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Strength And Balance Exercises To Improve Functional Outcomes And Mobility For A Patient With Parkinson's Disease And Co-morbidities: A Case Report

Nicholas LaSarso
University of New England

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N LaSarso, ATC, is a DPT student at the
University of New England,
716 Stevens Ave. Portland, ME 04103
All correspondence should be addressed to Nicholas LaSarso at: nlasarso@une.edu

The Patient signed an informed consent allowing the use of medical information, video footage and photographs for this case report. The patient also received information on the institutions policies regarding the Health Insurance Portability and Accountability Act.

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Abstract

Background and Purpose: Parkinson's disease (PD) is a movement disorder that can lead to declines in function and falls. As a common age-related neurological diagnosis, PD is most often accompanied by other co-morbidities. The purpose of this case report is to document the physical therapy management of a patient presenting with PD and other co-morbidities. This case report looks at the outcomes of strength and balance exercises on the patient's impairments, mobility and overall function.

Case Description: The 69 year-old male patient presented with a history of PD, Lyme disease, osteoarthritis, peripheral neuropathy (PN) and exposure to Agent Orange. He underwent a therapy program utilizing various forms of strength and balance activities to help improve deficits and help prevent further decline in function. Outcome measures included the Timed-Up-and Go (TUG) and Patient Specific Functional Scale (PSFS). Strength, balance, range-of-motion and coordination were also tracked over the course of therapy. Functional outcomes and impairments were tested at the initial evaluation and at two-week intervals over the course of 14 weeks.

Outcomes: At the end of the episode of care, the patient was found to have improved strength, balance and TUG scores compared to the initial evaluation measurements. Coordination, sensation, gait and the average score on the PSFS remained relatively unchanged.

Discussion: Despite PD and several co-morbidities, the patient was found to have improvements in strength, balance and functional outcomes. The patient's lack of improvement with certain outcome measures may be due to his complex medical history. A longer duration therapy program and future research focusing on additional types of therapies may be warranted to achieve maximal rehabilitation outcomes.

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Background:

PD is one of the most common age-related neurodegenerative disorders, second in frequency to Alzheimer's disease.[1] Approximately 1-2% of the population over age 65 suffers from PD and the incidence increases to 3-5% in people 85 years and older.[2] However, a small percentage (4-10 percent) of those diagnosed develop young-onset PD, which is defined by initial symptoms occurring before the age of 40.[3] The etiology is unknown, but believed to be related to environmental and genetic factors. The primary pathological finding is degeneration of the dopaminergic neurons of the pars compacta of the substantia nigra, leading to loss of dopamine in the striatum.**[1]** The cardinal features of PD consist of rigidity, bradykinesia, tremor and postural instability. Other symptoms include movement and gait disturbances, sensory changes, speech difficulties, swallowing disorders, cognitive/behavioral changes, autonomic nervous system dysfunction, gastrointestinal changes, and cardiopulmonary changes.[3] Ultimately, these complications can lead to declines in function. While PD cannot be prevented, multiple authors believe and studies document that patients with PD can benefit from physical therapy (PT) to maintain function and prevent rapid decline.[4-6] A study by Dibble et al.[4] found high intensity resistance strengthening could improve muscle size, force production and mobility. A study by Hirsch et al.[5] found balance training to be beneficial in improving balance times before falling and Sensory Orientation Test scores in patients with PD.[5] Although many articles have been published on PT management for patients with PD, there is a lack of information pertaining to PT management of patients with PD and other co-morbidities. Considering most patients diagnosed with PD are older in age, it is highly likely that these patients have co-morbidities that contribute to functional decline as well. Therefore, the purpose

of this case report is to illustrate a PT program with interventions to help reduce the risk of further decline in a patient suffering from PD and other co-morbidities.

Case Description:

The patient signed an informed consent for the release of information regarding demographics and medical history prior to the start of PT. The patient was a 69-year-old male who lived at home with his wife in a two-story home, with one set of stairs with railings on each side, leading to the second floor. He worked previously as an iron welder before retiring five years prior to the start of PT. His hobbies included traveling, fishing, sports and collecting different style walking canes. The patient also helped his supportive wife operate her electrologist business out of their home.

The patient's health status was considered fair. He had been diagnosed with PD one week before the PT initial evaluation, but had been experiencing symptoms for the past three years. The patient had a 10-year pack per day history of smoking when he was in the military, but had not used tobacco for approximately 30 years. He hadn't consumed alcohol for the previous 10 years. Prior to PT, he hadn't performed regular exercise since the military. Family history included colon cancer (father) and stroke (mother). His medical history included PD, Lyme disease, PTSD, PN, hypertension, exposure to Agent Orange and osteoarthritis (OA). The patient reported experiencing fogginess, which he attributed to Lyme disease prior to starting PT and reported symptoms during the initial visit. He complained of trouble sleeping along with pain in his left hand, which he attributed to PN and PTSD. He previously had two discectomies involving L2-L5 and had a cholecystectomy in 2006. The patient reported having Magnetic Resonance Imaging (MRI), blood tests, Electromyography (EMG) and Nerve Conduction Velocity Tests (NCV) done within the past year. However, none of these tests were available at

the time of the initial evaluation. He reported difficulties with bed mobility, transfers (chair to standing) and gait, specifically even and uneven surfaces and stairs. He also was unable to drive and had difficulties with cooking and cleaning. The patient family goals for PT were to minimize pain, improve balance, strength and gait so that he could be more active around the house and in the community. The systems review and patient's medication list can be found in Table 1 and Appendix 1 respectively.

Clinical Impression:

Based on the information from the history and systems review, the patient was found to have impairments of the musculoskeletal (MS) and neuromuscular systems (NM), secondary to PD, Lyme disease, OA, exposure to Agent Orange and PN. It was hypothesized that the patient would likely have deficits in strength, balance, sensation, gait and coordination. Based on the history, it was also hypothesized that these deficits were causing difficulties with activities of daily living (ADL's) and instrumental activities of daily living (IADL's). Due to activity limitations, the patient had difficulty participating in his normal daily activities and hobbies including: bathing, driving, cleaning, shopping, hiking, fishing, target practice, welding and traveling.

There were no differential diagnoses as the patient's medical diagnoses were confirmed. The plan for the examination was to obtain objective measurements for strength, balance, functional movements, sensation and coordination to create a therapy program that was unique to the patient and to track patient progress. Since the patient already had established diagnoses, less of an emphasis was placed on special tests. The patient was a good candidate for PT because he had numerous impairments of the MS and NM systems likely causing activity limitations, participation restrictions and decreasing function. The patient was motivated to improve his

impairments so that he could be as active as possible and prevent decline in function. Additionally, he had great family support, which would be helpful in achieving positive outcomes.

Examination: Tests and Measures

Based on the information obtained during the history and systems review, tests and measures were chosen based on the evidence from the literature, to objectively quantify the patient's MS and NM system deficits (see Table 2).

Range of motion (ROM) was measured according to methods described by Gajdosik et al.,[7] where the standard full-circle goniometer was found to be the ideal tool with emphasis on standardized methods. Manual Muscle Testing (MMT) was used to obtain strength measurements as described by Cuthbert et al.[8] Over 100 studies related to MMT were reviewed, including those that looked at clinical efficacy of MMT in the diagnosis of patients with symptomatology, and found good reliability and validity of MMT for patients with neuromusculoskeletal dysfunction. Due to these results, MMT was thought to be the most reliable and valid tool to measure strength of the patient.

Coordination of the upper and lower extremities (UE's/LE's) was tested by performing finger to nose movements and sliding the heel up and down the shin as described by O'Sullivan.[20] Swaine et al.[9] reviewed the reliability of coordination testing in adults with traumatic brain injuries (TBI) and found intraclass correlation coefficients (ICC [3.1]) for intrarater reliability of .971 and .986 and ICC's for interrater reliability of .920 and .913 for right and left UE's. While reliable in patients with TBI, one can infer it could also be beneficial for patients with PD.

Functional improvement was measured with the Timed-Up-and-Go (TUG) and Patient Specific Functional Scale (PSFS). The TUG, which involves both static and dynamic balance, measures the amount of time it takes to rise from a chair and return back. Individuals with scores greater than 20 seconds need assistance with ambulation and scores greater than 30 seconds indicate a higher risk of falling. The PSFS, a questionnaire used to quantify activity limitations and measure functional outcomes, rates five activities on a scale of 1-10, with one being "unable to perform" and 10 being "able to perform the activity at the same level as before injury or problem". Psychometric properties can be found in Appendix 2.

According Krebs et al.,[17] observational gait analysis is a suitable, but moderately reliable technique for assessing kinematic gait deviations. They report rater agreement on 7 of 10 gait observations and found there to be significant rater error when reporting conclusions on the exact phase of gait or the particular joint motions causing the gait deviation. Therefore, caution should be used with interpretation of observational gait analysis, especially if it is recorded by different testers.

The text, *Physical Rehabilitation by O'Sullivan*, Schmitz and Fulk[18-20] was used to gain further information and knowledge about tests and measures used when no relevant studies were found in the literature measures.

Clinical Impression 2:

Based on the data obtained during the initial evaluation, the initial impression was confirmed. The patient's primary problems involved impairments of the MS and NM systems that contributed to activity limitations and participation restrictions attributed to his multiple medical diagnoses. The examination findings were consistent with the referring diagnosis of General Medical, Paralysis Agitans (ICD-9 code 322.0); and therefore, the next step was to

proceed with interventions. Based on the medical diagnosis, the Physical Therapy Practice Pattern was 5E: Impaired Motor Function and Sensory Integrity Associated with Progressive Disorders of the Central Nervous System.[21] The patient continued to be appropriate for this case based on the findings from the initial evaluation, including impairments in strength, balance, coordination and sensation. As a result, the patient had been ambulating with a single-point cane and minimal manual assistance. Ultimately, these impairments were contributing to difficulties with ADL's, IADL's and recreational activities.

Based on the data from the examination, interventions were tailored to improve the patient's impairments, activity limitations and participation restrictions. Improving strength, balance, posture and coordination were thought to be beneficial in improving gait, locomotion and overall function. The patient was re-evaluated every four weeks to measure his progress including the PSFS and TUG.

The patient presented with numerous co-morbidities that were potential barriers to his prognosis, anticipated goals, expected outcomes and plan of care. The patient reported fogginess and fatigue associated with his diagnosis of Lyme disease, which made it difficult for him to focus and perform activities. He also reported difficulty sleeping due to pain from PN in his left hand and thumb, which had the potential to limit his prognosis due to fatigue and how much activity he could perform at therapy. PTSD is another co-morbidity that impacted his sleep patterns and impacting his therapy sessions. Due to the patient's multiple co-morbidities and progressive degenerative conditions, his prognosis was questionable, as it was difficult to determine his rate of decline. We determined that his plan of care would need to be altered based on his response to treatment and or changes in functional status. Due to the progressive nature of these conditions, it was unlikely that the risk of falls and functional decline would be eliminated

completely. However, Goodwin et al.[6] and Lima et al.[22] demonstrated that several measures of functional ability, such as strength, could be improved and maintained with PT and also showed the rate of functional decline could be slowed with PT. The patient was extremely motivated, had a positive attitude and good family support, which made him a good candidate for PT and aided in a positive prognosis. With the patient being a good candidate for physical therapy and no apparent red flags, it was deemed that no referrals or consultations outside of PT would be needed.

We recommended the patient attend PT twice weekly for eight weeks. Due to decreased strength, therapeutic exercise/activities involving resistive exercises were chosen as part of his therapy program. The patient's decreased coordination and balance led to the selection of proprioceptive/closed kinetic chain activities and therapeutic activities/exercise. While interventions focused on improving impairments, the primary focus was to improve the patient's overall function. Short (4 weeks) and long (eight weeks) term goals were established for the patient after the initial visit (see Table 5).

Interventions:

Coordination and communication with the patient, his primary care physician (PCP), and other therapists was essential throughout the patient's episode of care (EOC). Coordination and communication of appropriate, realistic and patient specific goals for PT were needed, as well as for the progression of the plan of care and home exercise program (HEP). Each session was documented to communicate the plan with other therapists at the clinic and to track progress, the patient's response, pain level and compliance with HEP. Objective data was also recorded at the time of the initial evaluation and subsequent re-evaluations including: ROM measurements, MMT, special tests, balance testing, functional outcomes, gait analysis and observations.

Patient/client instruction occurred at the initial evaluation for both the patient and his wife including the plan of care, prognosis, anticipated outcomes and the patient's HEP to ensure that the home program was performed safely and correctly.

Procedural interventions were provided twice weekly for 14 weeks despite the initial recommendation being two visits a week for eight weeks. The interventions were selected to improve and help prevent further decline of the patient's strength, flexibility, balance and endurance, while minimizing pain as much as possible. Due to decreased strength, therapeutic exercise/activities involving resistive strength exercises were chosen. The patient's decreased coordination and balance led to the selection of proprioceptive/closed kinetic chain activities and therapeutic activities/exercise. While interventions focused on improving impairments and the patient's overall function, the goal was to improve mobility, gait and decrease the need for assistance with transfers, ADL's and IADL's. The HEP was provided to supplement the therapy program at home. Due to the patient's risk for falls and assistance needed with numerous activities at home, the patient's wife was also educated on the HEP to ensure home safety. The interventions used and the evidence from the literature, which supports these interventions, can be found in Appendix 3. A detailed therapy program from the initial evaluation through the entire EOC can be found in Table 3.

The primary changes made to the interventions over time were a gradual progression in resistance and repetitions. The patient was progressed to higher resistances based on his response and tolerance to the intervention. The level of difficulty of balance and functional activities were also increased as the patient performed the interventions with increased tolerance. Several exercises were discontinued to provide time for functional exercises during one-on-one sessions. After particular exercises were discontinued, they were added to the patient's HEP. For example,

isometric hip abduction was discontinued after three weeks to allow for more functional sidestepping with a theraband, which mimics a movement performed in a typical day. Warm-up on the recumbent bike after week six progressed to walking on the treadmill, which is more functional involving more coordination and stability in a weight-bearing position. Overall, the patient was very compliant with his HEP and attendance of PT. He missed one week due to a shoulder injury he sustained from a fall. He also missed two days due to illness/fatigue. Over the EOC the patient attended 42 appointments out of the 48 scheduled. Despite missing several visits, the patient was diligent with his HEP and was very motivated in progressing with his therapy program.

Outcomes:

By the end of the EOC the patient had received a total of 28 treatment sessions. These sessions ranged from 45 minutes to one hour depending on the patient's time restrictions, level of fatigue and health status on the day of the session. The patient chose to end his EOC with ten approved visits remaining because he was granted home therapy through the United States Department of Veterans Affairs (VA). The patient reported that he was satisfied with the outpatient PT services, but stated home PT was more convenient and cost-effective. He stated that he felt he had improved his UE and LE strength, balance and walking speed. Additionally, he reported that his dizziness had improved slightly, but wasn't sure if that was related to PT or medication changes. At the initial evaluation the patient presented with impairments in strength, balance, coordination and sensation. These impairments were contributing to difficulties with gait/locomotion, transfers, ADL's, IADL's and recreational activities. At the final re-evaluation the patient was found to have improvements in MMT strength, static standing balance, coordination and TUG score (see Table 4 and Appendix 4). Despite less hypermetria with UE

coordination, the patient still had dysdiadochokinesia with bilateral heel to shin coordination testing (Table 4). Overall, the patient achieved six out of eight short-term goals and two out of five long-term goals (Tables 4 and 5). Despite being unable to achieve the goal of full 5/5 UE MMT strength, the patient made significant progress to the point where all UE MMT strength was graded at +4/5 to 5/5. However, the patient's PSFS scores and impairments related to sensation, and overall gait remained unchanged (see Tables 4 and 5). The patient also reported numerous falls throughout the EOC, which suggests that falls were neither prevented nor limited. The falls indicate that the patient was unable to achieve his short-term goal of decreasing instability/giving away from three times a week to once a week and long-term goal of decreasing instability/giving away from one time a week to once a month (Table 5).

Discussion:

The purpose of this case report was to document an extensive therapy program with the intention of improving deficits and rapid decline in a patient with PD and other co-morbidities. Throughout the EOC, a patient specific therapy program was developed to help reduce and maintain impairments. Considerable improvements were noted in UE and LE MMT, as well as with static standing balance and TUG scores. More importantly, the patient reported satisfaction with his progress and also recognized his improvement. Currently, there is evidence that supports PT management of patients with PD alone. A study by Goodwin et. al.[6] found exercise interventions beneficial in improving physical functioning, strength, balance and walking in patients with PD. An extensive intervention program with the emphasis on strength and balance exercises was chosen for this particular patient based on the evidence and outcomes from this piece of literature. Another study by Hirsch et. al.[5] found balance interventions increased balance

times before falling and Sensory Orientation Scores, and this led to the decision to incorporate numerous balance exercises into the plan of care.

There are several factors that may have affected the outcomes in this study and the extent to which the patient improved by delaying the progression of the therapy program. The patient missed several sessions throughout the EOC due to a shoulder injury he sustained from a fall. He also missed two appointments due to fatigue/illness. Throughout the EOC, the patient's physicians made changes to his medications, which may have affected the patient's response and tolerance to exercise from session to session due to fluctuating symptoms of dizziness. Lastly, during the EOC, the patient switched assistive devices from a single-point cane to a rolling walker. This switch may have lead to improved safety by the patient and improved tolerance to exercise.

The outcomes from this case report indicate that an extensive therapy program with strengthening and balance exercises may have yielded positive results in improving strength, balance and functional outcomes for this patient with PD and other co-morbidities. However, the patient was found to have no significant improvements related to coordination, sensation, gait, PSFS scores and falls. Future investigation of the PT management of patients with PD is needed to determine which interventions are the most beneficial and lead to the greatest improvements. This investigation could focus on different style therapy programs to reduce impairments and decline in function, such as Tai Chi and Lee Silverman Voice Technique (LSVT BIG). Longer PT episodes of care may be beneficial, as they would allow for more treatments and progressions of programs. Lastly, since falls are quite common in patients with PD, investigation focusing on fall risk reduction would be worth while due to the negative impact on patient quality of life and potential effectiveness of care.

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Tables and Appendices:

Table 1. Systems Review at Admission

Cardiovascular/Pulmonary	HR: 75 bpm, RR: 15 breaths per minute, BP: 125/78 mmHg
Musculoskeletal	Gross ROM: WFL for R and L UE/LE Gross Strength: R UE/LE=WFL, L UE/LE=WFL Gross Symmetry: WNL Height: 5' 8" Weight: 195 lbs.
Neuromuscular	Balance: Impaired Gait/Locomotion: Impaired Motor Control: Impaired Sensation: Impaired Vision: Intact Coordination: Impaired
Integumentary	Integument unremarkable
Communication	Intact
Affect, Cognition, Language, Learning Style	Unimpaired. Learns best from pictures and demonstrations.

HR= Heart Rate, bpm= beats per minute, RR= Respiratory Rate, BP= Blood Pressure, mmHg= millimeters of mercury, WFL= Within Functional Limits, R= Right, L=Left, UE= Upper Extremity, LE= Lower Extremity, WNL= Within Normal Limits, lbs. = pounds

Table 2. Tests and Measures at Admission

Tests and Measures	**Impairments at IE**		
Manual Muscle Testing (MMT) and Dynamometer		Right	Left
	Hip abduction	+4/5	+4/5
	Hip adduction	4/5	4/5
	Hip Flexion	4/5	4/5
	Knee Extension	+4/5	+4/5
	Knee flexion	+4/5	+4/5
	Ankle Dorsiflexion	+4/5	4/5
	Ankle Plantarflexion	+4/5	+4/5
	Ankle Inversion	+4/5	+4/5
	Shoulder flexion	4/5	+4/5
	Shoulder External Rotation	-4/5	+4/5
	Shoulder Internal Rotation	+4/5	+4/5

	Shoulder Abduction	+4/5	4/5
	Elbow Flexion	+4/5	+4/5
	Elbow Extension	+4/5	+4/5
	Dynamometer II	62 pounds	64 pounds
Standing Static Balance	- Feet together: 10+ seconds - Semi-tandem: 8 seconds - Tandem: 1 second - Single leg: Unable perform bilaterally (BL)		
Coordination	- Hypermetria with finger to patient's nose with BL upper extremities - Hypermetria with finger to therapist's finger with BL upper extremities - Dysdiadochokinesia with heal to shin with BL lower extremities		
Sensation	Impaired crude touch at C6 and C7 dermatome on left upper extremity.		
Timed-Up-and-Go (TUG)	38.80 seconds		
Patient Specific Functional Scale (PSFS)	Average score: 4.50		
Gait	Upon observation into the examination room, patient ambulated in a Parkinsonian gait pattern with use of a single point cane on right side. He had shortened step length and stride length. He also had general decreased gait speed and a stooped posture.		

MMT= Manual Muscle Testing; 5/5= holds test position against maximal resistance; +4/5= holds test position against moderate to strong resistance; 4/5= holds test position against moderate resistance; -4/5= holds test position against slight to moderate resistance; +3/5= holds test position against slight resistance; -3/5= gradual release from test position; +2/5= moves through partial range of motion (ROM) against gravity or moves through complete ROM gravity eliminated and holds against pressure; 2/5= able to move through full ROM gravity eliminated; -2/5= moves through partial ROM gravity eliminated; 1/5= no visible movement, palpable or observable tendon prominence/flicker contraction; 0/5= no palpable or observable muscle contraction.[7]

Table 3. Detailed Therapy Program

Intervention	Weeks 1-3	Weeks 4-6	Weeks 7-11	Weeks 12-14
Recumbent Bike: 10 min.	Level 1			
Treadmill: 10 min.			Speed: 1.7 mph	Speed: 2.0 mph
Low Row: 3x15	10 lb. cable	20 lb. cable	25 lb. cable	30 lb. cable
Balance Board (forward/backward):	3x30 each direction			

Walking forward/retro cable machine: 3x15	5 lb.	15 lb.	20 lb.	25 lb.
Total Gym (squats/calf raises): 2x15 each	Level 8	Level 10		Level 12
Isometric hip Abd. /Add.	3x15, 5 sec hold	3x 15, 5 sec hold		
Table Squats (no hands) 3x10	Body weight	5 lb. Dumbbell		10 lb. Dumbbell
Standing 3-way (hip Flex., Abd., Ext.): 3x10	2 lb. each direction	→	4 lb. each direction	→
Supine Bridges		3x15, 2 sec holds		
Side stepping: Red theraband		3x15 each way		
Cone agilities (Fwd. slalom, side-ways)			3x10 each way	3x15 each way
Semi-tandem balance: 4x1 min		Flat Surface		Blue Foam
Step-ups (Forward, Left/Right): 3x10		6 in. step	6 in. step	8 in. step
Pulley (ER., IR., Flex., Abd.): 3x15			ER./IR.: 0.5kg Flex/Abd: 1.0 kg	
Partial Lunges			3x15	
Cryotherapy			Cold pack 10 min	

Min. = Minutes, mph = Miles Per Hour, lb. = pounds, Abd. = Abduction, Add. = Adduction, sec= seconds, Flex. = Flexion, Ext. = Extension, Fwd. = Forward, ER. = External Rotation, IR. = Internal Rotation, in.= inch, Grey shading= intervention not performed; other interventions that were used, but were not considered primary interventions include: Cable punches, Farmer's carry, Lat-pull down with cable and gastrocnemius slant board

Table 4. Outcome Measures

Tests and Measures	**Movement**	**Impairments at Initial Evaluation**		**Impairments at Final Re-evaluation**	
Strength (MMT) and Dynamometer		Right	Left	Right	Left
	Hip abduction	+4/5	+4/5	5/5	5/5
	Hip adduction	4/5	4/5	5/5	5/5
	Hip Flexion	4/5	4/5	5/5	5/5

	Knee extension	+4/5	+4/5	5/5	5/5
	Ankle Dorsiflexion	+4/5	4/5	5/5	5/5
	Ankle Plantarflexion	+4/5	4/5	5/5	5/5
	Ankle Inversion	+4/5	+4/5	5/5	5/5
	Shoulder Flexion	4/5	+4/5	5/5	5/5
	Shoulder External Rotation	-4/5	+4/5	5/5	5/5
	Shoulder Internal Rotation	+4/5	+4/5	5/5	5/5
	Shoulder Abduction	+4/5	+/5	-5/5	-5/5
	Elbow Flexion	+4/5	+4/5	+4/5	+4/5
	Elbow Extension	+4/5	+4/5	-5/5	-5/5
	Dyanmometer II	62 pounds	64 pounds	76 pounds	72 pounds
Standing Static Balance	- Feet together: 10+ seconds - Semi-tandem: 8 seconds - Tandem: 1 second - Single Leg: Unable to do bilaterally		- Feet together: 10+ seconds - Semi-tandem: 10+ seconds - Tandem: 10 sec with forward lean - Single Leg: less than 2 seconds		
Coordination	- Hypermetria with finger to patient's nose with bilateral upper extremities - Hypermetria with finger to therapist's finger with bilateral upper extremities - Dysdiadochokinesia with heal to shin with bilateral lower extremities		- Less hypermetria with finger to patient's nose with bilateral upper extremities - Less hypermetria with finger to therapist's finger with bilateral upper extremities - Dysdiadochokinesia with heal to shin with bilateral lower extremities		
Sensation	Impaired crude touch at C6 and C7 dermatome on left upper extremity.		Impaired crude touch at C6 and C7 dermatome on left upper extremity.		
Timed-Up-and-Go (TUG)	38.80 seconds		31.31 seconds		
Patient Specific Functional	Average score: 4.50		Average score: 4.50		

Scale (PSFS)		
Gait	Patient ambulates in a Parkinsonian gait pattern with a single point cane. He has shortened step length and stride length. Also, he has decreased gait speed and a stooped posture.	Patient ambulates in a Parkinsonian gait pattern with a rolling walker. He has a shortened step length and stride length. Also, he has decreased gait speed and stopped posture.

MMT= Manual Muscle Testing; 5/5= holds test position against maximal resistance; +4/5= holds test position against moderate to strong resistance; 4/5= holds test position against moderate resistance; -4/5= holds test position against slight to moderate resistance; +3/5= holds test position against slight resistance; -3/5= gradual release from test position; +2/5= moves through partial range of motion (ROM) against gravity or moves through complete ROM gravity eliminated and holds against pressure; 2/5= able to move through full ROM gravity eliminated; -2/5= moves through partial ROM gravity eliminated; 1/5= no visible movement, palpable or observable tendon prominence/flicker contraction; 0/5= no palpable or observable muscle contraction.

Table 5. PT Goals

Short Term Goals (Four Weeks)	Long-Term Goals (Eight Weeks)
1. Patient will decrease instability/giving away from three times/week to one time/week to improve safety with community ambulation within four weeks from start of care.	1. Decrease instability/giving away from one time/week to one time/month to improve safety with community ambulation within eight weeks from start of care.
2. Patient will increase bilateral hip adduction and flexion from 4/5 to +4/5 to improve performance with ADL's within four weeks from start of care.	2. Increase all lower extremity muscle strength to 5/5 to improve performance with ADL's within 8 weeks from start of care.
3. Patient will increase right ankle dorsiflexion from 4/5 to +4/5 to improve performance with ADL's.	3. Increase all upper extremity muscle strength to 5/5 to improve performance with ADL's within eight weeks from start of care.
4. Patient will increase left shoulder flexion from 4/5 to +4/5 to improve performance with ADL's within four weeks from start of care.	I4. ncrease tandem stance balance from 4 seconds to 6 seconds to improve gait mechanics within eight weeks from start of care.
5. Patient to improve left shoulder external rotation from -4/5 to 4/5 to improve performance with ADL's within four weeks from start of care.	5. Increase average score on Patient Specific Functional Scale from 6.5 to 8.5 to improve performance with ADL's and gait within eight weeks from start of care.
6. Patient to increase tandem stance time from one second to four seconds to improve gait mechanics within four weeks from start of care.	
7. Increase the average score on the Patient Specific Functional scale from 4.5 to 6.5 to performance with ADL's and gait within four weeks from start of care.	

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437 **Appendix 1.** Medication List at admission

Medication	Dose/Frequency
Azithromycin (Lyme's Disease)	500mg/once a day
B-12 (Lyme's Disease)	2500mg, one capsule/once a day
Ultra Flora Balance (Lyme's Disease)	Three capsules/three times a day
Liposomal Glutathione (Lyme's Disease)	250mg/one capsule/twice a day
YUCCA (Lyme's Disease)	500mg/1-2 capsules/twice a day
PANA C-315 (Lyme's Disease)	One capsule/once a day
Metoprolol Tartrate (Post-Traumatic Stress Disorder)	25mg/ 0.5 capsule/twice daily
Sertaline (Post-Traumatic Stress Disorder)	100mg/one capsule/once daily
B-12 Sublingul (Heart)	1000 MCG/one capsule/once a day
Homocysteine Factors (Lyme's Disease)	One capsule/twice a day
Carbidopa/Levodopa (Parkinson's Disease)	25-100mg/one capsule/three times a day

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439 **Appendix 2.** Psychometric properties

Functional Outcome	Psychometric Property	Results	Author(s) of study
Timed-Up-and Go (TUG)	Test-retest reliability (Parkinson's)	Adequate test-retest reliability (ICC=0.85),	Steffen & Seney, 2008, Parkinson's Disease[10]
	Interrater/Intrarater Reliability (Parkinson's)	Excellent inter-rater reliability (r=0.99)	Morris et al, 2001[11]
	Interrater/Intrarater Reliability (Parkinson's)	Excellent inter-rater reliability (ICC=0.99) Excellent intra-rater reliability (ICC=0.98)	Bennie et al, 2003[12]
	Criterion Validity	Significant correlation between TUG and Berg Balance Scale (r=-0.47, p=0.04)	Bennie et al, 2003[12]
	Predictive Validity	TUG time >16 sec= increased fall risk (OR 3.86, CI 1.05, 14.27, P=0.043)	Mak and Pang, 2009[13]
	Criterion Validity-Predicted Fall Risk	Sensitivity:0. 69, Specificity= 0.62, Accuracy: 0.63, Area Under the Curve= 0.65)	Kerr et al 2010[14]
	Criterion Validity-Predicted Fall Risk	Increased TUG time (fallers mean 16.8 +/- 10.1 sec, nonfallers 11.2 +/- 5.2 sec)	Balash et al, 2005[15]

		increased risk for falls: adjusted OR= 1.18, 95% CI: 1.03-1.63	
Patient Specific Functional Scale (PSFS)	Interrater/Intrarater Reliability (UE Musculoskeletal)	Excellent interrater reliability (ICC2, 1= 0.713)	Hefford et al., 2012[16]

TUG= Timed-Up-and-Go; PSFS= Patient Specific Functional Scale; ICC= Intraclass correlation coefficient; r= relationship; p= probability or p-value; CI= Confidence Interval.[11-17]

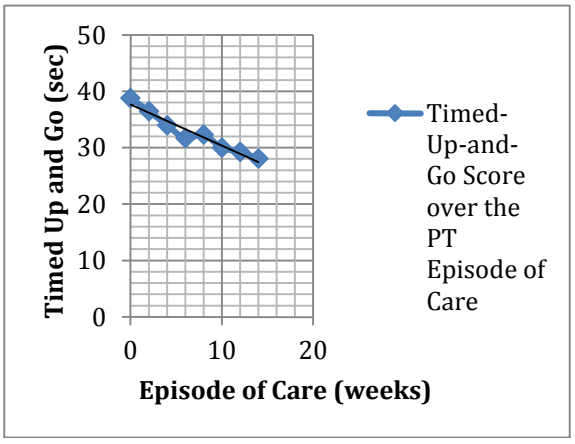
Appendix 3. Summary of Interventions Used

1. Isometric strengthening for early strengthening of the lower extremity	Isometric strengthening can be used to provide significant resistance and is often used during the beginning stages of strengthening to help facilitate neuromuscular adaptation to specific muscles. Also, isometric strengthening can be used to develop postural and joint stability.[23] Repetitive isometric contractions can be beneficial in decreasing muscle cramps, while increasing the effectiveness of isometric strengthening.[23] This particular patient performed repetitive isometric contractions early on to improve hip abductors and adductors. This was done to strengthen bilateral hip stabilizers, but decrease the potential for fatigue and delayed onset muscle soreness.[23]
2. Isotonic strengthening to improve strength of the bilateral upper and lower extremities	Isotonic strengthening involves muscle strengthening with a change in length during a muscle contraction. Eccentric strengthening is a type of strengthening that involves loading of a muscle beyond its force producing capacity, which causes physical lengthening of the muscle as attempt is made to control the load. It is a form of strength training used to improve muscle strength, while also preventing future injury.[23] A study on resistance training for patients with Parkinson's, found high force eccentric resistance training programs produce muscle hypertrophy, increase strength and improve mobility in patients with Parkinson's disease.[4] Thus, eccentric strengthening was used with this patient in hopes of facilitating muscle hypertrophy, increases in strength and improvements in mobility. While eccentric exercises can control greater loads and induce greater gains, concentric strengthening can beneficial as well. Both eccentric exercises and concentric muscle contractions are needed on a daily basis, such as with ambulation of stairs, transfers, transitions and lifting an object.[23] Based on this, concentric strength training was used with this patient to help strengthen muscles needed for those movements.
3. Balance training to improve static/functional balance with activity, improve coordination, improve stability, gait, transfers ADL's and IADL's.	Balance training is an intervention used to improve balance, coordination, stability and strength. Both static and functional balance training were used with this patient to improve his coordination, balance, stability, strength, mobility, transitions, and reduce the risk of falls. The decision to use balance training was aided by a study that looked at balance and strength training in patients with Idiopathic Parkinson's. This study found improvements in balance times before falling and increased Sensory Orientation Test scores[5].

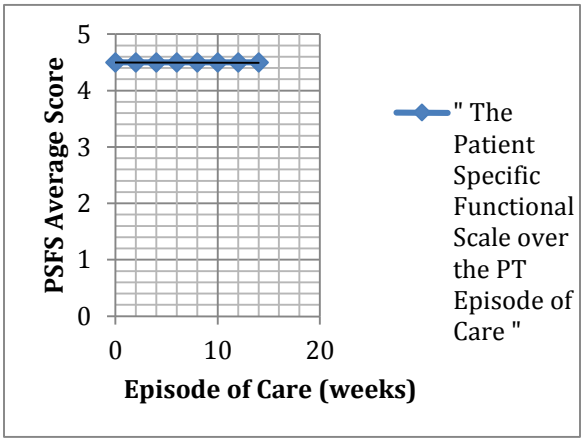
4. Functional strengthening and aerobic conditioning to improve cardiovascular endurance	Functional strength training was used with this patient to incorporate strength training for activities performed throughout the course of a normal day. These exercises consisted of squats, lunges, step-ups and gait training. Isotonic exercises focus mostly on individual or groups of muscles, while functional movements facilitate strengthening of multiple muscle groups simultaneously. This was particularly important to work on as the patient had difficulties with mobility, transitions and transfers.
5. Comprehensive HEP	Written instructions and pictures to improve static strength, functional strength, balance, coordination and gait
6. Cryotherapy to decrease pain and swelling	Cryotherapy was used with this patient several times over the course of his therapy progression, mostly to help decrease pain and promote healing when the patient sustained an injury from a fall. Clinical judgment was used in this situation as the patient had some pain and swelling from the fall he sustained. Cryotherapy can be beneficial in acute situations in helping reduce pain due to its analgesic effects, as well as help to decrease swelling.

ADL's= Activities of daily living, IADL's= Instrumental Activities of Daily Living, HEP= Home Exercise Program

Appendix 4. Changes in Outcome Measures:



A. Timed-Up-and Go Progression Progression



B. Patient Specific Functional Scale

Figure 1. Patient Performing Therapeutic Exercise

A. Patient warming-up on the recumbent bike

B. Patient performing functional strengthening

C. Patient performing step-up