2023

Physical Therapy management of Lower Exteremity Weakness and Balance Dysfunction Due to Sarcopenia and Frailty: A case report

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PHYISCAL THERAPY MANAGEMENT OF LOWER EXTREMITY WEAKNESS AND BALANCE DYSFUNCTION DUE TO SARCOPENIA AND FRAILTY: A CASE REPORT

by

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Bachelor of Science in Athletic Training, University of North Dakota, 2020

A Scholarly Project

Submitted to the Graduate Faculty of the

Department of Physical Therapy

School of Medicine & 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,

2023

This Scholarly Project, submitted by Carla Maurstad 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.

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DEPARTMENT Physical Therapy

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ACKNOWLEDGEMENTS

I would like to express my utmost gratitude to my faculty advisor and classmates that contributed to the editorial and revision process to achieve the finished product of this case report. Additionally, I would like to thank and acknowledge my professors, classmates, clinical instructors, and mentors that have helped guide and facilitate my learning to this point. Lastly, I would like to thank my family and friends that have supported me throughout my educational journey during my time in the Doctor of Physical Therapy Program at the University of North Dakota.

ABSTRACT

Introduction: The aging population is on the rise and is expected to increase from 8.5% to 16.5% for those aged sixty-five years and older by 2050. With the expected rise comes the increased prevalence of frailty that leads to a decline in physiological function placing individuals at risk for sarcopenia, disability, falls, hospitalization, and death. The purpose of this case study is on lower extremity muscle weakness (sarcopenia) and frailty and the effectiveness of physical therapy to improve muscle strength, balance, proprioception, and functional mobility to decrease the risk of falls, improve performance with daily activities, and improve overall quality of life.

Case Description: The patient was a 77-year-old female who presented to physical therapy with bilateral lower extremity weakness and decreased functional mobility due to an extensive list of comorbidities starting at the age of 2. The initial examination and evaluation found deficits in muscle strength, range of motion, balance, and functional mobility placing her at an increased risk for falls; given the diagnosis of decreased lower extremity strength, unspecified abnormalities of gait and mobility, and unsteadiness on feet.

Intervention: The patient was seen twice per week for eight weeks. Sessions focused on bilateral lower extremity neuromuscular re-education, strength, aerobic, and gait training, along with balance and proprioceptive training.

Outcomes: The patient showed both subjective and objective improvements in strength and mobility over the course of the eight weeks and was able to decrease her risk of falls from a moderate fall risk to a low fall risk per functional outcome measures.

Discussion: After evaluation the patient presenting with bilateral lower extremity weakness due to sarcopenia and frailty, it was shown that physical therapy intervention moderately improves muscle strength, active range of motion, balance, and gait to improve overall functional mobility and quality of life for the completion of daily activities. Case findings reporting on similar literature have also shown that physical therapy plays a significant role in reducing fall risk, hospitalization, and death in patients with sarcopenia and frailty. Further quality evidence is needed within the topic of physical therapy treatment parameters, successful interventions, and prognosis.

CHAPTER I

BACKGROUND AND PURPOSE

The aging population is on the rise globally. Currently, those aged sixty-five years and older make up 8.5% of the population which is expected to rise to approximately 16.7% by 2050.[1] With the expected increase in the aging population comes the increased prevalence of frailty from 16% in those older than sixty-five years to 52% in those eighty-five and older; impacting women and individuals with lower socioeconomic status most frequently.[2] One published article stated that frailty is conceptually defined as "A clinically recognizable state in which the ability of older people to cope with every day or acute stressors is compromised by an increased vulnerability brought by age associated declines in physiological reserve and function across multiple organ systems."[3] Another systematic review defines frailty as, "An age-associated biological syndrome characterized by decreases in the biological functional reserve and resistance to stressors due to changes in several physiological systems, which puts individuals at special risk for poor outcomes (disability, fall death, and hospitalization) from minor stressors."[4] Adults deemed as frail are shown to be at a 1.2-to-2.8-fold risk for falls, fractures, and hospitalization along with a 1.5-to-2.6-fold risk for physical limitations/disabilities, a 1.6-to-2.0-fold risk for loss of ADL's, a 1.8-to-2.3-fold risk for mortality, and an increased risk for admission to long-term care facilities. Those that are hospitalized for acute illnesses have a two-fold higher mortality rate risk than non-frail adults prior to discharge.[5,6]

Still, there is no 'gold standard' frailty definition that has been accepted globally. The most common frailty definition used is the frailty phenotype developed by Fried et al.[3] using the Cardiovascular Health Study cohort in 2001. This frailty phenotype is made up of five physical components that are used to define frailty: weakness, slow walking speed, low physical activity, unintentional weight loss, and self-reported exhaustion. Persons that meet no criterion are considered robust, persons that meet one or two criteria are considered prefrail, and persons that meet three or more of these criteria are considered frail.

Because frailty encompasses several physiological systems, the impacts on the body increases; notably effecting weight loss, low physical activity, and physical impairments such as low grip strength, low gait speed, and fatigue causing a decline in overall physical function.[4] A major component being a loss of muscle mass, known as sarcopenia, that is accelerated by the biological aging process.[4,7] Sarcopenia is known as "A syndrome characterized by progressive and generalized loss of skeletal muscle mass and strength with a risk of adverse outcomes such as physical disability, poor quality of life, and death" as defined by The European Working Group on Sarcopenia in Older People (EWGSOP) with a prevalence rate of 1%-29%, and up to 30% in women for community-dwelling older adults.[8] Lally F et al[9] studied a list of common predictors associated with frailty that are most commonly cited in the literature including sarcopenia, weakness, muscle strength, gait impairments, low activity levels, and poor endurance.

Due to the nature of the biological aging process, research shows a wide range of muscle mass decline as we age. One systematic review suggests that muscle mass decreases by 3%-8% per decade after the age of 30, 1.5% per year after age 50, and by 3% after age 80.[10] A second meta-analysis of randomized controlled trials (RCTs) suggests that those 50 years and older lose

an average of 15% of their muscle mass every 10 years and increases to 30% muscle mass loss after the age of 70.[11] A third article reports that muscle mass lost is due to type II muscle fibers and a reduction in muscle protein synthesis ultimately leading to a decrease in the muscle's ability to contract and generate force for muscle strength and completion of physical and daily activities.[12] Muscle weakness is a modifiable physiological risk factor among others including: poor balance and gait, decreased lower extremity strength, proprioceptive deficits, and visual impairments that leads to an increase risk of falls.[13,14]

Figure 1: Venn Diagram Comparing Frailty and Sarcopenia.

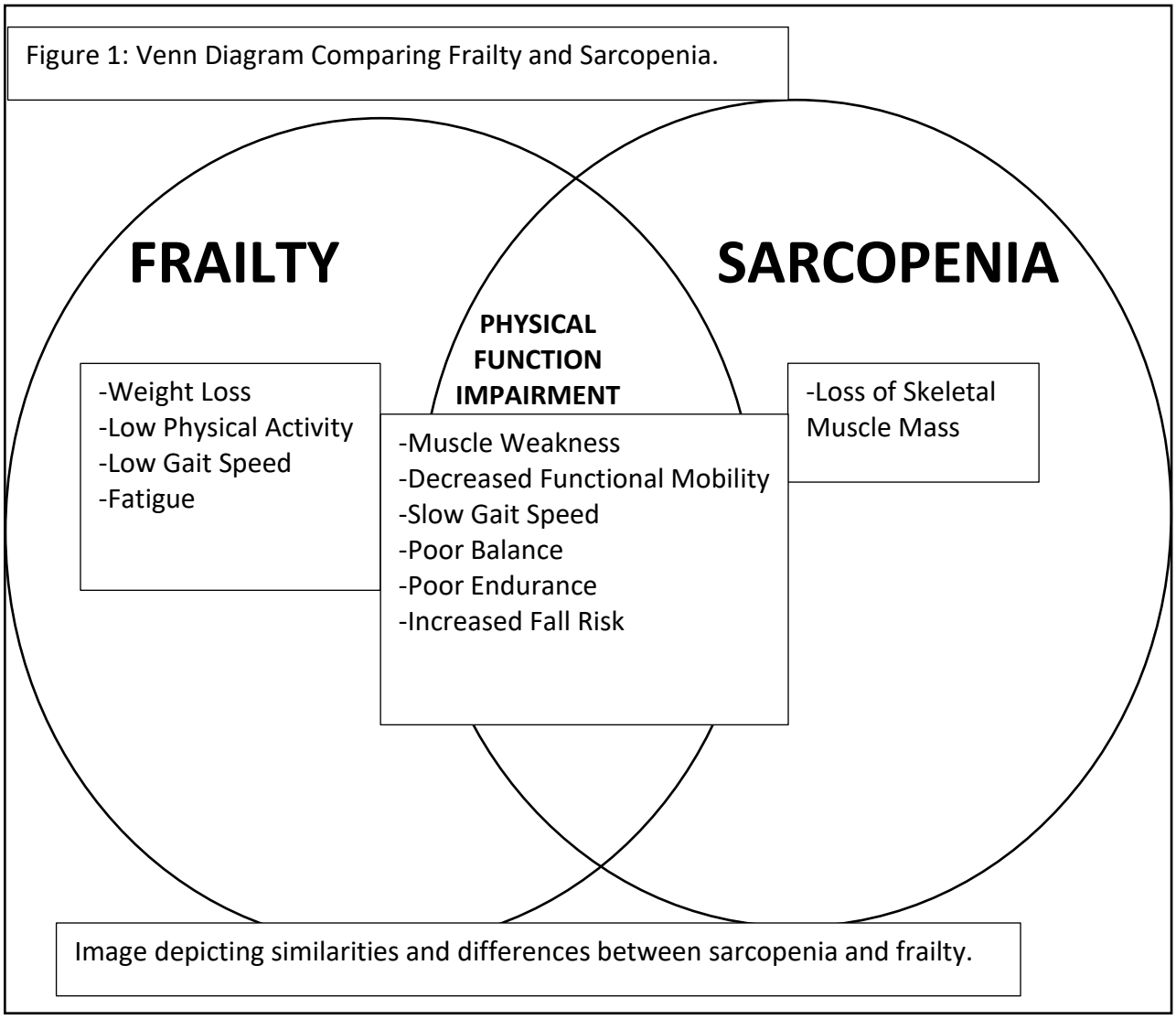

Image depicting similarities and differences between sarcopenia and frailty.

Physical therapy is one of the many ways adults can target the negative effects mentioned above associated with frailty and sarcopenia. Research suggests that participating in physical exercise can help combat the decreased muscle mass, increased fall risk, and decline in overall physical function. Physical therapists can guide people with sarcopenia and frailty following a thorough physical examination by establishing patient-centered goals to increase functional performance, quality of life, emotional health, and decreased risk of falls.[15]

A thorough examination by a physical therapist will include subjective questions pertaining to the patient's chief complaint, past medical history, and goals they wish to achieve along with an objective portion dedicated to the areas of concern focusing on range of motion (ROM), manual muscle testing (MMT) using a grading scale such as the Medical Research Council Manual Muscle Testing scale[16,17] (see table 1 below)[18], and special tests and functional outcome measures pertaining to the patient's chief complaint.

Functional outcome measures allow physical therapists to objectively measure physical capabilities and limitations of patients. A systematic review and meta-analysis published by Park SH[19] found that the Berg Balance Scale (BBS) was among the top fall risk assessments for stable and high specificity out of the 26 assessment tools analyzed. Downs S. et al[20] agreed with Park SH, finding the BBS to have high intra-rater reliability (0.98, 95% CI, 0.9 –0.99) and inter-rater reliability (0.97, 95% CI, 0.96-0.98); making it an effective outcome measure to utilize. Among other functional outcome measures, the Lower Extremity Functional Scale (LEFS) was found to have a higher reliability (0.94), sensitivity, and validity (0.41-0.65) than the SF-36 outcome measure with an enhanced focus on activities of daily living (ADL's) and functional activities that helps to assess patient's abilities through objective measures throughout physical therapy.[21] A third functional outcome measure with high remarks across literature is the Timed Up and Go

test (TUG) which was found to be more useful in ruling in falls versus ruling out falls due to the high specificity (0.74, 95% CI, 0.52-0.88) than sensitivity (0.31, 95% CI 0.13-0.57)[22] making it a valid screening tool for detecting balance deficits that could lead to increased risk of falls.[23] All three of these functional outcome measures come with a caveat despite their high remarks across literature—these tests should not be used solely in the examination of patients but should be used in conjunction with other outcome measures for the detection of fall risk and functional mobility deficits.

Table 1: MMT Grading Scale[18]

Muscle Function	Grade of Strength
No contraction felt within the muscle	0
Tendon becomes prominent or muscle contraction is felt, but no movement is visible	1
Moves through partial range of motion in gravity dependent position	2-
Moves through completion range of motion in gravity dependent position	2
Moves through partial range of motion in anti-gravity position	2+
Moves through full range of motion in anti-gravity position	3-
Able to hold anti-gravity test position without external pressure	3
Able to hold anti-gravity test position against slight external pressure	3+
Able to hold anti-gravity test position against slight-to-moderate external pressure	4-
Able to hold anti-gravity test position against moderate external pressure	4
Able to hold anti-gravity test position against moderate-to-strong external pressure	4+
Able to hold anti-gravity test position against strong external pressure	5

Following the initial evaluation by the physical therapist, patients with sarcopenia and frailty will work towards improving muscle strength, balance, proprioception, and functional mobility for carryover into daily activities and improvements in overall quality of life. Multiple research studies have shown that while physical exercise helps to combat frailty and sarcopenia, an exercise regime that includes functional exercise, balance training, and resistance training was found to decrease the fall rate in older people by 34%.[24] One systematic review found that resistance training for one-hour sessions, two to three times per week on alternating days, including a ten-minute aerobic warm-up and a two-minute rest break between resistance training exercises had a positive correlation with gains in muscle strength, improved functional mobility, stability, balance and coordination, and decreased fall risks. This systematic review concluded that resistance training paired with aerobic warmups two to three times per week helped increase muscle strength in older adults that carried over into improvements in balance, stability, decreased fall risks, and functional mobility for activities such as gait speed, walking endurance, and stair ambulation.[25]

Another systematic review found that resistance training programs completed three times per week, using three sets of 8-12 repetitions, at 20-30% intensity that is progressed to 80% intensity of the individual's one repetition maximum have been tolerated well by those considered frail.[4] This exercise prescription was found to have positive effects on increased muscle strength and improvements in gait. A third published article found that multi-component exercises programs that had physical activity as one of the components helped to reverse frailty, decrease fall rates, improve gait, balance, strength, and improve physical function and ability to complete daily activities.[2] Other exercise regimes that have been found to be effective in frail, elderly people within the literature include: Tai Chi, coordination training, endurance training,

and multi-component exercises.[4] While research seems to be conclusive on resistance training paired with balance and functional training for increasing muscle strength, functional capabilities, and reducing the risk of falls; they lack consistency as it pertains to the duration and frequency of physical therapy sessions and the rehabilitation timeline for decreasing falls risks. For example, one article found that 30-minute sessions, twice a week had a positive correlation on increasing muscle strength with functional carryover into ADLs[15] while another systematic review found positive results with an exercise prescription of 3 times a week.[4]

The focus for this case study is on lower extremity muscle weakness (sarcopenia) and frailty. Utilizing an exercise prescription that works towards improving muscle strength, balance, proprioception, and functional mobility will allow individuals with muscle weakness to decrease their risk of falls, improve performance with ADL's and improve overall quality of life. Developing an exercise prescription that is all-encompassing of these categories will allow for increased safety and quality of life for these individuals. This will show that treatments including a variety of strength, endurance, and balance activities will allow individuals to be active in the community and complete daily activities with a decreased risk of falls for increased safety.

CHAPTER II

CASE DESCRIPTION

The patient was a 77-year-old female that presented to physical therapy with bilateral lower extremity weakness and decreased functional mobility. She reported that she's been dealing with strength and balance problems since she was a young child and noticed increased difficulty with completing her daily activities due unsteadiness and fear of falling within the last 3 months. Relevant past medical history (PMH) included right total hip arthroplasty (THA), bilateral Achilles tendon rupture (non-surgical intervention, age 17), scoliosis with surgical intervention (age 16), osteoporosis, sarcopenia, and decreased motor control of left upper and lower extremity due to Polio (age 3).

Examination, Tests, and Measures

The patient reported that her back constantly ached, rating it a 5/10 pain utilizing the 0cm -10cm visual analog scale with 0 being "no pain" and 10 being "worst imaginable pain," (P <0.05, MCID <1.4 cm) and reported increased aching, sharp pain in the left lower extremity (LLE) with transfers, ambulation, and ADL's rating it a 6-7/10 intensity.[26] She stated that she had fallen twice in the past 3 months, noting that x-rays ordered by her primary care physician ruled out fractures; and reported an increase in near fall events due to increased feelings of unsteadiness. Along with the increased number of falls and near falls, the patient reported increased difficulty with getting in and out of the car and bathtub, ambulating up and down the stairs, bending over to pick objects up from the floor, and walking around stores without taking

frequent breaks. She expressed that the concerns mentioned above would not allow her to continue to live independently and properly care for herself, drive in the comm unity, attend church, and actively participate in exercise class at the senior center each week; all of which are personal activities she wished to maintain.

The physical therapy examination consisted of subjective questions gaining insight on pain, limitations with daily activities, functional mobility, leisure activities, etc. and is described above with reported limitations, pain, patient concerns, and goals she had made for herself. The objective examination included active and passive range of motion (ROM) using a goniometer and normative values, MMT reflex testing, gait analysis, balance and coordination testing, and functional outcome measures including BBS, TUG, and the LEFS. The patient's bilateral knee flexion, knee extension, plantarflexion, and dorsiflexion were measured and based off Dutton's Orthopaedic Examination, Evaluation, and Intervention, 6e[27] norms. (See Table 2). She was found to be within normal limits (WNL) for bilateral plantarflexion but limited in bilateral knee flexion and extension and bilateral dorsiflexion with the left lower extremity being more limited than the right.

Table 2: Patient's Active Range of Motion Measurements at Initial Evaluation:

	Left Lower Extremity	**Right Lower Extremity**
Knee Flexion	118 degrees	122 degrees
Knee Extension	-4 degrees	-2 degrees
Plantarflexion	52 degrees	50 degrees
Dorsiflexion	6 degrees	13 degrees

The patient's gluteus maximus, gluteus medius, iliopsoas, quadriceps, hamstrings, gastrocnemius/soleus complex, and ankle dorsiflexors with tested and graded using the Medical Research Council Manual Muscle Testing Scale[18] as strength deficits in these muscle groups have been associated with increased risk of falls and decreased balance reaction time leading to increased falls and injuries.[28] (See Table 3). Her patellar and Achilles tendon reflexes were assessed using the National Institute of Neurological Disorders and Stroke (NINDS) scale[29] and found to be intact and normal bilaterally; sensation is normal for light touch.

Table 3: Patient's Lower Extremity MMT at Initial Evaluation:

	Left Lower Extremity	**Right Lower Extremity**
Iliopsoas	3-/5	3/5
Gluteus Maximus	3-/5	3/5
Gluteus Medius	3-/5	3/5
Quadriceps	4-/5	4-/5
Hamstrings	4-/5	4-/5
Gastrocnemius/Soleus	4-/5	4-/5
Dorsiflexors	3-/5	3/5

Gait, balance, and coordination were assessed using three functional outcome measurements: BBS, TUG, LEFS. The patient ambulated using a single point cane (SPC) in her right hand and displayed a slow, antalgic gait. She was slow to initiate transfers and needed to build momentum to complete sit to stand transfers due to weakness. The patient required stand by assist (SBA) and/or contact guard assist (CGA) of one with a gait belt for increased safety due to lower extremity weakness and unsteadiness with completion of the functional outcome measures. Her LEFS score was 28/80, 35% maximum function (Reliability 0.94, 95% CI, validity: 0.41-0.65)[21] (see Figure 1 below) and BBS was 40/56 (inter-rater reliability 0.97; 95%

CI, MDC varied between 2.8 points and 6.6 points)[20] indicating a high fall risk; the TUG (specificity: 0.74, 95% CI, 1.00-1.02, p = 0.05; sensitivity: 0.31, 95% CI 0.13-0.57)[22] could not be utilized upon initial evaluation due to CGA being needed. Special tests used were the slump test and quadrant test to rule out radiculopathy; both were negative.

Figure 2: Lower Extremity Functional Scale at Initial Evaluation

Lower Extremity Functional Index

We are interested in knowing whether you are having any difficulty at all with the activities listed below because of your lower limb problem for which you are currently seeking attention. Please provide an answer for each activity.

Today, do you or would you have any difficulty at all with:

(Circle one number on each line)

Activities	Extreme Difficulty or unable to perform activity	Quite a bit of difficulty	Moderate difficulty	A little bit of difficulty	No difficulty
a. Any of your usual work, housework or school activities.	0	1	2	3	4
b. Your usual hobbies, recreational or sporting activities	0	1	2	3	4
c. Getting into or out of the bath.	0	1	2	3	4
d. Walking between rooms.	0	1	2	3	4
e. Putting on your shoes or socks.	0	1	2	3	4
f. Squatting.	0	1	2	3	4
g. Lifting an object, like a bag of groceries from the floor.	0	1	2	3	4
h. Performing light activities around your home.	0	1	2	3	4
i. Performing heavy activities around your home.	0	1	2	3	4
j. Getting into or out of a car.	0	1	2	3	4
k. Walking 2 blocks.	0	1	2	3	4
l. Walking a mile.	0	1	2	3	4
m. Going up or down 10 stairs (about 1 flight of stairs).	0	1	2	3	4
n. Standing for 1 hour.	0	1	2	3	4
o. Sitting for 1 hour.	0	1	2	3	4
p. Running on even ground.	0	1	2	3	4
q. Running on uneven ground.	0	1	2	3	4
r. Making sharp turns while running fast.	0	1	2	3	4
s. Hopping.	0	1	2	3	4
t. Rolling over in bed.	0	1	2	3	4
COLUMN TOTALS					

Score variation ± 6 LEFTS points
MDC & MCID = 9 LEFS points

Score 28 **/80**

Patient scored a 28/80 on the Lower Extremity functional scale.
Image obtained from https://www.burke.org/docs/LowerExtremityFunctionScale.pdf.[28]

Clinical Impression: Evaluation, Diagnosis, and Prognosis

After the initial evaluation, the patient was given the diagnoses of decreased lower extremity muscle strength (M62.81), unspecified abnormalities of gait and mobility (R26.9), and unsteadiness on feet (R26.81) per ICD10 codes utilized in the clinic for insurance and billing purposes. She was educated on the findings of the examination from both the student physical therapist's (SPT) and licensed physical therapist's (DPT) knowledge bases and deemed appropriate for physical therapy due to the decreased bilateral lower extremity ROM, bilateral lower extremity muscle weakness, and increased risk of falls per gait analysis, BBS, and LEFS. All clarifying questions were answered regarding examination findings before discussing the plan of care moving forward. The plan of care presented to the patient moving forward was to be seen 2 times a week for 8 weeks to address strength and ROM deficits, unsteadiness, and increased risk of falls through implementation of therapeutic exercise, neuromuscular re-education, therapeutic activity, and gait training examples including: aerobic, resistance, balance/coordination, and gait training exercises programs to improve her strength, functional mobility, and overall quality of life.

CHAPTER III

INTERVENTION AND PLAN OF CARE

The interventions utilized in the rehabilitation of frailty and lower extremity muscle weakness caused by sarcopenia focused on increasing strength and balance, physical function, and performance of daily activities, improving gait, and decreasing the risk of falls through aerobic and resistance training programs.[2,8] Research has shown that exercise programs that included resistance training in conjunction with balance training and functional exercises helped to reduce fall rates by 34% in older people.[24]

Based on the literature surrounding frailty, sarcopenia (muscle weakness), and increased fall risks, the exercise prescription chosen for this patient was one-hour sessions, two times per week, for eight weeks. Exercise sets and repetitions varied based on the patient's tolerance, however they averaged to be two sets of six to eight repetitions each paired with a two-to-three-minute rest break between exercises due to patient fatigue. The patient was sent home with a home exercise program (HEP) following the initial evaluation that was to be completed twice per day on days she did not have physical therapy. (see Table 4).

Each daily session began with a six-minute warmup on the bicycle to promote blood flow and tissue extensibility prior to strength, balance, and gait training. You can see the complex outline of exercises in Appendix 1. Due to the patient's high fall risk detected using the BBS, exercises in the first one-to-two weeks focused heavily on supine and seated strengthening activities to increase strength and endurance to decrease risk of falls. These exercises consisted of supine glute bridges, clamshells, adductor squeezes, short arc quads (SAQ), long arc quads

(LAQ), seated calf raises, hamstring curls, and repeated dorsiflexion due to pronounced weakness. As the patient progressed from these body weight activities listed above, resistance bands and ankle weights were utilized to increase muscle strength for functional carryover.

Table 4: Home Exercise Program

Supine Glute Bridges	2 x 6-8 repetitions, twice daily, on non-therapy days
Supine Clamshells	2 x 6-8 repetitions, twice daily, on non-therapy days
Seated Marches	2 x 6-8 repetitions, twice daily, on non-therapy days
Seated Calf Raises	2 x 10-12 repetitions, twice daily, on non-therapy days
Repeated Dorsiflexion in Seated	2 x 10-12 repetitions, twice daily, on non-therapy days

Weeks three through four focused heavily on exercises against gravity using weights for increased resistance along with standing exercises using external support such as the table/chair, gait belt, and contact guard assistance from one PT for increased safety. During these weeks, side lying clamshells, straight leg raises, weight shifting anterior/posterior and medial/lateral, side steps, marches, standing knee flexion, and step ups were used to focus on functional carryover into daily activities. As the patient progressed with activities against gravity with added resistance and supported standing activities, contact guard assist transitioned to stand by assist with external support and eventually to contact guard assist activities without external support to increase focus on balance, coordination, gait, and stair ambulation.

Week five reached the halfway point in the original plan of care and started with a progress note. During the progress note, the patient demonstrated improvements in bilateral MMT, lower extremity AROM, and functional outcome measures. The remainder of weeks five

through six consisted of balance and coordination activities beginning with contact guard assist (CGA) from one PT and no external support. During these weeks, the patient performed sit to stands, step ups, side steps, monster walks, standing calf raises, Romberg wide base of support (BOS) balance progressing to narrow base of support (NBOS), and ambulation around the clinic. As the patient progressed, CGA transitioned into stand by assist (SBA) and ankle weights were added to increase resistance for continued strengthening and endurance for functional carryover.

Weeks seven through eight focused heavily on functional activities to allow the patient to work towards independence with daily activities. These weeks included sit to stands from a standard chair height and lower surfaces without upper extremity support, picking objects up off the floor, getting up/down from the floor, ambulation with and without her cane, backwards walking, progressing NBOS balance to semi-tandem and tandem balance stances, slow and controlled marching, cone taps, step ups with eccentric control, and forward/lateral steps on an airex foam pad and Bosu ball. (See Appendix 1 for complete weekly breakdown of exercises).

To summarize the total number of visits discussed in this case report, the patient was seen for 16 total sessions. Each session, including the initial evaluation and progress note were 60 minutes long, consisting of neuromuscular re-education, therapeutic exercise, therapeutic activity, or gait training units. Most units utilized were neuromuscular re-education, therapeutic exercise, and therapeutic activity. Gait training was not included until week five; visit nine and on, due to the strength and balance deficits placing this patient at a moderate fall risk early in the rehabilitation process.

CHAPTER IV

OUTCOMES

The patient's outcomes were positive throughout the nine weeks spent with the student physical therapist (SPT). The patient's progress was demonstrated through subjective and objective measures. For subjective data, the patient was asked to rate her current functional status as a percent based on her prior level of function from 0% to 100% each therapy session. (see Table 5). The objective measures that demonstrate the patient's progress included goniometry measurements of bilateral lower extremity knee and ankle AROM, bilateral lower extremity MMT, and functional outcome measures.

Table 5: Patient perception on percent of function based on prior level of function

Therapy Session:	**Percent Rating:**	**Therapy Session (2):**	**Percent Rating (2):**
1	43%	9	54%
2	45%	10	58%
3	42%	11	61%
4	49%	12	65%
5	52%	13	63%
6	55%	14	67%
7	57%	15	72%
8	58%	16	75%

The patient's AROM, MMT, and functional outcomes measures progressed over the course of nine weeks. Initially, the patient was WNL for plantarflexion bilaterally, but limited in all other motions with the left lower extremity being limited more than the right. A progress note was performed on the ninth visit at the beginning of week five of eight to comply with Medicare part B rules which include a progress note every 30 days or every 10th visit, whichever comes first.[31]

During the progress note, the patient's AROM, MMT, and functional outcome measures (BBS, LEFS) were reassessed using standardized normative values as mentioned previously. The patient was found to be within functional limits (WFL) for bilateral for knee flexion and extension and bilateral ankle plantarflexion and dorsiflexion showing major improvements in AROM. The patient displayed bilateral gross lower extremity weakness upon initial evaluation with the left lower extremity being weaker than the right lower extremity but demonstrated gains in strength in bilateral lower extremities during the progress note. (see Table 6).

Table 6: Comparison of AROM and MMT from Initial Evaluation to Progress Note Update

	Initial Evaluation	**Initial Evaluation**	**Progress Note Update:**	**Progress Note Update:**
	Left Lower Extremity	Right Lower Extremity	Left Lower Extremity:	Right Lower Extremity:
Knee Flexion:	118 degrees	122 degrees	WFL	WFL
Knee Extension:	-4 degrees	-2 degrees	WFL	WFL
Plantarflexion:	52 degrees	50 degrees	WFL	WFL
Dorsiflexion:	6 degrees	13 degrees	WFL	WFL
Iliopsoas:	3-/5	3/5	3+/5	3+/5
Gluteus Maximus:	3-/5	3/5	3+/5	3+/5
Gluteus Medius:	3-/5	3/5	3+5	3+/5
Quadriceps:	4-/5	4-/5	4/5	4/5
Hamstrings:	4-/5	4-/5	4/5	4/5
Gastrocnemius/Soleus:	4-/5	4-/5	4/5	4/5
Dorsiflexors:	3-/5	3/5	3+/5	4-/5

For the BBS, a low fall risk cutoff score is 41/56, moderate fall risk 21/56, and high fall risk 20 and below[30] and a score for community-dwelling adults of >13.5 seconds on the TUG indicates a fall risk.[31] The BBS, LEFS, and TUG were all utilized during the progress note for reassessment. The patient demonstrated improvements in both the BBS and LEFS (see Table 7 below) allowing her to complete the TUG due to decreasing her risk of falls from moderate to low and increased muscle strength, AROM, and functional mobility.

Table 7: Functional Outcome Measure Comparisons

	Berg Balance Scale	Lower Extremity Functional Scale	Timed Up and Go Test
Initial Evaluation:	40/56 → moderate risk for falls	28/80 -35% of max function	Unable to complete due to being a moderate fall risk
Progress Note:	45/56 → low risk for falls	31/80 -45.5% of max function	15 seconds using single point cane and SBAx1; at risk for falls

Her TUG score was 15 seconds using a single point cane (SPC) and contact guard assist x1 for safety. For community-dwelling adults, a TUG score of >13.5 seconds indicates a fall risk.[31] Although her LEFS and BBS improved allowing her to complete the TUG for additional objective measures, the patient continued to demonstrate being at risk for falls and remained appropriate for further skilled physical therapy intervention to continue improving strength, balance and coordination, and functional mobility to decrease her risk of falls and allow her to complete daily and leisure activities safely.

The patient continued to progress throughout weeks five through eight, progressing needing CGA to SBA of one without external support during standing exercises due to increased balance and stability. She was able to progress some of the exercises, but not all. She was able to

progress balance to a semi-tandem stance, sit to stands from a lower surface without upper extremity support while holding a weight, ambulation without her cane and SBAx1, marching, and step ups with ankle weights. She was unable to obtain tandem stance on firm ground due to continued difficulty with balance and unable to balance on a single leg due to stability deficits.

The patient was able to make significant gains in muscle strength and endurance, balance and coordination, and gait mechanics with the use of verbal, tactile, and visual cues for proper exercise completion. The utilization of activities that challenged the patient's balance, strength, endurance, and functional mobility allowed the patient to identify strengths and weaknesses collectively with the SPT and PT, discuss progression towards goals and goals that have been met, and areas that need to be targeted further to allow for increased independence and decreased risk of falls. While the patient made significant gains towards her STG and some LTG, she did not meet all her goals within the original plan of care dates set. By the eighth week, the patient subjectively reported feeling 75% of her prior level of function and wanted to continue working towards her goals, another progress note had to be completed to request re-certification through Medicare to approve more physical therapy visits. Unfortunately, the SPT was not able to participate in the second progress note scheduled for week 9 of the patient's physical therapy duration due to the clinical rotation ending. (See Appendix 2 for complete breakdown of short-term and long-term goals).

Despite increasing the original plan of care duration due to the patient not meeting all her goals, the patient continuously progressed and showed improvements in muscular strength and endurance, functional mobility, and continued to decrease her risk of falling. The patient tolerated all physical therapy sessions well, and subjectively reported that she felt her HEP and exercises completed during her sessions helped increase her confidence with ambulating in the

community and around her home using her SPC. The patient demonstrated compliancy with her HEP early on, likely contributing to the continuous progress shown within physical therapy sessions. Overall, the patient was thoroughly satisfied with the progress she made over the course of the eight weeks and seemed determined to continue to progress with the SPT's clinical instructor at the start of week nine and on.

CHAPTER V

DISCUSSION

This case study was conducted to identify implications for physical therapy interventions in the management and treatment of lower extremity muscle weakness due to sarcopenia and frailty. The original plan of care was twice per week for eight weeks to allow the patient to progress and meet her goals. However, while the patient made significant gains during these eight weeks, the supervising PT and patient mutually extended the care plan to continue working towards meeting goals to decrease the patient's risk for falls, increase strength, and improve ability to complete daily activities and overall quality of life. Despite needing an extended plan of care to continue progressing the patient, she made significant gains towards her goals. Most notably, her LEFS and BBS functional outcome measures improved, demonstrating that she decreased her risk of falls from a moderate fall risk to a low fall risk[32], allowing her to complete the TUG test for additional outcome measurements for the extended plan of care.

Upon initial evaluation, the patient's AROM was WNL for bilateral plantarflexion, but limited in dorsiflexion and knee extension and flexion; with the left lower extremity being more limited than the right. At the progress note, the patient demonstrated WFL for all limitations found during the initial evaluation. The patient's MMT during the initial evaluation demonstrated bilateral gross lower extremity weakness with the left lower extremity being weaker than the right. During the progress note, the patient demonstrated improvements with all MMT tested initially showing significant gains in bilateral lower extremity strength. (see Table 2 in Chapter IV for comparisons).

Not only did the patient's objective scores improve over the course of eight weeks, but her subjective reports of her perceived overall function improved as well. Each session, the patient rated her current functional status from 0% to 100% based on her prior level of function. During the initial evaluation, the patient rated herself at 43% function and continued to improve across the eight weeks. During her last session of the initial plan of care, she rated herself 75% of normal function and was pleased with her progress despite wanting to extend her care plan to continue to progress. (see Table 1 in Chapter IV).

The patient's subjective and objective progressions over the course of eight weeks came with the use of a multi-component exercise regime including resistance training, balance and coordination training, gait training, and functional exercises to increase strength and mobility to help reduce her risk for falls.[2,8] It is speculated that the extended plan of care needed due to the slower progression in strength and functional mobility may be due to the extent of the patient's comorbidities and not solely based on her risk for falls. However, this does not mean that the multi-component regime is ineffective with the specified protocol of two-to-three sessions per week for optimal results. This proposes the idea of needing further research on additional factors that play into patient tolerance to physical therapy such as additional comorbidities (sarcopenia, frailty, neurological disorders, diabetes, etc.) that impact the intended plan of care.

Additional research is needed on longevity and care continuum for the management and progression of patients with sarcopenia and frailty causing lower extremity weakness. Published literature available for reference gives suggestions on weekly therapy session prescriptions and describes in detail the effectiveness and both positive and negative patient outcomes associated with the regimes. Published articles varied in their exercise recommendations, but most seen was two or three weekly sessions, one hour each which was what utilized in for this patient's care

plan. However, there is limited research available for the long-term care plan in the management and treatment using physical therapy interventions for progressive conditions. Incorporating gait training once the patient was at a decreased risk of falls is something that could have been utilized more for functional carryover into daily living for the patient as she lived alone and relied heavily on her functional capabilities to complete activities of daily living and housework to continue caring for herself independently.

Additional interventions that were not utilized due to the SPT and supervising PT's comfort level included Tai Chi. This intervention has been found effective in the treatment and management of patients with lower extremity weakness and could be used in future cases to see how it impacts the plan of care and the patient's progression.[4] This multi-component exercise regime includes functional movements that work both the upper and lower body simultaneously. The decision to utilize all other methods included aerobic, resistance training, balance, and functional mobility activities during this rehabilitation process allowed for a broader selection of exercises and activities each therapy session. Due to the nature of this patient's diagnoses and her goals, Tai Chi was not utilized due to a lack of SPT and PT knowledge and understanding of the movements and inability to properly instruct the patient through the exercise program. There continues to be a lack of research on the duration of multi-component exercise programs in the rehabilitation of people with sarcopenia, frailty, and risks for falls. This goes along with the increased research being needed for specific parameters revolving around weekly frequency, intensity, and time spent working on these deficits each session and their reported outcomes both negative and positive.

Overall, the exercise prescription utilized in this patient's plan of care was two sessions per week, one-hour each, for eight weeks using a multi-component exercise regime. This prescription was found to be the most heavily researched and found to be effective in increasing strength, improving balance and coordination, and reducing the risk of falls for patients.[4,8] The SPT and supervising PT chose this specific plan of care for the patient based off patient tolerance, physical limitations, and functional status upon initial evaluation due to the flexibility in choosing different exercises based on the patient's daily status and tolerance to treatment. For this patient, she progressed well over the course of the eight-week care plan, however due to the number of comorbidities and physical limitations she presented to therapy with, her plan of care was extended for continued management and progression as she was still considered at risk for fall at the end of the eight weeks.

REFLECTIVE PRACTICE

To be an effective clinician, reflection on the management and care for each patient is crucial in providing high quality, patient-centered care. Throughout this case study I was able to reflect daily on how the patient tolerated the therapy session, what went well, what interventions needed to be altered to increase the patient's tolerance, and how to better care for the patient the next session for continued management and progression. This allowed for increased time spent reviewing literature in finding interventions and protocols found to be effective in the treatment of lower extremity weakness due to sarcopenia and frailty. It not only allowed for self-reflection each day, but it allowed for collaboration and discussion each day with my supervising physical therapist on exercises that are progressing the patient towards her goals, those that are not, and overall progress towards her short and long-term goals following each session.

During the initial evaluation, it would have been helpful to ask further questions on interventions she has used in the past for the treatment of sarcopenia and frailty as these were not new diagnoses for the patient. Gaining insight into other treatment methods utilized previously would have helped me and my supervising PT understand specific interventions that both benefited and hindered the patient in the treatment for these conditions. This would have allowed me to better choose exercises known to help the patient based on patient tolerance and progression throughout her past treatment regimes. Diving deeper into this topic would have been both beneficial and educational in managing and progressing this patient throughout this plan of care.

Following the subjective portion of the initial evaluation, an inclusion that would have been beneficial to objectively measure muscular endurance throughout the original plan of care would be the use of the five times sit to stand functional outcome measure. This test would objectively show progression and/or regression in the patient's progress and serve as a functional activity to work on for functional carryover into daily tasks for the patient. Another functional outcome measure considered but not utilized would be the Activities-Specific Balance Confidence Scale (ABC Scale) that would allow the physical therapist greater insight into daily activities the patient finds difficult or lacks confidence in completing to integrate into daily sessions to continue working on for complete management and progression.

Another limitation throughout this case study includes the limited use of other exercise regimes proven to be effective in the literature. Tai Chi, which has been heavily researched in the rehabilitation process of those deemed frail has been found beneficial in improving strength, balance and coordination, and functional mobility.[4] Due to the unfamiliarity of Tai Chi to

myself, the supervising PT, and the patient, this regime was not utilized. However, this would be something to consider looking into for future patients during the rehabilitation process.

Throughout the original plan of care that was implemented, the patient showed progress in increasing lower extremity strength, range of motion, and functional mobility. Because the patient was pleased with her progressions each week solely based on physical therapy intervention, she was not referred to other healthcare professionals. To incorporate full body therapeutic interventions, the patient could have been referred to occupational therapy for more in-depth rehabilitation with activities of daily living and fine motor skills. However, the patient did not express concerns with completing activities of daily living so a consultation with an occupational therapist was not discussed throughout this plan of care.

Additional adjustments to the plan of care for future patients with bilateral lower extremity weakness due to frailty and sarcopenia include increased incorporation of functional activities within the treatment sessions to patient tolerance. This would allow for increased functional carryover into daily activities and allow the patients to subjectively report their ability to complete the same activities independently outside of physical therapy for continued feedback and progression. Future research could be conducted to show the effectiveness of including daily activities into therapy sessions for increased functional carryover in addition to traditional resistance and aerobic training exercises in the management and progression of frailty and sarcopenia.

Overall, the patient subjectively reported that she was pleased with her progress thus far. She subjectively and objectively showed progression towards her STG and LTG as well as improved all functional outcome measures, MMT, and lower extremity ROM that carried over into greater ease with daily activities and reduction in her risk of falls. The exercise regime

utilized in the management and care for this patient was proven to be effective, although continued literature on additional comorbidities and the utilization of other functional outcome measures could enhance the ability for physical therapists in the future to better care for patients with the same diagnosis.

APPENDIX I

Weekly Breakdown of Exercises

All exercises: 2 x 6-8 repetitions, followed by a 2–3-minute rest break	
Week 1 & 2	supine glute bridges, clamshells, adductor squeezes, short arc quads (SAQ), long arc quads (LAQ), hamstring curls, seated calf raises, seated pallof press, and seated repeated dorsiflexion - **Progressions included: resistance bands and ankle weights for increased strength and endurance**
Week 3 & 4	side lying clamshells, straight leg raise, weight shifting anterior/posterior and medial/lateral, side steps, marches, pallof press, butt kicks, and step ups ***All standing exercises utilized external support from table/chair for increased stability with CGAx1 and gait belt for safety*** - **Progressions included: activities against gravity with added resistance, CGAx1 supported standing activities → stand by assist with external support → contact guard assist activities without external support**
Progress Note	BBS: 48/56; improvement from 40/56 LEFS: 31/80; improvement from 28/80 TUG: ability to complete due to decreased fall risk; 15 seconds using CGAx1 and single point cane MMT: 4/5 for Plantarflexors, hamstrings, and quadriceps bilaterally; 3+/5 for iliopsoas, gluteus maximus/medius bilaterally; 4-/5 for R dorsiflexors, 3+/5 for L dorsiflexors AROM: LE AROM was found to be WFL and pain-free bilaterally
Week 5 & 6	sit to stands, step ups, side steps, monster walks, standing calf raises, pallof press, Romberg wide base of support (BOS) balance progressing to narrow base of support (NBOS), and ambulation around the clinic with single point cane - **Progressions included: CGA → SBA without external support, ankle weights for increased resistance**
Week 7& 8	sit to stands from a standard chair height and lower surfaces without upper extremity support, picking objects up off the floor, getting up/down from the floor, ambulation with and without her cane, backwards walking, progressing NBOS balance to semi-tandem and tandem balance stances, slow and controlled marching, cone taps, step ups with eccentric control, and forward/lateral steps on an airex foam pad and Bosu ball - **Progressions included: ankle weights/dumbbells, ambulation starting with CGAx1 and no cane → ambulation with SBAx1 and no cane**

APPENDIX II

Patient's Short-Term and Long-Term Goals:

Short-Term Goals:	**Long-Term Goals:**
In four weeks, 1. the patient will demonstrate independence and compliance with the home exercise program (HEP) to ensure safe and proper self-treatment, as an adjunct to in-house therapy. 2. The patient will demonstrate ability to complete sit-to-stand transfers with CGAx1 to demonstrate improvements in functional mobility with daily activities. **WEEK 5 PROGRESS NOTE UPDATE:** - Goals 1 and 2 met	In eight weeks, 1. The patient will demonstrate 90 to 100% knee and ankle AROM bilaterally for safe and effective mobility, such as walking, transferring from sit to stand, and dressing. 2. The patient will demonstrate gross LE strength with MMT of 4/5 or better, to allow for functional strength to perform daily activities such as lifting, walking, and stairs. 3. The patient will demonstrate ability to balance on a flat surface, with eyes closed, for 15 seconds to ensure proper proprioceptive ability and functional stability. 4. The patient will be able to squat to pick an item up off the floor. 5. The patient will be able to walk up and down an 8-inch step/curb independently with her cane. 6. Lower extremity Functional Index score will be 62+/80, indicating minimal functional limitations. **WEEK 5 PROGRESS NOTE UPDATE:** - Goal 1 met - Goal 2 60% met; B LE MMT 4/5 for Plantarflexors, hamstrings, and Quadriceps; 3+/5 for B iliopsoas, gluteus medius/maximus; 4-/5 for R dorsiflexors; 3+/5 for L dorsiflexors - Goal 3: Unable to progress due to CGAx1 for safety - Goal 4: Not attempted at this time - Goal 5: 25% met; Patient able to step up and down 2" step with CGAx1 - Goal 6: Goal 50% met; LEFS 31/80

WEEK 8 GOAL UPDATES:

- Goal 2: 80% met; B LE MMT 4/5 for Plantarflexors, hamstrings, quadriceps, iliopsoas, and gluteus medius/maximus; 4-/5 for B dorsiflexors
- Goal 3: 75% met; SBAx1 due to minimal trunk sway noted
- Goal 4: 50% met; SBAx1 needed due to unsteadiness and limited eccentric control during squatting motion
- Goal 5: 65% met; patient able to step up and down 6" step with SBAx1
- Goal 6: not re-assessed; plan for clinical instructor to re-assess during week 9

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