

AQUATIC THERAPY FOR A PATIENT POST-STROKE: A CASE REPORT

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A Case Report

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This case report is submitted in partial fulfillment of  
the requirements for the degree of  
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*The final copy of this case report has been examined by the signatories, and we find that both the content and the form meet acceptable presentation standards of scholarly work in the above mentioned discipline*

## Table of Contents

|  |    |
|--|----|
| Abstract .....   | 5  |
| Introduction .....   | 6  |
| Literature Review .....  | 6  |
| Stroke Overview .....  | 6  |
| Effects of Stroke .....  | 7  |
| Land-Based Physical Therapy Treatment .....                          | 10 |
| Aquatic Therapy .....  | 13 |
| Advantages .....   | 13 |
| Disadvantages .....  | 13 |
| Ai Chi .....   | 13 |
| Halliwick Method .....   | 14 |
| Watsu .....  | 14 |
| Bad Ragaz Ring Method .....  | 15 |
| Precautions and Contraindications .....                              | 15 |
| Aquatic Therapy Post-Stroke .....                                    | 16 |
| Physical Benefits .....  | 16 |
| Psychological Benefits .....   | 17 |
| Case Report .....  | 18 |
| Patient History/Review of Systems .....                              | 18 |
| Examination .....  | 19 |
| Intervention .....   | 21 |
| Outcomes .....   | 22 |
| Discussion .....   | 23 |
| Table 1: Manual Muscle Test (MMT) Grades at Initial Evaluation ..... | 25 |
| Table 2: Modified Ashworth Scale .....                               | 25 |
| Table 3: Berg Balance Scale (BBS) Tasks .....                        | 26 |
| Table 4: Long-Term and Short-Term Goals .....                        | 26 |

|  |    |
|--|----|
| Table 5: Intervention Summary .....  | 27 |
| Table 6: Comparison of Pre- and Post-Treatment Scores on the TUG, BBS, and Modified Ashworth Scale ..... | 27 |
| Table 7: MMT Grades Post-Treatment .....   | 27 |
| References .....   | 28 |
| Appendix A: Aquatic Maintenance Program .....  | 31 |

### **Abstract**

According to the Centers for Disease Control and Prevention, stroke is the leading cause of long-term disability in the United States. The effects of stroke may consist of neurologic, musculoskeletal, and cognitive manifestations. Those who have had a stroke may present with barriers to conventional dry land therapy, preventing them from acquiring their full rehab potential. There is evidence that aquatic therapy may improve strength, balance, gait, range of motion, and psychological well-being; but there is little research on aquatic therapy for the stroke population specifically.

The purpose of this case report is to describe the evaluation, intervention, and outcome of a patient with a history of stroke who participated in an aquatic therapy program. The patient is an 84 year-old male with right hemiplegia, resulting in impaired gait, balance, and overall functional mobility. The aquatic therapy sessions were twice a week for eight weeks and included tone reduction, gait training, balance activities, and strengthening exercises. After eight weeks, the patient demonstrated improved strength, reduced muscle tone, and decreased risk of falls as evidenced by improved scores on the Berg Balance Scale and Timed Up and Go (TUG) Test. This case report suggests that aquatic therapy may be beneficial for patients with stroke who show minimal progress with land therapy or are unable to tolerate land activities.

## **Introduction**

Stroke affects approximately 795,000 Americans each year and costs over \$70 billion in related medical expenses and disability (American Stroke Association, 2012). The effects of stroke are devastating and consist of neurologic, musculoskeletal, and cognitive manifestations. A secondary impairment that is the most significant complication in this population is falls (Schmid & Rittman, 2009). Typical outpatient physical therapy for people post-stroke includes services to improve mobility, activities of daily living, and community reintegration (Duncan et al., 2005). Patients post-stroke may present with barriers to conventional dry land therapy, such as impaired balance, decreased safety awareness, and a fear of falling. These barriers may prevent patients from acquiring their full rehab potential (Haring, 2002; Schmid & Rittman, 2007). The addition of an aquatic therapy program may be a solution to these barriers and allow for better functional outcomes. Aquatic therapy as an intervention for patients post-stroke will be discussed.

## **Literature Review**

### **Stroke Overview**

According to Sacco et al. (2013), a stroke is typically defined as a “neurological deficit attributed to an acute focal injury of the central nervous system by a vascular cause, including cerebral infarction, intracerebral hemorrhage, and subarachnoid hemorrhage.” Ischemic strokes occur when blood flow to the brain is interrupted, typically by atherosclerotic plaques. These plaques can cause a thrombus that clogs a blood vessel or an embolism that travels and lodges in another part of the circulatory system. According to the American Heart Association, ischemic stroke accounts for 87% of reported cases. Intracerebral hemorrhagic strokes are a result of abnormal bleeding in the brain and can be divided into primary and secondary causes. Primary

causes include the spontaneous rupture of blood vessels in the brain due to hypertension or amyloid angiopathy. Secondary causes include vascular abnormalities, tumors, or impaired coagulation (Paolucci et al., 2003). The main presenting symptom of an intracerebral hemorrhage is an isolated headache, which occurs in almost 30% of patients. Hemorrhagic strokes are less common than ischemic strokes but tend to have a higher incidence of death and morbidity (Sacco et al., 2013). Risk factors for stroke include hypertension, diabetes, hyperlipidemia, cigarette smoking, alcohol consumption, obesity, and decreased physical activity (Sacco et al., 2006).

There is some argument as to the prognosis of ischemic stroke versus hemorrhagic stroke. While patients with hemorrhagic stroke tend to have a higher incidence of death within the first month, it is believed that the survivors have better neurological and functional outcomes than do patients with ischemic stroke (Paolucci et al., 2003; Sacco et al., 2013). Primary factors that influence prognosis of functional outcomes include stroke severity, age, and onset-admission interval. Paolucci et al. (2003) found that, when matched by the aforementioned prognostic indicators, patients with hemorrhagic stroke showed better neurological and functional outcomes than patients with ischemic stroke. They attribute those results to the resolution of the hematoma caused by the hemorrhage, which then decreases compression on the brain.

### **Effects of Stroke**

Stroke is likely to cause impairments that affect the execution of the functional activities of the patient. According to Anderson and Whitfield (2013), over 85% of patients survive stroke, but up to 75% of those survivors do not make a complete recovery. A combination of physical, psychological, social, and sexual deficits may emerge.

Among the physical deficits that may be caused by stroke, balance and gait impairments are of major concern. Postural instability and sway are examples of balance impairments that are prevalent in those who have suffered a stroke. Postural instability results in weight shifting toward the unaffected side. It is seen during both static and dynamic balance activities and may even be present in higher functioning stroke survivors (Tyson, Hanley, Chillala, Selley, & Tallis, 2006). Compared to healthy elderly persons, those with stroke show up to five times the amount of postural sway (Weerdesteyn, de Niet, van Duijnhoven, & Geurts, 2008). A study by Tyson et al. (2006) suggests that balance in those with stroke is impacted most by weakness and sensory loss. The same study also attributes balance impairments to spasticity, visual deficits, and cognitive factors.

Common gait impairments include decreased speed, limited walking endurance, balance impairment, and altered balance and falls efficacy (Schmid et al., 2012). The most common gait pattern following a stroke is hemiparetic gait, in which compensatory patterns such as lower extremity circumduction, pelvic hike, and vaulting are often noted (Jung, Lee, Charalambous, & Vrongistinos, 2010). During gait, tripping is common due to decreased ankle dorsiflexion and knee extension (Weerdesteyn et al., 2008). Other motor problems include paresis, altered muscle tone, lack of motor control, and abnormal reflexes (Jung et al., 2010).

Those who have suffered a stroke are also at significant risk for developing cognitive impairments. Different cognitive signs and symptoms may occur depending on which area of the cortex is involved. Extensive lesions in white matter correspond with a great loss of axons and are associated with post-stroke dementia, or vascular dementia.



Vascular dementia is characterized by dementia that is accompanied by motor symptoms, which differentiates it from Alzheimer's disease (Haring, 2002).

According to Srikanth et al. (2003), those who have had a stroke tend to present with impairments of construction/spatial ability and sustained attention and processing speed. This population is also more likely to have aphasia or other language deficits. They may have problems with language production and/or comprehension (Haring, 2002; Srikanth et al., 2003). The treatment of cognitive impairments receives less attention in the rehabilitation process, but the effects may actually hinder the rehabilitation process (Haring, 2002).

The aforementioned neurologic, musculoskeletal, and cognitive effects of stroke put these patients at a significant risk for falls. A qualitative study by Schmid and Rittman (2009), in which male veterans with a history of stroke were interviewed, indicated that falls are a common issue of concern after a stroke. A large portion of falls are reported as occurring during indoor walking activities (Harris, Eng, Marigold, Tokuno, & Luis, 2005; Weerdesteyn et al., 2008). Some of the outcomes of falls include fractures, head injury, premature disability, and death. Increased use of health care resources and decreased ability to perform activities of daily living are direct results of these outcomes (Schmid & Rittman, 2009). Hip fractures are more prevalent than wrist fractures in the stroke population due to the impaired ability to break the fall with the affected arm. Due to poor frontal plane balance, more falls occur to the affected side (Weerdesteyn et al., 2008). Harris et al. (2005) and Schmid and Rittman (2009) infer that assistive devices such as canes and walkers may reduce fall risk and ensure a sense of stability in the patient following a stroke.

The culmination of deficits resulting from stroke may eventually cause the patient to develop depression or other psychological disorders. According to Anderson and Whitfield

(2013), anxiety and depression occur in about 33% of stroke survivors. They further discuss that a significant number of patients with stroke participate in fewer meaningful activities, stay at home, and become isolated from friends and family members. Another prevalent psychological issue that stroke survivors may develop is fear of falling (FoF), defined by Schmid & Rittman (2007) as “lower or decreased perceived self-efficacy or confidence in avoiding falls while completing activities and may exist with or without a prior fall.” Patients with a FoF tend to have increased worry about falling in public and therefore avoid leaving the home. FoF is also associated with decreased physical functioning and decreased community reintegration (Schmid & Rittman, 2009).

### **Land-Based Physical Therapy Treatment**

Stroke rehabilitation is multi-disciplinary and depends on the functional impairments with which the patient presents. There is no specific, standardized protocol for determining post-stroke interventions, but the Post-Stroke Rehabilitation Outcomes Project (Gassaway et al., 2005) has been introduced to examine efficacy of various interventions used in stroke rehabilitation. Interventions are chosen based on individual needs, which results in variation between patients and between rehabilitation centers (Gassaway et al., 2005).

According to Jette et al. (2005), the Agency for Healthcare Research and Quality developed a clinical practice guideline that classified post-stroke interventions into three categories: remediation, compensation, and motor control. Remediation includes neuromuscular facilitation, sensory stimulation, and strength training. Compensation emphasizes independence in activities of daily living by teaching patients compensatory

techniques using the non-paretic side. Lastly, motor control focuses on activities that mimic real-life situations.

In general, the typical treatment for stroke includes balance training, postural awareness training, strengthening exercises, transfer activities, and gait training (Jette et al., 2005; Natarajan et al., 2008). Jette et al. (2005) surveyed 86 physical therapists throughout the United States on their most commonly used interventions. The results indicate that functional activities are the main focus of stroke rehabilitation. Proprioceptive neuromuscular facilitation (PNF) was used in less than 5% of the interventions, and neurodevelopmental treatment (NDT) was used more frequently (6-28%). Global interventions, such as balance training, postural training, and motor learning interventions were the most common treatments. A survey of physical therapists by Natarajan et al. (2008) found similar results, with a majority of therapists using principles of NDT over PNF. A majority of those surveyed also suggested that tone be normalized when facilitating movement.

Initial intervention for the affected arm is commonly focused on eliciting small voluntary or reflexive movements. Constraint-induced movement therapy may be used to elicit these movements by restraining the unaffected arm in order to force use of the affected arm (Dobkin, 2005). Shoulder subluxations are often noted following a stroke, and reduction of any subluxations should occur before other upper extremity interventions are implemented (Suethanapornkul et al., 2008). Task-specific, functional training appears to be the most effective strategy in retraining the affected upper extremity (Dobkin, 2005).

Gait training is another important aspect of rehabilitation, and the use of assistive devices promotes early stability and safety in patients who have just suffered a stroke. A necessary aspect of gait training is working on control of the knee and foot for toe clearance during

walking. The patient may be fit for an ankle-foot orthosis to allow for foot clearance during walking and to provide static and dynamic stability (Dobkin, 2005). Over time, gait training will be done on various surfaces and the patient will work on increasing speed. Treadmill training with the use of a harness for partial body-weight support may be used (Dobkin, 2005; Jung et al., 2010). Outcomes of studies of treadmill-based gait training in stroke populations include increases in lower extremity strength, walking speed, endurance, and cardiovascular function (Jung et al., 2010). There is also evidence that progressive aerobic exercises, including treadmill walking, may be initiated to improve cardiovascular health and strength in patients post-stroke (Dobkin, 2005). Cho, Kim, and Lee (2013) investigated the effect of motor imagery training and gait training on balance and gait in patients with chronic stroke. Motor imagery training involved visually imagining, as well as physically sensing, that the paretic side moves like the non-paretic side. They found that the experimental group (motor imagery and gait training) demonstrated significantly decreased postural instability and increased gait speed when compared with the group that had gait training alone. It is important to remember that each patient is different and that no one intervention will be successful for all patients. Healthcare providers should collaborate with each patient in determining functional goals that are meaningful and individualized (Anderson & Whitfield, 2013).

Patients post-stroke may have other comorbidities that make it difficult for them to successfully participate in rehabilitation on dry land. Depression, FoF, and other psychological factors are significant obstacles to rehabilitation (Schmid & Rittman, 2007). A recent study by Schmid et al. (2012) shows an inverse relationship between balance and falls self-efficacy and post-stroke participation.

## **Aquatic Therapy**

**Advantages.** There are many advantages to aquatic therapy, and it may be used for a wide variety of patient populations. Hydrostatic pressure provides support in the water, allowing a weak patient to assume an upright posture that they might not be able to assume on dry land. Buoyancy offloads the joints that are immersed and provides assistance with movements of the upper and lower extremities. Range of motion activities may be initiated due to this property of water. Water is also viscous, providing a resistive effect against limb movement. This resistance increases proportionately to the velocity of the limb movement. Besides physical benefits, an aquatic environment may provide psychological benefits for the patient, including reduced anxiety and increased confidence and perceived well-being (Becker 2009).

**Disadvantages.** There are some possible disadvantages to aquatic therapy. Buoyancy may actually lead to difficulty with movement. The patient may become unstable during movement if he or she exhibit characteristics that facilitate floating, such as excessive adipose tissue or hypotonicity. Another disadvantage is that patients have decreased weightbearing in the water. For those with sensory deficits, sensory input may become further diminished. These disadvantages, however, may be avoided if the patient is in the proper depth of water and the proper treatment plan for the patient is administered (Sova, 2012).

**Ai Chi.** Ai Chi was developed in Japan by Jun Konno. This method combines total body strengthening and relaxation through progressive movements and deep breathing exercises. It helps patients achieve greater range of motion and mobility, while at the same time promoting relaxation and calming effects (Brody & Geigle, 2009). It has shown to be successful in many different populations, including patients who have stroke, balance deficits, paraplegia, hypertension, fibromyalgia, anxiety, depression, and many others. Ai Chi encourages relaxed

awareness, which has positive psychological benefits and increases mental alertness and proprioception as well (Sova, 2004).

**Halliwick method.** The Halliwick method was originally developed by James McMillan in the 1950s as a program to teach disabled children how to swim. It eventually became a method that is used for both children and adults who have psychosensory motor deficits and may benefit from active motor learning or relearning in an environment with little mechanical impact. This method is quite suitable for neurologic rehabilitation, and it allows participants to become actively involved in learning balance and postural control (Stanat & Lambeck, 2001). Overall, the exercises in the Halliwick method are useful for improving strength, flexibility, and balance (Noh, Lim, Shin & Paik, 2008).

The Halliwick method is based on a Ten Point Program, consisting of mental adjustment/disengagement, sagittal rotation control, vertical rotation control, lateral rotation control, combined rotation control, upthrust, balance in stillness, turbulent gliding, simple progression, and basic swimming movement. These ten points can then be grouped into four phases: mental adaptation, balance restoration, inhibition, and facilitation. These four phases are listed in order, starting with enabling the patient to become comfortable and independent in the water. Treatment will eventually progress to learning control of rotation and posture in still water and then progressing to maintaining balance and posture in turbulent waters. In the last phase, the patient will learn traditional swimming movements (Stanat & Lambeck, 2001). Patient populations that may benefit most from the Halliwick method are neurological, orthopedic, and developmental disorders (Sova, 2012).

**Watsu.** Watsu is a fairly recent aquatic therapy technique, created by Harold Dull in the 1980s. The name “Watsu” simply means “water shiatsu,” and it incorporates the moves and

stretches of Zen Shiatsu but is done in warm water. Like Ai Chi, mental relaxation is the primary goal of Watsu (Chon, Oh, & Shim, 2008). Watsu is a passive technique, with the therapist cradling the patient and moving him or her in a specific sequence (Sova, 2012). Relaxation allows the patient to easily achieve flexibility and mobility while immersed in water (Chon et al., 2008). Other benefits include decreased muscle guarding, decreased pain, and improved breathing patterns. Patient populations that may benefit most from Watsu include pain, head injury, neurological, chronic fatigue, hyperactivity, and psychological disorders (Sova, 2012).

**Bad Ragaz Ring Method.** The concept of the Bad Ragaz Ring Method (BRRM) was developed by physical therapists in Bad Ragaz, Switzerland, in the 1930s. BRRM is a method of muscle reeducation that utilizes specific patterns of resistance, endurance, elongation, relaxation, range of motion, and tone reduction. Specific unilateral or bilateral patterns of movement (typically PNF patterns) are performed and may be facilitated by the therapist or by the patient. Inflatable rings may be put around different areas of the body, providing even more resistance than the limb itself. Treatment goals associated with BRRM are tone reduction, relaxation, increased range of motion, muscle reeducation, strengthening, elongation, and improved postural alignment. Patient populations that benefit most from this method are neurological, orthopedic, and pain (Sova, 2012).

**Precautions and contraindications.** Aquatic therapy may not be the best option for everyone. There are particular conditions in which patients should either participate in aquatic therapy with caution or should not participate in it at all. One such precaution is a fear of the water. Having a well-lit, shallow pool with flotation devices and plenty of staff available may ease any fears in this case (Brody & Geigle, 2009). Also, those with cardiopulmonary

dysfunctions need to be monitored closely in an aquatic environment. Those with limited chest expansion may have difficulty breathing when immersed in the water above the level of the thorax. Patients with a known cardiac condition will need clearance from their primary care physician or cardiologist. Patients who are susceptible to chronic ear infections, chronic urinary tract infections, or yeast infections from water exposure also need to be monitored carefully (Brody & Geigle, 2009).

Some absolute contraindications to aquatic therapy include open and infected wounds, uncontrolled bowel or bladder, uncontrolled seizures, danger of bleeding or hemorrhage, and severe kidney disease. Patients with a fever should especially avoid aquatic therapy in a warm-water pool. This is not an exhaustive list of precautions and contraindications, and the risks and benefits for each patient should be considered on a case by case basis (Brody & Geigle, 2009).

### **Aquatic Therapy for Patients Post-Stroke**

**Physical benefits.** There are many properties of water itself that may make it an appropriate medium for stroke rehabilitation. The buoyancy of water may allow ease of movement of the affected side that may be more difficult for the patient to do on dry land without assistance. So, patients may be able to perform activities in the water more freely than on dry land, allowing for greater independence (Noh et al., 2008). In regards to balance, hydrostatic pressure is a property of water that helps to hold a patient upright and to possibly activate unused muscles. Deeper water will allow patients who have difficulty standing to perform exercises more easily and will help improve both static and dynamic balance (Sova, 2012). A study by Noh et al. (2008) compares scores on the Berg Balance Scale between an aquatic therapy group and a conventional therapy group in patients who have had a stroke. The aquatic therapy group showed greater score improvements on the Berg Balance Scale than the



conventional therapy group. The aquatic environment also allows for a reduction in joint overload and a reduction in postural sway (Resende, Rassi, & Viana, 2008). Underwater treadmill gait training can improve step response and rhythmicity, allowing for a more normal gait pattern (Jung et al., 2010).

Aquatic therapy may also have a positive effect on cardiovascular fitness. This is particularly important for those with stroke, since cardiovascular disease is one of the leading causes of death in people with stroke. Improved cardiovascular fitness may also improve the ability of a patient with stroke to perform functional activities that were limited by weakness and fatigue (Chu et al., 2004). A study by Chu et al. (2004) found that an eight week water-based exercise program improved  $VO_2$ max by 22% in patients with chronic stroke. Those who participated in the aquatic program also demonstrated significant improvements in strength and gait speed.

**Psychological benefits.** Ai Chi may be ideal for patients with stroke because it can minimize anxiety, fatigue, and depression, which tend to be barriers to rehabilitation (Brody & Geigle, 2012). A study by Aidar et al. (2013) showed that a 12-week aquatic exercise program decreased levels of depression and anxiety in patients with ischemic stroke more so than a group that did not participate in an aquatic exercise program. Water may also decrease FoF due to increased balance. The water acts as a support where patients can be challenged with stabilization and balance exercises without being afraid of falling. Being successful in completing tasks in the water that cannot be done on dry land may instill confidence and motivation in the patient (Jung et al., 2010; Resende, Rassi, & Viana, 2008). Schmid et al. (2012) suggest that overcoming psychological barriers may have the most influence on post-stroke participation in recovery.

## Case Report

### Patient History/Review of Systems

The patient was an 84 year-old Caucasian male with a history of ischemic stroke affecting the left middle cerebral artery five years ago. He was referred to physical therapy for impaired gait, impaired balance, and right hemiplegia. The patient displayed Broca's aphasia resulting from the stroke, so his wife provided the subjective information regarding his medical history and current level of functioning. The patient had a history of hypertension, coronary artery disease, atrial fibrillation, Type II diabetes, sleep apnea, and hernia repair. The patient's wife served as his caregiver and reported that he required assistance with bathing, grooming, dressing, cooking, and shopping. He used a wide base quad cane for household ambulation and a standard wheelchair when out in the community. The patient's wife denied any falls or hospitalizations since the stroke. The patient wore a hinged ankle foot orthosis (AFO) on his right leg due to foot drop. However, the AFO was set in slight plantarflexion and did not offer stability in the sagittal plane. The patient also had an intrathecal Baclofen pump to control spasticity on his right side. His goal was to be able to improve stability and endurance with walking so that he could attend his granddaughter's college graduation.

This case was unique due to the patient's complex medical history and the amount of time since onset. The patient received physical therapy services on dry land in the past, but his medical records were unable to be obtained to analyze specific interventions and outcomes. Based on the patient's high fall risk and reported minimal improvement with previous therapy, it was determined that he may benefit from aquatic therapy.

## **Examination**

A thorough examination was conducted to determine the patient's current level of functioning. Gait analysis revealed an ataxic gait pattern with decreased cadence, decreased gait stability with head turns/nods, decreased heel strike, decreased pelvic rotation, excessive trunk forward bending, lack of arm swing, and a wide base of support. The patient also displayed little weightbearing through his right lower extremity and right ankle plantarflexion with hyperextension of his right knee during terminal stance.

Manual Muscle Testing (MMT) was performed by the physical therapist to determine the strength of the patient's upper extremities, lower extremities, and lumbar spine musculature (Table 1). According to Cuthbert and Goodheart (2007), MMT is the most popular method for measuring muscle strength. Various muscle groups are given a grade from zero, meaning the muscle has no visible or palpable contraction, to five, meaning the muscle has full range of motion and is able to withstand maximal resistance (Cuthbert & Goodheart, 2007). The patient's left upper extremity tested in the range of 3+ to 4+, and his right upper extremity tested in the range of 0 to 2+. His left lower extremity tested in the range of 3+ to 4, and his right lower extremity tested in the range of 0 to 3.

Right upper extremity and right lower extremity spasticity were assessed using the Modified Ashworth Scale. The Modified Ashworth Scale is a six-point scale which rates a limb's resistance to passive stretch throughout its range of motion (Bohannon & Smith, 1987). The patient's right upper extremity had a resting position of shoulder internal rotation and adduction, elbow flexion, forearm supination, and wrist flexion. The patient's right lower extremity was given a score of two, and his right upper extremity was given a score of three (Table 2).

Other standardized outcome measures that were used include the Timed Up and Go (TUG) Test and the Berg Balance Scale (BBS). The TUG is a quick, easy to administer test that is used to predict fall risk based on gait velocity. To perform the TUG, a chair and a piece of tape or other marker are placed three meters away from each other. The instructions given to the patient are “on the word ‘go’ you will stand up, walk to the line on the floor, turn around, and walk back to the chair and sit down. Walk at your regular pace.” A stopwatch is started on the word “go” and stopped when the patient’s buttocks touches the chair (Podsiadlo & Richardson, 1991). According to Andersson et al. (2006), the cut-off score indicating risk of falls for the older stroke population is greater than 14 seconds. They found the TUG to have a sensitivity of 50% and a specificity of 78% for the stroke population. The patient used a quad cane and took 44 seconds to complete the TUG, placing him at high risk for falls.

The BBS is a 14-item objective measurement that assesses static and dynamic balance in adult populations to determine fall risk. Each task (Table 3) is scored on a five-point scale from zero to four, with a total score of 56 (Andersson et al., 2006). The patient scored 19/56 at the initial evaluation, indicating a high fall risk. Andersson et al. (2006) found the BBS to have a sensitivity of 63% and a specificity of 65% when used for predicting falls in patients post-stroke who scored less than 45/56.

Other examination findings include bilateral hamstring tightness with gross knee extension approximately 45 degrees when tested in a 90/90 position. Right ankle dorsiflexion was also lacking 15 degrees from neutral. Neurological screening reveals impaired light touch, proprioception, coordination, and sharp/dull discrimination on the hemiplegic side. The patient also displays a left lateral trunk lean in sitting, with resulting complaints of left buttock and back pain due to increased weightbearing through the left side. Following the evaluation, multiple

short-term goals and long-term goals consistent with the examination findings were established in the patient's plan of care (Table 4).

### **Intervention**

The patient participated in 60-minute aquatic therapy sessions in a 93-degree pool twice a week for eight weeks. These sessions included interventions for tone reduction, gait, balance, and strengthening (Table 5). The patient also received speech therapy services twice per week at the same facility. The patient wore his AFO, as well as water shoes, during treatment. Each session began with a ten-minute warm-up, including forward walking and side-stepping in three-and-a-half feet of water. The patient held onto a floating dowel and required close contact guard assistance from the physical therapist for safety. During the walking activities, emphasis was placed on heel-to-toe walking, facilitation of right hip and knee flexion, and maintaining midline and upright posture. The patient demonstrated decreased endurance and required several rest breaks throughout both the warm-up and during the rest of treatment. Following the warm-up, the patient performed three sets of hamstring and gastrocnemius stretches, with each stretch being held for 30 seconds.

To address the patient's upper extremity tone, passive range of motion using proprioceptive neuromuscular facilitation (PNF) D1 extension pattern was provided with the entire extremity submerged. The therapist utilized rhythmic rotation and deep pressure to the distal biceps tendon to encourage muscle relaxation. This was performed for about ten minutes or less, depending on how long it took for the tone to reduce.

Core stabilization, upper extremity strengthening, and balance training were done through a series of exercises using water fan paddles that were in an open position. The patient performed three sets of ten repetitions of shoulder adduction/abduction, horizontal

adduction/abduction, and flexion/extension. The physical therapist assisted the patient's right upper extremity. This series of exercises were performed in both five feet of water, as well as while sitting on an underwater bench, in order to address both sitting and standing balance.

Lower extremity strengthening exercises consisted of heel raises, hip abduction, marching, and mini-squats. Three sets of ten repetitions were performed. The patient was able to initiate movement in his right lower extremity but required assistance from the physical therapist and held onto a poolside railing for stability. Over time, the patient required less tactile cues from the physical therapist to facilitate movement of the right lower extremity. These exercises were progressed in week six by the addition of a one pound ankle weight.

Each session ended with deep water exercises performed in seven feet of water. The patient was supported by a floating noodle and the poolside railing. Exercises consisted of "bicycles," "jumping jacks," and "cross-country skiing." These exercises were done in order to improve core strength, lower extremity strength, and aerobic endurance. Initially, each exercise was done for two sets of 15 seconds and was later progressed to two sets of 30 seconds as the patient's endurance improved. Lastly, the patient hanged for approximately five minutes to provide a traction force to reduce his complaint of lower back pain.

During the eighth week, the patient was progressed to an "aquatic maintenance program," in which the patient may come to the facility twice per week and utilize the pool on his own without one-on-one supervision. The patient's wife was educated on aquatic exercise and how to safely guard the patient during transfers and ambulation in and around the pool. The patient was given an exercise program to perform on his own (Appendix A Figure 1).

## **Outcomes**

Outcome measures were taken at the initial evaluation, after 30 days of treatment, and after 60 days of treatment. Comparisons of the pre-treatment and post-treatment measurements were made to determine if there were any changes (Tables 6 and 7). The patient made slight improvements in his TUG time and BBS score. Specifically, the patient achieved a higher score on the following BBS tasks: sitting unsupported, standing to sitting, reaching forward with outstretched arm, turning to look behind, and transfers. The patient also exhibited fewer deviations during ambulation, including increased cadence and less forward bending at the trunk. The patient also demonstrated improved heel strike and less right knee hyperextension after his AFO was fixed. The patient displayed improved sitting posture with less left lateral trunk lean and was better able to self-correct with verbal cues.

The patient's right upper extremity tone reduced slightly and went from a score of three to a score of two on the Modified Ashworth Scale. The extremity continued to be hypertonic but was more easily moved and required less time to reduce by the eighth week of treatment. Also, the patient required less assistance with both upper and lower extremity movement during the exercises. The patient was able to actively move through more of the range of motion and needed help from the physical therapist to achieve the end range. Lastly, the patient's endurance improved. He required significantly shorter and less frequent rest breaks during the hour-long sessions.

## **Discussion**

The results of these outcome measures suggest that aquatic therapy may be beneficial for patients with a history of stroke. Although the patient continues to be a high fall risk, the patient made significant functional improvements that should not be overlooked. Further research

should be conducted on aquatic therapy for patients with *acute* stroke, and a randomized controlled trial needs to be conducted to determine if these results may be generalized. Aquatic therapy should be considered a viable option if the patient is unable to tolerate land activities or is not progressing on land.



Table 1

*Manual Muscle Test (MMT) Grades at Initial Evaluation*

| <u>Upper Extremity</u> |      |       | <u>Lower Extremity</u> |      |       | <u>Lumbar Spine</u> |   |
|------------------------|------|-------|------------------------|------|-------|---------------------|---|
|                        | Left | Right |                        | Left | Right |                     |   |
| Shoulder Flexion       | 3+   | 2-    | Hip Flexion            | 3    | 3     | Forward Bend        | 4 |
| Shoulder Abduction     | 3+   | 2-    | Hip Abduction          | 3    | 2-    | Extension           | 4 |
| Elbow Flexion          | 4+   | 1     | Hip Internal Rotation  | 3    | 2-    | Sidebend Left       | 4 |
| Elbow Extension        | 4+   | 1     | Hip External Rotation  | 3    | 2-    | Sidebend Right      | 3 |
| Wrist Flexion          | 4+   | 0     | Knee Extension         | 3+   | 1     | Rotation Left       | 4 |
| Wrist Extension        | 4+   | 0     | Ankle Dorsiflexion     | 4    | 0     | Rotation Right      | 4 |

Table 2

*Modified Ashworth Scale*

| Grade | Description   |
|-------|---|
| 0     | No increase in muscle tone  |
| 1     | 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(s) is moved in flexion or extension |
| 1+    | Slight increase in muscle tone, manifested by a catch, followed by minimal resistance throughout the remainder (less than half) of the ROM  |
| 2     | More marked increase in muscle tone through most of the ROM, but affected part(s) easily moved  |
| 3     | Considerable increase in muscle tone passive, movement difficult  |
| 4     | Affected part(s) rigid in flexion or extension  |

*Note.* Reprinted from “Interrater Reliability of a Modified Ashworth Scale of Muscle Spasticity,” by R. W. Bohannon and M. B. Smith, *Physical Therapy*, 67, p. 207.

Table 3

*Berg Balance Scale (BBS) Tasks*

---

Sitting to standing  
 Standing unsupported  
 Sitting unsupported  
 Standing to sitting  
 Transfers  
 Standing with eyes closed  
 Standing with feet together  
 Reaching forward with outstretched arm  
 Retrieving object from floor  
 Turning to look behind  
 Turning 360 degrees  
 Placing alternate foot on stool  
 Standing with one foot in front  
 Standing on one foot

---

Table 4

*Short-Term and Long-Term Goals*

| <u>Short-Term Goals</u>   | <u>Long-Term Goals</u>   |
|---|--|
| 1. Pt will perform cardio x 10min without fatigue   | 1. Pt to be able to ambulate for >150ft with quad cane with less deviations and improved stamina as noted by no c/o fatigue                |
| 2. Consult with orthotist regarding R AFO and potential need for stop to prevent hyperextension                       | 2. Pt to be able to perform pool stairs safely with stand by assist of therapist   |
| 3. Increase R ankle DF PROM from -15° to 0° to improve ability to perform heel strike with less R knee hyperextension | 3. Pt to perform bridge with improved R pelvic stability as noted by pelvis heights equal with lift in order to improve stability for gait |
| 4. Assess need for OT consult for splint as spouse reports splint is old and may need adjusting                       | 4. Pt to be able to sit in midline x2 min without difficulty   |
|   | 5. TUG Test in less than 30 seconds from 44 seconds with quad cane to improve gait efficiency  |
|   | 6. Pt to tolerate 30 mins of aquatic exercise/walking without c/o fatigue with 1-2 short rest breaks                                       |

Table 5

*Intervention Summary*

|   |
|---|
| 10-minute warm-up consisting of forward walking and side-stepping |
| Hamstring and gastrocnemius stretches                             |
| PNFD1 extension with rhythmic rotation to right upper extremity   |
| Lower extremity strengthening                                     |
| Paddle series   |
| Deep water exercises and lumbar traction                          |
| Progression to Aquatic Maintenance Program                        |

Table 6

*Comparison of Pre- and Post-Treatment Scores on the TUG, BBS, and Modified Ashworth Scale*

|                         | Pre-Treatment      | Post-Treatment     |
|-------------------------|--------------------|--------------------|
| TUG                     | 44 seconds         | 36 seconds         |
| BBS                     | 19/56              | 25/56              |
| Modified Ashworth Score | Upper Extremity: 3 | Upper Extremity: 2 |
|                         | Lower Extremity: 2 | Lower Extremity: 2 |

Table 7

*MMT Grades Post-Treatment*

|                    | <u>Upper Extremity</u> |       | <u>Lower Extremity</u> |       | <u>Lumbar Spine</u> |                |   |
|--------------------|------------------------|-------|------------------------|-------|---------------------|----------------|---|
|                    | Left                   | Right | Left                   | Right |                     |                |   |
| Shoulder Flexion   | 3+                     | 2+    | Hip Flexion            | 3+    | 3                   | Forward Bend   | 4 |
| Shoulder Abduction | 3+                     | 2+    | Hip Abduction          | 3+    | 2                   | Extension      | 4 |
| Elbow Flexion      | 4+                     | 1     | Hip Internal Rotation  | 3+    | 2-                  | Sidebend Left  | 4 |
| Elbow Extension    | 4+                     | 1     | Hip External Rotation  | 3+    | 2-                  | Sidebend Right | 3 |
| Wrist Flexion      | 4+                     | 0     | Knee Extension         | 4-    | 2-                  | Rotation Left  | 4 |
| Wrist Extension    | 4+                     | 0     | Ankle Dorsiflexion     | 4     | 0                   | Rotation Right | 4 |

*Note.* Refer to Table 1 for MMT grades at initial evaluation.

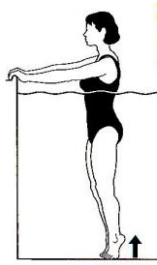
## References

- Aidar, F. J., Garrido, N. D., Silva, A. J., Reis, V. M., Marinho, D. A., & de Oliveira, R. J. (2013). Effects of aquatic exercise on depression and anxiety in ischemic stroke subjects. *Health, 5*, 222-228.
- American Stroke Association. (2012). Impact of strokes (stroke statistics) [Data file]. Retrieved from [http://www.strokeassociation.org/STROKEORG/AboutStroke/Impact-of-Stroke-Stroke-statistics\\_UCM\\_310728\\_Article.jsp#.T4dNTNIEIao](http://www.strokeassociation.org/STROKEORG/AboutStroke/Impact-of-Stroke-Stroke-statistics_UCM_310728_Article.jsp#.T4dNTNIEIao)
- Anderson, S., & Whitfield, K. (2013). Social identity and stroke: "They don't make me feel like, there's something wrong with me." *Scandinavian Journal of Caring Sciences, 27*, 820-830. doi: 10.1111/j.1471-6712.2012.01086.x
- Andersson, A. G., Kamwendo, K., Sieger, A., & Appelros, P. (2006). "How to identify potential fallers in a stroke unit: Validity indexes of 4 test methods." *Journal of Rehabilitation and Medicine, 38*, 186-191.
- Becker, B. E. (2009). Aquatic therapy: Scientific foundations and clinical rehabilitation applications. *American Academy of Physical Medicine and Rehabilitation, 1*, 859-872. doi: 10.1016/j.pmrj.2009.05.017
- Bohannon, R. W., & Smith, M. B. Interrator reliability of a modified ashworth scale of muscle spasticity. *Physical Therapy, 67*, 206-207.
- Brody, L. T. & Geigle, P. R. (2009). *Aquatic Exercise for Rehabilitation and Training*. Sheridan Books.
- Cho, H. Y., Kim, J. S., & Lee, G. C. (2013). Effects of motor imagery training on balance and gait abilities in post-stroke patients: A randomized controlled trial. *Clinical Rehabilitation, 27*, 675-680. doi: 10.1177/0269215512464702
- Chon, S. C., Oh, D. W., & Shim, J. H. (2008). Watsu approach for improving spasticity and ambulatory function in hemiparetic patients with stroke. *Physiotherapy Research International, 14*, 128-136.
- Chu, K. S., Eng, J. J., Dawson, A. S., Harris, J. E., Ozkaplan, A., & Gylfadottir, S. (2004). Water-based exercise for cardiovascular fitness in people with chronic stroke: A randomized controlled trial. *Archives of Physical Medicine and Rehabilitation, 85*, 870-874.
- Cuthbert, S. C., & Goodheart, G. J. (2007). On the reliability and validity of manual muscle testing: A literature review. *Chiropractic and Osteopathy, 15*.
- Dobkin, B. H. (2005). Rehabilitation after stroke. *New England Journal of Medicine, 352*, 1677-1684.

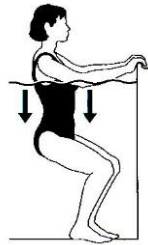
- Duncan, P. W., Zorowitz, R., Bates, B., Choi, J. Y., Glasberg, J. J., Graham, G. D., Katz, R. C., Lamberty, K., & Reker, D. (2005). Management of adult stroke rehabilitation care: A clinical practice guideline. *Stroke*, *36*, 100-143. doi: 10.1161/01.STR.0000180861.54180.FF
- Gassaway, J., Horn, S. D., DeJong, G., Smout, R. J., Clark, C., & James, R. (2005). Applying the clinical practice improvement approach to stroke rehabilitation: Methods used and baseline results. *Archives of Physical Medicine and Rehabilitation*, *86*, 16-33.
- Haring, H. P. (2002). Cognitive impairment after stroke. *Current Opinion in Neurology*, *15*, 79-84.
- Harris, J. E., Eng, J. J., Marigold, D. S., Tokuno, C. D., & Louis, C. L. (2005). Relationship of balance and mobility to fall incidence in people with chronic stroke. *Physical Therapy*, *85*, 150-158. Retrieved from <http://ptjournal.apta.org/content/85/2/150.long>
- Jette, D. U., Latham, N. K., Smout, R. J., Gassaway, J., Slavin, M. D., & Horn, S. D. (2005). Physical therapy interventions for patients with stroke in inpatient rehabilitation facilities. *Physical Therapy*, *85*, 238- 248.
- Jung, T., Lee, D., Charalambous, C., & Vrongistinos, K. (2010). The influence of applying additional weight to the affected leg on gait patterns during aquatic treadmill walking in people poststroke. *Archives of Physical Medicine and Rehabilitation*, *91*, 129-136.
- Morris, D. M. (1995). Aquatic neurorehabilitation. *Neurology Report*, *19*, 22-28.
- Natarajan, P., Oelschlager, A., Agah, A., Phol, P. S., Ahmad, S. O., & Liu, W. (2008). Current clinical practices in stroke rehabilitation: Regional pilot survey. *Journal of Rehabilitation Research and Development*, *45*, 841-850.
- Noh, D. K., Lim, J. Y., Shin, H. I., & Paik, N. J. (2008). The effect of aquatic therapy on postural balance and muscle strength in stroke survivors – A randomized controlled pilot trial. *Clinical Rehabilitation*, *22*, 966-976. doi: 10.1177/0269215508091434
- Paolucci, S., et al. (2003). Functional outcome of ischemic and hemorrhagic stroke patients after inpatient rehabilitation: A matched comparison. *Stroke*, *34*, 2861-2865.
- Podsiadlo, D. & Richardson, S. (1991). The timed "Up & Go": A test of basic functional mobility for frail elderly persons. *Journal of the American Geriatric Society*, *39*, 142-148.
- Resende, S.M., Rassi, C.M., Viana, F.P. (2008). Effects of hydrotherapy in balance and prevention of falls among elderly women. *Brazilian Journal of Physical Therapy*, *12*, 57-63.
- Sacco, R. L., et al. (2006). Guidelines for prevention of stroke in patients with ischemic stroke or transient ischemic attack. *Circulation*, *113*, 409-449.

- Sacco, R. L., et al. (2013). An updated definition of stroke for the 21<sup>st</sup> century: A statement for healthcare professionals from the American Heart Association/American Stroke Association. *Stroke*, *44*, 2064-2089. doi: 10.1161/STR.0b013e318296aeca
- Schmid, A. A. & Rittman, M. (2007). Fear of falling: An emerging issue after stroke. *Stroke Rehabilitation*, *14*, 46-55. doi: 10.1310/tsr1405-46
- Schmid, A. A. & Rittman, M. (2009). Consequences of poststroke falls: Activity limitation, increased dependence, and the development of fear of falling. *American Journal of Occupational Therapy*, *63*, 310-316. Retrieved from [http://shrs.iupui.edu/occupational\\_therapy/publications/schmidfinal2009.pdf](http://shrs.iupui.edu/occupational_therapy/publications/schmidfinal2009.pdf)
- Schmid, A. A., Puymbroeck, M. V., Altenburger, P. A., Dierks, T. A., Miller, K. K., Damush, T. M., & Williams, L. S. (2012). Balance and balance self-efficacy are associated with activity and participation after stroke: A cross-sectional study in people with chronic stroke. *Archives of Physical Medicine and Rehabilitation*, *93*, 1101-1107.
- Sova, R. (2004). The chi of water. *Rehab Management: The Interdisciplinary Journal of Rehabilitation*, April 2004. Retrieved from <http://www.rehabpub.com/features/42004/2.asp>
- Sova, R. (2012). Introduction to aquatic therapy and rehab. Port Washington, WI: DSL, Ltd.
- Srikanth, V. K., Thrift, A. G., Saling, M. M., Anderson, J. F., Dewey, H. M., Macdonell, R. A., & Donnan, G. A. Increased risk of cognitive impairment 3 months after mild to moderate first-ever stroke: A community-based prospective study of nonaphasic English-speaking survivors. *Stroke*, *34*, 1136-1143. doi: 10.1161/01.STR.0000069161.35736.39
- Stanat, F., & Lambeck, J. (2001). The halliwick method, part 1 and part 2. AKWA, 15.
- Suethanapornkul, S., Kuptniratsaikul, P. S., Kuptniratsaikul, V., Uthensut, P., Dajpratha, P., & Wongwisethkarn, J. (2008). Post stroke shoulder subluxation and shoulder pain: A cohort multicenter study. *Journal of the Medical Association of Thailand*, *91*, 1885-1893.
- Tyson, S. F., Hanley, M., Chillala, J., Selley, A., & Tallis, R. C. (2006). Balance disability after stroke. *Journal of the American Physical Therapy Association*, *86*, 30-38.
- Weerdesteyn, V., de Niet, M., van Duijnhoven, H., & Geurts, A. (2008). Falls in individuals with stroke. *Journal of Rehabilitation Research and Development*, *45*, 1195-1214. Retrieved from <http://www.rehab.research.va.gov/jour/08/45/8/pdf/Weerdesteyn.pdf>

**Appendix A: Aquatic Maintenance Program**



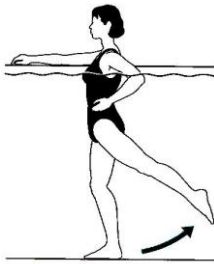
**Heel Raises**



**Mini Squats**



**Hip Abduction**



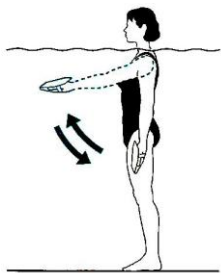
**Hip Extension**



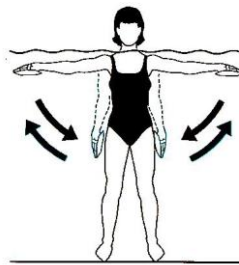
**Hip Flexion**



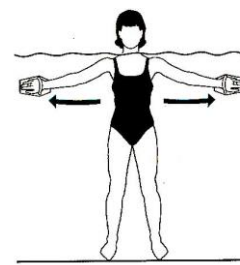
**Step-Ups**



**Arms up in front**



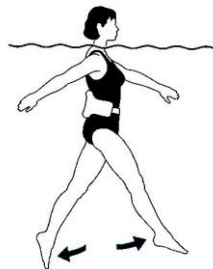
**Arms up and down at sides**



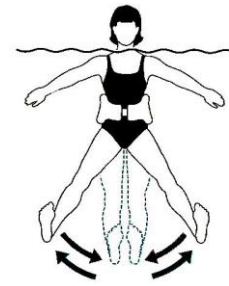
**Bring arms together in front**



**Bicycle**



**Skiing Motion**



**Jumping Jacks**