee towards her hip (3 sets of 20 reps), toe taps (3 sets of 30 sec reps), and butt kicks in order to emphasize flexing her left knee (3 sets of 10 reps). The session ended with gait training while going over the hurdles (4 sets of 6 hurdles). The patient's gait pattern was improving with the hurdles and she was making less mistakes with the step-to pattern, but the step-through pattern was still very difficult. The patient was very motivated by practicing gait with the hurdles and it had become something that she now looked forward to at the end of each session.

Interventions were progressed again at week six. Strength training was paired with functional movement patterns in different planes of movement. Strength training consisted of 5 minutes on the bike with low resistance and leg press (3 sets of 15 reps at 65 lbs.). Functional movement consisted of 8" step ups (3 sets of 10 reps), forward lunges (2 sets of 10 reps), and sideways lunges (2 sets of 10 reps). Balance training consisted of bosu ball double leg stance (3 sets of 30 seconds) and single leg stances (2 sets of 30 seconds). The session ended with the gait training the hurdles (4 sets of 6 hurdles). The patient was progressing well and stated that she noticed her balance was improving. She was able to complete the hurdles without knocking down any hurdles, and her endurance for strengthening exercises was improving significantly.

During the seventh week the patient stated that she was fatigued for more than 2 hours following physical therapy last week. That being said, during the seventh week the intensity was decreased, and more balance and gait training were incorporated into her treatment. The seventh week of therapy consisted of 5 minutes on the bike with low resistance, forward lunges (2 sets of 10 reps), butt kicks (2 sets of 10 reps), bosu ball double leg stance (3 sets of 30 sec), bosu ball step ups (2 sets of 10 reps), and finished with hurdles (8 sets of 6 hurdles). The patient had significant improvement with the hurdles and was able to complete all sets of them with the step-through gait pattern.

The eighth week of therapy consisted of both a re-examination and of interventions. The re-examination started the therapy session, followed by interventions. The results of the re-examination are discussed in Chapter IV. The interventions included 5 minutes on the bike with low resistance, step ups (2 sets of 10 reps), single leg stance on a 4-inch foam pad (3 sets of 30 seconds), single leg stance without a foam pad (3 sets of 30 seconds), and hurdles (4 sets of step to gait pattern, and 4 sets of step through gait pattern). The patient had minimal errors with the hurdles and single leg stances. She stated that she noticed an improvement in balance and that she had not had a fall since physical therapy started 8 weeks ago.

In addition to therapeutic exercise, neuromuscular reeducation, and gait training, the patient also received education throughout each treatment session. She was educated on fall prevention strategies, reducing fatigue, and MS disease progression. The fall prevention strategies included removing clutter around the house and in the walkways, removing throw rugs throughout the house, and having sufficient lighting throughout the house, especially at night. For managing fatigue, the patient was

educated on the 4 Ps: pacing, planning, prioritizing, and positioning.[19] Lastly, she was educated on MS disease progression through research articles that had recently been published.

Communication with the referring physician occurred through physical therapy notes. The physician received the initial evaluation note, as well as the progress note at 8 weeks. The notes included information regarding the patient's subjective information, level of function, tests and measure results, and interventions completed. No other health care disciplines were communicated with throughout this physical therapy program.

CHAPTER IV

OUTCOMES

Following 8 weeks of physical therapy, the patient's balance, endurance and strength improved significantly. She stated that she had not had any muscle spasms or falls since the start of physical therapy. The patient was very satisfied with the physical therapy that she received and decided to continue physical therapy for the following 8 weeks in order to continue to progress her balance and endurance.

Strength was reassessed through manual muscle test and 30-second chair test. Both improved from the start of therapy 8 weeks ago. The patient continued to have more weakness on the left than the right but had made significant progress as noted on Table 6. The 30-second chair test improved from 8 reps to 13 reps. The patient had still not reached the normative number of 15 repetitions in 30 seconds for the 60-64-year-old age range, but she had made significant improvement.[13]

Table 6: 8-week Progress Note Manual Muscle Test

	RIGHT	LEFT
HIP FLEXION	4/5	4/5
KNEE EXTENSION	5/5	4/5
KNEE FLEXION	5/5	4/5

Balance was reassessed through the single leg stance. As noted in Table 7, the patient was now able to stand on her left leg for more than 5 seconds; therefore, she was no longer in the high fall risk category for this test.[14]

Table 7: 8-week Progress Note Single Leg Stance

	RIGHT	LEFT
TIME (IN SECONDS)	25	15

Endurance and gait were reassessed through ambulating around the track until the patient was fatigued and required a rest break. She was able to double the distance that she was able to ambulate on the initial examination. The patient was able to ambulate 1000 ft with decreased circumduction, foot drop, knee recurvatum/hyperextension, and knee buckling throughout her gait pattern on the left lower extremity.

The patient's short- and long-term goals were met throughout physical therapy. Her short-term goal of ambulating 750 feet was exceeded. She was able to ambulate 1000 feet with reduced hemiplegic gait. The long-term goal of standing on her left leg for 15 seconds was also met. The patient had increased her endurance for when she was working and had no recent falls. Both of these skills will greatly affect her quality and participation in life.

As noted above, physical therapy greatly improved the patient's strength, balance, endurance, and gait. These improvements significantly improved the patient's quality of life and she was very affirming of the physical therapy that she received. The patient had not had any falls since beginning therapy, reducing her risk for future injuries.

CHAPTER V

DISCUSSION

The discussion of the clinical decision-making and the effectiveness of treatment demonstrated the positive effect that physical therapy can have on fatigue, endurance, strength, gait, and quality of life of a patient with relapsing-remitting multiple sclerosis. Overall, existing evidence supports the positive effects of physical therapy on multiple sclerosis, but the effects vary depending on the symptoms present, the severity of the disease, and between patients. A major limitation of this study is the exclusion of standardized measures to assess fatigue, endurance, and quality of life.

Procedures within this case study were guided by patient goals, examination and evaluation findings, and patient's response to the procedures. The patient was referred to physical therapy for thoracic muscle spasms, but following the first session, the spasms were no longer a concern of the patient. The patient's goals were more directed towards improved balance and endurance; therefore, the interventions were created to focus on improving balance and endurance. The tests and measures performed at evaluation of MMT, 30-second chair test, single leg stance, and ambulation indicated decreased strength, impaired balance, and limited endurance, and so the interventions focused on these impairments. The patient responded well to the interventions and was motivated by practicing gait with hurdles; thus, the interventions were progressed in the same direction of treatment and each session ended with practicing gait with hurdles.

Evidence cited below is from a systematic review in 2013, "Effects of Exercise Training on Fitness, Mobility, Fatigue, and Health-Related Quality of Life Among Adults with Multiple Sclerosis: A Systematic Review to Inform Guideline Development".[20] Fatigue is a common and debilitating symptom of MS and is typically measured through a self-report questionnaire. A limitation to this case study is that a self-report questionnaire for fatigue was not administered throughout the course of physical therapy. Examples of questionnaires for fatigue in patients with multiple sclerosis that should be used in future practice are Multiple Sclerosis Quality of Life-54, Modified Fatigue Index Scale, or Fatigue Severity Scale.[20,21] Quality of life is measured through a self-report questionnaire as well; however, this case study did not utilize a quality of life measure – another limitation. An example of a quality of life scale for a patient with multiple sclerosis for future practice is the Multiple Sclerosis Quality of Life-54.[21] This case study measured quality of life through patient satisfaction and verbal acknowledgements of an improved quality of life. This is not an objective measure, and therefore should not be utilized in the clinic for future case studies. Evidence is inconsistent in improving overall quality of life, but outcomes including pain, social function, physical composite, and mental composite after exercise indicate significant improvement.[20]

Evidence regarding exercise and fatigue is inconsistent, however interventions including resistance-training are the most effective for reducing fatigue.[20] Endurance and gait were assessed in this case study by ambulating around a track. This is not a standardized endurance and gait assessment. Future case studies should include standardized assessments such as 6-minute walk, Timed Up & Go, or the Timed 25-

Foot Walk. Evidence suggests that exercise protocols with aerobic exercise and resistance training improve walking endurance and gait the most effectively.[20] Strength was assessed through standardized tests and measures. Evidence supports that moderate intensity aerobic and resistance training two times per week can increase strength and aerobic capacity in adults with mild to moderate MS.[20]

Additional evidence on intervention strategies should be reviewed for future case studies. No patient with multiple sclerosis will respond exactly the same as this patient. A thorough review of intervention strategies available for multiple sclerosis should be assessed with each specific patient in mind. The National Multiple Sclerosis Society has many different resources for future practitioners.[4]

Upon review, aspects of this case study would be changed for future physical therapy practice. Upon collecting the history of the patient, questions regarding emotional well-being, sexual function, and health concerns beyond MS should also be asked as they are all important components of quality of life of the patient. Examination techniques should be standardized procedures; however, this case study did not use standardized procedures throughout every component of the examination. For example, endurance and gait should have been assessed with a standardized procedure such as the 6-min walk test or Timed Up & Go. A self-report questionnaire to assess fatigue and quality of life such as Multiple Sclerosis Quality of Life-54 should also have been utilized.[21] Additional referrals would only have been made if the patient was not progressing as expected.

The therapy provided for this patient was deemed as successful in the eyes of the patient and the physical therapist. The patient expressed an improvement in her

activities of daily living and requested to continue physical therapy for an additional 8 weeks. The patient had met all of the physical therapy goals that were stated initially, so the physical therapist deemed the treatment as successful. However, upon additional research there are aspects that should be adjusted for future physical therapy practice.

APPENDIX

Patient name:	Date:	Time:	AM/PM
NHI:	Test carried out by:		

The 30-Second Chair Stand Test

Overview: The 30 Second Chair Stand Test, in conjunction with other measures such as the 4-Stage Balance Test, Timed Up and Go (TUG) Test and an assessment of postural hypotension can help to indicate if a patient is at risk of falling.

Purpose: To test leg strength and endurance:

Equipment:
- A chair with a straight back, without arm rests, placed against a wall to prevent it moving
- A stopwatch/timer

Instructions to the patient:

1. Sit in the middle of the chair.
2. Place each hand on the opposite shoulder crossed at the wrists.
3. Place your feet flat on the floor.
4. Keep your back straight and keep your arms against your chest.
5. On "**Go**", rise to a full standing position and then sit back down again.
6. Repeat this for 30 seconds.

On "**Go**" begin timing.

Do not continue if you feel the patient may fall during the test.

Count the number of times the patient comes to a full standing position in 30 seconds and record it in the box below.

If the patient is over halfway to a standing position when 30 seconds have elapsed, count it as a stand. If the patient must use his or her arms to stand then stop the test and record "0" for the number below.

Number: (See over page for what this means)

A below average number of stands for the patient's age group indicates a high risk of falls.

Notes:

REFERENCES

1. Platta, M., Ensari, I., Motl, R et al. Effect of Exercise Training on Fitness in Multiple Sclerosis: A Meta-Analysis. *Archives of Physical Medicine and Rehabilitation.* 2016; 97:1564-72

2. McIsaac TL, Fritz NE, O'Sullivan SB. Multiple Sclerosis. In: O'Sullivan SB, Schmitz TJ, Fulk G. eds. *Physical Rehabilitation, 7e* New York, NY: McGraw-Hill; http://fadavispt.mhmedical.com.ezproxylr.med.und.edu/content.aspx?bookid=2603&sectionid=214792312. Accessed October 03, 2019.

3. Gunn, H, Markevics, S, Haas, B et al. Systematic Review: The Effectiveness of Interventions to Reduce Falls and Improve Balance in Adults With Multiple Sclerosis. *Archives of Physical Medicine and Rehabilitation.* 2015;96:1898-912.

4. Relapsing-remitting MS (RRMS). National Multiple Sclerosis Society. https://www.nationalmssociety.org/What-is-MS/Types-of-MS/Relapsing-remitting-MS. Accessed May 12, 2020

5. Khan F, Amatya B. Rehabilitation in Multiple Sclerosis: A Systematic Review of Systematic Reviews. *Archives of Physical Medicine and Rehabilitation.* 2017;98:353-67

6. Rolak LA. Multiple sclerosis: it's not the disease you thought it was. *Clin Med Res.* 2003;1(1):57-60. doi:10.3121/cmr.1.1.57

7. Hoang PD, Cameron MH, Gandevia SC, Lord SR. Neuropsychological, Balance, and Mobility Risk Factors for Falls in People With Multiple Sclerosis: A Prospective Cohort Study. *Archives of Physical Medicine and Rehabilitation.* 2014;95(3):480-486. doi:10.1016/j.apmr.2013.09.017.

8. Rose JW. Lectures: Prognosis. Multiple Sclerosis: Prognosis. https://library.med.utah.edu/kw/ms/prognosis.html. Accessed June 5, 2020.

9. Pittsburgh Institute for Multiple Sclerosis Care and Research. Exacerbation | University of Pittsburgh. http://www.ms.pitt.edu/diseasemanagement/exacerbation. Published June 23, 2015. Accessed July 7, 2020.

10. Relationships. National Multiple Sclerosis Society. https://www.nationalmssociety.org/Living-Well-With-MS/Relationships. Accessed July 7, 2020.

11. Rohrig M. A Resorce for Healthcare Professionals. Physical Therapy in Multiple Sclerosis. *National MS Society*. 2018.

12. Guide to Physical Therapist Practice 3.0. *American Physical Therapy Association*. 2014. http://guidetoptpractice.apta.org/. Accessed May 31, 2020.

13. Rikli RE, Jones CJ. Functional fitness normative scores for community-residing older adults, ages 60–94. *J Aging Phys Activity*. 1999;7:162–181.

14. Youdas JW, Madson TJ, Hollman JH. Usefulness of the Trendelenburg test for identification of patients with hip joint osteoarthritis. *Physiother Theory Pract*. 2010;26(3):184-194. doi:10.3109/09593980902750857

15. Wright AA, Cook CE, Baxter GD, et al. A comparison of 3 methodological approaches to defining major clinically important improvement of 4 performance measures in patients with hip osteoarthritis. *J Orthop Sports Phys Ther*. 2011;41:319–327.

16. Rikli, R. E. and Jones, C. J. Development and validation of criterion-referenced clinically relevant fitness standards for maintaining physical independence in later years. *The Gerontologist*. 2013; 53(2): 255-267.

17. Jacobs, J., Horak, F., et al. Multiple balance tests improve the assessment of postural stability in subjects with Parkinson's disease. *Journal of Neurology, Neurosurgery & Psychiatry*. 2006;77(3):322-326

18. 6 Inch FORZA Speed Training Hurdles [6 Pack]. *Net World Sports*. https://www.networldsports.com/6-inch-forza-speed-training-hurdles-6-pack.html?gclid=CjwKCAjw5cL2BRASEiwAENqAPnlDgoZgc37QnMMsPBjaauZs5uqhgZg4uleDl7xNwSu6HE16WbkTgxoCUNoQAvD_BwE. Accessed May 29, 2020.

19. Rintell D. Fatigue. MSAA. https://mymsaa.org/ms-information/symptoms/fatigue/?_ga=2.264730250.447006748.1594247035-1735540384.1594247035. Published 2013. Accessed July 8, 2020.

20. Latimer-Cheung AE, Pilutti LA, Hicks AL, et al. Effects of exercise training on fitness, mobility, fatigue, and health-related quality of life among adults with multiple sclerosis: a systematic review to inform guideline development. *Arch Phys Med Rehabil*. 2013;94(9):1800-1828.e3. doi:10.1016/j.apmr.2013.04.020

21. Vickrey, BG. Multiple Sclerosis Quality of Life (MSQOL)-54 Instrument. *UCLA Department of Neurology.* 1995.