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Collaboration of Music and Physical Therapy: A Case Study for Treatment of Balance and Coordination Impairments Following Radiation Necrosis

Micah Hale
University of North Dakota

Paige Slemmons
University of North Dakota

COLLABORATION OF MUSIC AND PHYSICAL THERAPY: A CASE STUDY FOR TREATMENT OF BALANCE AND COORDINATION IMPAIRMENTS FOLLOWING RADIATION NECROSIS

By

Micah Hale, SPT

Bachelor of Science in Kinesiology

University of North Dakota 2016

Paige Slemmons, SPT

Bachelor of Science in Psychology

University of North Dakota 2016

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This Scholarly Project, submitted by Micah Hale and Paige Slemmons 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.

Kristin Thomanschefsky, PT, DPT, GCS, NCS

David Relling, PT, Ph.D

PERMISSION

Title

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Micah Hale, SPT — 7.11.2018 Date

Paige Slemmons, SPT — 7/11/2018 Date

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ABSTRACT

Background and Purpose: Medulloblastomas are a form of cancer most commonly found in children. They are normally treated through surgery, radiation therapy, and chemotherapy. Radiation necrosis is a possible side effect of radiation therapy which can have devastating effects on a patient's function. Research on the effects of physical therapy interventions in treating the functional impairments which can result from medulloblastomas and radiation necrosis is limited. The purpose of this case study is to examine the effects of collaborative treatment between two student physical therapists and a student music therapist on a patient with functional limitations due to a medulloblastoma and radiation necrosis.

Case Description: The patient is a 35-year-old female who presented to therapy with an ataxic gait pattern, balance deficits, strength deficits, and impaired coordination of upper and lower extremities. Various balance, quality of life, and functional assessments were used. These measures included the Short Form 36 (SF 36), Berg Balance Test, Activity Specific Balance Confidence Scale (ABC Scale), Four Square Step Test (FSST), and the Five Times Sit to Stand test (FTSTS). She was rated as having an increased fall risk, decreased mobility, and decreased quality of life.

Intervention: The interventions performed with this patient focused on improving balance, coordination, gait, strength, and function. Interventions included stairs with unilateral upper extremity support, tandem-stepping exercises, boxing, and waltzing among others. Rhythmic auditory stimulation (RAS) was implemented into appropriate interventions in order to improve patient performance.

Outcomes: Improvement was seen with the Berg Balance Test, FSST, FTSTS. The Berg Balance improvement was significant and moved her into the low fall risk category. She remained below the cut-off scores for the FSST and FTSTS. Decline was seen with the ABC Scale and the SF-36.

Discussion: This case study demonstrated the efficacy of the implementation of RAS into physical therapy interventions in treating patients with cerebellar radiation necrosis secondary to a medulloblastoma as improvements were seen in balance, strength, retro-ambulation, and coordination. Further research is needed to assess whether results are replicable in similar patients.

CHAPTER I

BACKGROUND AND PURPOSE

A ***medulloblastoma*** is a cancerous tumor that starts in the posterior region of the brain called the cerebellum. This type of brain tumor is the most common malignant brain tumor of childhood accounting for approximately 20% of all childhood brain tumors.[1] Between 250 and 500 children are diagnosed with medulloblastomas each year in the United States.[1] Adults may be subject to diagnosis of medulloblastomas, though it is rare. Most medulloblastomas start posteriorly, and they often will spread to other parts of the brain or may even spread to the spinal cord.[1] Prognosis for patients with these types of brain tumors depends on the age of the patient and the extent of tumor migration, specifically to the spinal cord.[1] If the disease does not spread, the survival rate for patients tends to be between 70% and 80%.[1] However, if the cancer spreads to the spinal cord, the survival rate drops to approximately 60%.[1] Children below the age of 3 will often face a more aggressive disease and often have lower survival rates.[1]

A variety of impairments and functional deficits can occur secondarily to a medulloblastoma including headaches, nausea, vomiting, clumsiness, coordination deficits, and impairments in fine motor skills such as handwriting.[1] Vision problems can also occur, though it is rare.[1] If the cancer has spread to the spinal cord, additional symptoms may be seen including back pain, trouble walking, and problems controlling bowel and bladder functions.[1]

Treatment of medulloblastomas aims toward removing or decreasing the size of the tumor.[1] Surgery is primarily the first step of treatment in an attempt to extract as much of the tumor as possible.[1] After a surgical attempt is made, radiation therapy is usually the next step in treatment with the dose of radiation depending on how much of the tumor is left.[1] If a tumor remains after surgery, a higher-dosed radiation therapy is given. Radiation therapy may use a

number of different types of radiation and is geared toward killing cancer cells or stopping them from growing.[1] In addition to radiation therapy, chemotherapy may also be administered orally or through injection for the same purpose.[1] Although these treatments are often effective in controlling the disease and its progression, they often take a toll on the patients mentally and physically.

Radiation necrosis is a possibly devastating side effect caused by radiation therapy targeting a cancerous tumor. This radiation may begin to not only kill the targeted cancer cells but also healthy tissues in the area surrounding the tumor. Necrosis of healthy tissue due to radiation can be found in a variety of areas around the body. Soft-tissue radiation necrosis in the brain can develop as soon as six months after radiation therapy, but generally occurs within one to two years.[2]

Necrosis of brain tissue can cause a variety of functional and mental impairments. Symptoms often differ based on where the necrosis has occurred. Personality changes, impairment of memory, confusion, seizures, headaches, and drowsiness are common symptoms.[3] Functional impairments include balance, weakness in the extremities, impaired mobility, and even Brown-Sequard Syndrome.[3] These impairments may in turn lead to those affected being at a higher risk for falls and a reduced quality of life.

The prevalence of radiation necrosis of the brain is hard to determine as a wide range of figures have been reported. Estimates of the occurrence rate of necrosis secondary to radiation have ranged from 5-15%.[4] It has also been reported 50% of patients who survive multiple years after radiation therapy develop necrosis of healthy brain tissue.[4]

There is minimal literature on the treatment of medulloblastoma and radiation necrosis with physical and musical therapy. The patient followed in this case study demonstrated functional and balance deficits similar to patients with stroke, Parkinson's, and acquired brain injuries. Literature on the treatment of these disorders was used to substantiate our interventions throughout the course of treatment of this patient.

The idea of using music to support health has been around for centuries.[5] Music therapy includes different aspects of music. One of these aspects includes participant active participation in making music by hitting drums or playing melodies on a keyboard.[5] Another aspect includes using sounds to help facilitate movement, such as rhythmic auditory stimulation (RAS), and give auditory feedback on the quality of that movement.[5] Evidence was found that RAS may increase gait velocity, cadence, and stride length in patients with stroke.[5] The Music may also provide a positive reward that may increase the willingness of an individual to participate in therapy.

Physical Therapy aims to improve quality of life by addressing deficits with strength, balance, mobility, coordination, and other factors that affect movement and functional mobility. Physical Therapy utilizes different interventions and techniques such as gait training, assistive device fitting, strengthening, and neuromuscular training to achieve these goals. These goals are often in line with the goals of a Music Therapist. The different interventions from the two professions may complement each other well and increase the quality of patient care. While a Physical Therapist is assisting the client with a transfer or gait training, a Music Therapist may use music to provide cues and help facilitate the desired movement. The purpose of this case study was to examine the collaboration between Music and Physical therapy on the treatment of balance and coordination deficits following a medulloblastoma and radiation necrosis.

CHAPTER II

CASE DESCRIPTION

The current study describes the collaborative treatment of a 35-year-old female patient who was diagnosed with a medulloblastoma in the posterior fossa at 16 years old. The patient underwent surgery to remove the tumor and subsequently underwent radiation therapy. When the patient was 28 years of age she was diagnosed with radiation necrosis to her cerebellum secondary to radiation therapy.

The patient is currently unemployed but likes to volunteer at her church. She reports living alone in a ground-level apartment with no stairs and is independent with all activities of daily living (ADL's). The patient does not have family in the area and reports caregiver resources are limited to friends and others willing to help. The patient is able to drive and has no concerns about her ability to operate a vehicle. She reports she uses a walker at night to get to the bathroom in the dark but otherwise does not use an assistive device for ambulation. When asked about her history of traumatic brain injuries, the patient referenced back to her brain surgery but also added that she has experienced as many as six concussions secondary to falls. She reports being limited in static and dynamic standing balance, and feels she has some major deficits in reactive balance. The patient also notes she has a strong intention tremor when performing reaching activities with her right upper extremity.

Since her initial diagnosis, the patient reports she has been provided a variety of treatments including brain surgery, radiation therapy, medications, and physical therapy. The only treatment the patient has received within the past 12 months has been physical therapy and she reports she gets little to no physical activity daily. Today, the patient is on no prescribed medicines and only takes over the counter drugs such as Tylenol or Advil as needed for

headaches or body-aches. The patient's goal at the start of treatment is to increase activity levels as she reports getting a minimal amount of activity otherwise.

Examination

Multiple functional tests and quality of life measures were performed to evaluate the patient's current level of function. These tests included the Short Form 36 (SF-36), Berg Balance Test, Activity Specific Balance Confidence Scale (ABC Scale), Four Square Step Test (FSST), and the Five Times Sit to Stand test (FTSTS). See **Table 1** for scores. **Table 2** contains SF-36 scores. Functional measures are included in **Appendix A**.

Table 1. Initial Functional Tests and Quality of Life Measures

	Berg Balance Test	**ABC Scale**	**FSST**	**FTSS**
Initial Score	44/56	77%	20.61s	14.43s
Interpretation	Fall risk	Fall risk	Fall risk	Reduced functional mobility/ strength

The SF-36 is a self-reported quality of life measurement form. It measures eight different aspects of health: vitality (energy/fatigue), physical functioning, bodily pain, general health perceptions, role limitations due to physical health, role limitations due to emotional problems, social functioning, and mental health.[6] Each item is scored on a scale of 0-100 with 0 meaning low quality of life and 100 meaning high quality of life. A domain is assigned to each question. The score on each question within a domain is averaged to get the final score.[7] The SF-36 was found to be a valid and reliable instrument for assessing physical and emotional health in patients with brain tumors when compared to the Barthel Index and Beck Depression Inventory-II.[8] See **Table 2** for results.

Table 2. Initial SF-36 Scores

	Initial Score (out of 100)	Cut-off Score (stroke)
Physical Functioning	60	48
Role limitations due to physical health	25	76
Role limitations due to emotional problems	100	83
Energy/fatigue	35	56
Emotional well-being	84	77
Social functioning	50	86
Pain	70	76
General Health	45	64

The Berg Balance Scale is a widely used balance test in physical therapy. It is a 14-item scale designed to measure balance. Each item is assigned a score from 0-4 with 4 indicating the highest level of function. The range of potential scores is 0-56. A score of 0-20 indicates a high fall risk; 21-40, medium fall risk; 41-56, low fall risk. The minimal detectable change (MDC) for stoke patients who ambulate independently is 6.3.[9] Dogan et el found the cut-off score for stroke patients being healthy or in the fall risk category is a 45/56.[10] Blum and Korner-Bitensky performed a systematic review looking at the psychometric properties of the Berg in stroke patients.[11] It was found that the Berg had excellent internal consistency (Cronbach alpha= .92-.98), interrater reliability (intraclass correlation coefficients [ICCs]= .98), intrarater reliability (ICC=.97), and test-retest reliability (ICC=.98).[11] The Berg was also found to be a valid tool when compared with the Barthel Index, Postural Assessment Scale for Stroke, Functional Reach Test, Fugl-Meyer Assessment, Functional Independence Measure, Rivermead Mobility, and gait speed.[11]

The ABC Scale is a subjective, 16-item, self-reported measure to assess confidence in balance during several ambulatory activities. Each item is rated on a scale of 0-100%, with 0% indicating no confidence and 100% indicating full confidence. The average total score for stroke patients is 68.3%.[12] If an individual with stroke scores about 81.1%, one can be confident that the individual did not have a history of multiple falls, indicating a higher level of function.[13] Powell and Myers compared the ABC scale to the Falls Efficacy Scale (FES).[14] They found that both scales were internally consistent, had good test-retest reliability and demonstrated convergent and criterion validity. They found that the ABC scale was more sensitive to detecting a loss of confidence in balance among higher functioning individuals.[14]

The FSST was developed to look at the rapid stepping utilized in directional changing when trying to avoid obstacles.[15] It utilizes a cross to create four squares. The participant starts in the lower left quadrant and is instructed to step from one square to the other first clockwise and then counterclockwise. The time it takes for an individual to complete this task is recorded and averaged over three attempts. It is counted as a failed attempt if the participant touches the cross or fails to place both feet in the square. A failed attempt or a time of greater than 15 seconds indicates an increased risk for falls in individuals with stroke.[16] The FSST has excellent inter-rater reliability (ICC 0.99) and retest reliability (0.83 to 0.99) when used with older adults, people with vestibular disorders, and people who have suffered a stroke.[15] The FSST has been able to distinguish between fallers and non-fallers.

The FTSTS was developed to measure the functional strength of the lower limbs. It can be used with patients with stroke, Cerebral Palsy, Parkinson's, neurologic rehab, and vestibular disorders. The test is performed by timing how long it takes the participant to complete five sit to stands as fast as they can while maintaining control. A cutoff score of 12 seconds discriminates

between healthy individuals and those with chronic stroke.[17] When looking at stroke patients test/ retests reliability is excellent (ICC= 0.0994), interrater/interrater reliability is excellent (intra = 0.970, inter = 0.999), and criterion validity showed correlation between muscle strength of affected and unaffected knee flexors.[13,17]

Upper extremity and lower extremity manual muscle testing was performed. See **Table 3** for results. Results were graded on a 5-point scale. A score of 0/5 would mean that no contraction of muscle was palpated. A score of 5/5 would mean that the patient was able to maintain the muscle contraction against maximal resistance.

Table 3. Initial Manual Muscle Testing

	Hip Abduction	**Hip Adduction**	**Hip Flexion**	**Knee Flexion**	**Knee Extension**
Left	4	4	5	4	5
Right	5	5	5	5	5
	Shoulder Abduction	**Shoulder Flexion**	**Shoulder Extension**	**Elbow Flexion**	**Elbow Extension**
Left	4	4	5	5	5
Right	5	5	5	5	5

Gait was assessed with the Gait-Rite, video recording, and observation. The Gait-Rite was used to measure ambulation time, cadence, velocity, step length and time differential. See **Table 4** for results. Three trials were performed at a normal and fast speed without a metronome. The results were averaged. Two trials of a backwards walking were performed and averaged. There were metronome trials performed once at 104 bpm, 109 bpm, and 117 bpm. The patient ambulated independently with a non-uniform shuffling gait with a wide stance. A Trendelenburg gait was observed during left stance. A left foot drag was also observed during left swing phase. The patient was able to navigate one flight of stairs consisting pf 13 steps with a reciprocal

pattern using one hand rail. She is more confident using her left hand for support versus her right hand.

Table 4. Initial Gait-Rite Measurements

	Normal	Fast	Backward	104 bpm	109 bpm	117 bpm
Velocity (m/s)	1.01	1.25	0.43	0.50	0.85	1.08
Cadence (steps/min)	114.1	118.4	80.4	104.8	113.7	122.4
Step Length Differential (cm)	0.22	2.53	7.74	0.07	6.86	1.98
Step Time Differential (s)	0.05	0.06	0.28	0.07	0.012	0.04

Three trials were performed and averaged at a normal and fast speed. Two trials for backwards walking were averaged. The trials at 104 bpm, 109 bpm, and 117 bpm were only performed once.

Upper extremity coordination was assessed using a 10 second finger to nose touch test. The patient was instructed to touch the student physical therapist's finger held approximately 18 inches away at eye level and then touch her own nose. She was in a seated position. The number of total contacts in 10 seconds with either the finger or the nose was counted. She averaged 20.5 contacts with her left upper extremity and 12.5 with her right. An intention tremor was observed on her right. Lower extremity coordination was assessed with how many toe taps the patients could achieve in 10 seconds in a seated position. She averaged 22 with her left and 27.5 with her right. More difficulty dorsiflexing her left foot was observed. We were able to hear contacts with both feet, but the left foot contacts were slightly quieter.

Evaluation and Diagnosis

Upon evaluation of the examination results we found deficits with balance, coordination, and strength. The problems this patient is facing are considered chronic as she has been dealing

with them for an extended period of time and they have not been significantly changed. The patient currently is limited functionally with ambulating in open environments, ambulating on uneven surfaces, balancing in response to external forces, and negotiating stairs.

Problems List:

1. Ataxic Ambulation
2. Unable to navigate stairs without a hand rail.
3. 44/56 Berg Balance
4. 77% ABC Scale
5. 20.61s avg Four Square Step Test
6. 14.43s avg 5 times Sit to Stand
7. Left Shoulder flexion and abduction 4/5
8. Left hip Abduction, Adduction, and knee flexion 4/5

Physical Therapy Diagnosis: Motor incoordination negatively affecting gait and balance

Prognosis and Plan of Care

Upon examination and evaluation, the patient is thought to have a fair prognosis as her condition has been stable for the last few years. Interventions for this study will aim to improve her ability to function in open environments such as public places. These interventions will include strengthening exercises, exercises aimed toward improving static, dynamic, and reactive balance, and activities to improve gait. The patient's ability to negotiate stairs will also be addressed as well as her upper extremity and lower extremity coordination. Music therapy will

be integrated into these interventions in an attempt to give her cues for timing and improve fluidity of movement.

Initial goals for physical therapy:

Short Term Goals:

Following PT intervention, the patient will:

* Increase Berg Balance score 50/56 to increase patient safety (4 weeks).

* Increase ABC Scale score to 85% to improve patient confidence in ADLs (4 weeks).

Long Term Goals:

Following PT intervention, the patient will:

* Increase Berg Balance Score to 54/56 to increase patient safety (8 weeks).

* Decrease Four Square Step Test to 15s or less with supervision to decrease fall risk (12 weeks).

Re-examination in each test will be done at discharge to track progress made. Various examination tests will be performed between initial evaluation and discharge to track progress to that point. These include Five Times Sit to Stand, Finger to Nose, Four Square Step Test, and the patient's most limited parts of the Berg Balance Test (alternate foot on step, 360 degree turns, looking over shoulder).

Interventions

A variety of interventions were used to address this patient's functional limitations. Research has shown using music or a beat from a metronome for rhythmical cueing while performing exercises can improve balance, gait, coordination, and overall function in patients with similar conditions including stroke, brain injury, or Parkinson's disease. Hackney and Earhart found partnered dancing, particularly the waltz/foxtrot and tango, led to improvements in

balance, gait speed, and retro-ambulation in Parkinson's disease patients.[18] In 2010, Hackney and Eearhart found both non-partnered and partnered dance significantly improved balance, gait velocity, and cadence with the improvements being maintained past the one-month follow-up.[19] A 2015 study also found partnered dancing improved balance and overall mobility in patients with Parkinson's disease.[20] A 1998 study found RAS was effectively used during gait training to improve gait velocity, cadence, and stride length.[21] Suh et al. found RAS was effective when combined with gait training in improving gait velocity, stride length, cadence, and standing balance in hemiplegic stroke patients.[22] A study published in 2009 found RAS in combination with gait training led to significant improvements in one-limb stance, cadence, velocity, stride length, and posture head tilt following first stroke.[23] RAS has also been shown to improve upper extremity coordination in patients with Parkinson's disease or post-CVA.[24] Furthermore, in 2004 it was found music improved aiming and line tracking of upper extremity movements in patients afflicted with Parkinson's disease.[25]

Based on this past research, we saw it fitting to utilize rhythmical cueing during physical therapy interventions in order to improve gait kinematics, balance, and coordination. A total of 13 hour-long treatment sessions over the course of 12 weeks were administered including the initial and final evaluations. Each session involved the collaboration between two student physical therapists and a student music therapist in the administration of interventions. A series of interventions was developed which implemented RAS, when feasible, to improve the patient's performance and function. Below is a description of each intervention including its purpose, the equipment used, whether music therapy was implemented during its application, and the number of times each intervention was performed. Some interventions were used only once as they were deemed too difficult for the patient, music therapy was not able to be adequately implemented, or

the intervention did not achieve the desired response. A gait belt was worn by the patient at all times during interventions.

Ball Toss

The purpose of this intervention was to improve the patient's balance in standing and improve upper extremity coordination. The goal of ball toss was to challenge the patient to maintain her balance while catching and throwing. This exercise also required the patient to use bilateral upper extremity coordination. To perform this intervention, the patient stood stationary approximately 8-10 feet from a student physical therapist while they tossed a ball for the patient to catch. The patient then tossed the ball back to the student physical therapist. As the patient became more comfortable with ball toss, the student physical therapist threw the ball to the patient's side, overhead, or low to force the patient to reach. A second student physical therapist held on to the patient's gait belt in case she lost her balance. The patient required contact-guard to minimal assistance to maintain balance during ball toss.

Equipment used:

- Ball
- Gait belt

Music therapy was not implemented for this intervention.

Number of times intervention was performed during course of treatment: 1

Ball Kick

The purpose of this intervention was to improve the patient's balance by progressing her into single-leg stance and to improve the patient's lower extremity coordination. During ball kick the patient was forced to shift her weight onto one leg and lift her opposite foot off the floor to stop

and kick an approaching rolling ball. This required single-leg balance to stay upright on her stance leg as well as coordination to stop the rolling ball and kick with her opposite foot. To perform this intervention, the patient stood stationary approximately 8-10 feet from a student physical therapist while they rolled a ball toward the patient's feet. The patient was instructed to stop the ball by placing her foot on top as it rolled toward her. After the patient had stopped the ball she kicked it back to the student physical therapist. A second student physical therapist held on to the patient's gait belt in case of loss of balance. The patient required contact-guard to minimal assistance to maintain balance during ball kick.

Equipment used:

- Ball
- Gait belt

Music therapy was not implemented for this intervention.

Number of times intervention was performed during course of treatment: 1

Tandem-step tambourine taps

Tandem-step tambourine taps aimed to continue to progress the patient toward single-leg stance by having her perform the action statically. This intervention also worked on upper extremity coordination and smoothness of movement as the patient tapped a tambourine held stationary out in front of her. Additionally, this exercise was meant to build strength and endurance in both lower extremities as the patient was forced to place a large amount of body weight on her stance leg. Taps were performed at a cadence set by the student music therapist with a metronome. RAS was implemented during this intervention to improve upper extremity coordination during the tambourine taps through improved line tracking and aiming. Performance of this intervention

required the patient to keep her back foot on the floor and her forward foot on a 6" step. She then was told to hold her balance while she reached out to tap a tambourine held in front of her by a student physical therapist. The patient attempted to match her tambourine taps to the cadence set by the student music therapist with a metronome. 20 taps were performed with each upper extremity before switching lower-extremities. A second student physical therapist held on to the patient's gait belt in case of loss of balance.

Equipment used:

- 6" step
- Tambourine
- Metronome
- Gait belt

Music therapy was implemented for this intervention.

Number of times intervention was performed during course of treatment: 1

Tandem-step ball taps

Tandem-step ball taps worked as a progression of tandem-step tambourine taps. It continued to progress the patient toward single-leg stance and implemented upper extremity coordination as well. Lower extremity strengthening was another goal for this intervention. To perform this intervention, the patient kept her back foot on the floor and her forward foot on a 6" step. She was told to hold her balance while she tapped a ball thrown to her by a student physical therapist back to the thrower. Compared to tambourine taps, this became a more open environment as the patient had to use reactive balance and upper extremity coordination to remain upright and tap the ball back to the thrower. Two-minute sets were performed on each leg with number of sets

varying each session the intervention was performed. A second student physical therapist held on to the patient's gait belt in case of loss of balance. The student music therapist played background music during performance of this intervention.

Equipment used:

- 6" step
- Ball
- Gait belt

Music therapy was implemented for this intervention

Number of times intervention was performed during course of treatment: 3

Sprinter drill

The purpose of the sprinter drill was to improve gluteus maximus, medius, and minimus activation as well as improve core stability. RAS was implemented into this intervention with the goal of improving quality of movement and coordination. To perform this intervention, the patient placed both hands on a wall in front of her at shoulder height and shoulder width apart. The patient backed her feet from the wall forcing her to lean forward slightly. Maintaining a straight spine and keeping her lower extremities in line with her spine, the patient lifted one knee until her hip was flexed approximately 90 degrees. The patient was given verbal cues to activate or "squeeze" her core and gluteus muscles of her stance leg to maintain balance and stability. Repetitions were performed at a cadence set by the student music therapist using a metronome. Two sets of 20 repetitions were performed on each leg. The student physical therapist stood near the patient and monitored balance.

Equipment used:

- Wall
- Gait belt

Music therapy was implemented for this intervention.

Number of times intervention was performed during course of treatment: 1

Stairs with unilateral UE support

Stairs were performed as an intervention to improve strength in the patient's lower extremities, balance, lower extremity coordination, and functional ability to ambulate stairs in public places. RAS was implemented during this intervention with the purpose of improving gait kinematics, such as cadence and velocity, as well as quality of movement as the patient ascended and descended the stairs. To perform this intervention, the patient placed one hand on a rail as upper extremity support and negotiated a 13-step flight of stairs upward and downward. The patient used a reciprocal gait pattern and attempted to match her steps to a cadence set by the student music therapist using a metronome, autoharp, or guitar. The cadence for descending the stairs was set lower to force the patient to eccentrically control her descent. A student physical therapist held on to the patient's gait belt and walked behind the patient as she ascended the stairs and in front of her during her descent. A second student physical therapist timed how long each 13-step flight took. The patient performed sets ascending and descending using each hand as support during all sessions stairs were performed. The number of sets performed varied by session.

Equipment used:

- Stairs with bilateral rails
- Autoharp, metronome, or guitar
- Stopwatch
- Gait belt

Music therapy was implemented for this intervention.

Number of times intervention was performed during course of treatment: 5

Sit to stands

Sit to stands were performed as an intervention to improve strength in the patient's lower extremities and smoothness and quality of movement while rising from a seated position. RAS was implemented during sit to stands to improve cadence, velocity, and quality of movement as the patient performed the intervention. To perform this intervention the patient began seated in a chair with her feet shoulder width apart and good posture. She was then instructed to stand up from the chair without using her hands to an erect position and then sit down again. The patient was given cues to keep her weight on her heels and hinge at the hips. Cadence of repetitions was set by the student music therapist using an autoharp, guitar, or metronome. Sets of 10 repetitions were performed with the number of sets varying between sessions. A student physical therapist stood nearby to monitor for loss of balance.

Equipment used:

- Chair without wheels
- Autoharp, guitar, or metronome
- Gait belt

Music therapy was implemented for this intervention.

Number of times intervention was performed during course of treatment: 2

Boxing

Boxing was implemented as an intervention to improve the patient's balance, upper extremity coordination, strength, and endurance. RAS was implemented during boxing to improve the patient's upper extremity coordination and cadence of punches. The setup for boxing was adjusted over the course of treatment as equipment was changed to improve the intervention's therapeutic effect as well as to progress the difficulty. The first session boxing was used, the patient punched a speed bag which suctioned to the wall at head level while wearing a pair of boxing gloves. For this session, the patient punched the bag to the beat of "Eye of the Tiger" and "Gonna Fly Now" played by the student music therapist. The patient stood in tandem and periodically switched which foot was forward. In the second session of boxing, an exercise ball was used instead of the suction speed bag and the patient was given verbal cues for which hand to punch with as well as for combinations of punches. The patient performed one set of three minutes. From the third boxing session through the end of treatment, the patient was instructed to punch the ball as many times as possible in 30 seconds. The student music therapist played guitar at a fast beats-per-minute (bpm) to facilitate an increased punching speed. The patient continued to stand in tandem and switch which foot was forward between sets. This was progressed to the patient standing on foam during the intervention. A student physical therapist stood behind the patient and held on to her gait belt in case the patient lost her balance while a second student physical therapist timed the 30 seconds and held the exercise ball on top of a plinth table at the patient's shoulder height for her to punch.

Equipment used:

- Boxing gloves
- Exercise ball
- Plinth table
- Guitar
- Foam pad
- Stopwatch
- Gait belt

Music therapy was implemented for this intervention.

Number of times intervention was performed during course of treatment: 8

Figure 8

This intervention aimed to improve the patient's lower extremity coordination, balance, and lateral stepping ability. To perform this intervention, two cones were placed 4.5 feet from a middle cone to create a line. The patient was instructed to begin at the middle cone and laterally step to and around each side cone. The timer began once the patient took her first step. To finish the patient returned to the middle cone at which point the timer would stop. Altogether the patient's path created an "8" around the cones. A student physical therapist walked behind the patient and held her gait belt in case of loss of balance. A second student physical therapist ran the timer to capture how long it took the patient to complete the figure 8.

Equipment used:

- 3 cones
- Stopwatch
- Gait belt

Music therapy was not implemented for this intervention.

Number of times intervention was performed during course of treatment: 1

Push-pulls

Push-pulls were implemented as an intervention with the goal of improving the patient's reactive balance, ability to weight shift, lower extremity strength, and endurance. To perform push-pulls, the patient began standing stationary with her feet shoulder width apart, arms at her sides, and holding an end of a PVC pipe in each hand. A student physical therapist held the opposite ends of the PVC pipes the length of the pipes in front of the patient. The patient was instructed to maintain her balance without moving her feet as the student physical therapist used the pipes to apply a push, pull, or twisting force. For example, as the student physical therapist applied a pushing force toward the patient, the patient would lean forward slightly and apply a pushing force back toward the student physical therapist with the pipes. A second student physical therapist stood behind the patient and held on to her gait belt to monitor for loss of balance. This intervention was progressed to the patient standing on foam and eventually a BOSU Ball. Sets were timed and varied in length and number throughout treatment sessions.

Equipment used:

- 2 PVC pipes
- Stopwatch

- Foam pad
- BOSU ball
- Gait belt

Student music therapist played background music during initial session but was not implemented during subsequent sessions.

Number of times intervention was performed during course of treatment: 7

Waltz

The waltz was implemented for the purpose of decreasing gait ataxia, improving the patient's balance, and endurance. RAS was implemented during the waltz to improve the coordination and cadence of the patient's steps as she matched the rhythm of the music. To perform this intervention, the patient and student physical therapist began in the closed position where the two face each other. The patient placed her right hand in the student physical therapist's hand with her left hand on the student physical therapist's right shoulder. The student physical therapist used their left hand to hold the patient's right hand and held the patient's gait belt with their right hand. The student music therapist played a song in ¾ time while the student physical therapist and patient performed a three-step dance pattern in sync with the music. This intervention was progressed by implementing turns, having the patient perform the steps backward, speeding up the cadence, and decreasing the amount of manual contact from the student physical therapist by only holding on to the gait belt. Length of waltz intervention varied throughout treatment sessions. A second student physical therapist timed length of waltzing interventions which ranged from 3-10 minutes depending on time left in session and patient fatigue.

Equipment used:

- Guitar
- Stopwatch
- Gait belt

Music therapy was implemented for this intervention.

Number of times intervention was performed during course of treatment: 7

Rocker board

Rocker board aimed to improve proprioception, motor control about the ankles, balance, and the patient's ankle strategy. RAS was implemented during this intervention to improve the patient's lower extremity coordination and cadence. To perform this intervention, the patient stood on a rocker board with her feet shoulder width apart while using bilateral upper extremity support on a plinth table. The patient rocked forward and backward about the ankles for three minutes while matching the cadence set by the student music therapist using a metronome. A student physical therapist stood behind the patient with a hand on the patient's gait belt in case of loss of balance.

Equipment used:

- Rocker board
- Plinth table
- Gait belt

Music therapy was implemented for this intervention.

Number of times intervention was performed during course of treatment: 1

TheraBand exercises: lateral walking and forward twists

TheraBand exercises were implemented to improve the patient's lumbo-pelvic strength and stability as well as upper trunk-lower trunk dissociation. RAS was implemented during TheraBand exercises to improve the patient's quality of movement and coordination. A green TheraBand was used for this intervention.

- To perform lateral walking, the patient held an end of a TheraBand close to her abdomen while the student physical therapist held the opposite end of the TheraBand laterally to the patient. The patient was instructed to step laterally without crossing her feet three steps and then three steps back to her starting position. Sets of five repetitions on each side were performed though the number of sets varied throughout treatment sessions. The student music therapist played guitar and the patient was instructed to match her steps to the cadence.
- To perform forward twists, the patient held an end of the TheraBand to her anterior shoulder with her opposite hand while the student physical therapist stood behind the patient holding the opposite end of the TheraBand. The patient was then instructed to twist her upper trunk against the band's resistance so that the shoulder with the TheraBand came forward without moving her pelvis. The student music therapist played guitar and the patient was instructed to match her twists to the cadence.

A second student physical therapist stood and walked with the patient while holding her gait belt in case of loss of balance. These exercises were progressed by moving to a blue TheraBand and having the patient sing along with the music to implement dual-tasking.

Equipment used:

- TheraBand
- Guitar
- Gait belt

Music therapy was implemented for this intervention.

Number of times intervention was performed during course of treatment: 5

Obstacle course

The obstacle course was implemented to improve the patient's gait in a more open environment and her dynamic balance. To perform this intervention, a variety of objects were placed around the treatment room for the patient to negotiate including BOSU balls, steps, mats, cones, and hula-hoops. The patient was timed for how long it took her to complete the obstacle course one time around. The patient initially completed the obstacle course with no assistive devices and used bilateral walking poles in later trials to assess for differences in time to completion. A student physical therapist walked with the patient and held on to her gait belt during this intervention. The student music therapist played background music on their guitar for multiple trials.

Equipment used:

- Obstacles (BOSU balls, mats, etc.)
- Guitar
- Stopwatch
- Gait belt
- Walking poles

Music therapy was implemented for this intervention.

Number of times intervention was performed during course of treatment: 1

Reactive stepping backward

Due to the patient's impaired ability to maintain balance in response to an external force, reactive stepping was implemented so she could practice using a step strategy to keep herself upright after being pushed. To perform this intervention, the patient leaned into the student physical therapist's hands at the shoulder. The student physical therapist quickly pulled their hands away forcing the patient to regain her balance using a stepping reaction. The student physical therapist remained ready to catch the patient in case of loss of balance.

Equipment used:

- Gait belt

Music therapy was not implemented for this intervention.

Number of times intervention was performed during course of treatment: 1

Four square stepping

The purpose of this intervention was to improve lateral stepping, agility, lower extremity coordination, and balance. RAS was implemented into this intervention to improve the patient's lower extremity coordination, cadence, and velocity of steps. To perform this intervention, a cross was laid on the floor to create four squares. The patient started in the lower-left quadrant and moved clockwise all the way around and then counter-clockwise back to the beginning square. The patient remained facing forward during entire intervention. A student physical therapist walked with the patient and held on to her gait belt in case of loss of balance. A second

student physical therapist timed how long it took the patient to complete one trial. The intervention was completed with and without music played by the student music therapist on their guitar which the patient attempted to synchronize her steps with.

Equipment used:

- Plastic cross
- Guitar
- Stopwatch
- Gait belt

Music therapy was implemented for this intervention.

Number of times intervention was performed during course of treatment: 2

Outdoor ambulation

Outdoor ambulation aimed to work on ambulation in a more open setting and involved stepping on and off curbs as wells as negotiating angulated terrain. RAS was implemented during outdoor ambulation to improve gait kinematics such as gait velocity, stride length, gait symmetry, and cadence. Performance of this intervention included a 30-minute walk outside which involved a 15-minute walk with no assistive device and 15 minutes using walking poles. A student physical therapist walked near the patient at all times in case of loss of balance. The student music therapist played music on a guitar while the patient was instructed to match the cadence.

Equipment used:

- Guitar
- Walking poles
- Gait belt

Music therapy was implemented for this intervention.

Number of times intervention was performed during course of treatment: 1 (a second session of outdoor ambulation was attempted but had to be discontinued as patient could not ambulate due to gusts of wind)

Outcomes

The patient discussed in this case study demonstrated improvements and declines in different tests, including functional assessments, quality of life measures, and manual muscle testing, from initial examination to discharge. Improvements were seen on various assessments, including the Berg Balance Scale, Four Square Step Test, and the Five Times Sit to Stand. Her emotional/ mental health showed decline via the SF-36. She declined to complete a home exercise program stating that the time and energy it took to complete an exercise plan was not worth the little improvement she would see. She also stated that her physical ability to perform different tasks varied from day to day. The tables listed below may include the score established on the initial evaluation, best score throughout treatment, and the discharge score. They also include the cutoff scores to differentiate between a healthy and an impaired individual. See **Table 5** for an overview of scores of functional test. See **Table 6** for change in SF-36. See **Table 7** for change in strength throughout the sessions. See **Table 8** for the different coordination tests. See **Table 9** for Gait-Rite results.

Table 5. Initial-Discharge Functional Tests and Quality of Life Measures

Quality of life/ Functional Assessment	Initial Score (average)	Best Score (attempt)	D/C score (average)	Cut-off Score for Stroke
ABC	77%	77%	76.25%	81.1%
Berg	44/56	54/56	54/56	45/56 (MDC 6.3)
Five Times Sit to stand	14.43s	11.84s	13.2s	12s
Four Square Step Test	20.61s	15.46s	15.54s	15s

Table 6. Initial-Discharge SF-36 Scores

	Initial Score (out of 100)	D/C Score (out of 100)	Cutoff Score for Stroke
Physical Functioning	60	45	48
Role limitations due to physical health	25	25	76
Role limitations due to emotional problems	100	66	83
Energy/fatigue	35	45	56
Emotional well-being	84	56	77
Social functioning	50	25	86
Pain	70	80	76
General Health	45	50	64

Table 7. Initial-Discharge Manual Muscle Testing

Strength	Initial Score	Best Score	D/C Score
Seated Hip ABD L, R	4/5, 5/5	5/5, 5/5	5/5, 5/5
Side lying Hip ABD L, R	3/5, 5/5	4/5, 5/5	4/5, 5/5
Shoulder Flex L, R	4/5, 5/5	5/5, 5/5	5/5,5/5
Shoulder ABD L, R	4/5, 5/5	4/5, 5/5	4/5, 5/5
Grip Strength L, R	49.33, 66 lbs	56,72 lbs	52.3, 64.7 lbs

Table 8. Coordination Tests

Coordination	Initial score (average)	Best score (attempt)	D/C score (average)
10 s finger to nose, L,R	20.5, 12.5	22.5, 12.5	22.5, 12.5
Toe taps L, R	22, 27.5	25, 30	22,29

Table 9. Final Gait-Rite Measurements

	Normal	Fast	Backward	108 bpm	123 bpm
Velocity (m/s)	0.94 (1.01)	1.24 (1.25)	0.47 (0.43)	0.94	1.04
Cadence (steps/min)	108.3 (114.1)	119.5 (118.4)	92.2 (80.4)	108.9	119.1
Step Length Differential (cm)	0.26 (0.22)	6.95 (2.53)	0.15 (7.74)	3.37	3.81
Step Time Differential (s)	0.05 (0.05)	0 (0.06)	0.06 (0.28)	0.11	0.02

That data for normal and fast walking was averaged over three trials. Backward walking was performed once. The data for 108 and 123 bpm was averaged over two trials. The initial average is placed in ( )'s. Different bpm were used during initial evaluation so that data is not included.

CHAPTER III

DISCUSSION

This study followed the collaborative treatment between two student physical therapists and a student music therapist in treating a 35-year-old female who suffered radiation necrosis to the cerebellum after undergoing treatment for a medulloblastoma at the age of 16. Treatment included 13 hour-long sessions which spanned a total of 12 weeks. Interventions were performed with intent to improve the patient's strength, coordination, balance, and overall function while implementing music therapy when appropriate.

The outcomes of this study show the patient improved in various measured functional assessments. Most notably, the patient improved from a score of 44/56 to 54/56 on the Berg Balance Test showing a marked decrease in her risk for falls. This was a significant change in score (MDC=6.3).[9] Her score of 54/56 places her above the cutoff score of 45.[10] The biggest improvement within the Berg was seen with alternating foot placement on a stool. On initial evaluation the patient had multiple losses of balance and required minimal assistance by a student physical therapist. On final evaluation she only needed supervision for safety and was able to score full points on this part of the Berg. This translated to a smoother, steadier gait pattern when navigating stairs.

She improved in the Five Times Sit to Stand Test which signifies improvements made in lower extremity strength and motor control. Quality of movement also improved as the patient's movement became more fluid by the end of intervention. The cutoff score for the Five Times Sit to Stand is 12 seconds.[17] On the day of discharge her average time was 13.20s, which would indicate impaired function. Her best time throughout treatment was 11.84s, which would place her above the cutoff score. It is important to note, performance may have been affected by the

patient self-selecting a slower pace to minimize dizziness. Due to the patient inconsistently performing below cut-off, the authors of this article still consider the patient to be weak and in need of strengthening intervention.

A five second improvement was also seen in the patient's performance of the Four Square Step Test. Her time of 15.54 seconds places her close to the cutoff score of 15 seconds.[16] This may be an indication of improved motor planning and coordination as well as dynamic balance and agility. Significant improvements were not seen in upper extremity strength, confidence in balance, or upper extremity coordination. More improvement may have been seen if a home exercise program had been implemented and followed.

Many mental and emotional components were involved with the treatment of this patient. The patient stated throughout the treatment sessions that we would not see improvements. This train of thought may have decreased her motivation for Physical Therapy, even though she did enjoy her time at therapy. Over the last few weeks of therapy there was an increase in patient anxiety. She found a lump over her medial thyroid. This increased anxiety because her other tumors had also been midline. She had an appointment with her endocrinologist after our final session with her. This could have played a role in the decreased scores dealing with mental and emotional health in the SF-36.

There were not major objective changes found during gait using the Gait-Rite. The patient demonstrated the biggest improvements with backward ambulation. The difference in her step length decreased from 7.74 cm to 0.15 cm. This correlated with a more symmetrical gait pattern. She required minimal assistance to maintain balance during the initial evaluation but only required supervision at discharge during retro-ambulation. At the end of this study she still demonstrated a Trendelenburg gait pattern with left stance and a left foot drag during left swing

phase. Due to this patient's decreased balance and unsymmetrical gait pattern the authors of this study recommended that she walk with an assistive device, as in walking poles, when ambulating outside. The patient disagreed with the suggestion of using walking poles.

In conclusion, physical therapy interventions combined with music therapy may have a positive impact on function in patients who have suffered cerebellar radiation necrosis secondary to treatment for medulloblastoma. The primary improvements seen in the patient included in this case study were balance, strength, coordination, and retro-ambulation. Due to the improvements achieved during this short study, the authors believe this patient may benefit from further physical therapy intervention. Limitations of this study include small sample-size making results ungeneralizable, difficulty implementing music therapy, lack of patient motivation, and human error. Further research is needed to assess if these results are generalizable.

Future studies on benefits of collaborative treatment between physical and music therapy in treating patients with cerebellar radiation necrosis after medulloblastoma should focus on forward ambulation kinematics including stride length, gait speed, and cadence, upper extremity coordination during reaching, and reactive balance.

APPENDIX A

Short Form 36

Berg Balance Test

Activity Specific Balance Confidence Scale

Four Square Step Test

Five Times Sit to Stand

Medical Outcomes Study Questionnaire Short Form 36 Health Survey (SF-36)

About: The SF-36 is an indicator of overall health status.

Items: 10

Reliability: Most of these studies that examined the reliability of the SF_36 have exceeded 0.80 (McHorney et al., 1994; Ware et al., 1993). Estimates of reliability in the physical and mental sections are typically above 0.90.

Validity: The SF-36 is also well validated.

Scoring:
The SF-36 has eight scaled scores; the scores are weighted sums of the questions in each section. Scores range from 0 - 100
Lower scores = more disability, higher scores = less disability
Sections:

- Vitality
- Physical functioning
- Bodily pain
- General health perceptions
- Physical role functioning
- Emotional role functioning
- Social role functioning
- Mental health

References:

McHorney CA, Ware JE, Lu JFR, Sherbourne CD. The MOS 36-Item Short-Form Health Survey (SF-36®): III. tests of data quality, scaling assumptions and reliability across diverse patient groups. *Med Care*1994; 32(4):40-66.

Ware JE, Snow KK, Kosinski M, Gandek B. *SF-36® Health Survey Manual and Interpretation Guide*. Boston, MA: New England Medical Center, The Health Institute, 1993.

Ware JE, Sherbourne CD. The MOS 36-Item Short-Form Health Survey (SF-36®): I. conceptual framework and item selection. Med Care 1992; 30(6):473-83.

Medical Outcomes Study Questionnaire Short Form 36 Health Survey

This survey asks for your views about your health. This information will help keep track of how you feel and how well you are able to do your usual activities. Thank you for completing this survey! For each of the following questions, please circle the number that best describes your answer.

1. In general, would you say your health is:	
Excellent	1
Very good	2
Good	3
Fair	4
Poor	5
2. Compared to one year ago,	
Much better now than one year ago	1
Somewhat better now than one year ago	2
About the same	3
Somewhat worse now than one year ago	4
Much worse now than one year ago	5

3. The following items are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?
(Circle One Number on Each Line)

	Yes, Limited a Lot (1)	**Yes, Limited a Little (2)**	**No, Not limited at All (3)**
a. **Vigorous activities**, such as running, lifting heavy objects, participating in strenuous sports	1	2	3
b. **Moderate activities**, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf	1	2	3
c. Lifting or carrying groceries	1	2	3
d. Climbing **several** flights of stairs	1	2	3
e. Climbing **one** flight of stairs	1	2	3
f. Bending, kneeling, or stooping	1	2	3

g. Walking **more than a mile**	1	2	3
h. Walking **several blocks**	1	2	3
i. Walking **one block**	1	2	3
j. Bathing or dressing yourself	1	2	3

4. During the **past 4 weeks**, have you had any of the following problems with your work or other regular daily activities **as a result of your physical health**?
(Circle One Number on Each Line)

	Yes (1)	**No (2)**
a. Cut down the amount of time you spent on work or other activities	1	2
b. **Accomplished less** than you would like	1	2
c. Were limited in the **kind** of work or other activities	1	2
d. Had **difficulty** performing the work or other activities (for example, it took extra effort)	1	2

5. During the **past 4 weeks,** have you had any of the following problems with your work or other regular daily activities **as a result of any emotional problems** (such as feeling depressed or anxious)?
(Circle One Number on Each Line)

	Yes	**No**
a. Cut down the amount of time you spent on work or other activities	1	2
b. **Accomplished less** than you would like	1	2
c. Didn't do work or other activities as **carefully** as usual	1	2

6. During the past 4 weeks, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbors, or groups?	
Not at all	1
Slightly	2
Moderately	3
Quite a bit	4
Extremely	5

7. How much bodily pain have you had during the past 4 weeks?	
None	1
Very mild	2
Mild	3
Moderate	4
Severe	5
Very severe	6
8. During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?	
Not at all	1
A little bit	2
Moderately	3
Quite a bit	4
Extremely	5

These questions are about how you feel and how things have been with you **during the past 4 weeks**. For each question, please give the one answer that comes closest to the way you have been feeling. **(Circle One Number on Each Line)**

9. How much of the time during the **past 4 weeks** . . .

	All of the Time	**Most of the Time**	**A Good Bit of the Time**	**Some of the Time**	**A Little of the Time**	**None of the Time**
a. Did you feel full of pep?	1	2	3	4	5	6
b. Have you been a very nervous person?	1	2	3	4	5	6
c. Have you felt so down in the dumps that nothing could cheer you up?	1	2	3	4	5	6
d. Have you felt calm and peaceful?	1	2	3	4	5	6
e. Did you have a lot of energy?	1	2	3	4	5	6

	All of the Time	Most of the Time	A Good Bit of the Time	Some of the Time	A Little of the Time	None of the Time
f. Have you felt downhearted and blue?	1	2	3	4	5	6
g. Did you feel worn out?	1	2	3	4	5	6
h. Have you been a happy person?	1	2	3	4	5	6
i. Did you feel tired?	1	2	3	4	5	6

10. During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting with friends, relatives, etc.)? (Circle One Number)	
All of the time	1
Most of the time	2
Some of the time	3
A little of the time	4
None of the time	5

11. How TRUE or FALSE is each of the following statements for you. (Circle One Number on Each Line)

	Definitely True	Mostly True	Don't Know	Mostly False	Definitely False
a. I seem to get sick a little easier than other people	1	2	3	4	5
b. I am as healthy as anybody I know	1	2	3	4	5
c. I expect my health to get worse	1	2	3	4	5
d. My health is excellent	1	2	3	4	5

Berg Balance Scale

The Berg Balance Scale (BBS) was developed to measure balance among older people with impairment in balance function by assessing the performance of functional tasks. It is a valid instrument used for evaluation of the effectiveness of interventions and for quantitative descriptions of function in clinical practice and research. The BBS has been evaluated in several reliability studies. *A recent study of the BBS, which was completed in Finland, indicates that a change of eight (8) BBS points is required to reveal a genuine change in function between two assessments among older people who are dependent in ADL and living in residential care facilities.*

Description:
14-item scale designed to measure balance of the older adult in a clinical setting.

Equipment needed: Ruler, two standard chairs (one with arm rests, one without), footstool or step, stopwatch or wristwatch, 15 ft walkway

Completion:

Time: 15-20 minutes

Scoring: A five-point scale, ranging from 0-4. "0" indicates the lowest level of function and "4" the highest level of function. Total Score = 56

Interpretation:
41-56 = low fall risk
21-40 = medium fall risk
0 –20 = high fall risk

A change of 8 points is required to reveal a genuine change in function between 2 assessments.

Berg Balance Scale

Name: _____ Date: _____

Location: _____ Rater: _____

ITEM DESCRIPTION	SCORE (0-4)
Sitting to standing	_____
Standing unsupported	_____
Sitting unsupported	_____
Standing to sitting	_____
Transfers	_____
Standing with eyes closed	_____
Standing with feet together	_____
Reaching forward with outstretched arm	_____
Retrieving object from floor	_____
Turning to look behind	_____
Turning 360 degrees	_____
Placing alternate foot on stool	_____
Standing with one foot in front	_____
Standing on one foot	_____

Total _____

GENERAL INSTRUCTIONS

Please document each task and/or give instructions as written. When scoring, please record the lowest response category that applies for each item.

In most items, the subject is asked to maintain a given position for a specific time. Progressively more points are deducted if:

- the time or distance requirements are not met
- the subject's performance warrants supervision
- the subject touches an external support or receives assistance from the examiner

Subject should understand that they must maintain their balance while attempting the tasks. The choices of which leg to stand on or how far to reach are left to the subject. Poor judgment will adversely influence the performance and the scoring.

Equipment required for testing is a stopwatch or watch with a second hand, and a ruler or other indicator of 2, 5, and 10 inches. Chairs used during testing should be a reasonable height. Either a step or a stool of average step height may be used for item # 12.

Berg Balance Scale

SITTING TO STANDING
INSTRUCTIONS: Please stand up. Try not to use your hand for support.
( ) 4 able to stand without using hands and stabilize independently
( ) 3 able to stand independently using hands
( ) 2 able to stand using hands after several tries
( ) 1 needs minimal aid to stand or stabilize
( ) 0 needs moderate or maximal assist to stand

STANDING UNSUPPORTED
INSTRUCTIONS: Please stand for two minutes without holding on.
( ) 4 able to stand safely for 2 minutes
( ) 3 able to stand 2 minutes with supervision
( ) 2 able to stand 30 seconds unsupported
( ) 1 needs several tries to stand 30 seconds unsupported
( ) 0 unable to stand 30 seconds unsupported

If a subject is able to stand 2 minutes unsupported, score full points for sitting unsupported. Proceed to item #4.

SITTING WITH BACK UNSUPPORTED BUT FEET SUPPORTED ON FLOOR OR ON A STOOL
INSTRUCTIONS: Please sit with arms folded for 2 minutes.
( ) 4 able to sit safely and securely for 2 minutes
( ) 3 able to sit 2 minutes under supervision
( ) 2 able to able to sit 30 seconds
( ) 1 able to sit 10 seconds
( ) 0 unable to sit without support 10 seconds

STANDING TO SITTING
INSTRUCTIONS: Please sit down.
( ) 4 sits safely with minimal use of hands
( ) 3 controls descent by using hands
( ) 2 uses back of legs against chair to control descent
( ) 1 sits independently but has uncontrolled descent
( ) 0 needs assist to sit

TRANSFERS
INSTRUCTIONS: Arrange chair(s) for pivot transfer. Ask subject to transfer one way toward a seat with armrests and one way toward a seat without armrests. You may use two chairs (one with and one without armrests) or a bed and a chair.
( ) 4 able to transfer safely with minor use of hands
( ) 3 able to transfer safely definite need of hands
( ) 2 able to transfer with verbal cuing and/or supervision
( ) 1 needs one person to assist
( ) 0 needs two people to assist or supervise to be safe

STANDING UNSUPPORTED WITH EYES CLOSED
INSTRUCTIONS: Please close your eyes and stand still for 10 seconds.
( ) 4 able to stand 10 seconds safely
( ) 3 able to stand 10 seconds with supervision
( ) 2 able to stand 3 seconds
( ) 1 unable to keep eyes closed 3 seconds but stays safely
( ) 0 needs help to keep from falling

STANDING UNSUPPORTED WITH FEET TOGETHER
INSTRUCTIONS: Place your feet together and stand without holding on.
( ) 4 able to place feet together independently and stand 1 minute safely
( ) 3 able to place feet together independently and stand 1 minute with supervision
( ) 2 able to place feet together independently but unable to hold for 30 seconds
( ) 1 needs help to attain position but able to stand 15 seconds feet together
( ) 0 needs help to attain position and unable to hold for 15 seconds

Berg Balance Scale continued...

REACHING FORWARD WITH OUTSTRETCHED ARM WHILE STANDING
INSTRUCTIONS: Lift arm to 90 degrees. Stretch out your fingers and reach forward as far as you can. (Examiner places a ruler at the end of fingertips when arm is at 90 degrees. Fingers should not touch the ruler while reaching forward. The recorded measure is the distance forward that the fingers reach while the subject is in the most forward lean position. When possible, ask subject to use both arms when reaching to avoid rotation of the trunk.)
( ) 4 can reach forward confidently 25 cm (10 inches)
( ) 3 can reach forward 12 cm (5 inches)
( ) 2 can reach forward 5 cm (2 inches)
( ) 1 reaches forward but needs supervision
( ) 0 loses balance while trying/requires external support

PICK UP OBJECT FROM THE FLOOR FROM A STANDING POSITION
INSTRUCTIONS: Pick up the shoe/slipper, which is in front of your feet.
( ) 4 able to pick up slipper safely and easily
( ) 3 able to pick up slipper but needs supervision
( ) 2 unable to pick up but reaches 2-5 cm(1-2 inches) from slipper and keeps balance independently
( ) 1 unable to pick up and needs supervision while trying
( ) 0 unable to try/needs assist to keep from losing balance or falling

TURNING TO LOOK BEHIND OVER LEFT AND RIGHT SHOULDERS WHILE STANDING
INSTRUCTIONS: Turn to look directly behind you over toward the left shoulder. Repeat to the right. (Examiner may pick an object to look at directly behind the subject to encourage a better twist turn.)
( ) 4 looks behind from both sides and weight shifts well
( ) 3 looks behind one side only other side shows less weight shift
( ) 2 turns sideways only but maintains balance
( ) 1 needs supervision when turning
( ) 0 needs assist to keep from losing balance or falling

TURN 360 DEGREES
INSTRUCTIONS: Turn completely around in a full circle. Pause. Then turn a full circle in the other direction.
( ) 4 able to turn 360 degrees safely in 4 seconds or less
( ) 3 able to turn 360 degrees safely one side only 4 seconds or less
( ) 2 able to turn 360 degrees safely but slowly
( ) 1 needs close supervision or verbal cuing
( ) 0 needs assistance while turning

PLACE ALTERNATE FOOT ON STEP OR STOOL WHILE STANDING UNSUPPORTED
INSTRUCTIONS: Place each foot alternately on the step/stool. Continue until each foot has touched the step/stool four times.
( ) 4 able to stand independently and safely and complete 8 steps in 20 seconds
( ) 3 able to stand independently and complete 8 steps in > 20 seconds
( ) 2 able to complete 4 steps without aid with supervision
( ) 1 able to complete > 2 steps needs minimal assist
( ) 0 needs assistance to keep from falling/unable to try

STANDING UNSUPPORTED ONE FOOT IN FRONT
INSTRUCTIONS: (DEMONSTRATE TO SUBJECT) Place one foot directly in front of the other. If you feel that you cannot place your foot directly in front, try to step far enough ahead that the heel of your forward foot is ahead of the toes of the other foot. (To score 3 points, the length of the step should exceed the length of the other foot and the width of the stance should approximate the subject's normal stride width.)
( ) 4 able to place foot tandem independently and hold 30 seconds
( ) 3 able to place foot ahead independently and hold 30 seconds
( ) 2 able to take small step independently and hold 30 seconds
( ) 1 needs help to step but can hold 15 seconds
( ) 0 loses balance while stepping or standing

STANDING ON ONE LEG
INSTRUCTIONS: Stand on one leg as long as you can without holding on.
( ) 4 able to lift leg independently and hold > 10 seconds
( ) 3 able to lift leg independently and hold 5-10 seconds
( ) 2 able to lift leg independently and hold ≥ 3 seconds
( ) 1 tries to lift leg unable to hold 3 seconds but remains standing independently.
( ) 0 unable to try of needs assist to prevent fall

( ) TOTAL SCORE (Maximum = 56)

Patient Name: _____ Date: _____

The Activities-specific Balance Confidence (ABC) Scale*

Instructions to Participants: For each of the following activities, please indicate your level of confidence in doing the activity without losing your balance or becoming unsteady from choosing one of the percentage points on the scale from 0% to 100% If you do not currently do the activity in question, try and imagine how confident you would be if you had to do the activity. If you normally use a walking aid to do the activity or hold onto someone, rate your confidence as if you were using these supports.

0%	10	20	30	40	50	60	70	80	90	100%
No Confidence										Completely Confident

How confident are you that you will not lose your balance or become unsteady when you...

1. ...walk around the house? _____%
2. ...walk up or down stairs? _____%
3. ...bend over and pick up a slipper from the front of a closet floor? _____%
4. ...reach for a small can off a shelf at eye level? _____%
5. ...stand on your tip toes and reach for something above your head? _____%
6. ...stand on a chair and reach for something? _____%
7. ...sweep the floor? _____%
8. ...walk outside the house to a car parked in the driveway? _____%
9. ...get into or out of a car? _____%
10. ...walk across a parking lot to the mall? _____%
11. ...walk up or down a ramp? _____%
12. ...walk in a crowded mall where people rapidly walk past you? _____%
13. ...are bumped into by people as you walk through the mall? _____%
14. ...step onto or off of an escalator while you are holding onto a railing? _____%
15. ...step onto or off an escalator while holding onto parcels such that you cannot hold onto the railing? _____%
16. ...walk outside on icy sidewalks? _____%

*Powell LE & Myers AM. The Activities-specific Balance Confidence (ABC) Scale. Journal of Gerontology Med Sci 1995; 50(1):M28-34.

Total ABC Score: _____

Scoring: _____ **/ 16 =** _____% of self confidence
Total ABC Score

MEDICARE PATIENTS ONLY
100% - _____% Function = _____% Impairment

Patient Signature: _____ Date: _____

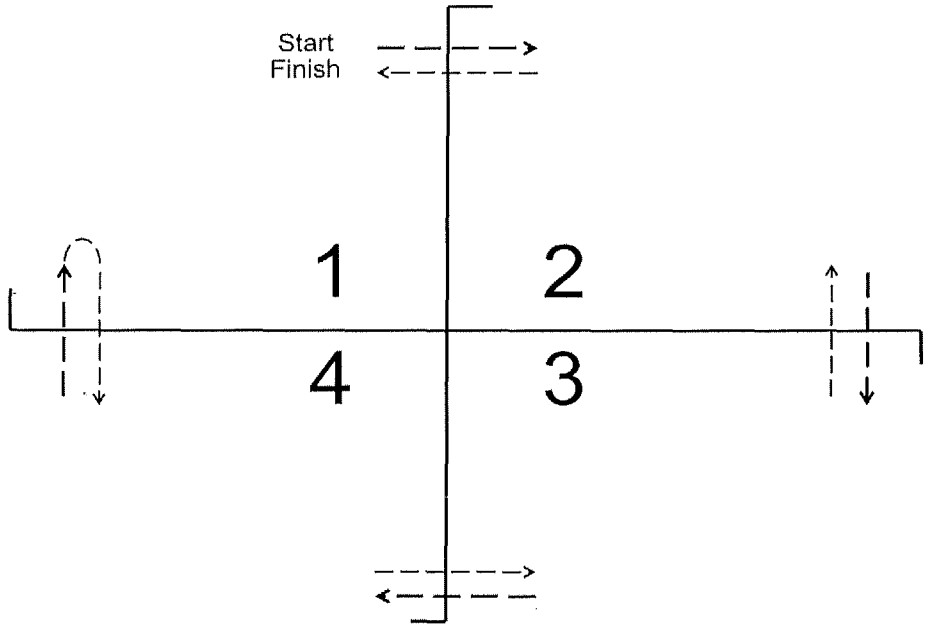
Therapist Signature: _____ Date: _____

Four Step Square Test Instructions

General Information:

- The patient is instructed to stand in square 1 facing square number 2 (see figure below)
- The patient is required to step as fast as possible into each square in the following sequence: 2, 3, 4, 1, 4, 3, 2, and 1
  - requires the patient to step forward, backward, and sideway to the right and left
- Equipment required for the FSST includes a stopwatch and 4 canes.

Set-up (derived from Dite and Temple 2002): A square is formed with the 4 canes by resting them flat on the floor.



Patient Instructions (derived from Dite and Temple 2002):

- "Try to complete the sequence as fast as possible without touching the sticks. Both feet must make contact with the floor in each square. If possible, face forward during the entire sequence."
- Demonstrate the sequence to the patient.
- Ask the patient to complete one practice trial to ensure the patient knows the sequence. Repeat the trial if the patient is unsuccessful

at completing the sequence, loses balance, or contacts a cane during the trial.
- Two FSST are completed with the best time taken as the score.
- A score is still provided if the patient is unable to face forward during the entire sequence.

Scoring:
- the best time of two FSST is the score
- stopwatch starts when the first foot contacts the floor in square 2
- stopwatch finishes when the last foot comes back to touch the floor in square 1

Four Step Square Test (FSST)

Name:_____

Assistive Device and/or Bracing Used:_____

Date:_____

Trial 1_____sec.____ Trial 1_____sec.____

FSST Score (best timed trial):_____sec.____

Date:_____

Trial 1_____sec.____ Trial 1_____sec.____

FSST Score (best timed trial):_____sec.____

Date:_____

Trial 1_____sec.____ Trial 1_____sec.____

FSST Score (best timed trial):_____sec.____

Date:_____

Trial 1_____sec.____ Trial 1_____sec.____

FSST Score (best timed trial):_____sec.____

References:

Dite, W. and Temple, V. A. (2002). "A clinical test of stepping and change of direction to identify multiple falling older adults." Arch Phys Med Rehabil **83**(11): 1566-1571.

Five times Sit to Stand Test:

Method:
Use a straight back chair with a solid seat that is 16" high. Ask participant to sit on the chair with arms folded across their chest.

Instructions:
"Stand up and sit down as quickly as possible 5 times, keeping your arms folded across your chest."

Measurement:
Stop timing when the participant stands the 5th time.

Outcomes:

- (Guralnik 2000)
  Inability to rise from a chair five times in less than 13.6 seconds is associated with increased disability and morbidity

- (Buatois, et al., 2008)
  The optimal cutoff time for performing the FTSS test in predicting recurrent fallers was 15 seconds (sensitivity 55%, specificity 65%). 2,735 subjects aged 65 and older in an apparently good state of health were tested.

- (Bohannon, 2006)
  Metaanalysis results "demonstrated that individuals with times for 5 repetitions of this test exceeding the following can be considered to have worse than average performance" (Bohannon, 2006)
  - 60-69 y/o **11.4 sec**
  - 70-79 y/o **12.6 sec**
  - 80-89 y/o **14.8 sec**

References:

Guralnik, J. M., L. Ferrucci, et al. (2000). "Lower extremity function and subsequent disability: consistency across studies, predictive models, and value of gait speed alone compared with the short physical performance battery." *J Gerontol A Biol Sci Med Sci* 55(4): M221-31.

Buatois S, Miljkovic D, Manckoundia P, Gueguen R, Miget P, Vancon G et al. Five times sit to stand test is a predictor of recurrent falls in healthy community-living subjects aged 65 and older. *J Am Geriatr Soc* 2008; 56(8):1575-1577.

Bohannon RW. Reference values for the five-repetition sit-to-stand test: a descriptive metaanalysis of data from elders. *Percept Mot Skills* 2006; 103(1):215-222.

REFERENCES

1. Medulloblastoma. St. Jude Children's Research Hospital Website. https://www.stjude.org/disease/medulloblastoma.html.

2. Buboltz J, Dulebohn S. Hyperbaric, brain radiation necrosis. 2017.

3. Damage to the nervous system due to radiation therapy. Merck Manuals Consumer Version Web site. https://www.merckmanuals.com/home/brain,-spinal-cord,-and-nerve-disorders/tumors-of-the-nervous-system/damage-to-the-nervous-system-due-to-radiation-therapy.

4. Valk PE, Dillon WP. Radiation injury of the brain. *Am J Neuroradiol.* 1991;12(1):45-62.

5. Chen JL. Annals of the new york academy of sciences. *Annals of the New York Academy of Sciences.* 2018;0(0). https://nyaspubs.onlinelibrary.wiley.com/doi/full/10.1111/nyas.13726.

6. Ware JE, Sherbourne CD. The MOS 36-item short-form health survey (SF-36). I. conceptual framework and item selection. *Med Care.* 1992;30(6):473-483.

7. 36- item short form survey (SF 36). Rand Health website. https://www.rand.org/health/surveys_tools/mos/36-item-short-form.html

8. Adomas Bunevicius. Reliability and validity of the SF-36 health survey questionnaire in patients with brain tumors: A cross-sectional study. Health and Quality of Life Outcomes. 2017;15. https://search.proquest.com/docview/1895207281. doi: 10.1186/s12955-017-0665-1.

9. Stevenson TJ. Detecting change in patients with stroke using the berg balance scale. *Australian Journal of Physiotherapy.* 2001;47(1):29-38. http://www.sciencedirect.com/science/article/pii/S0004951414602968. doi: 10.1016/S0004-9514(14)60296-8.

10. Doğan A, Mengüllüoğlu M, Özgirgin N. Evaluation of the effect of ankle-foot orthosis use on balance and mobility in hemiparetic stroke patients. *Disabil Rehabil.* 2011;33(15-16):1433-1439. Accessed Jun 20, 2018. doi: 10.3109/09638288.2010.533243.

11. Blum L, Korner-Bitensky N. Usefulness of the berg balance scale in stroke rehabilitation: A systematic review. Phys Ther. 2008;88(5):559-566. https://academic.oup.com/ptj/article/88/5/559/2742392

12. Botner EM, Miller WC, Eng JJ. Measurement properties of the activities-specific balance confidence scale among individuals with stroke. *Disability and Rehabilitation.*

2005;27(4):156-163. https://doi.org/10.1080/09638280400008982. doi: 10.1080/09638280400008982

13. Beninato M, Portney LG, Sullivan PE. Using the international classification of functioning, disability and health as a framework to examine the association between falls and clinical assessment tools in people with stroke. *Phys Ther.* 2009;89(8):816-825. https://academic.oup.com/ptj/article/89/8/816/2737671. doi: 10.2522/ptj.20080160.

14. Powell LE, Myers AM. The activities-specific balance confidence (ABC) scale. *J Gerontol A Biol Sci Med Sci.* 1995;50A(1):M34. https://academic.oup.com/biomedgerontology/article/50A/1/M28/616764. doi: 10.1093/gerona/50A.1.M28.

15. Langford Z. Physiotherapy. *Physiotherapy.* 2015;61(3):162. https://www.journalofphysiotherapy.com/article/S1836-9553(15)00036-3/abstract.

16. Blennerhassett JM, Jayalath VM. The four square step test is a feasible and valid clinical test of dynamic standing balance for use in ambulant people poststroke. *Archives of Physical Medicine and Rehabilitation.* 2008;89(11):2156-2161. https://www.archives-pmr.org/article/S0003-9993(08)00787-9/fulltext. doi: 10.1016/j.apmr.2008.05.012.

17. Mong, Yiqin, MSc|Teo, Tilda W., MSc|Ng, Shamay S., PhD. 5-repetition sit-to-stand test in subjects with chronic stroke: Reliability and validity. *Archives of Physical Medicine and Rehabilitation.* 2010;91(3):407-413. https://www.clinicalkey.es/playcontent/1-s2.0-S0003999309009344. doi: 10.1016/j.apmr.2009.10.030.

18. Hackney, M. E., & Earhart, G. M. (2009). Effects of dance on movement control in Parkinson's disease: a comparison of Argentine tango and American ballroom. *Journal of rehabilitation medicine*, *41*(6), 475-481.

19. Hackney ME, Earhart GM. Effects of dance on gait and balance in parkinson's disease: A comparison of partnered and nonpartnered dance movement. *Neurorehabil Neural Repair.* 2010;24:384-392.

20. Dreu D, J M, Kwakkel G, Wegen V, H EE. Partnered dancing to improve mobility for people with parkinson's disease. *Front Neurosci.* 2015;9.

21. Hurt CP, Rice RR, McIntosh GC, Thaut MH. Rhythmic auditory stimulation in gait training for patients with traumatic brain injury. J Music Ther. 1998;35:228-241

22. Suh JH, Han SJ, Jeon SY, et al. Effect of rhythmic auditory stimulation on gait and balance in hemiplegic stroke patients. *NeuroRehabilitation.* 2014;34:193-199.

23. Hayden R, Clair AA, Johnson G, Otto D. The effect of rhythmic auditory stimulation (RAS) on physical therapy outcomes for patients in gait training following stroke: A feasibility study. *Int J Neurosci.* 2009;119:2183-2195.

24. Thaut, M. H., & Abiru, M. (2010). Rhythmic auditory stimulation in rehabilitation of movement disorders: a review of current research. *Music Perception: An Interdisciplinary Journal*, *27*(4), 263-269

25. Bernatzky G, Bernatzky P, Hesse H, Staffen W, Ladurner G. Stimulating music increases motor coordination in patients afflicted with morbus parkinson. Neurosci Lett. 2004;361(1-3):4-

26. Medical Outcomes Study Questionnaire Short Form 36 Health Survey (SF-36). Brandeis University Website. ttps://www.brandeis.edu/roybal/docs/SF-36_website_PDF.pdf.

27. Berg Balance Scale. American Academy of Health and Fitness Website. https://www.aahf.info/pdf/Berg_Balance_Scale.pdf

28. Dite, W. and Temple, V. A. (2002). "A clinical test of stepping and change of direction to identify multiple falling older adults." Arch Phys Med Rehabil 83(11): 1566-1571.

29. Five times Sit to Stand. University of Missouri Website. geriatrictoolkit.missouri.edu/5x-STS.rtf