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**Aquatic Therapy for Multiple Sclerosis**

**Overview of Multiple Sclerosis**: **Etiology**

Multiple Sclerosis (MS) is the most common demyelinating disease of the central nervous system (CNS). 1 It primarily occurs in women aged 20-40.1 Although the exact etiology of MS is unknown,2 there are different theories about its cause. The dominant theory is that MS starts with an inflammatory process in which immune cells such as lymphocytes cross the blood brain barrier and attack neurons in the central nervous system (CNS) thus causing demyelination of these neurons and the development of scarring plaques within the CNS.2 In later stages of the disease process, there may be microglial activation that causes chronic neurodegeneration.2

**Types of Presentation**:

MS can progress and present in different manners. The most common presentation of MS is Relapsing-Remitting MS (RRMS), which affects approximately 85 percent of patients with MS.2 It is characterized by acute attacks with periods of exacerbated neurological dysfunction followed by remissions, during which the patient may experience fewer symptoms3.Another common course of the disease is Secondary-Progressive MS (SPMS), which begins like RRMS and then progresses with steady functional decline that may or may not be accompanied by acute attacks.2, 3 The two other classifications, Primary Progressive MS (PPMS) and Progressive Relapsing MS (PRMS), are more rare presentations.2, 3 PPMS is characterized by a continuously worsening condition without acute attacks.2 PRMS is characterized by steady progressive decline and acute attacks. 2,3

**Common Impairments and Functional Limitations**:

Patients with MS present with varying impairments depending on which parts of the CNS are affected.3 Early symptoms often involve visual disturbances, paresthesias, weakness1 and fatigue.2 Fatigue is very common in patients with MS occurring in 75%-95% of individuals.2 Approximately 80% of patients with MS have pain as well as visual symptoms.2 Spasticity occurs in approximately 75% of cases of MS and can cause further problems such as pain, contractures, problems with skin integrity and falls.2

Other challenges that patients with MS face includes hypersensitivity to heat, problems with coordination, balance deficits, and cognitive impairments such as depression, anxiety, poor short-term memory, poor concentration, and poor visual-spatial abilities. Patients with MS are often less active and have a decreased aerobic capacity.2 As the disease progresses, patients may experience impaired speech or swallowing including dysarthria, diminished verbal fluency, dysphonia, and dysphagia.2

These common impairments lead to functional limitations for patients with MS. Patients often have difficulty with transfers and performing activities of daily living (ADLS). 2 They have difficulty with gait due to fatigue, spasticity, weakness or ataxia.2 Many of these impairments reduce their balance and increase their risk of falling.2

**Typical outcome measures:**

Outcome measures used for this patient population often lack consistency. The American Physical Therapy Association’s neurological section has a subsection, the MS EDGE, which recommends outcome measures for patients with MS. Their recommended outcome measures for outpatient care includes: the 12-Item MS Walking Scale, the6-Minute Walk Test,the9-Hole Peg Test, theBerg Balance Scale, the Dizziness Handicap Inventory, MS Functional Composite, MS Impact Scale (MSIS-29), the MS Quality of Life Scale (MS Qol-54), the timed 25 Foot Walk, and the Timed Up & Go (TUG). 4 Many of these are used in research studies as well. Both Bayrakatar et al5 and Kurt el al6 used the TUG to examine the effectiveness of aquatic interventions for improving balance. Another test, the six minute walk test, was used by Dalgas et al and Bayrakatar et al in studies investigating the effect of aquatic therapy on MS.5, 7

Most studies also used the Expanded Disability Status Scale to categorize the disease severity in patients with MS prior to starting a study.8, 9 This outcome measure is often conducted by a neurologist9. Additionally, many studies have used the fatigue impact scale or its modified version as an outcome measure for patients with MS.

**Typical Physical Therapy Interventions and Land Based Physical Therapy”**

Typical land based interventions aim at improving mobility, strength, cardiovascular endurance, and balance.2 A prospective randomized controlled trial by Kerling et al investigated improving strength and aerobic capacity in patients with MS.8 The trial was two weeks in duration with two groups: one that performed only aerobic exercise twice a week for forty minutes; and another that combined aerobic and resistance exercise twice week for forty minutes.8 Both groups improved in maximum muscle force, aerobic capacity, and fatigue.8

Another study by Dalgas et al suggests that the use of strength training interventions with patients with MS is effective. This randomized control trial examined thirty-eight patients with moderately involved MS.7 The exercise group performed progressive resistance training on their lower extremities twice-a-week for twelve weeks while the control group received no treatment.7 Members of the exercise group had increased muscle fiber cross sectional area and increased isokinetic strength after 12 weeks of progressive resistance training.7

A systematic review of randomized controlled trials and controlled trials supported the use of progressive Resistance Training (PRT) for improving strength in MS patients.10 The studies reviewed used interventions that ranged from two to five sessions per week and from two to twenty weeks in duration.12 All studies reported patient increases in strength over time in the experimental groups.12 Another systematic review and meta-analysis conducted by Platta et al. found small cumulative effect size in favor of strength training and a large cumulative effect size in favor of improving cardiorespiratory fitness for land-based therapy in patients with MS.11

Interventions can also improve balance in persons with MS. A single blind randomized controlled trial by Tarakci et al10 investigated the effectiveness of group exercise for improving balance, functional mobility, and fatigue in 99 subjects with MS .10 The exercise group met for sixty minutes three times per week for twelve weeks and the control group received no treatment.10 Exercises consisted of flexibility, range of motion, strengthening, core stabilization and functional balance activities.10 There were statistically significant d improvements in the exercise group compared to the control group on the BBS, 10 MWT, and 10-step test.10 There was also a reduction in spasticity in the Modified Asthworth Scale, an improvement in the Fatigue Severity Scale, and improvements in the Multiple Sclerosis Quality of Life Questionnaire. 10

**Evidence for Aquatic Therapy: Benefits of Water in General for Therapy**

There are specific properties unique to water that can create a therapeutic environment for a patient. Hydrostatic pressure, buoyancy, resistance, turbulence and thermodynamics can be used to challenge a patient in aquatic therapy. Hydrostatic pressure, or the pressure that the water exerts on the body, depends on both the density of the fluid and the depth of immersion.1,3 Hydrostatic pressure can aide in treating venous insufficiency and edema because blood and lymphatic fluid are pushed from the lower extremities toward the heart.13 Hydrostatic pressure also aids in strengthening respiratory muscles, such as the diaphragm and intercostal muscles, by providing them with resistance. 13 The pressure that the body experiences due to hydrostatic pressure also stimulates sensory input and can aide in cases of neuropathy.13

When a body is immersed in water, it experiences an upward force equal to the weight of the volume of water displaced; this is known as buoyancy.13 Buoyancy has many benefits including a decrease in the weight bearing force, which is proportional to the depth of immersion.14 This phenomenon relieves pressure on the joints, which encourages pain-free movement. 13 It also helps patients who have trouble moving on land move in the water.5 Buoyancy is related to the specific gravity of water and the person in the water.13 Water’s specific gravity is 1g/cm3 while the average human body is less than 1g/cm.13 Since the average human body is less dense, people float in water.13 This reduces fears of falling in patients who perform aquatic balance training.15

Shape resistance of water can be manipulated to challenge the patient.16 An object moving in water experiences increased resistance in the direction of movement and lower pressure behind the direction of movement. 13 Resistance felt is dependent on the velocity of movement and surface area of the object.13 These concepts can be utilized in aquatic therapy. For example, using paddles in the water and increasing the speed of movement can both increase the resistance that the patient experiences.

A body also encounters resistance with colliding waves from moving water or turbulence. Turbulence is defined as violent and unsteady movement of air or water and is characterized by swirling.13 Turbulence generally increases resistance and can be used in therapy. An example of this is when the therapist gets the patient to walk in one direction and return in the other direction, or to perform exercises in front of a jet at the side of the pool. Turbulent water can also provide balance training in the water by challenging a patient’s stability.5

Another aspect of water that affects the patient is thermodynamics Water has a high heat capacity, and it is an efficient heat conductor, which means that the human body will adapt to the water temperature faster than the water will adapt to the body’s temperature.14 The therapeutic water range in aquatic therapy is generally 92-96 F.13 Cold and warm water temperatures have different physiological effects. Therefore, the pool temperature should be selected in line with the goals of therapy. Many patients with MS have heat sensitivity, so cooler temperatures would be appropriate with this patient population.1 Cool water decreases the heart rate, decreases cardiac output and the work of the myocardium, increases blood pressure and vasoconstriction and reduces inflammation.13

**Evidence for Aquatic Therapy with MS:**

Aquatic therapy studies treating patients with MS have focused on reducing pain, fatigue, weakness, and depression while improving balance.5, 15, 17,18, 21 A trial by Kargarfar et al. examined the effect of aquatic therapy on fatigue and quality of life.17 The study was a randomized controlled trial of thirty-two women with RRMS.17 The experimental group received eight weeks of aquatic exercise three times per week for sixty minutes. The subjects in the control group were asked to maintain their normal activity. 17 In the aquatic exercise group, there was a significant decrease in fatigue on the Modified Fatigue Impact Scale (MFIS) and a decrease in health-related quality of life on the Multiple Sclerosis Quality of Life-54 (MSQOL-54) scale.17 However, this trial was underpowered and contained a large number of dropouts that were not accounted for. Additionally, it included only women, so it may not be applicable to all patients with MS.

Another trial by Broach and Dattilo found some evidence supporting increased strength with aquatic therapy.1 This quasi-experimental single subject multi-probe design followed four women with RRMS1. Subjects received eight weeks of aquatic therapy three times per week.1 Muscle strength was measured using a hand-held dynamometer that measured peak force in pounds and a Microfit muscle tester for manual muscle testing.1 While the trial found mixed results in strengthening of all the muscles tested, the hamstring, quadriceps, hip flexor, triceps, biceps, and shoulder abductor strength remained the same or improved in all subjects, possibly indicating a delay in progressive weakness.1 This finding indicates that aquatic therapy may help persons with MS maintain strength. However, a well-designed randomized controlled trial is needed to confirm these results.

Bayraktar el al. conducted a controlled trial examining aquatic therapy’s effect on fatigue and functional mobility.5 The controlled trial consisted of twenty-three ambulatory female patients. The intervention group received sixty minutes of aquatic therapy sessions twice a week for eight weeks.5 The control group was assigned a twice-per-week home exercise program with active range of motion and abdominal breathing exercises.5 The aquatic group improved in functional mobility (TUG), static standing balance, upper and lower extremity muscle strength, and there was a reduction in fatigue (Fatigue Severity Scale).5 There were no improvements from baseline in the control group.5 While these results are promising, the trial had a high dropout rate and a small sample size. It also contained some design flaws that may have introduced bias including a lack randomization, a lack of blinding and only including women in the study.5

A trial conducted by Mar et al. suggests that aquatic therapy may improve pain, muscle fatigue and spasms as well as depression and autonomy.18 This was a randomized controlled trial of forty subjects with MS.15 The experimental group completed forty sessions of Ai Chi exercises, and the control group performed forty sessions of abdominal breathing and contraction-relaxation exercises in a therapy room.15 The experimental group showed a significant (P < 0.028) and "clinically relevant decrease in pain intensity compared with baseline."15 There were also reductions in muscle spasms, fatigue (FSS), depression (Beck Depression inventory), and improved autonomy compared to the control group. 18 Overall, this study was well designed and scored an 8/11 on the PEDro scale for bias. The study could have included blinding, and they may have introduced a confounding factor in the intervention because only the intervention group performed their exercises to music.

**Evidence That Aquatic Therapy Benefits Patients with Spasticity:**

One trial by Kesiktas et al suggests that aquatic therapy may reduce spasticity. This was a controlled trial of twenty matched spinal cord injury patients who were taking oral baclofen.19 The experimental group performed twenty minutes of water exercises three times a week for ten weeks while the control group continued with usual care.19 There was a statistically significant decrease in oral baclofen intake in the hydrotherapy group (P <0.01) as well as a statistically significant improvement in the Modified Ashworth Scale score indicating a reduction in spasticity. 19 While the sample size of this trial was small, the results suggest that aquatic therapy may reduce spasticity.

 **Strength Training and Aquatic Therapy:**

A review by Plecash et al.15 found that water based programs for stroke rehabilitation have shown higher strength gains compared to land based programs.15 This was further supported by a study by Zhang el al.20 Zhang et al. conducted a randomized controlled trial of thirty six subjects with sub-acute CVA and a paretic lower limb.20 The study evaluated the effect of aquatic exercise on muscle strength on a paretic lower limb.20 The experimental group performed forty minutes of aquatic exercise five times a week for eight weeks, and the control group performed forty minutes of land based physical therapy five times a week for eight weeks.20 The interventions in both groups included treadmill walking and resistance exercise.20 The study found that the aquatic exercise group improved the strength of their paretic limbs and muscle co-contractions more than the control group. 20 These results indicate that aquatic exercise may be more beneficial than land based exercise in strengthening a paretic lower limb in sub-acute stroke patients. While the sample size was small, the preliminary results of this trial are promising. The trial was well designed and scored a 9/11 on the PEDro scale for bias. These results would suggest that conducting a larger randomized controlled trial would be worthwhile.

**Balance Training and Aquatic Therapy:**

Aquatic therapy is often used in balance training for patients with neurological diseases due to the properties of water and the decreased risk of falling.13 A systematic review of randomized controlled trials and quasi-experimental trials by Buzelli et al-showed “fair” evidence supporting the use of aquatic therapy to improve dynamic balance and gait speed in patients with neurological conditions: 21 Walking speed improved in two studies in the review that used aquatic aerobic exercise and balance exercises in the water. However, the study design for these were weak because they lacked a control group.21

Two studies support the use of aquatic therapy as an intervention to improve balance in patients with Parkinson’s disease. One was a randomized controlled trial by Kurt et al. of forty subjects with Parkinson’s disease.6 This trial investigated the effect of Ai Chi aquatic therapy on balance, functional mobility, health-related quality of life, and motor impairment.6 All subjects with PD were either a 2 or 3 on the Hoehn and Yahr scale.6 The experimental group performed Ai Chi for sixty minutes five times a week for five weeks while the control group performed sixty minutes of land-based therapy for the same frequency and length of time.6 The study found a statically significant improvement in experimental group (Ai Chi) over the control group (land based) in dynamic balance (anteroposterior index/ mediolateral index), overall balance index, the BBS, TUG, Unified Parkinson’s Disease Scale and Parkinson’s Disease Questionnaire.6 This study was well designed with a larger sample size and longer intervention periods than many aquatic therapy studies. The longer duration may have better allowed the study to examine the effects of aquatic therapy than other studies. The results from this study suggest that aquatic therapy may have advantages over land-based therapy in this population.

There was another study on aquatic therapy as an intervention to improve balance in patients with Parkinson’s disease was conducted by Vivas et al. This study was a randomized controlled trial of eleven subjects with Parkinson’s disease, and it compared aquatic and land based therapy for treating postural stability in people with Parkinson’s. 22 All subjects were stage two to three on Hoehn and Yahr scale without medication.22 The study consisted of four weeks of intervention twice a week for forty-five minutes. The experimental group improved in BBS approximately 3 points more than the land based group at follow-up, and they improved 5 points more on the Unified Parkinson’s Disease Rating Scale. However the other variables that were measured did not reach significance. This may be due to the small sample size of the study and the short duration of the trial. This could have introduced a type II error that not detected an existing difference between the groups. This difference would have been detected if the study had had a larger sample size.

**Conclusion:**

Properties of water can be used in therapy to establish a unique therapeutic environment for patients with MS. The water provides buoyancy and may reduce a patient’s fear of falling1, which allows for more advanced postural control exercises to take place. Water also provides multi-directional resistance and turbulence, which can be utilized to encourage strength training in these patients.15 Aquatic therapy can include aerobic exercise, strengthening, balance and stability as well as stretching exercises. There is evidence in multiple studies that aquatic therapy relieves pain, 15 reduces muscle spasms,15 ,19 and reduces fatigue in patients with multiple sclerosis. The evidence supports aquatic therapy as an intervention for MS.

While there are no well-designed studies that support the use of aquatic therapy for strength training in patients with MS, there is strong evidence for aquatic therapy in strengthening patients with stroke. 20 Zhang et al provided evidence that aquatic therapy may be more beneficial in strengthening a paretic lower limb than land-based therapy.20 However, it is unclear how much of this evidence is transferable to patients with multiple sclerosis. There also is evidence from two studies that aquatic therapy may improve balance more than land-based therapy in persons with Parkinson’s disease.6, 22 However, these results may not be transferable to patients with MS.

The current body of evidence does not support aquatic therapy over the use of land-based therapy for patients with MS. Most of the trials do not compare land-based and water based therapy. In addition, the current studies on aquatic therapy in patients with MS are not well designed as they often lack control groups, contain small sample sizes and are tainted by bias. . Often the studies are underpowered with small sample sizes and lack assessor blinding.23 Standardizing the outcome measures used in these studies would aid in comparing studies.23

 There is a need for larger well-designed randomized controlled trials on aquatic therapy for patients with MS. More research may be warranted due to the current fair evidence that aquatic therapy is beneficial to this population. Studies could compare efficacy of land-based therapy to aquatic therapy as has been done in populations with stroke and Parkinson’s disease. Future studies could also examine aquatic therapy as a co-treatment with land-based therapy.23

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