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The Collaboration of Music Therapy and Physical Therapy: A Case Study for Rehabilitation Treatment of a Patient with Chronic Stroke

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This Scholarly Project, submitted by Kaci Hemmesch and Taylor Kunz 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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(Graduate School Advisor)

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PERMISSION

Title Physical Therapy and Music Therapy Collaboration for the Treatment of Chronic Stroke: A Case Study

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ABSTRACT

Background and Purpose:

Strokes are the fifth leading cause of death in the United States and nearly 800,000 people suffered from a stroke last year alone. Even though two-thirds of those people had survived, many of the survivors were left with a number of activity limitations and participation restrictions. The research is extensive in the realm of physical therapy interventions and how it can help with those disabilities, but truly lacks the knowledge behind the effects of a collaboration of music therapy with physical therapy.

Case Description:

This case study follows an 85-year-old woman with lasting chronic impairments from a right cerebrovascular accident four years ago to measure the effects of a 13-week interdisciplinary intervention program.

Interventions:

Following an initial evaluation, the client performed 11 one-hour treatment sessions over an 11-week period. The patient was co-treated during each session by two music therapy students and two physical therapy students under the guidance and direction of a licensed music therapist and a licensed physical therapist. Interventions included gait training with rhythmic auditory stimulation, lower extremity strengthening, proprioceptive neuromuscular facilitation (PNF) patterns, balance training and core

stability with musical components such as Rhythmic Auditory Stimulation (RAS), Patterned Sensory Enhancement (PSE) and Therapeutic Instrumental Music Performance/Playing (TIMP).

Outcomes:

After 11 weeks of music and physical therapy collaborative interventions, the client was reassessed, and outcomes were recorded. The client demonstrated increased competency for the Berg Balance Scale, decreased the amount of assist for transfers for all functional outcome measures, decreased time with Five Time Sit to Stand test and showed increase response and awareness of metronome during GaitRITE ®.

Discussion:

Collaboration of treatment between music therapy and physical therapy improved functional mobility, sitting and standing balance, decreased assist with transfers and increased awareness of RAS (Rhythmic Auditory Stimulation) in gait, with this client with a Chronic Stroke.

CHAPTER I

BACKGROUND AND PURPOSE

The fifth-leading cause of death in the United States is Cerebrovascular Accident. (CVA) also known as Stroke.[1,2] Nearly 800,000 people suffered from a stroke last year and although two-thirds survived, they were left with several disabilities. Strokes occur due to problems with the blood supply to the brain; either the blood supply is blocked or a blood vessel within the brain ruptures.[1] Once this happens, the brain cannot receive enough oxygen or nutrients resulting in neuronal death. This is a medical emergency and prompt treatment must be sought. [2]

Based on the severity of the stroke, there are many symptoms in which a physical therapist can treat to help the patient improve and function as independent as possible. The most functional recovery occurs within the first two months which is why it is so important to start the rehabilitation process early. One of the main factors that determines the amount of functional recovery is the level of neuroplasticity. Neuroplasticity is the ability of the brain to form and reorganize synaptic connection in response to learning or experience or following an injury.[4] In a study by Dąbrowski and Czajka, they reported that some spontaneous motor recovery occurs, but further advances in motor function rely on motor rehabilitation training, a form of motor learning.[5,6] These individuals with stroke should engage in motor rehabilitation training in an effort to relearn motor skills that were lost due to injury.[6] In addition, this kind of training can even have small effects

on a client with a stroke throughout his or her lifetime.[5] By doing so, this helps the patient reach their highest potential. A prospective epidemiological study reported that 58% of clients who survive their first stroke eventually regain independence in activities of daily living (ADL) and 82% of the clients with a stroke will walk independently again with or without the use of walking aid or orthosis. [3] This is why it is important to carefully assess all factors in the client's ability and why it is also important to continue to progress and modify based on the client's response to treatments to allow him/her to achieve the most success in his/her healing, Even though the main focus of rehabilitation is usually physical, emotional and cognitive changes in these clients' lives are also affected. This is where the benefits of music therapy come into play.

Music Therapy is a health profession in which the use of music is used to create a therapeutic relationship between physical, cognitive, emotional and social needs of individuals.[7] After a strength and needs assessment, the qualified music therapist provides the indicated treatment interventions that include: singing, moving to, and/or listening to music. Music involvement in this therapeutic way allows for not only improvements in the client's strength but can be transferred to other areas of their lives. One beneficial aspect of music therapy is that it provides an avenue for communication to those who may find it difficult to express themselves otherwise. Research also supports the effectiveness of overall physical rehabilitation and the facilitation of movement, client's motivation and engagement in their treatment, while also providing emotional support and a way to express feelings. One specific technique music therapist's use for clients with neurological conditions is called Rhythmic Auditory Stimulation (RAS). This is a neurologic technique used to facilitate the rehabilitation of movements that are

intrinsically biologically rhythmical to interventions such as gait. RAS can be used as an entrainment stimulus to provide rhythmic cues during movement or as a facilitating stimulus for training to achieve a more functional gait pattern.

The effects of RAS on improving gait has been well cited in the literature. A study by Hayden, et al assessing the effects of RAS on physical therapy outcomes in gait training following stroke, authors found that statistically significant gains in single leg stance and cadence with implementations of RAS.[8] Similarly, a study by Thaut, et al, assessing RAS on gait training in hemiparetic stroke rehab found a statistically significant increase in velocity, stride length, and reduction of EMG amplitude in the gastrocnemius muscle in an RAS group compared to a control group.[9] Both studies suggest the evidence that RAS is an efficient tool in enhancing gait rehabilitation in clients with a stroke.

Raglio, Zaliani, Baiardi, et al researched the effects of active music therapy for clients with a stroke in the post-acute rehabilitation phase.[10] They found that all groups showed positive trends in quality of life, functional and disability levels, and overall gross mobility. In addition, the experimental group showed a decrease in anxiety and depression along with an increase in grip strength and improvement in non-verbal and sonorous music relationships. Although, this is not a direct correlation to the interdisciplinary methods of physical therapy and music therapy, it shows the positive effects of music therapy regarding treatment and recovery of clients in the post-acute phase.

In another study, Horne-Thompson and Bramley researched the benefits of interdisciplinary practice in a palliative care setting of an 8-week combined music therapy and physiotherapy group. [11] The group was assessed on the Edmonton Symptom

Assessment Scale (ESAS) and De Morton Mobility Index (DEMMI). The ESAS looked at a variety of topics including: pain, tiredness, depression, anxiety, wellbeing, etc. The DEMMI assesses bed and chair mobility, static and dynamic balance along with a gait portion. The results of this interdisciplinary study showed that all symptoms of the ESAS improved by participating in this group and mobility was either maintained or improved on the DEMMI. This shows that the benefits to include a more holistic approach between music therapy and physical therapy interventions has positive effects to treatment and physical rehabilitation improvements.

Although there has been an increase in the amount of research being published about the effectiveness of music therapy and the treatment of clients, it is still lacking research involving the collaboration of music therapy and physical therapy together. After conducting a literature review, the student researchers of this study were unable to find much literature about the combination of music therapy and physical therapy and the effects to treat clients with chronic stroke. However, the student researchers were able to find research articles showing positive effects using music therapy techniques for treating clients with other chronic neurological conditions that were similar to stroke including Alzheimer's and Parkinson's disease. [12,13] In doing this literature review, the student researchers created an intervention plan to see the effects of combining physical therapy and music therapy for a client with chronic stroke in hopes to increase functional mobility and independence for the client.

The purpose of this case report was to research and provide a detailed description of the interdisciplinary treatment and rehabilitation outcomes of an 85-year-old female four years post stroke. This client's treatment was completed by two student physical

therapists (SPTs) and two student music therapists (SMTs) under the direct supervision of a licensed physical therapist and a licensed music therapist.

CHAPTER II

CASE DESCRIPTION

The client was an 85-year-old, Caucasian female whom sustained a CVA from that resulted in left leg and shoulder pain, difficulty with balance and gait, left sided neglect, and poor short-term memory four years ago. She has received various physical therapy treatments since the CVA but has not been able to return to full independence and requires 24-hour care between family and caregiver. The patient lives in a home that has three stairs with a railing to enter her home. All amenities are on the main level. She does not have to walk further than 50 ft. to get anywhere in her home. The patient has assistive devices for the bathroom including shower seat, grab bars, etc. She is currently walking with hand hold assist of one person and uses wheelchair for longer distances.

Initial Physical Therapy Examination

The client was assessed for functional mobility. Functional testing consisted of the Berg Balance Scale (BBS), Cognitive Timed Up and Go (C-TUG), Timed Up and Go (TUG), Five Time Sit-to-Stand (FTSTS) test and GaitRITE ® analysis.

For the BBS, the client scored an 11/56, requiring maximum assistance, putting her in the “high risk category” with 100% impairment. A study from Downs, Marquez, and Chiarelli showed that the BBS has high intra- and inter-rater reliability for those who score 20 out of 56 or above (intrarater = 95% CI, 0.97 to 0.99) & (inter-rater = 95% CI

0.96 to 0.98). [14] However, absolute reliability decreases when the participants scored below 20. So, for our patient, being able to detect modest clinically important changes was decreased.

The average time for her age category (community dwelling adults) on the TUG is less than 13.5 seconds. The client's average time at 49.9 seconds was much higher than this norm. The client required moderate assist of one for sit to stand and hand hold assist while ambulating. A study from Alghadir, Al-Eisa, Anwer, et al. showed excellent test-retest reliability for the TUG in measuring balance in clients with chronic stroke. [15] The reliability of the TUG provided had an intraclass correlation coefficient = 0.98. Our client scored many deviations below the mean to detect an minimal change, but did improve on her need for assistance during the test.

According to a study conducted by Mirelman et al the increased time seen in our client could have been due to her decreased cognition from her stroke.[16] They researched the effects of cognitive function on motor control and an assessment of TUG scores. The researchers found that clients with mild cognitive impairments showed an increase in TUG times due to the subtasks required in the test. Those clients with cognitive impairments had increased difficulty with these tasks due to the complexity.

The client was unable to count back from 100 by 7's, so the Cognitive TUG was modified for the client's cognitive level. The client demonstrated the ability to count backwards by 5's while seated and so the C-TUG used this modification to be performed. The client's average score was 54.2 seconds with handhold assist of one person and moderate assist of one to perform sit to stand. First trial the client was accurate to the number 40 but did pause in the middle of the trial. Second trial the client was accurate to

15 but stopped counting when she returned to chair to sit down. Based on the study by Chan, Si Tou, Tse et al, the C-TUG demonstrates excellent intra-rater, interrater and test-retest reliabilities and can be used as a useful tool in those clients who have had a stroke. [17]

On the FTSTS, the client was able to complete five sit-to-stands from a standard wheelchair in 70 seconds. She required moderate assist of one person for ascending/descending for the first two sit to stands and maximum assist of one for last three in series. The client also required verbal cues to stand completely upright and to have forward weight shifting to clear the wheelchair for each repetition. Her score is quite far above the 12 second cut-off score between healthy elderly and elderly client's post-stroke. In the same study, it demonstrated that the FTSTS Test measures one aspect of transfer skill and provides a method to quantify functional lower extremity strength and/or movement strategies the client uses to complete the transitional movement. The FTSTS showed excellent test-retest reliability (ICC = 0.994), interrater (ICC = 0.999) and intrarater reliability (ICC = 0.970).[18] In another study reported by Mong et al, the FTSTS Test is also a reliable measurement tool that correlates with knee flexor muscle strength but did not correlate to balance ability in clients with a stroke.[19]

The client's gait speed was measured using GaitRITE ® system with stand by assist of one person with winter boots on. First trial was conducted and the client's cadence 77.4 steps/min and her "self" velocity was 0.319 meters/second (m/s). She did have two instances where she lost her balance due to tripping over her own foot but was able to self-correct. Second trial the client was told to walk "fast" and had a cadence of 79.5 steps/min and a velocity of 0.309 m/s. The third trial was at "self" velocity and

metronome set at 77 steps/min and her cadence was 77.4 steps/min with a velocity of 0.273 m/s. Lastly, the fourth trial was at a faster pace with metronome set at 79.5 steps/min. The client's cadence was 88.2 steps/min and velocity were 0.323 m/s. The average self-velocity of females ages 80-89 is 0.80 m/s which is over double the speed at which our client was walking.[20] The client also walked with unequal step lengths, right greater than left. A study conducted by Hee-jae, Ilhyoek, Hyo joo, et al concluded that walking test at the normal pace appears to be more suitable for estimating physical function and deterioration due to chronic disease. [21] However, walking test at a maximum pace might be more useful for estimating client general health and skeletal muscle mass.

Systems Review

A systems review was also conducted. The client did not show any concerning abnormalities within the cardiopulmonary and integumentary system. The neuromuscular system included impairments within the realm of balance and gait. The musculoskeletal system showed gross weakness with greater weakness on the left side which is partly due to the CVA affecting the neuromuscular system. Upon observation, the client had some postural deficits both in sitting and standing postures. The client demonstrated a right leaning posture, forward head and rounded shoulders. The client was able to semi-correct posture with verbal cues.

Evaluation

After the examination, the two physical therapy student researchers determined that the client presented with problems in the areas of altered gait pattern with unequal

step length and high steppage right foot (potentially due to winter boots during GaitRITE ®), dragging of left foot, decreased balance, decreased walking endurance and velocity, need for moderate to maximum assist with transfers, cognitive impairment, and decreased function of left upper extremity. The SMT's determined that music therapy alongside physical therapy interventions would be beneficial for this client's improvements in the functional impairments at the time of evaluation.

Goals were determined based on the evaluation of the client and were designed to help improve the following: balance, functional mobility, endurance, and increased use and awareness of left upper extremity. Short-term goals were not included due to the shorter nature of the program along with her chronic stroke condition and we did not expect quick progress. The client had long-term goals set that were all to be met within the 11 weeks of interventions. These long-terms goals were created upon by both student therapists and the patient and are listed in Table 1.

Table 1. Long Term Therapy Goals

Goal 1	Patient will increase confidence to ambulate at SBA 50 ft. to increase ambulation independence and allow her to ambulate in her house.
Goal 2	Patient will be able to ambulate 150 ft. with CGA without rest to improve functional endurance and ambulate within the community.
Goal 3	Patient will score above 6/56 on the Berg Balance Scale to show a minimal detectable change in balance and decrease the risk of falling.
Goal 4	Client's gait speed will increase to 0.4 m/s in order to ambulate efficiently and safely in her house.
Goal 5	Patient will be able to complete sit to stand transfer at CGA to reduce risk of falling and increase transfer independence.
Goal 6	Client's time on the TUG will improve to 47 seconds to reach minimal detectable change and increase functional mobility and transfers.
Goal 7	Client's FTSTS time will improve to 60 seconds to improve coordination and safety of transfers.

Diagnosis

After the evaluation was completed, the student therapists determined that the client's findings were indicative to the client's prior diagnosis of CVA with left-sided hemiparesis. The client was not officially examined for cognition during this process; however, the client did show cognitive impairments with the C-TUG.

Prognosis

Based on the examination and evaluation of the client's diagnosis, the student researcher's impression of the client's prognosis was *fair*. Due to the nature of progression with a Chronic CVA we knew that the client would not likely make drastic improvement changes. She is likely to slightly improve with functional mobility to make activities of daily living (ADL) easier and to reduce family/caregiver assistance. However, due to her cognition impairment, we were unable to give her a higher grade.

Plan of Care

The plan of care for this patient was to receive physical therapy with music therapy components 1 time for 60 minutes per week for 11 weeks. Interventions established in the plan of care included therapeutic activity, therapeutic exercise, neuromuscular reeducation, and gait training as needed with enhancements from the use of music.

The SMT's worked on gait mechanics using the RAS technique to improve step length, cadence, speed, etc. Music therapy such as TIMP and PSE were also used to help the patient perform functional reaching with PNF patterns, weight shifting, marches and

side stepping for lower extremity strength and balance and lastly with core stability. At the end of the 11 weeks of interdisciplinary interventions, the patient was re-assessed on all functional measures and was then discharged.

CHAPTER III

INTERVENTION

During the 11 weeks of therapy, interventions were created to help the client achieve the functional goals laid out in the beginning of this process. Interventions included exercises to improve the client's balance, strength, endurance, posture, left upper extremity awareness and function, gait mechanics, and independence during sit to stand transfers.

Proprioceptive Neuromuscular Facilitation (PNF) is a functional and neuromuscular approach that identifies habitual patterns of posture and movement; corresponding dynamic strength, flexibility, and coordination; and neurophysiological principles of the sensory/motor system on muscular recruitment and motor control of a symptomatic region.[22] It is widely used and a very effective therapeutic exercise to improve physical functioning of clients with a stroke. In a study evaluating the immediate effects of PNF patterns on lower extremity muscle tone and stiffness in chronic clients with a stroke, authors recommended utilizing PNF patterns as an intervention to decrease stiffness and tone of the lower extremity muscles.[23] Although this study was completed on lower extremities, there may be crossover to the upper extremities due to the nature of stroke being an upper motor neuron lesion.

Each treatment session for the client in this present study began with a 5-10 minute warm up of PNF patterns, which included chops and reverse chops (D1 extension

and flexion) bilaterally, as well as “So Big” (bilateral, symmetrical D2 extension and flexion). Chops and Reverse Chops were utilized to decrease stiffness in the left upper extremity to prevent flexion contractures and increase the client’s awareness of the left upper extremity. “So Big” was utilized to correct excessive kyphotic posture.

Bilateral D2 flexion and extension was performed with maximal assist, progressing to moderate assist by a student therapist to the client’s left upper extremity; the right upper extremity could perform the pattern independently. The patient was verbally cued 25% of the time to follow her eyes with her hands and look up to the ceiling during the D1 flexion component. During chops and reverse chops, the left upper extremity initially required max assist from a student therapist, along with moderate verbal cues 50% of the time to encourage trunk and cervical rotation by stating, “follow your hands with your eyes”. The patient progressed to completing chops and reverse chops with maximal assist from her own right upper extremity for her left upper extremity, and verbal cues to encourage trunk and cervical rotation decreased to minimally. As the patient continued to progress in independence with PNF patterns, she was given a drum mallet to grasp in both hands, and a paddle drum was held at both the top and bottom of the PNF pattern for her to tap with the drum mallet. In a study by Shimura and Kasai, authors assessed PNF and the initiation of voluntary movement and motor in upper limb muscles in comparison to neutral posture.[24] They found that different neurophysiological mechanisms occurred during PNF patterns, including differences in muscle discharge and motor cortex excitability, creating improved motor ability in that limb.

Having the client hold a drum mallet and hit a paddle drum with intentions to stimulate a functional movement pattern (PNF pattern) was a music therapy intervention called Therapeutic Instrumental Music Performance/Playing (TIMP). TIMP is defined by Thaut in Rhythm, Music and the Brain (2005) as the playing of musical instruments, in order to exercise and stimulate functional movement patterns.[25] With this technique, appropriate musical instruments are chosen in a therapeutically meaningful way in order to emphasize range of motion, endurance, strength, functional hand movements, finger dexterity, and limb coordination. During TIMP, instruments are not typically played in the traditional manner, but are placed in different locations to facilitate practice of the desired functional movements.[25]

In a study by Lim et al, [26] researchers attempted to determine if an active musical experience (TIMP) during exercise influence an individual's perception of pain, fatigue and exertion, compared to receiving traditional occupational therapy. All subjects were in clients with a diagnosed neurological disorder or had just gone orthopedic surgery. Authors found TIMP resulted in significantly less perception of fatigue and exertion levels than traditional occupational therapy, and that TIMP can be used as an effective sensory-motor rehab technique to decrease perceived exertion and fatigue levels of in clients in physical rehab. Results of these study parallel what student therapists observed with the client in this present study; in that no matter the duration the client had been doing an activity, it was often difficult to switch to a different activity if she was playing a drum or piano herself, as the client was very engaged with the drumming/piano playing and appeared unmindful of her own fatigue levels.

Sit-to-stand training comprised a large portion of our interventions. Interventions for this client to improve sit to stands included: seated weight shifting, repetitions practicing sit to stands, lower extremity strengthening, and balance training; each will be elaborated below.

Both anterior and medial-lateral weight shifting were used as interventions to improve sit to stands. In a study by Na et al, [27] results stated that dimensional acceleration ranges in all three planes (anterior-posterior, medial-lateral, and vertical) were significantly lower in clients with a stroke compared to healthy clients during sit to stands; and during stand to sit, medial-lateral acceleration was significantly lower, with no difference between clients with a stroke and healthy clients in anterior-posterior or vertical accelerations. Authors of this study therefore recommend training all three balance dimensions for sit to stands training, and specifically mediolateral balance with foot positioning during stand-to-sitting. Along with these recommendations, a study by Boukadida, et al determined that in clients with a stroke, common impairments for completing sit to stands include lateral deviation of the trunk towards the unaffected side, and asymmetrical weight bearing even before initiation of seat-off. [28] These authors concluded that interventions to improve weight bearing symmetry may improve sit to stands.

In parallel with results from these studies, this client displayed both asymmetrical trunk/postural control in seated, by opting towards a position of lateral flexion to the right with excessive kyphosis, as well as expressing “fear of falling” when anterior weight shifting. To correct mediolateral postural weight bearing deficits and sensitize the patient to shifting her center of gravity anteriorly for anterior acceleration, weight shifting was

used as an intervention in various forms. Weight shifting activities were typically completed for ~10-15 minutes, depending on patient tolerance.

Anterior weight shifting was performed sitting on a flat, high-low table, and many variations of it were used, including: 1) holding onto the back of a rolling chair with both upper extremities (right upper extremity independent; left upper extremity max assist to maintain contact with chair), and pushing the rolling chair forward and pulling it backwards; 2) repeated weight shifting anteriorly and posteriorly with arms at sides while being encouraged to reach "nose over toes" 3) repeated weight shifting anteriorly then returning to neutral with both upper extremities clasped in "prayer" position (90 degrees of shoulder flexion and full elbow extension bilaterally), with the left upper extremity being supported by a student physical therapist (SPT); 4) the patient held a drum mallet in both hands, and was asked to weight shift forward to hit a drum held outside her BOS anteriorly; 5) weight shifting anteriorly, while reaching with her right upper extremity forward to play keys on a handheld keyboard held outside her BOS anteriorly; and lastly 6) Different colored musical bells were set in front of the client's feet, in order to challenge cognition while completing an anterior weight shift. The patient was instructed to identify and pick up a specific colored bell off the ground by her feet, and hand it back to a student therapist. On return from all anterior weight shifts, the client was encouraged to return to a position of complete spinal extension via verbal cues to look up at the clock or ceiling, in order to reduce her kyphotic posture.

Variations 4-6 of anterior-posterior weight shifting were again forms of the music therapy intervention TIMP, where having the client play an instrument was utilized to produce a functional movement. Variations 1-3 of anterior-posterior weight shifting

variations used a different style of musical interventions, called rhythmic auditory stimulation (RAS). During these first three variations of anterior-posterior weight shifts, a student music therapist played a guitar at a steady rhythm, which created a tempo for the client to entrain the pace of her movement to as she rhythmically shifted anteriorly and posteriorly. RAS is a neurologic technique used to facilitate the rehabilitation of movements that are intrinsically biologically rhythmical. RAS is most famously known as an effective intervention to improve gait but can also be used as an intervention that provides immediate entrainment stimulus for rhythmic cues during movement.[29]

Medial-lateral weight shifting was also implemented to improve sit to stands, in order to teach the patient to accept more weight on the left side of the body, to promote more symmetrical weight bearing and improve mediolateral balance acceleration upon standing. Reinforcing the idea of mediolateral weight shifting to improve sit to stands, the study by Boukadida, et al also found that clients with hemiparesis were less accurate in their perceptions of symmetrical weight bearing than healthy clients.[28] They also make note that average loading on paretic limbs is smaller in stroke fallers, with about 24-29% body weight; that asymmetrical weight bearing in sit to stands is a fall mediator; and clients who bore less weight on a paretic limb had a poorer score of mobility in the independence functional measure scale. They recommend restoring symmetrical weight bearing by having clients increase weight under their affected foot, as well as placing the affected foot posterior to the unaffected foot to increase its weight bearing during sit to stands.

Along with improving sit to stands for reasons stated above, medial-lateral weight shifting was also implemented for several other purposes, including balance training, core

strengthening, and functional reaching. All variations of weight shifting were performed bilaterally, on a stable, high-low plinth mat. When oblique core strength and functional reaching were being targeted, the client performed activities sitting on this stable, high-low plinth; when attempting to further challenge mediolateral balance and core strength, the client was additionally placed on a Lily pad, Dina disc or Airex pad. The client was then asked to reach laterally outside her BOS with an upper extremity for various objects and activities, including: holding a drum mallet and reaching laterally to hit a paddle drum located outside her BOS (held by a student therapist); reaching laterally to a keyboard located outside her BOS, to play a note that was pre-selected by a student therapist; and reaching laterally to retrieve musical bells placed outside her BOS. TIMP was again the musical intervention for medial-lateral weight shifting, as the patient was using/playing instruments in meaningful ways to facilitate functional movement and the necessary components of the functional movement (range of motion, coordination, ect). [25]

Following weight shifting activities, the client completed repetitive sit to stand practice for 15-20 minutes, depending on patient tolerance; 5-15 repetitions was the goal. Sit to stand transfer training was completed on a flat, high-low plinth mat. The height was adjusted between 21 and 23 inches. 5-10 repetitions were typically completed in a row, or until patient fatigue; only enough time was given in between transfers for the patient to reset her feet and regain her sitting balance and posture. At least 5 additional sit to stands were completed every treatment session, due to transferring from the client's wheelchair to the plinth, and to stand for gait training. A study by Barreca et al[29] highlights the importance of repetitions of sit to stands in survivors of a stroke, where the study found that participants who complete multiple repetitions of sit to stands were significantly

more able to perform consistent, independent sit to stands. Boukadida et al, [28] came to the same conclusions, stating that both physically and mentally repeated practice of sit to stand tasks can improve ability to stand independently.

In completing the sit to stand transfer training: The patient was given moderate to maximal verbal cues 50-75% of the time to bring her nose over toes, bring both feet posterior to her knees, and use her right hand to push off the mat prior to standing. One student physical therapist stood in front of the patient, with the palms of her hands resting on the client's scapula bilaterally; as the patient weight shifted anteriorly, the student therapist leaned posteriorly, then continued to guide the client up to full standing. A second student therapist stood with one palm on the client's low back, and another palm placed superior to the client's sternum as facilitation techniques for spinal extensors during the transfer. Depending on the fatigue level of the client, between minimal to maximal assist of 1 student therapist was needed. On days the client exhibited less fatigue, her left paretic foot was placed posterior to the right foot so it may accept more of the weight bearing as recommended by Na, et al; on the contrary, other days the client's left lower extremity was so fatigued that it maintained no contact with the ground, and a student therapist had to block the left foot to prevent it from sliding anteriorly or rising off the ground. [27]

Music therapy also played a large contribution to sit to stand interventions. A student music therapist began by playing and shortly holding a note on a clarinet, Chroma harp, or guitar; this was the client's cue to begin standing from her seated position. After this initial cue, the student music therapist played an increasing crescendo during an upscale on the clarinet, Chroma harp, or guitar as the client continued to stand into full

extension phase. At the top of the sit to stand (full hip, knee, and spinal extension) the student music therapist held a note at the top of the musical scale, while another music therapist held a bell high in the air and rang it for further cueing for the patient to search for the bell to promote complete spinal extension (as the patient tended to stay forward flexed). Once the client had achieved full knee, hip, and spinal extension, the student music therapist began a decrescendo with a downscale; this was the cue for the client to initiate the stand to sit portion and return to her seated position. Once the client was seated, a period of time was given for the client to reset her feet and posture (no music was played in any form), and then the cycle repeated.

Patterned Sensory Enhancement (PSE) is the name of the music therapy intervention just described as an intervention for sit to stand training. PSE is a technique which uses the rhythmic, melodic, harmonic and dynamic-acoustical elements of music to provide temporal, spatial, and forced cues for movements that reflect functional exercises and ADL's. PSE is applied for movements that are not rhythmical by nature and provides more than just temporal cues. To elaborate, the reason sit to stands may be viewed as a rhythmic task in this present study is due to the fact that the client was repeating multiple repetitions in a continuous cycle. However, a sit to stand is not typically rhythmic by nature but is instead a transfer that is typically performed one repetition at a time. PSE was used here to facilitate this transfer by more than just a temporal/speed cues, but also as a major cue to initiate and complete both the sit to stand and stand to sit components. The client was able to recognize these cues and respond appropriately.

As the client presented with paresis in the left lower extremity and demonstrated markedly impaired balance, strength and balance training were also main interventions. Na, et al found that the duration to complete a sit to stand is substantially longer in clients with stroke (compared to healthy individuals), due to weakness of a paretic leg. [27] Strength training therefore targeted both lower extremities, in order to improve functional tasks such as sit to stands and gait. Balance training targeted both static and dynamic balance. Exercises during treatment sessions often targeted both strength and balance simultaneously.

The first three treatment session's interventions to improve balance and lower extremity strength included: 1) The clients faced a high-low plinth mat which was raised to just above the client's umbilical level. Exercises at this mat included bilateral marching, mini squats, and side steps, while the client used her right upper extremity to grasp the mat for support, along with contact guard assist to minimal assist by one student therapist. Repetitions were completed until client fatigue. These exercises were completed while music therapists played and sang songs on the guitar. This was a form of PSE, where rhythmic melody was used to force cues for the client's movement. 2) Targeting balance, cones were set on the mat outside the client's base of support (BOS) both laterally and anteriorly. She was asked to cross midline with an upper extremity to retrieve a cone from one side of the mat and place it back onto other cones located outside her BOS on the opposite side of the mat. Another standing balance intervention included the client holding a drum mallet and having to tap a paddle drum located outside her BOS both laterally and anteriorly with the mallet. This again was the music therapy

intervention TIMP, using musical instruments to create a desired functional movement. Repetitions of both interventions were completed until patient fatigue.

The patient did not initially tolerate these standing strength and balance exercises well, as facing the mat became a distraction, and the patient became fatigued after only a few minutes of standing- evident by increased kyphotic posture, frequent verbal cues to remain standing up tall, and verbal complaints of fatigue. As the student therapists wanted to preserve the client's energy for functional sit to stand and gait training, the following sessions, the client's lower extremity strengthening, and balance training was performed in sitting. Seated exercises were completed for 3 sets of 10 repetitions. Interventions for lower extremity strengthening performed in sitting included: bilateral seated marches, and bilateral long arc quads. Both previously listed exercises were performed with a 3-pound ankle weight on the right lower extremity, with minimal to moderate assist for the left lower extremity, and facilitatory tapping to the left quadricep. The patient was further stimulated by music through a form of PSE. Music therapy students played the guitar while singing a melodic song specifically created for this client. In the song, music therapy students started with a chorus where the client was allowed to rest, which transitioned into rhythmically singing, "right, left, right, left" as cues for the client to lift that lower extremity. As lower extremity short arc quads and seated marches are not a common movement or rhythm in nature, this was an effective intervention at creating both temporal and forced cues for movement with this client; the client responded very well to the song.

A variation of long arc quads was also performed by rolling a soccer ball to the patient and having her kick it, again with a 3-pound weight on the right lower extremity,

but independent on the left lower extremity, for 3 sets of 10 repetitions bilaterally. Student music therapists would strum intensely when the client kicked the ball for further stimulus to movement, a form of PSE. Supporting strengthening interventions for our client with chronic stroke, a systematic review assessing strength and activity after stroke, authors concluded that strengthening interventions post-stroke increase strength, improve activity tolerance, and do not lead to increased spasticity; suggest strengthening program should be part of rehabilitation following stroke.[30]

Seated balance interventions included medial-lateral and anterior-posterior weight shifting while tapping music objects outside the client's BOS, as described previously. When targeting balance specifically, the client sat seated on a Lily pad balance disc or Airex pad for these interventions. In a systematic review and meta-analysis by Duijnhoven et al, [31] authors looked at the effects of exercise on balance capacity in clients with chronic stroke, the authors found that balance capacity in chronic clients with a stroke can be improved by exercise in the chronic phase after stroke. Specifically, they found that exercises targeting balance, weight shifting, and/or gait were the most effective exercises for improving balance capacity.

As the patient gained strength and endurance, previously listed strength and balance exercises were still completed in sitting but were additionally reintroduced in standing. Standing exercises included marching in place with by one student physical therapist; and side steps with CGA by 1 student physical therapist and verbal cues for the client to keep her feet facing the front of the room. Repetitions were completed until patient fatigue. Marching in place and side steps were completed with student music therapists playing there "right, left, right, left" song, as previously described in seated

strengthening exercises, the same version of PSE. In a study by Hong, assessing immediate effects of PSE for home-bound clients with a stroke on upper extremity function, authors found that a PSE upper extremity strengthening program was an effective strategy in enhancing upper extremity function, decreasing depression levels, and improving interpersonal relationships.[32] Although our study used PSE in combination with lower extremity strength training, there may be a bridging effect to apply to the lower extremities, due to the nature of stroke being an upper motor neuron lesion.

Core strength and endurance was also targeted via unsupported prolonged sitting and standing during previously listed exercises. To challenge core strength even further during seated exercises, the patient was also asked to sit on a Lilly pad balance disc or Airex pad. The client was challenged to maintain upright posture on an unsupported, unstable surface, while completing lower extremity exercises and both anterior-posterior and medial-lateral weight shifting. Medial lateral weight shifting targeted eccentric control of abdominal oblique core musculature, anterior-posterior weight shifting targeted eccentric control of anterior abdominal musculature and spinal extensors and sitting unsupported to complete lower extremity exercises targeted core endurance. Core endurance was also challenged in standing, by having to maintain an up-tall posture against gravity. Verbal cues were provided minimally-moderately provided 25-50% of the time by asking the client what time it was, in order for her to search up the wall for the clock to promote spinal extension. The client was able to maintain sitting/standing unsupported the majority of the treatment session, with verbal cues every 4-5 minutes to correct increasing cervical and thoracic flexion, and occasional/infrequent breaks to sit in the wheelchair (supported).

Core strengthening was implemented with this client, however direct core stabilization was not. Recent literature has cited the effects of core stability training having beneficial effects on clients with a stroke. In a study by Haruyama et al[33] assessing core stability training on trunk function, standing balance, and mobility in clients with a stroke, authors concluded that core stability training has beneficial effects on improving all three. Core stabilization in this article referred to contraction of transversus abdominis, abdominal drawing-in, and selective movements of the pelvis. Authors found the core stabilization group had better results compared to a conventional physical therapy program; with the core stabilization group showing more improved trunk function, dynamic sitting balance, standing balance, and mobility. Authors concluded with recommendations supporting incorporating core stability training into stroke rehabilitation.

The final intervention incorporated for this client was gait training. Gait training was utilized to improve the client's gait mechanics, endurance, and strength. It was completed each treatment session, according to patient tolerance. Primary goals were to improve cadence, step length, step height, and assist level. Gait training was performed around the perimeter of a classroom, the patient was typically able to complete 1-3 laps around the room before requiring rest, totaling 116 to 348 feet. The patient began gait training with handheld assist by one student therapist and progressed to contact guard assist by one student therapist. During gait training, the patient was verbally cued by student physical therapists to increase her step lengths bilaterally, with statements such as, "take big steps" and "try and bring your right foot past your left foot when you step."

During gait training, the majority of cueing for movement came from music therapy students. One student physical therapist maintained CGA with the gait belt behind the patient. Two music therapy students walked in front of the patient, providing rhythmic cues via the tempo of music played by various instruments. Most commonly used instruments were an acoustic guitar and paddle drum in combination; a clarinet was also occasionally used. This musical intervention technique was RAS. This specific form of RAS was used as a facilitating stimulus, in order to achieve a more functional gait pattern.[25]

Over the 11 weeks of treatment, interventions were implemented to improve the client's balance, strength, endurance, posture, left upper extremity awareness and function, gait mechanics, and independence during sit to stand transfers. Primary music therapy interventions used included TIMP (therapeutic Instrumental Musical Performance/Playing); PSE (Patterned Sensory Enhancement); and RAS (Rhythmic Auditory Stimulation). Many of the interventions used utilized were used to improve more than one of the client's previously listed functional deficits.

CHAPTER IV

OUTCOMES

After the evaluation and 11 intervention sessions of the collaboration of SMT and SPT's, a reassessment of the initial tests and measures was conducted. The findings are below in Table 2. This client was discharged after 13 weeks.

Reassessment

The client was able to slightly improve her scores on the FTSTS and BBS (see table 2). The client's score on the TUG increased in time but required less assistance for the sit to stand transfer. The client's C-TUG increased in time, but again required less assistance in transferring and also was more accurate in her counting at discharge. Her GaitRITE ® data showed slight improvements with the "faster gait speed and no metronome", but decreased meters/second on the other levels at discharge. However, from initial evaluation to discharge, she had increased awareness of the metronome beats showed positive responses when the metronome or music was being played. One of the seven long term goals for the patient were met at the end of the 12 weeks while showing progress with all seven goals. Reference Table 3 below for details.

Patient Satisfaction

The client's family reported that her awareness of surroundings and ambulation length before needing a break improved during this time period. The student researchers also noticed that when positive feedback was given, the client responded well and in

agreement on several occasions. During the beginning sessions, she would report that she was fatigued, and her left side caused her some pain. Towards the end of her program, she would verbally report not having pain as often and was able to increase her endurance to not take as many breaks throughout her sessions.

Table 2. Assessment Outcomes

Test	**Initial Eval**	**At Discharge**	**Age-Related Norms**
TUG	49.9 seconds (Mod A)	56.04 seconds (Min A)	<13.5 seconds
Cognitive TUG	54.2 seconds (Mod A for transfer, CGA for ambulation)	73.82 seconds (Min A for transfer, CGA for ambulation)	<15.0 seconds
FTSTS	70 seconds (Mod A to Max A)	69.42 seconds (Min A to Mod A)	17 seconds
BBS	11/56	12/56	42/56
CGS	0.319 m/s SBA	0.241 m/s SBA	0.8 m/s
FGS	0.309 m/s SBA	0.328 m/s SBA	
GS with Metronome "self pace"	0.273 m/s SBA (set at 77 beats/min)	0.248 m/s SBA (set at 73 beats/min)	
GS with Metronome "fast pace"	0.323 m/s SBA (set at 79.5 beats/min)	0.246 m/s SBA (set at 84 beats/min)	

CGA = Contact Guard Assist, Min A = Minimal Assist, Mod A = Moderate Assist, Max A = Maximum Assist, GS = Gait Speed

Response to Interventions

The client responded well to all interventions employed by the student and music therapists but responded particularly well to those involving RAS or direct musical stimulation. For example, during weight shifting activities where the client was asked to hit a drum or play a piano key outside her BOS, it was hard to get her to stop and move on to the next activity, as she enjoyed playing notes so much. The ease of sit to stands

transfers, and gait stride and cadence both demonstrated noticeable improvements to student therapists when RAS was used. During gait, musical cues were often more effective than verbal cues. Instead of saying, “take longer steps,” cues to “step every time we hit the drum,” along with the corresponding drumbeats were more effective in increasing the clients step length and cadence. Similarly, when completing sit to stands, a cue by holding a bell high and ringing it was often more effective to get the client to stand into full extension than a verbal cue to stand all the way up.

The client also responded well to verbal cues, but due to her cognitive impairments, the effects of the cue were usually short lasting (minutes) and verbal cues therefore had to be frequent. The amount of strength, endurance, and functional training the patient was able to complete per treatment session often depended on the client’s fatigue level coming into the session. To elaborate, some days the client came to treatments with high energy, and other days the patient was worn out from activities prior in the day. Her ability to participate also depended on her level of cognition for the day, as some days she liked to fixate on a topic, such as where her handkerchief or daughter was located, which caused delays in amount of time we could spend on an activity. This client also exhibited different energy levels each treatment session. Her energy levels typically were dependent on what the client had done in the day prior to a treatment session. For example, on days her kids were in town visiting, she was very worn out by therapy time. On these low energy days, rest periods ranged from 5-10 minutes in between interventions, and were required much more frequently. (On a typical “good” and energized day, the client usually required from 2-3 minutes between interventions for rest.) On these low energy days, the client required a much higher assist level for every

intervention and was unable to ambulate or complete standing exercises for typical durations. On the day of this client's final evaluation, she was fatigued and having a low-energy day, where she demonstrated an endurance and assist level atypically low compared to her one of her energized days.

Throughout the 13 weeks, the client was able to learn each intervention well and demonstrated progressions in completing each at a more independent level, and with less verbal cues each treatment session, along with showing improvements in increased strength and endurance. The client also demonstrated reduced "fear of falling" as evident by reduction in verbal statements by the client over the course of the 13 weeks, such as, "I'll end up on the floor if I do that." This client's love for music helped make the combination of music and physical therapy interventions so effective. Interventions with musical stimuli engaged the client to a much higher degree; she was able to complete activities more effectively and for longer duration when music was incorporated. Therefore, the student musical and physical therapists concluded music therapy is an effective intervention and should be added to stroke rehabilitation.

Table 3. Accomplishment of Goals

	Description	Goal Outcome
Goal 1	Patient will increase confidence to ambulate at SBA 50ft. to increase ambulation independence.	Not Met; Patient verbalized confidence with CGA.
Goal 2	Patient will be able to ambulate 150 ft. with CGA without rest to improve functional endurance and ambulate within the community.	**Met**; Patient was able to ambulate up to 348 ft. with CGA on one occasion, but on average 232 ft towards the later sessions.
Goal 3	Patient will score above 6/56 on the Berg Balance Scale to show a minimal detectable change in balance and decrease the risk of falling.	Not Met; Patient made progress with functional independence from Mod → Max A to CGA/Min A → Mod A with tasks.
Goal 4	Client's gait speed will increase to 0.4 m/s in order to ambulate efficiently and safely.	Not Met; Client's gait speed decreased to 0.241 m/s.
Goal 5	Patient will be able to complete sit to stand transfer at SBA to reduce risk of falling and increase transfer independence.	Not Met; Patient required Min A to complete sit to stand transfer.
Goal 6	Client's time on the TUG will improve to 47 seconds to reach minimal detectable change and increase functional mobility and transfers.	Not Met; Client's time decreased to 56.04 seconds, but progressed from Mod A to Min A
Goal 7	Client's FTSTS time will improve to 60 seconds to improve coordination and safety of transfers.	Not Met; Patient did improve score to 69.24 seconds and progressed from Mod A/Max A to Min/Mod A.

Impairments/Limitations at Discharge

At the time of discharge, the client was still demonstrating a decrease in cognition, functional mobility such as gait, transfers, balance and coordination, and overall endurance. Her cognitive impairments provided limitations to this case study due to the lack of retention of cues, instructions and other tasks throughout each session.

Therefore, the patient education intervention was minimally effective. The patient required persistent cues on instruction and sequencing to ensure proper form for the various exercises. One of the limitations to the study was the inconsistency of shoe attire worn by the client at initial evaluation and discharge. This could have skewed our data collection for the outcome measures above. However, the main limitation to this study was only working with one client for one hour and only one time a week. There could have been greater retention and progress made in her goals if there was more time spent in this interdisciplinary program. Lastly, there were no follow-up reports or further evaluations of the client for outcomes after discharge.

CHAPTER V

DISCUSSION

Strokes are a very common and well researched neurological condition affecting millions of people in the world today. However, the use and effects of an interdisciplinary program between physical therapy and music therapy has not been well studied. The writers and researchers of this case selected many interventions combining the skills of physical therapy and music therapy in hopes to improve the client's functional independence throughout many aspects of her life. The client did make slight improvements towards her goals at the time of re-evaluation and discharge. The greatest improvement was exercise and ambulation endurance. From the initial evaluation until discharge, she was able to ambulate and increase her number of sets/reps with the various exercises with fewer breaks in between. She did improve slightly on her FTSTS and BBS tests; however, she progressed to needing less assistance with multiple tasks even though her scores did not improve.

The findings above correlate to other studies found that use RAS as a technique in stroke rehabilitation. In an article by Chouhan et al, they looked at the gross motor function, fine motor skills, and gait/balance of clients that followed treatment with RAS.[34] This technique was very beneficial to the interdisciplinary intervention program and the client showed positive responses to this technique and was able to improve her ability

to move smoother and safer throughout the course of treatment with RAS from the SMT's.

This client had a love for music with a strong musical background, which in part made music therapy interventions such an effective intervention for this client. As previously stated in *response to interventions,* any activity including direct musical stimulation or RAS increased the client's participation, duration, and effectiveness in her ability to complete an activity.

Physical therapy interventions in combination with RAS created a form of choreography/dance, which was very motivating to the patient due to her strong musical background. By using RAS in combination with physical therapy interventions, rhythmic sequences were created which made learning the intervention easier for the client. RAS also allowed the patient to entrain her movement to the tempo of the music, which provided a stimulus for the client to know when to move, therefore creating smoother motion. RAS was a very effective and motivating intervention for this client, and although may not be equally as motivating to every client, still has beneficial effects on movement.

Reflective Practice

There are many clinical implications that can be taken from these results above. One of which is the addition of the RAS technique with physical therapy treatments. The client responded very well to this source of rhythm and performed better which each intervention that it included. The RAS technique was the most beneficial in our intervention program because it allowed our client to follow the beat and create smoother

movements with gait, marches, side-stepping, etc. The student researchers noticed that the client responded better to music and had increased motivation to perform during each session. Not every client will respond with this same manner, but if you are able to find the technique or musical style that they enjoy or that matches their motivation, it can provide many beneficial attributes to their treatments.

There were several limitations during this study, but there are two that show an overarching effect on the treatment of this client. One of the limitations is her cognitive function due to her dementia. The retention of verbal cues and sequencing of tasks between sessions was decreased and made it more difficult to continue making progressions in her functional goals. The other main limitation to this study was the lack of time spent between the patient and the student researchers. Treatment session were limited to once a week for 60 minutes.

Based on these limitations, the following recommendations may be beneficial in future studies between music therapy and physical therapy to improve the quality of results. The first suggestion would be for the student researchers to evaluate the effectiveness of the combination treatments between chronic and the acute stage of a stroke. It would beneficial to learn and see the effects of a client with more potential to return to a full independent level. The second suggestion being to increase the treatment session frequency. This change could provide adequate time to see progressions and improvements within the clients of study. In a study about the efficacy of RAS, the treatments were conducted four plus times each week, so to get an accurate depiction of the effects it would be recommended to treat more frequently. Another suggestion for future studies would be the ability to compare two different neurologically impaired

groups. One group would be the control where they receive only physical therapy interventions while the other group receives the interdisciplinary treatment between physical therapy and music therapy. This could provide better results on the effectiveness of the combination treatment and potentially provide the world with a new evidence-based physical therapy technique for patient interventions with neurological impairments.

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