# The Combined Effects of Physical Therapy and Music Therapy on an Older Adult with Chronic Left-Sided Hemiparesis: A Case Report

by

Nicholas Holkup, B.G.S., SPT
University of North Dakota, 2017

Scott Syverson, B.S., SPT
University of North Dakota, 2017

Cindy Flom-Medland, PT, PhD, NCS (Faculty)
University of North Dakota

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This Scholarly Project, submitted by Nicholas Holkup and Scott Syverson 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.

_____

(Graduate School Advisor)

_____

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## ACKNOWLEDGEMENTS

The patient described in this case report signed an Educational Experience Volunteer Release and Informed Consent Form, allowing information gathered from participation in treatment sessions to be released and used for education purposes by The University of North Dakota's Department of Physical Therapy without any identifying information. All patient confidentiality has been maintained, and Health Insurance Portability and Accountability Act (HIPAA) policies have been upheld.

The writers recognize and thank Lauren Sullivan, SMT, for her participation in treatment interventions, Cindy Flom-Meland, PT, PhD, NCS for her faculty supervision of treatments and the writing of this report, and the patient for his willingness to participate in our interventions and subsequent case report.

## ABSTRACT

**Background and Purpose***:* Stroke and other disorders that involve the neurological system can have adverse effects such as hemiparesis, spasticity, hypertonicity, and gait and balance deficits. Due to neurological disorders being so prevalent, proper rehabilitative treatments are necessary to return to a functional lifestyle. Multiple approaches across the therapy spectrum have been utilized, but rarely are these therapeutic approaches completed concurrently among different disciplines. The purpose of this case report is to address the interdisciplinary co-treatment by students of music therapy and physical therapy on a patient exhibiting chronic left-sided hemiparesis.

**Case Description:** This case report describes a 56-year-old male patient who exhibits chronic left-sided hemiparesis and spasticity following two tumor resections from his right frontal lobe over the span of the past twelve years. These symptoms greatly affect his gait biomechanics and muscular endurance with activity.

**Interventions:** Treatment was done by utilizing pre-gait and gait activities along with rhythmic auditory stimulation, or the use of external rhythmical cueing, to help aid in symmetrical and reciprocal movements bilaterally. Tests and measures used to examine functional changes included the Timed Up-and-Go,

the Five-Time Sit-to-Stand, Berg Balance Scale, Two-Minute Walk Test, Short-Form 36 and GAITRite® pre- and post-intervention data.

**Outcomes and Discussion:** The patient was improved his scores on the TUG, FTSST, and BBS tests. However, no significant differences were found in pre-and post-test data for the Short Form 36, 2MWT or GAITRite®. Subjectively, it was evident the patient's confidence and mechanics during all tests and measures had improved. This suggests that patients with chronic hemiparesis may improve function when incorporating both music and physical therapy rehabilitation efforts.

# CHAPTER I

## BACKGROUND AND PURPOSE

Hemiparesis is associated with multiple health issues such as stroke, cerebral palsy, brain tumors, and many other neurologic injuries or disorders[1,2]. It can also be an adverse effect of brain surgery. Nearly 800,000 people in the United States suffer from having a stroke annually, which is one of the most common causes of hemiparesis. Consequently, 80% of stroke victims have some degree of muscular weakness[2]. Since hemiparesis affects such a large population in the United States, having adequate rehabilitation treatments to improve these patients' quality of life (QoL) is crucial. Stroke rehabilitation is often a multidisciplinary approach, which can involve medical doctors, physical therapists (PT), occupational therapists, and speech and language pathologists. Movement pattern difficulties, weakness for large muscle groups affecting daily activities, and gait patterns are areas most often addressed by PTs. Many different therapeutic interventions, including music therapy (MT), have been shown to improve hemiparesis.

Music therapy has been a well-documented form of treatment for stroke rehabilitation, particularly for improving gait parameters and sequencing of tasks in patients suffering from hemiplegia or hemiparesis. Most often this treatment comes in the form of Rhythmic Auditory Stimulation (RAS) and focuses on gait

training, which is also a major component of PT treatment. RAS is the use of rhythmic sensory cueing from an external stimulus in the form of music in order to perform tasks or movements along an evenly-timed template. The emphasis of RAS is to eliminate asymmetries in bilateral movements; which, in this case, is gait for a patient with hemiparesis. The mechanism to which RAS acts is an auditory-motor synchronization to result in even, functional motor output. The external rhythm serves as a time reference for continuous and anticipatory movements[3]. As an example, the patient will walk to an external rhythm from music and/or a metronome, taking a step on each beat in order to have equal movements side-to-side.

RAS has been shown to improve gait parameters and balance when performed post-stroke in a patient with hemiparesis. Specifically, research has reported that RAS can improve plantar flexion at heel strike, knee flexion during mid-stance, side-to-side gait[3], velocity, stride length, cadence, swing symmetry[4,5], overall stability[6] and greater scores on the Dynamic Gait Index[7]. In general, increased success has been documented when RAS is performed more frequently throughout the day and week. Literature supports at least 30 minutes of RAS 3-5 times per week for 4-6 weeks in order to see significant differences in the gait parameters previously listed[3-8].

Although gait training using RAS has shown positive improvements, it usually only addresses the hemiplegic/hemiparetic lower extremity and does not take into account the hemiplegic upper extremity post-stroke. A majority of RAS literature focuses on gait training, and there seems to be limited research on the

use of RAS for the upper extremity. However, literature has indicated that functional pushing and pulling movements in a rowing motion done with RAS has been shown to improve range of motion and strength in the affected upper extremity[9,10].

In the existing literature, RAS is typically used in adjunct with other interventions and is rarely used on its own. Routine PT gait training and neurodevelopmental training (NDT) have commonly been used as adjuncts with RAS. Though there has been a useful amount of research completed on MT treatments with PT rehabilitation, few studies have been completed investigating pre-gait activities in conjunction with MT. These activities would break down the movement patterns of gait into smaller components such as stepping or lunging in place, weight shifting, and toe-tapping up onto a step to an external auditory rhythm. Most existing literature about RAS and gait addresses hemiparesis/hemiplegia in the acute or post-acute stages, rather than in a chronic situation of greater than 6 months.

The purpose of this case report is to address the interprofessional co-treatment by students of MT (SMT) and PT (SPT) on a patient exhibiting chronic left-sided hemiparesis. The treatment will utilize pre-gait and gait activities in conjunction with RAS. The goal of this report is to bridge gaps in the existing literature with regards to chronicity, pre-gait activities and frequencies of treatment as previously explained. During this case study, a lower treatment frequency of 1 hour per week for 12 weeks was used, as compared to what has been used in previous research. This was due to time constraints in scheduling

for both the students and patient along with what was needed to meet academic standards for the coursework this report was a part of. Improving the subject's antalgic gait and increasing his overall QoL was the main focus of treatment. Treatment for the patient's hemiplegic left UE was a secondary focus of our treatment, particularly prolonging endurance of movement prior to onset of spasticity. This patient was treated by two SPTs and one SMT under direct supervision of a licensed PT and MT.

# CHAPTER II

# CASE DESCRIPTION

## Examination

The patient presented in this case study is a 56-year-old Caucasian male who exhibits left-sided hemiparesis and spasticity following a tumor resection from his frontal lobe 12 years prior. After this initial resection, he was experiencing seizures up until 2 years ago, at which time he had a second resection completed. No seizure activity has since been reported. However, he still exhibits chronic hemiparesis and spasticity in his left upper and lower extremity. He has completed suggested acute and outpatient physical therapy treatments and has also been a patient at the student-led pro bono clinic at the University of North Dakota Department of Physical Therapy for many years.

Even though he has participated in rehabilitation throughout his recovery process, he continues to have weakness, increased tone, and spasticity in both his left upper extremity (UE) and lower extremity (LE). As a result, he presents with an antalgic gait favoring his left LE, including a prolonged swing phase and decreased step length, stride length, stance time and single-leg support time on his left. To correct this, he uses a single-point cane (SPC) and a functional electrical stimulation device (i.e. Bioness), which provide mild improvements in his gait.

The patient's left UE exhibits a tendency to stay in the flexion pattern of internal shoulder rotation, elbow and wrist flexion, and forearm pronation, as is typical following an upper motor neuron injury such as stroke. This UE is quick to fatigue, which causes an increase in spasticity with movement.

The patient currently lives in a handicap-accessible, three-level home with multiple staircases. The house was designed with these multiple staircases to aide him as a part of his rehabilitation. The house also includes a home gym consisting of strength machines, balance equipment (i.e. BOSU ball, balance boards), cardiovascular equipment (i.e. treadmill, elliptical), and a railing to allow him to perform standing exercises safely. If additional assistance is needed for safety or any other purposes, his wife, children, and grandchildren also live in the home.

The patient is a highly motivated individual which allows for modified independence with his activities of daily living (ADLs). However, since he lives with his family, assistance is always available when needed. His high level of motivation can also be a risk factor to him, as sometimes he will work past the point of fatigue and risk his own safety unintentionally. He does have some limitations with moderate or vigorous activities, lifting objects, bending/kneeling, and walking long distances. He also does not feel comfortable driving independently anywhere other than his residential neighborhood.

The patient is retired. He had previously been in the Armed Services and also worked for the University of North Dakota in the Information Technology

Department. In his free time, he enjoys spending time with his grandkids, listening to music, and exercising in his home gym.

## Tests and Measurements

The tests and measures utilized in this case study included the Short Form 36 Survey Instrument (SF36), Timed Up-and-Go (TUG) test, Cognitive TUG test, the Berg Balance Scale (BBS), the Two Minute Walk Test (2MWT), a Five Times Sit-to-Stand (FTSST) measure, and a GAITRite® evaluation. These tests and measures were taken at both the first and last treatment sessions to determine if there were any significant changes as a result of the concurrent PT-MT treatment. The pre- and post-intervention results for these tests can be found in Table 1, the results for the SF36 in Table 2, and GAITRite® information in Table 3, which can all be found at the end of this report.

The Berg Balance Scale (BBS) has been the most commonly used assessment tool for rehabilitation across the entire stroke continuum and has consistently shown excellent internal consistency, interrater and intrarater reliability, and test-retest reliability[11]. The 2MWT has also shown excellent inter- and intrarater reliability when being used to evaluate walking after a stroke[12]. The TUG has been proven to have excellent test-retest reliability when used on patients with chronic hemiparesis after stroke[13]. The FTSST has shown excellent test-retest reliability along with excellent intra- and interrater reliability[14]. Lastly, the SF36 has been proven to be a valid measure of both mental and

physical health for individuals following a stroke[15], and was the assessment chosen by the researchers to measure QoL.

The patient underwent an evaluation on the GAITRite® machine, which measures various gait parameters with high accuracy. These results can be found in Table 3. It was found that the left LE has a much longer swing phase compared to his right LE. He also has a decreased stance phase and single-leg support time on his left LE compared to his right. Overall, there is a large decrease in step length and stride length bilaterally. By observation, the SMTs also noted his foot clearance is limited on the left LE along with a circumduction motion of the hip to clear his left LE during the swing-through phase of gait.

## Systems Review

The neuromuscular system is the most affected system after the tumor resection, which is evident based on his hemiparesis and spasticity. Movement of the left UE and LE has an asymmetry when compared to the right side. There are minor deficits in functional task completion, such as a mild decrease in balance, gait and transfer variations, and increased work in completion of these tasks. Therefore, with use of his Bioness and SPC, he exhibits modified independence in his ADLs. All communication ability is normal, and there are no known issues regarding the cardiovascular/pulmonary or integumentary systems.

## Evaluation

The patient responded well to all tests and measures. Along with the findings previously described, he exhibits a mild deficit in balance when

performing transfers and 360° turns as he allows his center of mass to fall outside his base of support.

Problem List:

- Left-sided hemiparesis
- Gait deficits (i.e. circumduction, foot drop, balance)
- Active and passive range of motion limitations of joints in left UE and LE (i.e. shoulder, elbow, wrist, metacarpophalangeal, hip, knee, and ankle). These were not formally measured because of difficulty maintaining joints in certain positions due to increased tone and spasticity.
- Overall reduced muscular endurance, UE has greater limitation

## Prognosis and Plan of Care

The clinical impression of the SPTs confirms and coincides with the medical diagnosis and what was found in the history, examination, and evaluation process. It was determined that the patient is appropriate for MT and PT co-treatment because of the proven benefits found in the already-existing literature.

Initial long-term and short-term goals from the evaluation are listed below. The purpose of these goals was to decrease spasticity and increase ROM and strength in the hemiparetic left UE and LE. Additional goals were aimed at improving gait abnormalities and asymmetries found during the examination process. Driving independently was one of the patient's personal goals, as well as improving his ability to get up from the floor. Unfortunately, due to time constraints, these goals were not addressed during this study.

Short-Term Goals (To be met in 3 weeks):

1. The patient will shift weight evenly through his hips and touch the top of 4 inch box with his right foot to the tempo of 30 bpm and be accurate at least 80% of the time to progress towards normalized gait pattern.
2. Patient will step to rhythm of at least 68 bpm with 80% accuracy for improved gait mechanics to allow him to safely ambulate stairs in his home and community.
3. Patient will demonstrate understanding following performance of two lower and upper extremity strengthening exercises, each to be performed with his home gym equipment as a supplement to any HEP given during sessions

Long-Term Goals (To be met in 12 weeks)

1. The patient will increase left single-leg support by 10% of total gait cycle, measured by the GAITRite® device, to improve gait mechanics and overall community ambulation.
2. The patient will improve his BBS score from 48/56 to 53/56 in order to increase unilateral LE balance and weight bearing activities and decrease risk of fall.

## CHAPTER III

## INTERVENTION

The patient participated in therapies once a week for 12 weeks. Initially, treatments were variable in that the interventions were changed each session until a simple, systematic, and consistent plan was developed later in the 12-week process. All interventions involving the bilateral LEs were designed to improve left LE strength, gait parameters, and balance, which would help improve scores on all tests and measures given. All interventions performed to an external rhythm were done so by the use of an autoharp played by the SMT. The beat/rhythm was further emphasized with a metronome application on the SMT's smart phone. Before an exercise was performed, the MT student would play the autoharp/metronome for a few beats. A gait belt was applied for all activities. The Bioness was left off unless otherwise specified in the descriptions below. A minimum of standby assistance (SBA) of one student PT was given for each exercise.

**List of Interventions:**

- Gait Training with RAS:
    - The patient was instructed to step reciprocally and walk to the beat played by the SMT. His foot was to contact the floor each time the metronome and autoharp sounded. The trial was to last until the patient began to experience fatigue and/or multiple errors or

inconsistencies in the stepping were present. In general, two to three trials were performed.

- Toe Taps on Box with RAS:
    - The patient was to stand in front of a stepping box, ranging from 2-6” in height. He was to tap his toe on top of the box to the beat that the metronome/autoharp provided. In general, three trials were completed: one with the R foot only, one with the L foot only, and the third trial in a bilateral and reciprocal motion. One SPT would give handheld support for safety while the other SPT provided facilitation at the patient’s hips to promote weight bearing on the stance leg.
- Stepping Over Cones in Sequence
    - The patient was instructed to step over five cones in sequence using his left LE with his Bioness on and SPC in his right hand. This was completed with an external rhythm played on the autoharp and metronome by the SMT. Emphasis was placed on the patient flexing his left hip and knee to step over the cone, along with practicing ankle dorsiflexion and a proper heel strike. In general, three trials were performed with only the left LE each time.
- NDT Stair Training
    - The patient was instructed to ascend and descend a single set of fourteen stairs with descension performed backwards. Emphasis was placed on proper technique of hip/knee flexion and ankle

dorsiflexion. This was facilitated by a SPT's hand placement to avoid circumduction. In general, three trials of ascension and descension were performed.

- UE Coordination Training with RAS
    - While sitting, the patient was instructed to hold musical instruments in both hands and was to hit them together to the beat of a song played on the guitar by the student MT. For instance, rhythm sticks and hand cymbals were used to hit together at the midline of his body to the beat. Emphasis was placed on large movements, attempting to bring the spastic left UE into greater shoulder abduction and external rotation, elbow extension, and forearm supination. In general, one trial was performed until fatigue and spasticity set in for the left UE and/or the patient requested to terminate the exercise.
- Mirror Therapy
    - The patient was to sit in front of a standard mirror box and place his left UE into the enclosed space of the box, and his right UE into the open space with the mirror. While looking into the mirror image of his right hand, he was to perform pronation, supination, and wrist extension movements bilaterally for 15-20 repetitions of each movement.
- Sit-to-Kneeling and Kneeling-to-Sitting Transfers

    - The patient was instructed to perform transfers from sitting in a stable chair without wheels to the carpeted floor on his knees. From there, he was to face the chair, push strongly through his right UE while simultaneously turning and lifting himself onto the chair. Only one trial of this was performed throughout the 12 weeks.
- RAS with Prolonged Strides
    - The patient began in the starting position of standing upright with feet parallel to each other, shoulder-width apart. The patient was instructed to take average step/stride lengths in place to an external rhythm played on the autoharp by the SMT. He would then take an average step forward with either LE, stay in this position for another beat, and return to the starting position on the next beat. The focus was placed on prolonged weightbearing through each LE with each forward step. The patient's right hand would keep in contact with a wall for comfort and stability. One SPT would provide facilitation at the hips to promote proper pelvic rotation and hip and knee flexion of the forward leg. In general, three trials were performed: one stepping forward with the right LE only, one with the left LE forward only, and the last with reciprocal steps forward.

Some interventions were discontinued after a few treatment sessions for various reasons. Mirror therapy was discontinued after one treatment session because of time constraints; previous research has shown that large amounts of continuous time are needed to show benefits in forearm/wrist range of motion[16].

NDT stair training was also discontinued, as the patient already demonstrated adequate functional mobility in ascending and descending stairs. Stepping over cones in sequence was eventually discontinued because the same hip and knee motions could be replicated using the toe-taps on box exercise. Lastly, sit-to-kneel and kneel-to-sit transfers were discontinued after one treatment session because of time constraints along with the patient having a near-fall during one of the final attempts. In addition, the patient wished to discontinue practicing these transfers because he did not enjoy having skin contact with the rough textured carpet during the trials. Any other UE coordination training exercises apart from what is previously mentioned were discontinued, as spasticity would generally set in and not allow the patient to perform any further UE exercise with acceptable form for the remainder of the sessions.

Approximately halfway through the 12 weeks, a consistent pattern of interventions was established for each session. The final consistent pattern that would be performed each session for the remaining second half included UE coordination training with RAS, RAS with prolonged strides, toe taps on a box with RAS, and walking with RAS. This final list of interventions was modified based on the patient's advancements in strength, endurance and range of motion. Tempo for each exercise would vary based on the SPTs' and SMT's discrepancy. Most were set at 55-60 beats per minute to mimic the average walking pace of the patient noted on the GAITRite®.

Patient participation was excellent for all interventions applied. He was generally in good spirits and was willing to work very hard, try any new

interventions presented, and would go until fatigue and exhaustion set in during trials. The patient is well aware of his physiological strengths and limitations, and he performed the exercises to the best of his capabilities.

The patient tolerated all interventions relatively well, apart from a near-fall when performing kneeling-to-sitting transfers and a few minor self-corrected losses of balance throughout the 12 weeks. The only setback in intervention plan was the usage of the patient's left UE for exercise. We would normally begin the session with the UE coordination training exercise, but this would cause spasticity and tremendous fatigue in the patient's left UE for the remainder of the session and no further UE exercises would be performed.

No formal home exercise program (HEP) was given to the patient, as he was already performing an adequate amount of exercise in his home gym, including a leg press, stationary bike, and treadmill. He would also perform the previously-described exercises at home with music of different tempos playing in the background, which was his idea.

## CHAPTER IV

## OUTCOMES

After undergoing the 12 weeks of interdisciplinary treatment of MT and PT, the patient was taken through the same tests and measures that were performed during the initial sessions. This would provide the case report objective and quantitative measures to assess for improvement, which can be found in Tables 1-3. GAITRite® data with musical variables was also obtained at the end of the twelve weeks, with results shown on Table 4 at the end of the document. These variables were similar to the walking RAS intervention, with the SMT playing the Autoharp and singing. This was not done pre-intervention due to the SMT being absent during the initial GAITRite® trials.

The patient responded well to therapies overall with no real negative consequences. Only minor, non-significant improvements are noted in the tested data between the initial and final treatment. GAITRite® data revealed that the use of gait training with RAS helped even out gait parameters between the left and right LEs. However, many of these parameters still fall out of the sample normal values provided by the GAITRite® machine.

Subjectively, the patient feels his gait mechanics have improved greatly since the beginning of treatment sessions. He reported feeling stronger and more confident bearing weight through his left LE, and that some of his aches attributed to incorrect gait mechanics had decreased.

The chronicity of the left-sided hemiparesis can likely explain the lack of significant differences between pre- and post-test data. The patient still exhibits functional limitations regarding this hemiparesis, such as difficulties getting up from floor (kneel-sit transfers), altered gait patterns and increased energy expenditure in doing so.

The patient was able to meet a few goals by the final treatment session. All short-term goals previously listed were met throughout the 12 weeks of treatment with percentages measured at the SPT's discretion. Neither long-term goal was met. When using his cane with the Bioness on, the patient increased his single-leg support time on the left, however was not increased by 10% of the gait cycle as the long-term goal desired. The Berg Balance Scale final score was not able to be increased to a 53/56. However, the patient still exhibits a low fall risk with the final score obtained.

The patient was satisfied with the interventions given. He would report that regardless of what objective data showed, he did feel stronger and more confident in his walking and ability to bear weight through his left LE. He enjoyed the exercises provided, and reported that he would likely continue doing some of these interventions at home with the exercise routine he already performs independently.

# CHAPTER V

# DISCUSSION

Overall, the patient's quality of movement improved throughout the 12 week case study. This improvement, however, required focus on the motor task at hand. An example of this improved quality of movement was the patient's FTSST. Though the time values actually worsened from pre- to post-testing, the patient's quality of movement for the activity improved. He executed a more controlled, safer movement. The 2MWT was another example of the improved quality of motion. It is worth mentioning that the patient walked a similar distance during this test after the 12 weeks of intervention, and he did this with improved motion.

The tests and measures that did improve were all variations of the TUG and his BBS. His TUG scores improved based on both numerical values and movement quality. This improved quality of movement will enhance overall safety when performing ADLs and other functional activities he performs on a regular basis. It should also be noted that he did have a one point increase on the BBS. Although he initially was rated in the "low fall risk" category based on the standardized scoring for the BBS, in theory, he was at an even lower risk of falling following the course of intervention. This one-point improvement was gained in the "Standing on One Leg" category for his left LE. Initially, the patient was unable to lift his right foot from the floor independently. After treatment, he

was able to lift his right foot from the floor independently for less than three seconds, which allowed him to gain one more point.

Previous research has also found that RAS yields improved quality of both segments of the gait cycle (i.e. swing symmetry, stability, etc.), and the quality of the gait cycle as a whole (i.e. functional assessment scores)[3-8]. The patient in this study showed improved quality of all movements performed when he focused on the task. Each pre-gait activity he completed throughout treatment improved slightly, which lead to an increased functional capacity mentioned above.

## Reflective Practice

Based on the outcomes observed, loosely performing similar treatment sessions to what were consistently performed in the final six to eight weeks of this case study would be recommended. Rather than performing six to eight gait exercises per treatment session, performing three to four exercises for longer duration was shown to be more beneficial. It would be beneficial to learn if patients with similar symptoms and/or diagnoses have had any previous experience with music therapy and if they would be interested in incorporating it into their rehabilitation. Learning the answers to these questions will determine if incorporating music therapy would be an acceptable form of treatment. Other information that would be useful to know as the therapist treating similar patients would be when their spasticity seems to be the worst, what “triggers” their muscle tone, and how much time they would be willing to invest in their treatment.

Another way the evaluation process can be improved is by using the same functional assessments for these patients that have been used in prior research. Other factors that would determine the patient's rehabilitation potential would include both their motivation and socioeconomic status. Attending both physical and music therapy sessions can be expensive. The cost of physical therapy can be cut slightly if the patient is highly motivated and is compliant with their home exercise program, whereas a proper music therapy session requires a music therapist to be present. Though these therapies are expensive, regaining functional abilities is priceless. Seeing the positive outcomes that were acquired by a patient who had chronic hemiparesis only improved the authors' opinions about multidisciplinary approaches. There are many different ways to treat each pathology, and utilizing the minds of multiple disciplines will often benefit the patient. Multidisciplinary approaches are an area that not only physical therapists, but all medical professionals should embrace and incorporate more into their practices.

## Limitations and Future Research

The main limitations for this case study were time-based. Previous research studies using RAS to improve gait training performed treatment sessions 3-5 times per week. This increased treatment time has yielded significant positive results. This lack of time limited not only the physical aspect of rehabilitation, but also the psychological aspect. Music therapy can address psychological aspects of an individual, but due to the lack of time, this area was

unable to be addressed. The amount of time since the onset of symptoms is another area that limited results. The patient was more than 12 years out of his initial surgery that caused his left-sided hemiparesis and spasticity. This amount of time could have limited the amount of improvement that was possible, especially with regards to the left UE spasticity and limited endurance.

Another item that limited this particular research study was the patient's current functional state. He was a highly motivated individual, was active, and had been dedicated to his rehabilitation process since the onset of symptoms. His improved functional status, though desirable, decreased the possibility of significant results from our interventions.

Other limitations included a lack of experience the student therapists had with patients of this disease-state. None of the students involved had spent any significant amount of time or practice in a neurological rehabilitation setting.

Because UE rehabilitation ability is often decreased in patients with hemiplegia or hemiparesis, this would benefit from further research using the interdisciplinary approach with both MT and PT. Another area of future research is determining the minimal amount of treatment time per week that is necessary to elicit beneficial responses during gait and other functional movements. For example, performing two 90-minute treatment sessions per week to determine longer sessions less often could change RAS's effects. It should also incorporate other music therapy techniques, similar to techniques used in this study while performing the toe tapping exercise. Another useful area of investigation could be incorporating music therapy techniques into PT exercises/techniques for teaching

proper sit-to-stand, kneel-to-sit, and floor-to-stand transfers. Future research should continue to investigate the effects of pre-gait exercises in conjunction with music therapy techniques on the gait cycle.

# APPENDIX

UNIVERSITY OF NORTH DAKOTA
DIVISION OF RESEARCH & ECONOMIC DEVELOPMENT

UND.edu

**Institutional Review Board**
Twamley Hall, Room 106
264 Centennial Dr Stop 7134
Grand Forks, ND 58202-7134
Phone: 701.777.4279
Fax: 701.777.6708
Email: UND.irb@research.UND.edu

June 21, 2017

| | |
|---|---|
| **Principal Investigator(s):** | Cindy Flom-Meland, PT, PhD, NCS |
| **Project Title:** | The Effect of Collaboration of Physical Therapy and Music Therapy for Individuals with Neurologic Health Conditions |
| **IRB Project Number:** | IRB-201706-371 |
| **Project Review Level:** | Exempt 4 |
| **Date of IRB Approval:** | 06/21/2017 |
| **Expiration Date of This Approval:** | 06/20/2020 |

The application form and all included documentation for the above-referenced project have been reviewed and approved via the procedures of the University of North Dakota Institutional Review Board.

If you need to make changes to your research, you must submit a Protocol Change Request Form to the IRB for approval. No changes to approved research may take place without prior IRB approval.

This project has been approved for 3 years, as permitted by UND IRB policies for exempt research. You have approval for this project through the above-listed expiration date. When this research is completed, please submit a Termination Form to the IRB.

The forms to assist you in filing your project termination, adverse event/unanticipated problem, protocol change, etc. may be accessed on the IRB website: http://und.edu/research/resources/human-subjects/

Sincerely,

Michelle L. Bowles, M.P.A., CIP
IRB Coordinator

MLB/sb

Cc: Chair, Physical Therapy

The University of North Dakota is an equal opportunity / affirmative action institution

**University of North Dakota Exempt Certification Form – SEPTEMBER 2015 VERSION**
**Research Involving Existing Records or Data**

**Complete this form if you are requesting permission to review existing records or conduct analysis of existing datasets.**

All research with human participants conducted by faculty, staff, and students associated with the University of North Dakota, must be reviewed and approved as prescribed by the University's policies and procedures governing the use of human subjects. No activities are to be initiated without prior review and approval by the Institutional Review Board.

**Please answer the following questions regarding your research. Handwritten forms are not accepted – responses must be typed.**

1. **Are the data existing? Existing means the data are 'on the shelf' (i.e., they were collected prior to this research proposal).** ☒ **Yes** ☐ **No**

If you answered "No" to the above question, this research does not qualify as exempt. Please fill out and submit a "Human Subjects Review Form". If you answered "Yes", continue to question 2.

2. **Will there be any contact with the subjects?** ☐ **Yes** ☒ **No**

If you answered "Yes" to the above question, this research does not qualify as exempt. Please fill out and submit a "Human Subjects Review Form". If you answered "No", continue to question 3a.

**3a. Are the data publicly available?** ☐ **Yes** ☒ **No**

If you answered "No" to the above question, please continue to question 3b. If you answered "Yes", **skip** question 3b and provide the information requested below.

**3b. Will the data be documented in a manner that subjects cannot be identified, either directly or through identifiers linked to the subjects (e.g., subject name, social security number, birth date, coding, etc.) ?**
☒ **Yes** ☐ **No**

If you answered "No" to the above question, this research does not qualify as exempt. Please fill out and submit a "Human Subjects Review Form". If you answered "Yes", please provide the information requested below:

If the research involves the use of audio, video, digital or image recordings of subjects, this research does not qualify as exempt. Please fill out and submit a "Human Subjects Review Form".

**Principal Investigator:** Cindy Flom-Meland

Telephone: 701-777-4130 E-mail Address: cindy.flom.meland@med.und.edu

Complete Mailing Address: SMHS stop 9037, 1301 North Columbia Road, Depart of PT suite 321

School/College: SMHS Department: PT

**Student Adviser (if applicable):** _____

Telephone: _____ E-mail Address: _____

Address or Box #: _____

School/College: _____ Department: _____

**** All IRB applications must include a Key Personnel Listing*

**Project Title:** The Effect of Collaboration of Physical Therapy and Music Therapy for Individuals with Neurologic Health Conditions

**Proposed Research Beginning Date:** May 2017

***Exempt research will be approved for 3 years from the original approval date.***

9. **If data are not publicly available, please provide a letter of support from the agency, or IRB approval from the agency.**

10. **Describe procedures you will implement to protect confidentiality and privacy of participants.**

11. **If the project involves medical record information, complete the HIPAA Compliance Application and submit it with this form.**

**Necessary attachments:**

- ☐ Signed Student Consent to Release of Educational Record Form (students and medical residents only);
- ☐ Investigator Letter of Assurance of Compliance;
- ☐ Key Personnel Listing;
- ☐ Advertisements.

**NOTE: The UND IRB requires that all key personnel involved in the research complete human subject education before IRB approval to conduct research can be granted.**

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By signing this form, I certify that the above information is accurate, and that this research will be conducted in accordance with the statements provided above. The investigators will not intervene or interact with identified research subjects in the conduct of this research project.

Cindy Flom-Meland 6-1-17

(Principal Investigator) Date:

(Student Adviser) Date:

***All students and medical residents must list a faculty member as a student adviser on the first page of the application and must have that person sign the application.***

Submit the signed application form and any necessary attachments to the Institutional Review Board, 264 Centennial Drive Stop 7134, Grand Forks, ND 58202-7134; or bring it to Twamley Hall, Room 106.

4. In non-technical language, briefly describe the purpose of the study and state the rationale for this research.

The purpose of this study is to evaluate the outcomes of three clients that received collaborative physical therapy and music therapy as part of PT 590 Directed Studies course during the spring semester of 2017. The pre- and post-test results of the Readiness for Interprofessional Learning Scale (RIPLS) Questionnaire, completed by the physical therapy and music therapy students, will also be evaluated to examine any change in attitude of the students towards interprofessional learning.

5. In non-technical language, describe study procedures.

The outcome data will be reviewed, analyzed, and utilized in 2 ways. 1). To describe a model of inter-professional collaboration as a potential curriculum model 2). To analyze the outcomes of each client and to inform a potential larger study in the future.

6. What is (are) the type(s) of records to be reviewed (medical records, data sets, etc.)?

Outcome data collected at the beginning and at the end of the course for each of the clients will be reviewed and compared to observe for any improvement in function (i.e. walking parameters, balance, fall risk, quality of life)

7. Describe what data will be recorded, including the date range of the files/records you will be reviewing.

The data reviewed will be from January to April 2017. It will include outcome data from the following standard physical therapy tests: Berg Balance measure, 5 times sit to stand, timed backwards walking (including distance), Timed Up and Go, Timed Up and Go Cognitive, gait parameters (with use of GaitRite – sensor mat that measures speed, step length, stride length, etc., and quality of life).

8. How will data be stored?

The data will be stored in a locked storage area in the Department of Physical Therapy at the University of North Dakota. Records from the study will be destroyed using a paper shredder three years following the conclusion of this study.

9. If data are not publicly available, please provide a letter of support from the agency, or IRB approval from the agency.

Not applicable.

10. Describe procedures you will implement to protect confidentiality and privacy of participants

The outcome data will not be linked to any individual person; identifying information will not be utilized in any reporting procedures or written documents.

11. If the project involves medical record information, complete the HIPAA Compliance Application and submit it with this form.
Not applicable.

**Table 1: Pre- and Post-Intervention Data of Functional Tests and Measures**

| Test/Measure | Initial Result (Pre-Test) | Final Result (Post-Test) |
|---|---|---|
| TUG with cane | 20.34 seconds | 17.65 seconds |
| TUG without cane | 25.04 seconds | 20.82 seconds |
| Cognitive TUG with cane | 27.07 seconds | 24.08 seconds |
| Cognitive TUG without cane | 25.84 seconds | 22.09 seconds |
| Berg Balance Scale | 48/56 (low fall risk) | 49/56 (low fall risk) |
| Two Minute Walk Test | 279.11 feet | 256.90 feet |
| Five Time Sit-to-Stand | 13.50 seconds | 15.62 seconds |

**Table 2: Pre- and Post-Intervention Outcomes of the Short Form 36 Survey Instrument**

| Scale Category | Pre-Test Results | Post-Test Results | Normative Data for Chronic Stroke |
|---|---|---|---|
| Physical Functioning | 60 | 55 | 48 |
| Role Limitations Due to Physical Health | N/A | 0 | 76 |
| Role Limitations Due To Emotional Problems | 100 | 100 | 83 |
| Energy/Fatigue | 80 | 80 | 56 |
| Emotional Well-Being | 92 | 100 | 77 |
| Social Functioning | 100 | 100 | 86 |
| Pain | 100 | 77.5 | 76 |
| General Health | 100 | 45 | 64 |

**Table 3: GAITRite® Pre- and Post-Intervention Data**

| Gait Parameter | Mean Outcomes 1/24/2017 | Mean Outcomes 4/25/2017 | Sample Normal Values |
|---|---|---|---|
| Step Time (sec) | 1. **L**=1.072; **R**=.600<br>2. **L**=1.119; **R**=.559<br>3. **L**=1.103; **R**=.584<br>4. **L**=.857; **R**=.485 | 1. **L**=1.122; **R**=.653<br>2. **L**=1.119; **R**=.586<br>3. **L**=1.224; **R**=.822<br>4. **L**=0.904; **R**=.494 | 0.53-0.59 sec |
| Swing Time (%GC) | 1. **L**=38.2%; **R**=22.2%<br>2. **L**=42.8%; **R**=23.0%<br>3. **L**=43.5%; **R**=26.0%<br>4. **L**=42.3%; **R**=28.2% | 1. **L**=39.7%; **R**=22.6%<br>2. **L**=38.7%; **R**=20.6%<br>3. **L**=37.3%; **R**=28.7%<br>4. **L**=42.3%; **R**=26.7% | 36-44% GC |
| Stance Time (%GC) | 1. **L**=61.8%; **R**=77.9%<br>2. **L**=57.2%; **R**=77.0%<br>3. **L**=56.5%; **R**=74.0%<br>4. **L**=57.7%; **R**=71.8% | 1. **L**=60.3%; **R**=77.4%<br>2. **L**=61.4%; **R**=79.4%<br>3. **L**=62.8%; **R**=71.4%<br>4. **L**=57.7%; **R**=73.3% | 56-64% GC |
| Single Support Time (%GC) | 1. **L**=22.5%; **R**=37.7%<br>2. **L**=23.5%; **R**=41.8%<br>3. **L**=26.1%; **R**=43.2%<br>4. **L**=28.6%; **R**=41.6% | 1. **L**=22.5%; **R**=39.9%<br>2. **L**=20.4%; **R**=39.1%<br>3. **L**=28.2%; **R**=38.0%<br>4. **L**=26.7%; **R**=42.4% | 38-42% GC |
| Double Support Time (%GC) | 1. **L**=41.7%; **R**=38.7%<br>2. **L**=36.3%; **R**=33.1%<br>3. **L**=31.8%; **R**=30.5%<br>4. **L**=27.9%; **R**=28.1% | 1. **L**=39.2%; **R**=.37.6%<br>2. **L**=36.9%; **R**=39.6%<br>3. **L**=33.1%; **R**=34.4%<br>4. **L**=31.1%; **R**=30.8% | 16-24% GC |
| Step Length (cm) | 1. **L**=44.226; **R**=36.915<br>2. **L**=45.143; **R**=38.856<br>3. **L**=52.122; **R**=46.869<br>4. **L**=60.111; **R**=55.970 | 1. **L**=43.145; **R**=35.856<br>2. **L**=41.695; **R**=31.343<br>3. **L**=41.640; **R**=41.818<br>4. **L**=55.497; **R**=50.393 | 58-85 cm |
| Stride Length (cm) | 1. **L**=80.285; **R**=80.091<br>2. **L**=86.419; **R**=82.275<br>3. **L**=98.982; **R**=98.795<br>4. **L**=116.075; **R**=116.097 | 1. **L**=79.718; **R**=79.122<br>2. **L**=74.442; **R**=73.271<br>3. **L**=84.374; **R**=83.468<br>4. **L**=110.36; **R**=105.185 | 116-170 cm |

1: No bioness/no cane/normal walking pace
2: Bioness/no cane/normal walking pace
3. Bioness/cane/normal walking pace
4. Bioness/cane/fast walking pace

L= Left lower extremity
R=Right lower extremity
GC=Gait Cycle

**Table 4: GAITRite® Post-Intervention Data with Music Variables**

| Gait Parameter | Mean Outcome 4/25/2017 | Sample Normal Values |
|---|---|---|
| Step Time (sec) | 1. L=1.252; R=.818<br>2. L=1.011; R=1.106<br>3. L=1.330; R=0.840 | 0.53-0.59 sec |
| Swing Time (sec)/%GC | 1. L=37.8%; R=25.9%<br>2. L=30.3%; R=30.5%<br>3. L=36.8%; R=26.4% | 36-44% GC |
| Stance (sec)/%GC | 1. L=62.2%; R=74.2%<br>2. L=69.7%; R=69.5%<br>3. L=63.2%; R=73.6% | 56-64% GC |
| Single Support (sec)/%GC | 1. L=26.4%; R=37.1%<br>2. L=31.5%; R=29.3%<br>3. L=27.2%; R=35.7% | 38-42 % GC |
| Double Support (sec)/%GC | 1. L=35.9%; R=35.4%<br>2. L=36.7%; R=34.8%<br>3. L=36.2; R=35.4% | 16-24% GC |
| Step Length (cm) | 1. L=43.799; R=43.071<br>2. L=42.999; R=40.222<br>3. L=47.126; R=42.620 | 56-85 cm |
| Stride Length (cm) | 1. L=86.567; R=88.382<br>2. L=83.721; R=82.167<br>3. L=89.475; R=90.608 | 116-170 cm |

1. No Bioness/Cane/Normal Walking Pace/No Music
2. No Bioness/Cane/Normal Walking Pace/ Music Only
3. No Bioness/Cane/Normal Walking Pace/Music and Voice

R=Right Lower Extremity
L=Left Lower Extremity
GC=Gait Cycle

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