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The Effectiveness of Aquatic Therapy with Persons Who Have Experienced a Cerebral Vascular Accident

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THE EFFECTIVENESS OF AQUATIC THERAPY WITH PERSONS WHO HAVE EXPERIENCED A CEREBRAL VASCULAR ACCIDENT

by

Heather L. Tweedie

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Heather L. Tweedie
THE EFFECTIVENESS OF AQUATIC THERAPY WITH PERSONS WHO HAVE EXPERIENCED A CEREBRAL VASCULAR ACCIDENT

Heather L. Tweedie, M.S.
Western Michigan University, 2005

This study examined the effectiveness of using aquatic therapy (AT) as a technique in the treatment of cerebral vascular accidents (CVA). The unique properties of the aquatic environment were manipulated to determine change in range of motion, muscle tone, balance, functional ambulation, and psychological functioning particularly social relationship and positive and negative feelings.

A single subject design was conducted using two subjects that participated in a twelve week aquatic therapy program. Aquatic therapy showed to be effective in treating common symptoms of a CVA. More research needs to be completed to ensure the effectiveness of aquatic therapy in congruency with the stroke population. AT demonstrated to be a safe and productive treatment modality for the variables tested.
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CHAPTER I

INTRODUCTION

Background of Study

Cerebral vascular accident (CVA), or stroke, is the most common diagnosis seen by occupational therapists (Bierman & Atchison, 2000). Stroke is defined as “an interruption in the blood flow that causes an inadequate supply of oxygen and nutrients to reach portions of the brain” (Bierman & Atchison, 2000, p.122). As of 2000, stroke was the third leading cause of death in the United States, surpassed only by heart disease and cancer. At least 500,000 people suffer from a stroke each year. Out of the 2 million that have experienced a stroke, it is estimated that only 10% fully recover, leaving 40% with a mild disability, and 50% severely disabled, requiring around the clock care (Bierman & Atchison, 2000).

There are some common effects on the body and the mind that are seen with someone who has experienced a stroke. Many lose voluntary movement and control of one side of the body, called hemiplegia. A client with hemiplegia may present with an asymmetrical posture, have difficulty sustaining or maintaining balance, neglect the impaired side of the body, and lack sensation in one or more extremity. Impairments in vestibular processing may be present which will limit mobility and safety. If a client has impaired balance they may have difficulty with vertical postures due to gravity and
difficulty adjusting to position changes. When attempting ambulation, the client may lean or fall to the hemiplegic side, demonstrating an absence of normal protective reactions. Sensory impairments can affect basic levels of modulation, processing, and awareness of input. Communication disorders are also common. These clients may have difficulty with speech comprehension or verbalization. Persons with CVA may experience psychological changes including depression, loss of interest, anxiety, and inability to withstand stressful situations. All of these common problems impact a person’s occupational performance. They are faced with a new lifestyle where their movement or speech may be limited, leading to a loss of quality of life and hopelessness about the future (Bierman & Atchison, 2000).

Traditional stroke rehabilitation has included a variety of approaches. Biomechanical techniques are used to increase muscle strength and endurance through basic exercise. Neurodevelopmental treatment reinforces normal movement patterns by correcting abnormal movement and giving sensory input to promote movement in the affected muscles. Another popular technique is the rehabilitative approach, in which the client learns new ways of completing their activities of daily living to regain independence. Constraint induced movement therapy is another common approach. This entails restraining the non affected upper extremity to force use of the affected extremity. While these traditional approaches are widely used by rehabilitation professionals, the aquatic therapy (AT) approach is one that may offer an effective complimentary approach. However, AT is not widely used with the stroke population but is considered a promising practice by therapists who utilize the modality with other populations.
Definition of Terms

According to Fischer, Kratz, Jimenez, Watson, Spence, Sanford, Goertz, & Scolaro (2001) aquatic therapy is defined as the use of water as a context in which interventions are delivered for rehabilitation purposes. As noted earlier, some of the common effects of a stroke are limited active (AROM) and passive (PROM) range of motion, abnormal muscle tone, impaired balance, reduced functional ambulation, and problems in psychological functioning. Active range of motion (AROM) is the “amount of movement possible at a joint when the patient voluntarily moves the limb by muscle contraction” (Podolski, C., & Trombly, C. 2002, p. 48). Passive range of motion (PROM) is the “amount of movement possible at a joint when an outside force moves the limb” (Podolski, C., & Trombly, C. 2002, p. 48). When a client has lost the ability to move a limb through a full range of motion any functional activity becomes difficult to achieve. By submerging the body into water they are able to relax and move through a fuller ROM which in turn strengthens the muscles targeted to increase functional land use, meaning daily activities performed on land.

According to Bass-Haugen and Mathiowetz (2002), muscle tone is the resistance of a muscle to passive elongation or stretching. Many people who have experienced a stroke may present with high tone in which the extremity is in a range from slight to rigid tension. Tone can be difficult to normalize on land due to the powerful forces of gravity.

“Balance is the ability to maintain an upright posture against the dynamically changing effects of gravity on our body segments” (Sabari, 2002, p. 509). When treating someone with hemiplegia, it is difficult for him to find their center of balance or gravity,
due to sensory and motor impairments on one side of their body. His balance becomes a safety concern and makes movement and functional activities difficult.

"Functional ambulation is the purposeful application of the mobility training taught to the client to enable movement from one position or place to another" (Adler, C., Creel, T., Lillie, S., Tipton-Burton, M., 2001, p. 173). With balance and muscle tone impairments, ambulation or mobility of any kind becomes a challenge.

According to Mosey (1996), psychological function is strongly influenced by the emotional or feeling part of human experience, psychological functioning refers to the process of using information from past events and information currently available from the environment in such a way as to view oneself, others, and one's life situation realistically. When a client is in the water for the first time and realizes the simplicity of movement he develops increased self worth and confidence of skills they thought were forever lost.

Purpose of the Study

The purpose of this study was to explore the effectiveness of Aquatic Therapy with persons who have experienced a stroke. There are only a few reports of the effectiveness of AT in the literature studying the stroke population, and an inadequate amount of research in the field of aquatic therapy with individuals who have had a stroke.
The research that is available is limited mainly to persons with multiple sclerosis and arthritis.
CHAPTER II

LITERATURE REVIEW

Introduction

Background of the Problem

The number of aquatic therapy publications has grown dramatically since the mid 1980's. The aquatic special interest section of the American Physical Therapy Association has produced a bibliography containing more than 334 articles pertaining to the therapeutic use of water. Closer examination of the list reveals that most of these publications are anecdotal in nature. Only 30% of the articles listed are descriptions of research activities and one third of these are research reports of patient outcomes resulting from aquatic therapy programs (Morris, 1995). As stated earlier there is a small body of literature describing the effects of aquatic therapy on stroke recovery. A majority of the articles reviewed pertain to range of motion, strength, balance, ambulation, and psycho-social status. The variables reviewed are similar to the variables in this study; however, the populations vary.

According to Broach and Datillo, in 1996 improvements associated with aquatic therapy have been observed for many people with disabilities including individuals with multiple sclerosis, cystic fibrosis, spinal cord injury, arthritis, orthopedic impairments, cerebral palsy, acquired brain injury, ALS, developmental disability and autism. Although stroke was not mentioned other central nervous system disorders were, these
disorders may present with similar deficits, such as limited ROM, abnormal tone, impaired balance and ambulation, and psychological functioning.

History of Aquatic Therapy

The application of AT for therapeutic purpose dates to the ancient Greek civilization by Hippocrates in 400 BC with reports that therapeutic baths were prescribed although the effects were unknown. In the seventh century, doctors in Europe began to explore the effects that water had for people (Fees, Lehman, and Goldberg, 1998). In the 1920’s pool therapy was pioneered by Charles Lowman, an orthopedic surgeon and founder of the orthopedic hospital in Los Angeles. These early programs focused on orthopedic and neurological conditions. The treatments emphasized stretching, strengthening and pain reduction (Morris, 1995). The Roosevelt Warm Springs Institute for Rehabilitation was founded in 1927 by former president Franklin D. Roosevelt. Due to his personal struggle with polio he received aquatic therapy to provide relief and strengthen his weakened muscles. This institute continues to be famous for its warm, mountain spring-fed therapeutic swimming pools. This was the nation’s first rehabilitation center for children and adults with severe disabilities (Fun and Leisure: From Visit to Vision: A New Dream for Georgia Warm Springs, 2004.). In the 1960’s and 1970’s there was a decrease in popularity for AT as rehabilitation professionals were becoming more interested in mechanical and electronic sources for therapeutic purposes. However, during the 1980’s AT became popular once again as a way to complement other modalities used in rehabilitation. Prior to this time physiotherapists in Europe had conducted research on the efficiency of AT, developing water treatment approaches,
which has influenced the development and serve as a guideline for the programs in the United States. In 1992 the American Physical Therapy Journal established an aquatic physical therapy section to define and set standards for AT treatment in America (Morris, 1995).

Properties of Water

The aquatic environment is therapeutically rich with the properties of viscosity, frontal resistance, buoyancy, and hydrostatic pressure. “Water physics contribute to the therapeutic potential of treatment in the water and create an environment that often is more conductive to achieving therapeutic goals than some land based exercise” (Broach & Datillo, 1996, p.41). “The aquatic environment allows clients to engage in meaningful occupations that may otherwise be difficult or impossible during land based treatment” (Fischer, M., Kratz, A., Jimenez, B., Watson, C., Spence, C., Sanford, T., Goertz, H., & Scolaro, M., 2001, p.15). Therapy performed in the water gives the individual the chance to master functional activities. A therapy program can begin earlier and is more effective in strengthening muscle imbalances. It is important to understand the properties and laws that coincide with the aquatic environment to increase the effectiveness of aquatic therapy.

In 1996, Broach and Datillo hypothesized that with the combination of the water’s physical properties and the prescribed activity, AT creates a unique environment to produce many physiological benefits. “Viscosity refers to the friction between molecules of liquid or gas, causing the molecules to tend to adhere to each other (cohesion) and in the water to a submerged body (adhesion)” (Lindle, Wasserman, &
Water is more viscous than air due to the resistance. Walking through the water is compared to walking through a wind storm. “Viscosity assists movement while creating a slight resistance against movement. This increases strength, stabilizes a limb through ROM, and increases response time for equilibrium responses” (Esraghi, 2003, p.59).

“Frontal resistance results from horizontal forces of water” (Lindie et al., 2001 p.117). While on land the primary force acting on the body is the downward vertical force of gravity. The bigger the frontal surface area of an object, the more energy is required to walk through it. An example would be sidestepping, which creates less of force because of the decreased surface area. Walking forward with arms out at the side increases the frontal resistance due to more surface area (Lindle et al., 2001). Water has approximately twelve times the resistance of air so walking in the water is more beneficial to increase muscle strength and facilitate proper gait than walking on land.

“Archimedes Principle is the loss of weight of a submerged body equals the weight of the fluid displaced by the body”, (Lindle et al., 2001 p.119-120) which determines buoyancy. Buoyancy is an upward vertical force that is a key concept in aquatic therapy. “Buoyancy decreases the effects of gravity by allowing more independence. It decreases weight bearing and it’s impact on the joints and spine, improves functional abilities, helps decrease muscle guarding, improves clients handling and produces a more comfortable therapy session” (Esraghi, 2003 p.59). Buoyancy aids the client to assume an upright supported position earlier in their rehabilitation process that may not be possible on land. With more support there is less handling by the therapist. This allows the client to move more independently through the water.
“Hydrostatic pressure is the pressure exerted by molecules of a fluid upon an immersed body” (Lindle et al., 2001 p.121). Pressure will increase with depth and the fluid density of water. Hydrostatic pressure has a positive affect on internal organs, aids in venous return, and helps to decreases swelling and pressure. It promotes circulation and prevents blood from pooling in the lower extremities. It also helps strengthen and assist with exhalation directly effecting speech production. “The hydrostatic pressure and viscosity of water gives the individual 14 times more somatosensory feedback than air, therefore providing information about where body parts are in relationship to one another and how the body is moving through the water” (Styer-Acevedo, 2004, p.7). “Sound understanding of the physical properties and hydrodynamics of water enables the occupational therapist to prescribe aquatic interventions that best address the client’s needs. Placing the client in a gravity free environment of the pool represents an automatic adaptation of the client’s total environment” (Garrett, 1994, p.57).

Variables

Range of Motion

“Aquatic therapy provides physiological and psychological benefits, develops lifetime leisure skills, and promotes a healthy lifestyle” (Broach & Datillo, 1996 p.38). “Training for a complex activity such as walking requires more than just strength training. It is equally important to reinforce the correct pattern of muscle recruitment” (Petrofsky et al. 2002, p.8), which makes it easier to achieve functional activities. With a reduction in tone, extremities can mimic smooth fluid movement in the water. The
extremities become more flexible and with the increased support will lead to greater ROM. Some clients lack full AROM due to weakness. The water allows the muscles to be strengthened without the force of gravity and results in a greater AROM.

In 1998, Johnson's study examined the beneficial effects of two previously unreported aquatic exercise routines on the recovery of upper extremity movement and function. Their study involved four patients who were referred to aquatic therapy by their physicians. The purpose of the study was to investigate the benefits of two exercise routines using a ball and wand. These exercises were designed to help regain function of the affected upper extremity of someone who has had a stroke.

Within-subjects comparisons between pre and post-treatment were conducted using the Wilcoxon matched pairs signed-rank test. Baseline measures were taken from the patients functional evaluations by the physician, social worker, physical, occupational, and speech therapists prior to aquatic therapy. Data were collected from the investigators, daily progress notes and a self-report by the patient. These data were compiled into two main categories: 1) performance level of exercises, using a ball and wand, which were coded according to the investigators and 2) return of independence with activities evidenced by the Frenchay Activities Index (FAI) completed by the patient. Comparing the pre and post-tests the investigators found improvements in all four patients. The results of the FAI showed patients raw scores improved from 15-35 to 31-50; however, the reliability and validity of the measurements with the exercises using the ball and wand were uncertain. Another downfall was that there was not an objective physical measure specific to the upper extremity to determine if the exercises using the ball and wand were effective. The researcher only used the daily therapy notes to record
progress along with the FAI. The FAI is an objective measure of daily living skills however does not specifically measure upper extremity progress. It was not clear if they piloted their measurement, which would have been helpful. Another limitation of this study was using other healthcare employees’ functional assessments of the patients, which may alter the reliability.

Suomi & Lindauer (1997) wanted to ascertain the effect of the Arthritis Foundation Aquatic Program (AFAP) exercises on strength and range of motion measures in women with arthritis. Persons with rheumatoid arthritis experience muscle atrophy, reduced muscle strength, and a decrease in ROM. This research was not looking to find the effectiveness of specific exercise associated with arthritis but if the mode of exercise used was effective.

The study consisted of 68 aquatic based exercises designed to increase ROM, strength and mobility. All instructors were certified through the AFAP. The sample age range included women between 45-70. Thirty women met the inclusion criteria, twenty were placed in the experimental group while the control group consisted of the remaining ten. The frequency of the treatment was three forty-five minute sessions a week for six weeks.

The Nicholas Manual Muscle instrument was used to test the isometric muscle strength of the participants. A 13 inch goniometer was used to determine AROM. Joints of the shoulder and hip were selected for the ROM assessment. They used a standard protocol, conducted identically each time measurements were taken. A pretest and posttest were taken to measure the changes, one week prior to treatment and one week post treatment. The results for hip strength and ROM for the experimental group showed
a significant increase in strength and ROM compared to the control group. Shoulder strength and ROM showed no significant changes. The shoulder in this study was not submerged, meaning the environmental effects of the water were not utilized. The water may not have been deep enough to submerge the shoulder. This may have been an error in the study. The results of this study validated the AFAP effectiveness for increasing strength and ROM of submerged joints.

Templeton, Booth, and O’Kelly (1996) studied the effects of aquatic therapy with rheumatoid arthritis (RA). The purpose of this study was to objectively determine whether people with RA experienced change in joint flexibility and functional ability post aquatic therapy treatment. They also wanted to find out whether the change in joint AROM correlated with the change in levels of assistance, pain, and difficulty experienced while functioning in activities of daily living (ADL). This study used the self reporting Functional Status Index to record meaningful functional status change using aquatic intervention. The participants’ AROM were measured using a goniometer. Thirteen participants were selected. Measurements were taken prior to the beginning of aquatic therapy intervention and eight weeks after. A multivariate analysis of variance was conducted to study the hypothesis. The frequency of treatment was twice a week for eight weeks for forty-five minute sessions.

The results showed a significant difference with active ROM and mean changes in overall functional status. Data obtained indicated a decrease in pain, and increased functional ability of the subjects. These findings support the research hypothesis that aquatic therapy is an effective rehabilitation technique for increasing overall joint flexibility and functional ability, and that the joint flexibility change inversely correlated
with the functional status change. A limitation to this study was that method of recruitment was not discussed. They also neglected to mention the severity level of their participants, only that they lived independently.

Kendrick, Binkley, McGettigan, & Ruoti (2002), examined the effects of water exercise for improving strength and endurance for adults in rural and urban areas. Suburban and inner-city cohort groups volunteered in the study to participate in either a 10 or 12 week aquatic program. Participants were required to get medical clearance prior to start of the program. Prior to the beginning of the study participants were measured in grip strength, bicep curls, bench press, leg press, knee flexor and extensor peak torque and muscular endurance.

This study used a quasi experimental design with cohort groups to analyze the data using an ANOVA. Right and left hand grip, bicep curls, leg press, knee flexor and extensor peak torque improved significantly by the end of the study. The results of the study showed both ten and twelve week groups to be effective in improving both upper and lower body strength and endurance. One limitation to the study was the different research time for each group. To increase the validity, the researchers needed to conduct the same protocol for each group. There was also a cultural bias, the inner city group may not have access to the same resources as the suburban group with regards to the equipment used for measurements to gain a baseline and measure progress.

Muscle Tone

Tonal changes have been noted due to the increased water temperature. Garrett (1994) suggests that simple immersion in a therapeutic pool, with its neutral warm
temperatures of 92-96F acts to reduce central nervous system tone, thus relieving the effects of spasticity. The increased water temperature also helps to promote muscle relaxation and decreases rigidity, which in turn enhances muscle strength and joint mobility. A recent study by Petrofsky, Connel, Parrish, Lohman, & Laymon (2002) speculate that by increasing muscle temperature, internal friction in muscles will be lowered and it will be easier to move. With the reduction of spasticity the client will be able to move more freely and through a fuller range of motion. The warm water also aids in soothing pain and stiff joints to allow treatment to begin earlier and progress faster than on land.

Balance

Douris (2003) hypothesized that exercise in the water can slow the speed of falling, secondary to the properties of viscosity and density, allowing an individual with impaired balance more time to detect postural errors that might lead to a fall. With extra time to detect a fall the client may be able to retrain their brain in less time then when they are on land. Water is also a safer, more effective environment for balance training.

Douris conducted a study in 2003 to research if aquatic therapy is more effective than traditional land therapy for improving balance. Ruoti and Associates described the support offered by water as allowing more independent upright postures. They proposed that in water there may be an increase in afferent stimulation from greater cutaneous inputs, that muscles may be more freely firing, as patients are less fearful of movement, and that activity in the water may facilitate vestibular input. The authors hypothesized that exercise in the water may be more effective for clients with musculoskeletal
impairments, significant joint pathology, and keeping physically active to impact balance ability.

There were 12 subjects total, 6 exercised in the water and 6 on land. All subjects met the requirements for inclusion and exclusion criteria. The exercise protocol for the pool was as follows: walking activities which included; walking and marching forward, sidestepping, and tandem walking all for 11 feet for each activity. Other activities in the water included: marching in place, hip flex/extension, abduction/adduction, toe heel raises, shallow knee bends, and sit to stand activities. They attended 12 sessions within 6 weeks. They administered a two group pretest – posttest design using a mixed model 2x2 ANOVA. The Berg Balance Scale was used as a progressive measure. The results of the study showed that balance improved in both groups, however, they concluded that postural control improved greatest in the aquatic group. Also the aquatic group improved significantly in strength, body sway, and forward reach. A few limitations to the study included the small amount of time for the duration of the study and small sample size. The measures used in this study may not have been sensitive enough to show the true effectiveness of the study and/or aquatic therapy.

Suomi & Koceja (2000) carried out a study to assess the reliability of postural sway in women with lower extremity arthritis to ascertain the affects of an aquatic exercise treatment program on these measures. The purpose of this investigation was to determine the effects of aquatic therapy on this population measuring postural sway using the two-legged stance test. This study wanted to represent a sample population of people attending arthritis aqua classes. Twenty-seven women met the inclusion criteria for the study and were randomly assigned to a group, 17 in the experimental and 10 in the
control group. The participants were tested with the static two-legged stance with vision and then a trial without vision. The treatment the experimental group received was the standard protocol for the AFAP which consist of 68 aquatic exercises. The frequency of treatment was three times per week for forty-five minutes for a duration of six weeks. The effects of aquatic exercise were analyzed by repeated measures ANOVA using a planned comparison approach with an independent 2X2 design.

Results indicated the aquatic group made significant reductions in their total sway area and their sway in the medial lateral direction using full vision, and reduced their total sway area and their sagittal and medial-lateral sway with vision occluded. The reliability data collected indicated that the two-legged stance test is a reliable measure to assess balance in women with lower extremity arthritis. The data collected in this study was easy to understand and assessable for use in the clinical setting.

Functional Ambulation

Morris, Buettner, and White conducted a study in 1996 to establish if community based exercise programs for people who have had strokes were effective. The program consisted of community members joining a class focused on exercises specific for the stroke population. There has been research conducted on community based exercise programs for populations of arthritis, chronic pain, multiple sclerosis, and general deconditioning. Prior to this study there has been no previous research for community based exercise programs in the aquatic environment for people with stroke.

They conducted an ABAB single subject treatment withdrawal design. Three male subjects participated in the study, meeting three criteria. To obtain a baseline they
collected data using the functional reach test and the Footswitch Stride Analyzer. The results of the study showed positive effects on the participant’s gait velocity, stride length, single-limb stance time and possibly balance. Some limitations to this study were the amount of time collecting data in the water, small number of subjects, and confusing data analysis. With design improvement and then replication, this research design could potentially yield useful data for clinical application.

Alexander, Butcher, & MacDonald (2001), examined the effects of a twelve week community based water exercise program on gait, flexibility, strength, self-reported disability, and other psych-social measures of 32 older adults with arthritis. The frequency of treatment was twice a week for twelve weeks. Repeated measures ANOVA were used to determine the differences in scores between the pre- and post-test for each variable. They used the Canadian Arthritis Society’s Water Works program for their sessions. All classes were instructed by certified arthritis fitness instructors.

To collect their measures they used gait filming and film analysis. Each participant was filmed on an indoor track to analyze gait. The gait variables measured were; stride length and time, step length and frequency, average velocity, stance and swing time, height of toe clearance, stride width, vertical displacement and peak horizontal velocity of center of mass. Three types of kinematic variables were determined 1). Segment inclination displacement, 2).Joint displacement and 3).Angular velocities. Other measures included flexibility, the sit and reach test, grip strength, self reported disability using the Health Assessment Questionnaire, psycho-social measures using the Medical Outcomes Study Form Health Survey, and pain was measured using the Medical Outcomes Survey-Pain Index.
An ANOVA was used to determine the differences between the pre and posttests of each variable. The results of the biomechanical gait variables showed that participants improved significantly in both stride length and step length following aquatic exercise. The kinematic gait variables resulted in the inclination of the two lower limb segments increasing significantly, ROM of the lower leg during ambulation, and hip and shoulder ROM also increased significantly. With the flexibility and strength measures, two of the measures improved significantly, the third measure increased following the three months. However, it was not of significance. For the psycho-social, self-reported disability decreased significantly. Based on the results of the study, the authors recommended water exercise for persons with arthritis. One limitation to the study was keeping track of the numerous measurements collected throughout.

Stowell, Fuller, & Fulk (2004), studied the effects of aquatic and land based therapy to improve functional mobility for an individual with a spinal cord injury. The participant in this study was a 20 year old male with an incomplete C6 spinal cord injury. The subject received therapy two times a week for 4 months that included land and water therapy. Traditional land treatments consisted of sit to stand transfers and full weight bearing activities with a walker. Water therapy consisted of lower extremity exercises, supine facilitation exercises, gait training in deep and waist level water depth. The study conducted an ABA single subject design.

The measurements consisted of an ambulation assessment, manual muscle testing, and EMG measurements. The improvements seen after four months were sit to stand transfers, the participant progressed to minimal assistance of one therapist, improved ambulation by 28 ft using a walker and minimal assistance of one therapist, and overall
improvements in combined EMG lower extremity measurements from both land and water. Results of this single subject study showed significant increases in functional mobility. This case study also described the potential clinical benefits of incorporating aquatic therapy with land based treatment. Stowell, Fuller, & Fulk, feel the aquatic environment provided an additional therapeutic option designed to facilitate maximum stimulation of the spinal cord locomotion circuitry. They found deep-water reciprocating activities, gait training in waist deep water, and supine reciprocating isolation exercises all mimicked the reciprocating reflexive motion of ambulation. Since both therapy modalities were used it was hard to tell which was more effective. However, the patient received a year of land based therapy prior to AT and hit a plateau. One can assume it was because of the aquatic therapy that this participant continued to progress; however, this is a limitation.

Psychological Function

Broach and Dattilo (1996) propose that psychological benefits of participants in aquatic therapy have been identified to include improved mood, enhanced self-esteem and body image, and decreased anxiety and depression. Morris (1995) believes that the ability to perform more advanced functional skills and to move more independently provides psychological benefits including motivation and self-esteem. Being comfortable in the aquatic environment can aid to achieve confidence in functional independence. “The ability to participate in more occupational activities outside of the water increases as a direct result of increased endurance and relaxation, reduced pain and higher self-esteem gained from engaging in water based activities” (Fischer et al., 2001, p.15).
According to Kacavas, Morrison, and Hurley (1977), the advantages of the pool are two-fold. From a physical viewpoint the client gains increased motion, flexibility, and resistive exercise in the water. From a psychological point the client experiences satisfaction from being able to complete an activity with as little assistance as possible.

Summary

There have been benefits documented for aquatic therapy however minimal with the stroke population. Review of the literature has revealed aquatic therapy to be an effective treatment modality when treating clients with deficits in ROM, ambulation, balance, ADL’s, and psychological functioning.

Garrett (1994) commented that in the last few years aquatic therapy has become a popular intervention to promote an individual’s return to functional activities. However, there is a lack of research on its effectiveness for persons with stroke. Given that this diagnosis is cited as most frequently treated in occupational therapy, there should be a wide range of well researched treatment approaches (AOTA, 1997). It was the aim of this pilot study to determine if aquatic therapy had a positive effect on ROM, muscle tone, balance, functional ambulation, and psychological functioning particularly with regards to social relationships and positive and negative feelings.
This study was completed to answer the question “What is the effectiveness of aquatic therapy on ROM, muscle tone, balance, functional ambulation and psychological functioning particularly social relationship and positive and negative feelings among persons with stroke?”
CHAPTER III

METHODOLOGY

Recruitment

A convenience sample was used to recruit the participants from Marion R Spear’s Occupational Therapy outpatient clinic, located on Western Michigan Universities campus which was operated by a registered occupational therapist (OTR) and occupational therapy fieldwork students. The clinic population consisted mainly of clients with stroke. Participants were required to match certain criteria for participation. Inclusion criteria included people with stroke, hemiparesis, increased muscle tone, impaired balance and ambulation, and limited ROM. Excluded from the study were people with moderate to severe cognitive impairments, incontinence, respiratory difficulty, and open wounds. If cognitive functioning was suspected, the Mini Mental examination was conducted to screen for impairments. A medical chart review was conducted to screen for recruitment. This included reviewing their most current evaluations and documentation of treatment sessions. The evaluations included information on balance status, ROM, ambulation, sensation, visual perception, muscle tone, cognition, functional independence with regard to activities of daily living, and emotional status. Clients that met the criteria through a chart review were contacted by phone with information about the study. If they agreed to learn more, they were sent the
informed consent document (see appendix 1). A time was arranged to meet to go over the form with the potential participant and the caregiver. The form was read to them and they were given a copy. Questions about the document followed. Two subjects agreed to participate in the study.

Participants

Participant number one was 62 year old man who had a stroke in April of 2002. He spent 6 weeks in the hospital due to complications following the stroke; pneumonia, and seizures. Following hospitalization he continued treatment in an inpatient rehabilitation facility for 2 months. After returning home he received outpatient therapy for 8 weeks. He continued to present with deficits in proprioception, vestibular processing, apraxia, right side neglect and hemianposia. Upon discharge from outpatient rehabilitation, due to suspended reimbursement, he was referred for continuing occupational and speech therapy at Western Michigan University’s Marion R Spears outpatient Adult Clinic and the Van Riper Speech Clinic. On initial evaluation, it was determined that he continued to require maximum assist transfer, was unable to get in the shower, and was dependent for dressing. He was once again eligible for reimbursement at a local hospital outpatient clinic for 3 months receiving occupational and physical therapy while continuing to receive treatment at the Unified Clinic. The only medical history prior to his stroke was being diagnosed with type II diabetes. Following his stroke he became insulin dependent. The medications he receives are as follows: Coumiden for stroke prevention, Dilatin for seizures, Vanaflex and Bachlofin for muscle spasms,
Lopressor and Bigoxin for the heart, insulin for diabetes, and Effexor which is an antidepressant. Since November of 2003 after outpatient treatment was completed, an occupational therapist was providing treatment in the client's home as a replacement for the Unified Clinic. Prior to AT he was transferring with minimal to moderate assistance, was able to get in the shower using a shower bench with moderate assistance, required setup for UE dressing, was able to use the computer, and was demonstrating improved cognition evidenced by the ability to perform calculations and follow complex directions.

Participant number two was a male 72 years old who experienced a stroke on August 4th 1997. After leaving the hospital he attended inpatient rehabilitation for 7 weeks and followed with two months of outpatient rehab. He had been attending the Van Riper speech clinic on Westerns campus for 5 years. He began exercising independently in a public pool for ambulation exercises 4 years prior to this study. He had also been attending the Marion R Spears outpatient occupational therapy for approximately one year. Prior to his stroke he had back surgery from a fall in 1990, effecting his lumbar vertebrae 4 and 5. He had high cholesterol and triglycerid. He also had flat feet that were painful during weight bearing and as a result walked on the outsides of his feet. The medications he receives are as follows: Coumiden, Triptel to prevent seizures and muscle spasms, Gemfibrozil for cholesterol and triglycerid, Fosinopril and Hydrochlorothiazide for hypertension, and a diuretic. Following his stroke he presented with expressive aphasia, and required maximum assistance for transfers and ADL's. Presently his is able to complete ADL's with minimal assistance and transfers are stand by assist, but unsafe. He had used compensatory strategies to accommodate his needs; however, most are unsafe.
Procedures

The frequency of the treatments included one-hour sessions, twice weekly for twelve weeks at an indoor, outpatient physical rehabilitation clinic. Both participants were receiving land based occupational therapy treatment in conjunction with the aquatic therapy. Participant number one was being treated three times a week and participant number two was being treated two times per week for land based occupational therapy. Both received speech therapy two days a week. The traditional occupational therapy treatment focused on weight bearing techniques to facilitate normal patterns of movement, exercises to correct muscle imbalances, and activities to increase independence with activities of daily living. The student investigator was not always the primary therapist for the participants’ land sessions. The aquatic therapy was the experimental treatment and included guided exercises in the pool to assist with ambulation, postural tonal changes, joint mobility, and balance improvements. Each participant received therapy appropriate for their current functional level.

Exercises in the water were similar to those on land and included those used to promote balance such as standing with or without support, sitting or straddling a noodle, ambulating with resistance provided, reaching for objects out of their center of gravity, and participating in activities such as volleyball. It should be noted that with all activities the intensity of the activity could be increased by providing turbulence. According to Lindle 2001, turbulence is disturbed or disputed water flow. ROM and activities for tonal changes were mostly completed in supine, with guided exercises from the therapist.
Relaxation techniques were used to promote a decrease in tone in order to facilitate full ROM with an extremity. Ambulation activities included walking in all directions forward, backward, sideways, and grapevines which is walking sideways crossing one leg over the other. Weights and buoyant cuffs on the participants’ ankles were used to stimulate and strengthen the hip flexors and extensors and challenge equilibrium reactions. In the deep water, participants used a noodle for balance and in order to float, with weights on ankles to promote and strengthen normal gait patterns. Other activities included sit to stand transfers using the stairs and walking up and down the stairs to increase independence in the home.

Data Collection and Analysis

The research method used was a quantitative, quasi-experimental single subject ABA design. In addition to the pretest and posttest, repeated measures were employed every three weeks to measure progress. Progress was measured by comparing the test results to their baseline and repeated measures. Visual analysis using graphs and tables were used to determine if the experimental treatment was effective.

Instruments and Measurements

Goniometry

Baseline measures included a series of pretests prior to entering the pool. These measures were conducted in the participant’s home by the student investigator. For the
purpose of this study joints of the upper extremity that were chosen for measurement included; shoulder, elbow, and wrist. In the lower extremities hip and knee measurements were taken (see appendix 2). Measurements were taken on the extremities extremities of both subjects, their unaffected sides were within functional limits. To measure ROM active and passive, a goniometer was used. Movements chosen for measurement of the shoulder were: flexion, extension, abduction, horizontal abduction/adduction, and internal and external rotation, elbow flexion/extension, wrist flexion/extension, hip flexion/extension, and abduction/adduction, and knee flexion/extension. PROM was only measured if there was no AROM.

**Modified Ashworth Scale**

The Modified Ashworth Scale, a scale for measuring the degree of spasticity, was used to note tonal changes (see appendix 3). Mathiowetz, & Bass-Haugen (2002), note the resistance encountered to passive movement through the full available range was rated on a five point scale ranging from no increase in muscle tone to limb rigid in flexion or extension. There have been several studies of the reliability. Bohannon and Smith reported an interrater reliability coefficient of .85, which supports the use of this modified scale for assessing elbow flexors with CNS dysfunction. Despite its limitations of validity, the Modified Ashworth scale is the best available measure of muscle tone and the most widely cited in the literature. Both subjects presented with increased tone in the right upper extremity.
**Berg Balance Scale**

To assess balance the Berg Balance Scale (BBS) was used (see appendix 4). According to Douris (2003), the BBS is an ordinal scale of balance that is well validated and reliable, it is straightforward and takes less than 20 minutes to administer. Reliability has been established with the elderly and stroke patients. In addition the BBS has shown to have strong internal consistency. Shumway-Cook and Woollacott describe the BBS as the best predictor of falls status amongst community dwelling older adults. Criterion related validity of the BBS has been established by Berg and associates in 1992 using the Barthel Index of self care and mobility and the Fugl Meyer. A subject with a BBS score of 55 can be described confidently as a non-faller. The lower the BBS score, the greater the risk for falls. A person with a score below 40 is almost 12 times more likely to fall than a person with a score above 40 (Mathiowetz, & Bass-Haugen 2002).

**Functional Ambulation Measure**

The functional ambulation was measured in linear feet in the participant’s home (see appendix 5). Measurements were taken between each room in the home measuring the distance required to travel to reach the destination. The participant was asked to ambulate through the home. The amount of assistance needed and the devices used for ambulation were recorded. Clinical observations of gait, weight bearing, and weight shifts for normal gait patterns were also recorded.
Burden of Stroke Scale

Emotional status was measured with regards to social relationships and positive and negative feelings using the Burden of Stroke Scale (BOSS) (see appendix 6). The only domains included from this scale were Domain 6: Social relationships and Domain 8: positive and negative feelings. The BOSS is a health-status assessment instrument designed to measure patient-reported difficulty in numerous domains of functioning and psychological distress associated with specific functional limitations and general well-being in stroke survivors. A study conducted by Doyle, McNeil, Hula, and Mikolic in 2003 established validity of the BOSS to be moderate in strength and statistically significant.
CHAPTER IV

RESULTS

Introduction

Visual analysis was used to determine the significant changes through the course of the study. The independent variable was the aquatic therapy treatment. The dependent variables in this study were ROM, tone, balance, functional ambulation, and psychological functioning, particularly looking at social relationship and positive and negative feelings. The measurements were taken at three week increments throughout the duration of twelve weeks.

Range of Motion

Subject One

Subject one had no active movement in his right upper extremity, according to ROM measurements taken passively as noted below in figure 1. All shoulder measurements showed an increase from 9 degrees to 59 degrees between baseline and final measures. External rotation and horizontal abduction demonstrated a dramatic increase to full PROM by week twelve.
Normal elbow range is 0 at full extension to 150 at full flexion. While subject One began the study with full extension, elbow flexion increased a total of 60 degrees flexion by week twelve. Refer below to figure 2 for details.
Figure 2 Subject One Elbow PROM

Both flexion and extension of the wrist increased as a result of the treatment as noted below in figure 3.
For the lower extremity the joints of the right hip and knee were measured. At pretest hip adduction, abduction, and extension were only measured passively due to no active movement noted. Refer to below figure 4 for passive hip measures. Hip extension remained the same passively for pretest and week three at 10 degrees. By week six, extension was measured actively for a total increase of 10 degrees by week twelve. For the first two weeks adduction was measured passively and by week six had reached active movement. By the end of the study adduction had reached full active range. Abduction showed a steady increase passively until week twelve, when the measurement
was taken actively at 30 degrees. Flexion was measured actively throughout the entire study and demonstrated an increase of ten degrees. (Refer to figure 5 for active measure details)

Figure 4 Subject One Hip PROM
Knee extension was measured passively and remained constant throughout the study. Flexion was also measured passively and yielded an increase of 10 degrees. Please refer to figure 6 for details.
Subject Two

Subject two presented with a mix of active and passive movements. All measurements were taken for the right extremities. Joints of the shoulder, elbow, and wrist were measured. Shoulder flexion, horizontal adduction and abduction, and inter/external rotation were measured passively (Refer to figure 7). All movements showed an increase in PROM. Internal and external rotation reached full passive range by week twelve.
Extension and abduction were measured actively (refer to figure 8). Both movements demonstrated increases in AROM throughout the treatment.
Elbow extension – flexion range was at full PROM at pretest and remained the same throughout most of the study (Refer to figure 9). However, elbow range decreased by 30 degrees at week twelve.
Figure 9 Subject Two Elbow PROM

Wrist flexion demonstrated a steady increase of 15 degrees passively throughout the study. Extension also increased for a total of 10 degrees by week twelve (Refer to figure 10).
The joints of the hip and knee were measured for lower extremity ROM. All movements in the hip were active. Refer to figure 11 for details about hip AROM. Each movement yielded increases, however flexion and abduction demonstrated significant increases. Flexion increased by 60 degrees and abduction by 41 degrees.
Figure 11 Subject Two Hip AROM

Knee extension remained at full PROM throughout the study (Refer to figure 12).
Knee flexion was measured actively and a 15 degree increased was noted (Refer to figure 13).
The Modified Ashworth Scale was used to measure tone. Passive range of motion measurements of the shoulder, elbow, wrist, and digits of the right upper extremity were completed for both subjects.
Subject One

At pretest all of subject one’s measurements showed a marked increase in muscle tone through most of ROM, with no evidence of contractures. Throughout the study the shoulder, elbow and wrist measurements demonstrated a decrease in tone. The digits remained the same through the twelve weeks (Refer to figure 14).

Figure 14 Subject One Tone
Subject Two

For subject two a decrease in tone was noted in all motions except for elbow movement. By week twelve there was no increase in muscle tone noted with movement in the shoulder. Digital tone decreased significantly ending the study at only a slight increase in muscle tone (Refer to figure 15).

**Figure 15 Subject Two Tone**
Balance

Subject One

The Berg Balance scale was used to determine balance status. Subject one showed a significant increase in balance scores ranging from a raw score of 18 at pretest to 31 at week twelve. There was a steady balance improvement noted throughout the study (Refer to figure16).

Figure 16 Subject One Balance
Subject Two

Subject two’s balance status showed a significant increase in stability. His pretest raw score of 23 increased to 39 at posttest. Overall subject two’s balance scores increased by 16 points (Refer to figure 17).

Figure 17 Subject Two Balance
Subject One

Functional ambulation was measured by the distances between rooms in the subject's individual homes. There were a total of nine distances measured in subject one's home between each room in the house, measuring doorway to doorway. Two measures remained the same throughout the study while the other seven decreased in the amount of assistance needed to ambulate through the home. At pretest the assistance levels ranged from maximum assistance to minimal assistance, by week twelve levels ranged from moderate assistance to supervision. Overall there was a decrease in assistance levels noted throughout the study (Refer to table 1).
<table>
<thead>
<tr>
<th>Subject one</th>
<th>10ft</th>
<th>16ft</th>
<th>17ft</th>
<th>18ft</th>
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<th>21ft</th>
<th>23ft</th>
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</tr>
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<tr>
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<td>MOD</td>
<td>MOD</td>
<td>MAX</td>
<td>MIN</td>
<td>MIN</td>
<td>MOD</td>
<td>MOD</td>
<td>MOD</td>
<td>MIN</td>
</tr>
<tr>
<td>3wks</td>
<td>MOD</td>
<td>MOD</td>
<td>MOD</td>
<td>MAX</td>
<td>MIN</td>
<td>MOD</td>
<td>MOD</td>
<td>MOD</td>
<td>MIN</td>
</tr>
<tr>
<td>6wks</td>
<td>MIN</td>
<td>MIN</td>
<td>MIN</td>
<td>MOD</td>
<td>MIN</td>
<td>MOD</td>
<td>MOD</td>
<td>MAX</td>
<td>MIN</td>
</tr>
<tr>
<td>9wks</td>
<td>MIN</td>
<td>MIN</td>
<td>MOD</td>
<td>MIN</td>
<td>CGA</td>
<td>MOD</td>
<td>MOD</td>
<td>MOD</td>
<td>CGA</td>
</tr>
<tr>
<td>12wks</td>
<td>CGA</td>
<td>MIN</td>
<td>MIN</td>
<td>MIN</td>
<td>S</td>
<td>MIN</td>
<td>MOD</td>
<td>MOD</td>
<td>CGA</td>
</tr>
</tbody>
</table>

MAX A = Maximum Assistance  
MOD A = Moderate Assistance  
MIN A = Minimal Assistance

Table 1 Subject One Functional Ambulation

There were seven distances measured for functional ambulation within subject two’s home. With all distances the subject began the study with minimal assistance to ambulate through the home and ending the study only requiring supervision. There was a significant decrease in assistance levels for household distances with regards to ambulation noted (Refer to table 2).
<table>
<thead>
<tr>
<th>Subject two</th>
<th>21ft</th>
<th>22ft</th>
<th>29ft</th>
<th>32ft</th>
<th>32ft</th>
<th>40ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
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<td>MIN A</td>
<td>MIN A</td>
<td>MIN A</td>
<td>MIN A</td>
<td>MIN A</td>
</tr>
<tr>
<td>3wks</td>
<td>MIN A</td>
<td>MIN A</td>
<td>MIN A</td>
<td>MIN A</td>
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<td>MIN A</td>
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<tr>
<td>6wks</td>
<td>CGA</td>
<td>CGA</td>
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<td>CGA</td>
<td>MIN A</td>
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<tr>
<td>9wks</td>
<td>S</td>
<td>S</td>
<td>CGA</td>
<td>S</td>
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<tr>
<td>12wks</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
</tr>
</tbody>
</table>

**MAX A** = Maximum Assistance  
**MOD A** = Moderate Assistance  
**MIN A** = Minimal Assistance  
**CGA** = Contact Guard  
**S** = Supervision

**Table 2 Subject Two Functional Ambulation**

**Psychological Function**

Psychological function measures were taken only at pre and posttest using the Burden of Stroke Scale. Only domain 6, Social relationships and 8, Positive and Negative feelings were used for the purpose of the study.
Subject One

For the duration of the study, subject one's responses detected that it had become more difficult to keep old friendships going and maintain roles in life. It had become less difficult to socialize with strangers. Difficulty levels remained the same for socializing with friends and family and enjoying activities with them (Refer to figure 18).

![Domain 6: Social Relationships](image)

Figure 18 Subject One Domain 6-1

Feelings of anxiety and frustration with regards to social situations increased (Refer to figure 19).
Feeling dissatisfied with themselves and life increased in conjunction to a social situation. However, this did not limit the subject from engaging in meaningful activities (Refer to figure 20).
Figure 20 Subject One Domain 6-3

Feelings of anxiety and loneliness decreased with regards to stroke while anger increased and sadness remained the same (Refer to figure 21).
By the end of the study the emotions the subject was dealing with did not affect his participation in meaningful daily activities (Refer to figure 22).
Posttest scores revealed that feelings of happiness and calmness had increased while confidence and optimism about the future remained the same (Refer to figure 23).
Figure 23 Subject One Domain 8-3

Subject Two

Throughout the study subject two felt it was more difficult to enjoy activities, socialize with friends and family, and maintain life roles. Yet he expressed having less difficulty socializing with strangers. Difficulty levels for maintaining old friendships
remained the same (Refer to figure 24).

![Graph](image)

**Domain 6: Social Relationship**

**Subject Two**

- **Socialize with friends or family**
- **Socialize with people you are meeting for the first time**
- **Maintain your role as friend or family member**
- **Keep old friendships going**
- **Enjoy leisure activities with friends or relatives**

Answers:
- 0 = Not at all
- 0.5 = A little
- 1 = Moderately
- 3 = Very
- 4 = Cannot do

**Figure 24 Subject Two Domain 6-1**

There was no change in expression of frustration, anxiety, or unhappiness with regards to social situations (Refer to figure 25).
By the end of the study difficulties in social situations were not preventing him from participating in important life events or cause him to feel dissatisfied with his life (Refer to figure 26).
Feelings of loneliness, anxiousness, and sadness decreased throughout the study while the feeling of anger remained the same (Refer to figure 27).
Figure 27 Subject Two Domain 8-1

Subject two showed no change in engaging in meaningful activities from pretest to posttest (Refer to figure 28).
Posttest scores indicated that the subject’s confidence and optimism about the future increased while feeling of happiness and calmness did not change (Refer to figure 29).
Figure 29 Subject Two Domain 8-3
Discussion

The objective of this study was to determine if AT is an effective modality for the improvement of stroke related deficits. It was hypothesized that AT can be used as a complementary therapy to increase ROM, normalize muscle tone, improve balance, ambulation, and improve social relationship and negative and positive feelings. Improvements in ROM were noted for both subjects. There were some inconsistencies within the measurements, mainly with PROM. For a few measurements PROM decreased and it was also noted during those weeks that tone increased. Meaning when spasticity is present there is resistance to movement during ranging. However, overall there was an increase noted with PROM due to decreased tone. When tone is normalized the joint is more likely to demonstrate smooth fluid passive movement. ROM measurements were taken in the subject’s home. If measured directly following the pool, additional increases may have been noted due to the relaxation of muscle tone in the warm water. It seems that due to aquatic therapy subject one had facilitated active movement in the lower extremity where previously there was no active movement noted. In the beginning of the study hip flexion was the only movement measured activity in subject one and by week twelve all movements were measured actively. This may be from a decrease in gravity
and a more supportive and less restrictive environment that joints were more easily able
to move to strengthen the muscles needed for gait patterns on land.

In both subjects tone decreased. Which is consistent with finding noted from the
literature that immersion in warm water in a therapeutic pool decreases spasticity. The
affected lower extremity was measured for ROM but not tonal changes, it would be
interesting to research in a future study to determine if there were also tonal changes
observed with an increase of ROM in the lower extremities.

Functional ambulation showed improvements with a decrease in assistance levels
for both subjects. During the measurements it seemed easier for subjects to ambulate on
surfaces such as wood and linoleum. Carpeting seemed to increase their assistance levels.
At pretest, subject one was using a sidestepper cane. By the next measurement the
sidestepper was replaced with a quad cane, which is less supportive. Subject one’s
assistance levels did not change much until mid study, when he was able to ambulate
better with less assistive device (AD) support. Not only did subject one decrease
assistance needed from a therapist but also the type of AD needed to ambulate. It
appeared difficult for subject one to turn corners and ambulate in tight spaces. Although
his quality of gait improved, his balance was tried in these difficult places in his home.
By the end of the study his endurance increased evidenced by decreased time needed to
complete measurements and decreased shortness of breath (SOB).

In the beginning of treatment in the pool the subject required two, 2 pound
weights to aid in keeping his right leg on the bottom of the pool. By the end of treatment
his hip extensors had been activated evidenced by the subject only needing one, 2 pound
weight. He was able to demonstrate proper gait techniques in the water which was
generalized to on-land ambulation.

For subject two, his assistance levels decreased and his quality of ambulation
improved. Observations were noted for improvements with equal weight bearing and
stride length. His endurance also increased, requiring fewer breaks during the testing.
Due to the supportive environment of the pool, the subjects were able to move more
freely and facilitate proper gait technique, as well as strengthen weak muscles needed for
proper gait to improve ambulation on land.

Both subjects improved balance status. Subject one began at a score of 18 on the
BBS and their interpretation of an 18 is wheelchair bound. By week twelve there was an
increase seen to 31. According to the BBS interpretation a 31 is walking with assistance.
A few components that demonstrated a significant change were transfers, standing
unsupported, standing with feet together, retrieving objects from the floor, and reaching
out of base of support (BOS). In the water the subject’s balance was noted to improve,
evidenced by less support during balance activities and decreased balanced support
during ambulation. Subject one began in the pool requiring maximum to moderate assist
with activities, by the end of the twelve weeks the same activities were used only the
subject’s assistance level decreased to minimal to contact guard assist. He was also able
to maintain static standing balance without therapist support by week twelve.

Subject two started at 23, according to the BBS is walking with assistance and
ended at 39 which is also walking with assistance. However, he was at the end range of
that category by week twelve. Some components that showed significant improvements
were standing unsupported, standing with feet together, tandem standing, retrieving
objects from the floor, and stool stepping. In the pool, subject two required moderate assistance for balance activities in the shallow end and decreased to minimal assistance by the end of treatment. Deep-water activities started at maximum assistance and decreased to minimum assistance. Throughout the treatment subject two graduated to more advanced balance activities.

Psychological status was difficult to determine in this study. The Burden of Stroke Scale, which employs a Likert scale for responding, may have been difficult for the subjects to understand. Also since this is a new assessment the validity and reliability are still being tested. The results were mixed. Some improvements were seen, as well as perceived set backs, and other answers with regards to social roles and feelings remained the same. Some personal feelings may have increased negatively due to the increased frustration of being more independent but not able to complete all activities desired. In both cases it was easier to communicate with people they were meeting in all situations for the first time. This may be due to the social atmosphere of the pool. While they were receiving therapy they were given the opportunity to socialize with others also in the pool. Observations were of increased positive mood were noted. The subjects seemed happier and more confident in their skills. This was noted through the subject’s general statements in conversation. Quantifying their feelings and difficulty with socialization may have been too difficult to comprehend using the BOSS.
Recommendations

This study demonstrated that the use of aquatic therapy had a positive effect on ROM, muscle tone, balance, and functional ambulation for two persons with stroke. Further research needs to be done with a larger sample and the inclusion of control and experimental group comparison. Measures of mobility and tone comparing immediate as opposed to delayed post-aquatic therapy are recommended as well. A further limitation of this study was the fact that both subjects were receiving land-based therapy at the same time as AT. It is possible that the changes seen in this study were due to the AT, since both subjects were observed to be making slow minimal gains in land therapy. The aquatic therapy seemed to expedite their progress. If another study was to be done, AT should be investigated alone. The psychological status measurement may not have been sensitive enough or easy to understand to show change. Finally, it is recommended that future studies include a more functional assessment of daily living skills and the subject’s perception with regards to difficulty levels of ADL’s should be used.

Summary

The results coincide with the hypothesis, AT was indicated as a successful tool for treating patients who have experienced a stroke with regard to increasing ROM, active and passive, normalizing tone, and improving balance and ambulation. Psychological functioning was difficult to determine for improvements with social relationships and positive and negative feelings. However, throughout the study
increased mood and self-confidence was noted by the investigator. Overall this study yielded positive results for using aquatic therapy to reach therapy goals.
APPENDIX A

Informed Consent
You have been invited to participate in a research project entitled “The effectiveness of aquatic therapy for persons with cerebral vascular accidents.” This study is investigating the effectiveness of aquatic therapy using the unique properties of water to conduct treatment. This is the thesis project of Heather Tweedie OTR.

You will be asked to attend 2, one-hour sessions per week for 12 weeks with Heather Tweedie OTR. Prior to starting the pool sessions a land session will be required to obtain a baseline for treatment. Then every three weeks the baseline measure will be repeated for a total of 6 assessment sessions lasting approximately one hour each at the participant’s home. These sessions are in addition to the aquatic therapy. The measures include: measuring active and passive movements, measuring muscle tone, completing the Berg Balance Scale to assess balance, completing two domains of the Burden of Stroke Scale to assess feeling states and social relationships, and functional ambulation within the client’s home. The pool sessions will begin once baseline measures have been completed. Aquatic therapy will be an addition to your traditional therapy you receive. You may refuse to participate at anytime and no negative consequences will result. Traditional therapy will continue should you decide to withdraw from the study.

As in all research, there may be unforeseen risks to the participant. If an accidental injury occurs, appropriate emergency measures will be taken; however, no compensation or treatment will be made available to you except as otherwise specified in this consent form. One potential risk of participation in this project is a pool injury. However, Heather Tweedie is a certified lifeguard and is trained to prevent and respond to any potential complications inherent in swimming activities. Another potential risk is disclosing personal psychological information and the potential for emotional reactions. Should you experience the need for follow up counseling as a result of sharing personal information, you will be referred for mental health counseling at your expense. The therapy will be provided at no additional charge to you; however you will be responsible for the cost of pool passes if you choose to pursue therapy for the study. The passes are 35 dollars per month for therapist and participant, so the total cost to you would be $105.

There are possible benefits to this research including improving balance, ambulation, joint mobility, muscle tone, and emotional status as well as increase the knowledge in general about the possible advantages of aquatic therapy for other persons. Aquatic therapy includes exercises in the water such as walking, marching, balancing on flotation equipment, and stretching. All the information collected from you is confidential. That means that your name will not appear on any papers on which this information is recorded. The forms will be coded and kept in a locked file cabinet in the office of the research advisor, Dr Ben Atchison. A separate master list with the names of participants and the corresponding code numbers will be used. Once the data are collected and
analyzed, the master list will be destroyed. Data will be retained for at least three years locked in a cabinet in Dr. Ben Atchison's office.

You may refuse to participate or quit at anytime during the study without prejudice or penalty. If you have any questions or concerns about this study, you may contact either Heather Tweedie at 773/592-4444 or 269/521-7814 or Ben Atchison at 269/387-7270. You may also contact the chair of Human Subjects Institutional Review Board at 269/387-8293 or the vice president for research at 269/387-8298 with any concerns that you have.

This consent document has been approved for use for one year by the Human Subjects Institutional Review Board as indicated by the stamped date and signature of the board chair in the upper right corner. Do not participate in this study if the stamped date is more than one year old.

Your signature below indicates that you have read/or have been explained to the purpose and requirements of the study and that you agree to participate.

<table>
<thead>
<tr>
<th>Signature of the participant</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signature of caregiver</td>
<td>Date</td>
</tr>
</tbody>
</table>

Consent obtained by:

<table>
<thead>
<tr>
<th>Initials of the researcher</th>
<th>Date</th>
</tr>
</thead>
</table>
APPENDIX B

ROM Assessment
# Range of Motion

Participants name

<table>
<thead>
<tr>
<th>Shoulder</th>
<th>PROM</th>
<th>AROM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexion</td>
<td>0-180</td>
<td></td>
</tr>
<tr>
<td>Extension</td>
<td>0-60</td>
<td></td>
</tr>
<tr>
<td>Abduction</td>
<td>0-180</td>
<td></td>
</tr>
<tr>
<td>Horizontal Abduction</td>
<td>0-45</td>
<td></td>
</tr>
<tr>
<td>Internal Rotation</td>
<td>0-70</td>
<td></td>
</tr>
<tr>
<td>External Rotation</td>
<td>0-90</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Elbow and Forearm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexion - Extension</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wrist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexion</td>
</tr>
<tr>
<td>Extension</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hip</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Flexion</th>
<th>Extension</th>
<th>Abduction</th>
<th>Adduction</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hip</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Knee</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Flexion</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Extension</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Abduction</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Adduction</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX C

Modified Ashworth Scale
# Modified Ashworth Scale for Grading Spasticity

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No increase in muscle tone</td>
</tr>
<tr>
<td>1</td>
<td>Slight increase in muscle tone manifested by a catch and release or by minimal resistance at the end of the range of motion when the affected part or parts are moved in flexion or extension</td>
</tr>
<tr>
<td>+1</td>
<td>Slight increase in muscle tone manifested by a catch, followed by minimal resistance throughout the remainder of the ROM</td>
</tr>
<tr>
<td>0</td>
<td>Marked increase in muscle tone through most of the ROM, but affected parts are easily moved</td>
</tr>
<tr>
<td>1</td>
<td>Considerable increase in muscle tone: passive movement difficult</td>
</tr>
<tr>
<td>2</td>
<td>Affected part or parts rigid in flexion or extension</td>
</tr>
</tbody>
</table>
APPENDIX D

Berg Balance Scale
Berg Balance Scale

Sitting Unsupported
4  Able to sit safely and securely for 2 minutes
3  Able to sit 2 minutes with supervision
2  Able to sit for 30 seconds
1  Able to sit for 10 seconds
0  unable to sit unsupported

Sitting to Standing
4  Able to stand, no hands, stabilize independently
3  Able to stand independently using hands
2  Able to stand using hands more than one try
1  Minimal assist to stand or stabilize
0  Moderate to maximum assist

3. Standing to sit
4  Sits safely with minimal or no use of hands
3  Controls descent with use of hands
2  Uses back of legs against chair to control descent
1  Sits independently but has uncontrolled descent
0  Needs assistance to sit

4. Transfers
4  Able to transfer safely with minor use of hands
3  Able to transfer safely, must used hands
2  Able to transfer with verbal cues or supervision
1  One person to assist
0  Two person assist

5. Standing unsupported
4  Able to stand safely for 2 minutes
3  Able to stand two minutes with supervision
2  Able to stand 30 seconds unsupported
1  Able to stand 30 seconds after several tries
0  Unable to stand 30 seconds unassisted
6. Standing with eyes closed
   4  Able to stand safely for 10 seconds
   3  Able to stand 10 seconds with supervision
   2  Able to stand for 3 seconds
   1  Able to stand for less than 3 seconds
   0  Needs help to keep from falling

7. Standing with feet together
   4  Able to place feet together and stand for 1 minute
   3  Able to place feet together and stand 1 minute with supervision
   2  Able to place feet together and stand for 30 seconds
   1  Needs help to attain position but can hold for 30 seconds
   0  Can’t perform

8. Tandem standing
   4  Able to independently place feet in tandem, hold for 30 seconds
   3  Able to get one foot in front of the other, hold 30 seconds
   2  Able to take small step independently, hold 30 seconds
   1  Needs help to place feet, hold for 15 seconds
   0  Can’t perform

9. Standing on 1 leg
   4  Able to lift 1 leg and hold more than 30 seconds
   3  Able to lift 1 leg and hold 5-10 seconds
   2  Able to lift 1 leg and hold 3-5 seconds
   1  Able to lift leg but can’t hold 3 seconds
   0  Can’t perform

10. Turning trunk
    4  Looks behind both sides, good weight shift
    3  Looks behind 1 side only
    2  Turns sideways only, but maintains balance
    1  Needs supervision when turning
    0  Needs assistance to keep from falling
11. Retrieving object from floor
   4 Able to pick up an object and stand safely and easily
   3 Picks up object but needs supervision
   2 Unable to retrieve but within 1-2 inches and maintains balance
   1 Unable to retrieve, needs supervision while trying
   0 Can’t perform

12. Turning 360 degrees
   4 Able to turn 360 safely in less than 4 seconds, either direction
   3 Able to turn 360 safely in less than 4 seconds, one direction only
   2 Able to turn 360 safely but more than 4 seconds
   1 Needs close supervision or verbal cues
   0 Can’t perform

13. Stool stepping
   4 Safely completes 8 steps in less than 20 seconds
   3 Safely completes 8 steps in more than 20 seconds
   2 Safely completes 4 steps
   1 Completes 2 steps, needs supervision or minimal assistance
   0 Can’t perform

14. Reaching forward while standing
   4 Can reach forward confidently greater than 10 inches
   3 Can reach forward safely greater than 5 inches
   2 Can reach forward safely greater than 2 inches
   1 Can reach forward but needs supervision
   0 Needs help to keep from falling
APPENDIX E

Functional Ambulation
Measure of Functional Ambulation

Distance from the bedroom to the bathroom

Assistance needed  S  CGA  MIN  MOD  MAX
Device used

Distance from the bedroom to the Living room

Assistance needed  S  CGA  MIN  MOD  MAX
Device used

Distance from the bedroom to the kitchen

Assistance needed  S  CGA  MIN  MOD  MAX
Device used

Distance from the bedroom to the front room

Assistance needed  S  CGA  MIN  MOD  MAX
Device used

Distance from the bathroom to the front room

Assistance needed  S  CGA  MIN  MOD  MAX
Device used
Distance from the bathroom to the kitchen

Assistance needed  S  CGA  MIN  MOD  MAX
Device used

Distance from the bathroom to the living room

Assistance needed  S  CGA  MIN  MOD  MAX
Device used

Distance from the living room to the front room

Assistance needed  S  CGA  MIN  MOD  MAX
Device used

Distance from the living room to the kitchen

Assistance needed  S  CGA  MIN  MOD  MAX
Device used

Distance from the kitchen to front room

Assistance needed  S  CGA  MIN  MOD  MAX
Device used

Comments
APPENDIX F

Burden of Stroke Scale
### Burden of Stroke Scale (BOSS)

#### Domain 1: Mobility

<table>
<thead>
<tr>
<th>Because of your stroke, how difficult is it for you to...</th>
<th>Answer Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ...maintain your balance?</td>
<td>1</td>
</tr>
<tr>
<td>2 ...walk 1 flight of stairs?</td>
<td>1</td>
</tr>
<tr>
<td>3 ...stand up from a resting position?</td>
<td>1</td>
</tr>
<tr>
<td>4 ...kneel down?</td>
<td>1</td>
</tr>
<tr>
<td>5 ...get to where you want as quickly as you would like?</td>
<td>1</td>
</tr>
</tbody>
</table>

*You've indicated that you have some difficulties moving around inside or outside your home.*

| How often do difficulties in moving around cause you to feel anxious, unhappy or frustrated? | 2 |
| How much do difficulties in moving around cause you to feel dissatisfied with yourself or your life? | 3 |
| How much do difficulties in moving around prevent you from doing the things in life that are important to you? | 3 |

#### Domain 2: Self-Care

<table>
<thead>
<tr>
<th>Because of your stroke, how difficult is it for you to...</th>
<th>Answer Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 ...dress yourself?</td>
<td>1</td>
</tr>
<tr>
<td>2 ...bathe yourself?</td>
<td>1</td>
</tr>
<tr>
<td>3 ...do light household chores, such as clearing the table, or making your bed?</td>
<td>1</td>
</tr>
<tr>
<td>4 ...prepare meals?</td>
<td>1</td>
</tr>
<tr>
<td>5 ...do your everyday activities as quickly as you would like?</td>
<td>1</td>
</tr>
</tbody>
</table>

*You've indicated that you have some difficulties taking care of your personal needs.*

| How often do difficulties in taking care of your personal needs cause you to feel anxious, unhappy or frustrated? | 2 |
| How much do difficulties in taking care of your personal needs cause you to feel dissatisfied with yourself or your life? | 3 |
| How much do difficulties in taking care of your personal needs prevent you from doing the things in life that are important to you? | 3 |
### Domain 3: Communication

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>...talk?</td>
<td>1</td>
</tr>
<tr>
<td>...understand what people say to you?</td>
<td>1</td>
</tr>
<tr>
<td>...understand what you read?</td>
<td>1</td>
</tr>
<tr>
<td>...write a note?</td>
<td>1</td>
</tr>
<tr>
<td>...talk with a group of people?</td>
<td>1</td>
</tr>
<tr>
<td>...be understood by others?</td>
<td>1</td>
</tr>
<tr>
<td>...find the words you want to say?</td>
<td>1</td>
</tr>
<tr>
<td>You've indicated that you have some difficulties communicating.</td>
<td></td>
</tr>
<tr>
<td>How often do difficulties communicating cause you to feel anxious, unhappy or frustrated?</td>
<td>2</td>
</tr>
<tr>
<td>How much do difficulties communicating cause you to feel dissatisfied with yourself or your life?</td>
<td>3</td>
</tr>
<tr>
<td>How much do difficulties communicating prevent you from doing the things in life that are important to you?</td>
<td>3</td>
</tr>
</tbody>
</table>

### Domain 4: Cognition

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>...concentrate?</td>
<td>1</td>
</tr>
<tr>
<td>...solve day to day problems?</td>
<td>1</td>
</tr>
<tr>
<td>...remember to do your everyday tasks?</td>
<td>1</td>
</tr>
<tr>
<td>...learn new things?</td>
<td>1</td>
</tr>
<tr>
<td>...remember what people say?</td>
<td>1</td>
</tr>
<tr>
<td>You've indicated that you have some difficulties thinking and remembering.</td>
<td></td>
</tr>
<tr>
<td>How often do difficulties thinking and remembering cause you to feel anxious, unhappy or frustrated?</td>
<td>2</td>
</tr>
<tr>
<td>How much do difficulties thinking and remembering cause you to feel dissatisfied with yourself or your life?</td>
<td>3</td>
</tr>
<tr>
<td>How much do difficulties thinking and remembering prevent you from doing the things in life that are important to you?</td>
<td>3</td>
</tr>
</tbody>
</table>
### Domain 5: Swallowing

*Because of your stroke, how difficult is it for you to...*

<table>
<thead>
<tr>
<th></th>
<th>Answer Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>...chew your food?</td>
</tr>
<tr>
<td>2</td>
<td>...swallow solid foods?</td>
</tr>
<tr>
<td>3</td>
<td>...swallow liquids?</td>
</tr>
</tbody>
</table>

You’ve indicated that you have some difficulties eating or swallowing.

<table>
<thead>
<tr>
<th></th>
<th>Answer Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>How often do difficulties eating or swallowing cause you to feel anxious, unhappy or frustrated?</td>
</tr>
<tr>
<td>5</td>
<td>How much do difficulties eating or swallowing cause you to feel dissatisfied with yourself or your life?</td>
</tr>
<tr>
<td>6</td>
<td>How much do difficulties eating or swallowing prevent you from doing the things in life that are important to you?</td>
</tr>
</tbody>
</table>

### Domain 6: Social Relationships

*Because of your stroke, how difficult is it for you to...*

<table>
<thead>
<tr>
<th></th>
<th>Answer Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>...enjoy leisure activities with friends or relatives?</td>
</tr>
<tr>
<td>2</td>
<td>...keep old friendships going?</td>
</tr>
<tr>
<td>3</td>
<td>...maintain your role as a friend or family member?</td>
</tr>
<tr>
<td>4</td>
<td>...socialize with people you're meeting for the first time?</td>
</tr>
<tr>
<td>5</td>
<td>...socialize with friends or family?</td>
</tr>
</tbody>
</table>

You’ve indicated that you have some difficulties in social situations or relationships.

<table>
<thead>
<tr>
<th></th>
<th>Answer Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>How often do difficulties in social situations or relationships cause you to feel anxious, unhappy or frustrated?</td>
</tr>
<tr>
<td>7</td>
<td>How much do difficulties in social situations or relationships cause you to feel dissatisfied with yourself or your life?</td>
</tr>
<tr>
<td>8</td>
<td>How much do difficulties in social situations or relationships prevent you from doing the things in life that are important to you?</td>
</tr>
</tbody>
</table>
### Domain 7: Energy & Sleep

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Because of your stroke, how difficult is it for you to...</td>
<td></td>
</tr>
<tr>
<td>1  ...get enough sleep?</td>
<td>1</td>
</tr>
<tr>
<td>2  ...have enough energy to take care of your personal needs?</td>
<td>1</td>
</tr>
<tr>
<td>3  ...have enough energy to think clearly?</td>
<td>1</td>
</tr>
<tr>
<td>4  ...stay awake throughout the day?</td>
<td>1</td>
</tr>
<tr>
<td>You've indicated that you have some difficulties with energy and sleep.</td>
<td></td>
</tr>
<tr>
<td>5  How often do difficulties with energy and sleep cause you to feel</td>
<td>2</td>
</tr>
<tr>
<td>anxious, unhappy or frustrated?</td>
<td></td>
</tr>
<tr>
<td>6  How much do difficulties with energy and sleep cause you to feel</td>
<td>3</td>
</tr>
<tr>
<td>dissatisfied with yourself or your life?</td>
<td></td>
</tr>
<tr>
<td>7  How much do difficulties with energy and sleep prevent you from</td>
<td>3</td>
</tr>
<tr>
<td>doing the things in life that are important to you?</td>
<td></td>
</tr>
</tbody>
</table>

### Domain 8: Positive & Negative Feelings

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Because of your stroke, how often do you feel...</td>
<td></td>
</tr>
<tr>
<td>1  ...lonely?</td>
<td>2</td>
</tr>
<tr>
<td>2  ...anxious?</td>
<td>2</td>
</tr>
<tr>
<td>3  ...angry?</td>
<td>2</td>
</tr>
<tr>
<td>4  ...sad?</td>
<td>2</td>
</tr>
<tr>
<td>5  How much does your feelings and emotions prevent you from doing the</td>
<td>3</td>
</tr>
<tr>
<td>things in life that are important to you?</td>
<td></td>
</tr>
<tr>
<td>Because of your stroke, how often do you feel...</td>
<td></td>
</tr>
<tr>
<td>6  ...confident?</td>
<td>2</td>
</tr>
<tr>
<td>7  ...happy?</td>
<td>2</td>
</tr>
<tr>
<td>8  ...calm?</td>
<td>2</td>
</tr>
<tr>
<td>9  ...optimistic about the future?</td>
<td>2</td>
</tr>
</tbody>
</table>

**Answer Scales**

<table>
<thead>
<tr>
<th>Scale</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Not at all</td>
</tr>
<tr>
<td>2</td>
<td>Never</td>
</tr>
<tr>
<td>3</td>
<td>Not at all</td>
</tr>
</tbody>
</table>
APPENDIX G

HSIRB Approval Letter
Date: August 25, 2004

To: Ben Atchison, Principal Investigator  
Heather Tweedie, Student Investigator for thesis

From: Amy Naugle, Ph.D., Interim Chair

Re: HSIRB Project Number: 04-07-04

This letter will serve as confirmation that your research project entitled “The Effects of Aquatic Therapy on Persons with Cerebral Vascular Accidents” has been approved under the full category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note that you may only conduct this research exactly in the form it was approved. You must seek specific board approval for any changes in this project. You must also seek reapproval if the project extends beyond the termination date noted below. In addition if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: July 21, 2005
BIBLIOGRAPHY


Sabari, J. (2002). Optimizing Motor Control Using the Carr and Shepherd Approach. In M.V. Radomski & C.A. Trombly (Eds.), *Occupational Therapy for Physical Dysfunction* (pp. 509). Maryland: Lippincott Williams & Wilkins.


