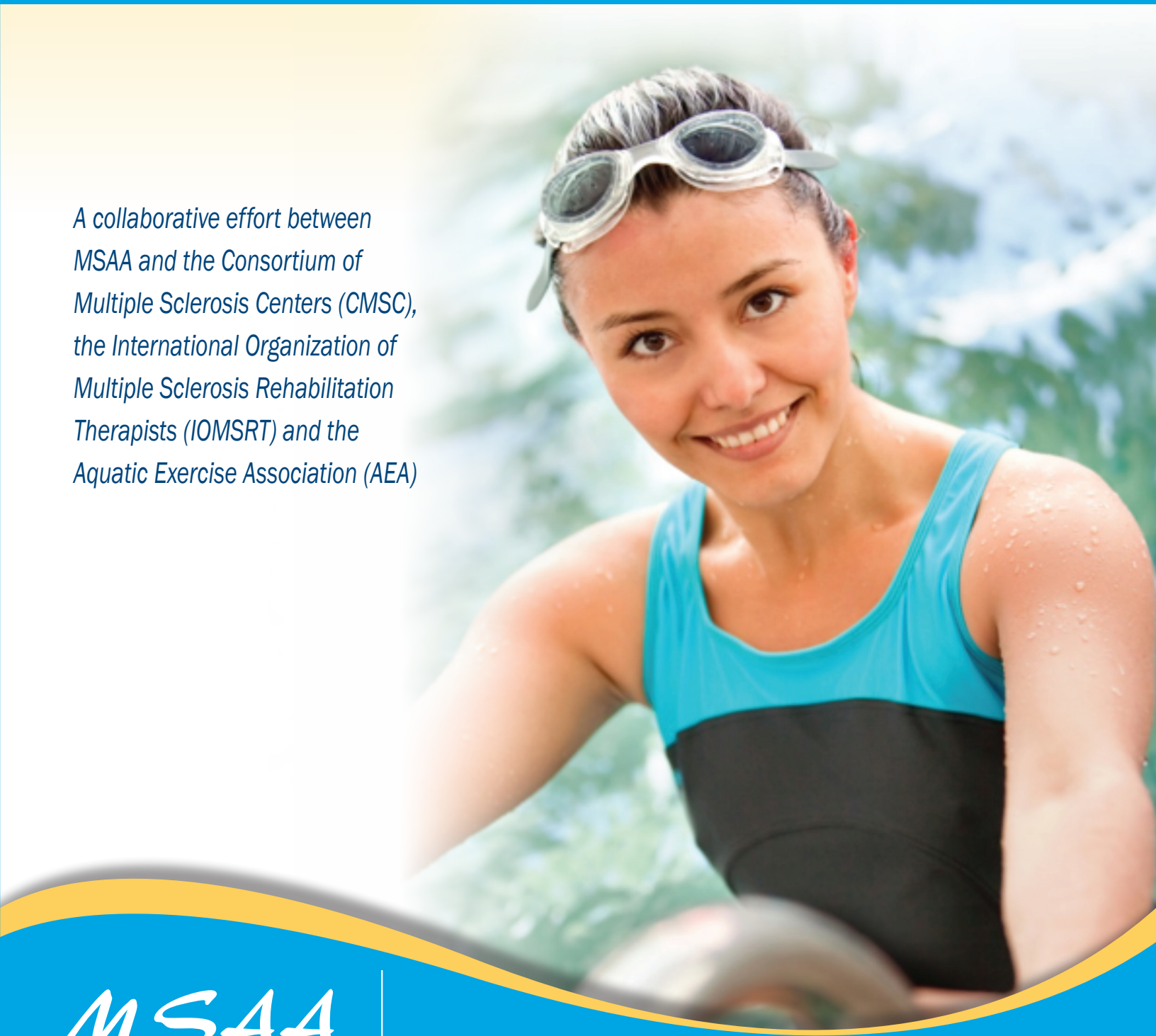
AQUATIC EXERCISE & MULTIPLE SCLEROSIS:

A Healthcare Professional's Guide

A collaborative effort between MSAA and the Consortium of Multiple Sclerosis Centers (CMSC), the International Organization of Multiple Sclerosis Rehabilitation Therapists (IOMSRT) and the Aquatic Exercise Association (AEA)



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Aquatic Exercise and Multiple Sclerosis: A Healthcare Professional's Guide

About this Publication:
The Multiple Sclerosis Association of America (MSAA) is honored to collaborate with the Consortium of Multiple Sclerosis Centers (CMSC), the International Organization of Multiple Sclerosis Rehabilitation Therapists (IOMSRT) and the Aquatic Exercise Association (AEA) to expand academic knowledge of aquatic exercise and multiple sclerosis through the writing of this publication. MSAA would like to express its tremendous gratitude and appreciation for the authors and reviewers of this publication who contributed their collective time, talents and expertise to enhance the understanding and awareness of this important topic.

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MSAA strives to provide useful, up-to-date information on matters of concern to the MS community. This material is intended for general information purposes only and it does not constitute medical advice. Individuals are urged to consult their physician prior to the start or change of any exercise program or routine. MSAA, its staff, and those affiliated with the writing of this publication cannot be held responsible for any unintentional errors.

SWIM FOR MS
ANY POOL, ANY TIME

Swim for MS is a national fundraiser in which volunteers are encouraged to create their own swim challenge while recruiting online donations to support the Multiple Sclerosis Association of America. Swim challenges can range from swimming laps for pledges to jumping cannonballs for cash. Swim for MS appeals to swim enthusiasts of all ages, social and community groups, individuals living with MS, students seeking volunteer service hours, and families enjoying their backyard pool.

Funds raised support individuals with multiple sclerosis through the many programs and services offered by MSAA, including the increased awareness, understanding, and availability of water-based exercise programs for the MS community.

MSAA would like to thank Genzyme Corporation for its generous support for the development of this healthcare professional's guide and future aquatic exercise initiatives through its national sponsorship of Swim for MS.

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Introduction

Multiple sclerosis (MS) is the leading neurological cause of disability among adults. The disability resulting from the progressive and degenerative nature of MS leads individuals with MS to identify and define professionals to help guide their healthcare and personal needs. There are many different types of professionals who may have the opportunity to work with people with MS. People with MS have healthcare providers to help deal with the effects of a progressive disease and these individuals include physicians, nurses, psychologists, psychiatrists, and therapists (speech therapists, occupational therapists, physical therapists, and recreational therapists). Other types of professionals, including exercise specialists, personal trainers, aquatic exercise specialists, and vocational rehabilitation specialists may also interact with people with MS at many points in their lives. This manual is intended to provide information to any professional who might have the opportunity to work with an individual with MS in an aquatic exercise setting.

Overview of Exercise and MS

Multiple sclerosis (MS) is a demyelinating disease of the central nervous system (CNS) that affects approximately 400,000 people in the United States, and 1,000,000 people between 16 and 65 years of age worldwide (Kantarci & Wingerchuk, 2006). It is a neurodegenerative disease, which can be characterized by a course of demyelination-mediated relapses and remissions, superimposed upon gradual neurologic deterioration, resulting in a clinical course that is unpredictable in its progression and severity. Current thinking is that the etiology of MS is some interaction between genetic predisposition and an inciting environmental antigen, resulting in an autoimmune response in a susceptible host. The pathophysiology associated with MS is the slowing or stopping of saltatory conduction of action potentials along myelinated axons in the CNS. This results in a clinical presentation that is varied and unpredictable in age of onset, disease progression, and the signs and symptoms experienced by each person with MS.

A longitudinal study that questioned nearly 2,000 people with MS identified the following most commonly reported signs and symptoms. The number in parenthesis is the weighted percentage of respondents in that study of people with MS who experienced the symptom at the time of the study (Minden et al., 2006).

- Fatigue (83.1%) – considered by many people with MS to be their most debilitating symptom. It is subjective, and based on the individual's perception of his/her own level of fatigue. The fatigue related to MS is multifactorial and may be due to the disease process, secondary complications of the disease, polypharmacy and others. A brief definition of MS-related fatigue is "an overwhelming sense of tiredness, lack of energy or feeling of exhaustion" (Leocani et al., 2001). A more thorough definition of MS-related fatigue is a "reversible, motor and cognitive impairment with reduced motivation and desire to rest, either appearing spontaneously or brought on by mental or physical activity, humidity, acute infection, and food ingestion. It is relieved by daytime sleep or rest without sleep. It can occur at any time but is usually worse in the afternoon. In MS, fatigue can be daily, has usually been present for years and has greater severity than any premorbid fatigue" (Mills & Young, 2008).

- Difficulty walking (67.2%) – which may be due to a number of impairments of body function, including weakness, lack of balance, dyscoordination, hypertonia or spasms, fatigue, and others.

- Stiffness and spasms (63.1%) – may be related to spastic paralysis, tonic spasms, diminished flexibility, and others.

- Bladder problems (59.8%) – may include bladder hesitancy, urgency, frequency, and incontinence, particularly if there is spinal cord-level involvement.

- Memory and other cognitive problems (55.8%) – most typically involving working memory, attention and information processing speed.

- Pain and other unpleasant sensations (54.3%) – there is a 70% lifetime prevalence of pain in persons with multiple sclerosis (PWMS) (Rowland et al., 2010), and may come from a variety of sources including dysesthesias from MS plaques, disuse/overuse injuries from compensatory movement patterns, pain from spastic muscles, trigeminal neuralgia and others.

- Emotional or mood problems (37.5%) – including major depression, which has a point prevalence rate of 14% (Goldman Consensus Group) and a lifetime prevalence rate of ~50% (Daroff & Bradley, 2012), a rate markedly higher than that in other populations of people with chronic disease.

- Vision problems (37.4%) – ranging from monocular vision changes from optic neuritis, visual field deficits due to pathology in the visual pathways, diplopia and lack of oculomotor control due to dysfunction in cranial nerves III, IV and VI, and/or vestibular pathways.

- Dizziness or vertigo (36.2%) – possibly due to visual system problems as noted above, or dysfunction in cranial nerve VIII and/or the vestibular pathways. May also be related to orthostatic hypotension and other secondary causes.

- Bowel problems (34.5%) – as with bladder problems, may include urgency or incontinence.

- Tremors (30.2%) – typically intention tremors due to involvement of the cerebellar tracts or dorsal columns, but may include titubation or essential tremor.

- Sexual problems (29.9%) – may include primary sexual dysfunction (e.g., erectile dysfunction), particularly with spinal-level lesions. May also be a secondary complication due to other problems including depression, fatigue, muscle weakness, and others.

- Difficulty moving arms (23.5%) – due to involvement in the cortical motor, cerebellar, or spinal motor tracts, fatigue, or diminished flexibility.

- Swallowing problems (21.8%) – due to involvement of CN V (mastication), CN VII (muscles of facial expression involved in bolus management), and CN IX, X and XII (swallowing).

- Speech problems (20.2%) – may be due to impaired breath support due to respiratory dysfunction, altered postural support, or cranial nerve involvement (VII, IX, X and XII).

- Seizures (2.1%) – are marginally more common in PWMS than in those who do not have MS, but the mechanism is not understood.

In addition to the above impairments, researchers have identified weakness in respiratory muscles even in people with mild MS (Fry et al., 2007). Deficits in both inspiratory and expiratory ability were identified in people with mild to severe MS.

Maximal aerobic capacity in people with MS has been shown to be over 30% lower than age-matched healthy controls. This deconditioning occurs in mildly to moderately impaired people with MS (Howe & Gomperts, 2006). In individuals with mild impairment from MS, VO_2max was found to be significantly related to the level of neurologic impairment (Romberg et al, 2004). The Expanded Disability Status Scale (EDSS) is an outcome measure used to determine level of disability related to MS. The measure goes from 0 (no deficits) to 10 (death due to MS). Critical levels of the EDSS are 6.0, which indicates the person needs an assisted device for gait, and 7.0, which indicates the person requires a wheelchair for mobility. Each one-point increase on the EDSS was associated with a decrease in VO_2 peak of about 2mL/kg/min.

Balance is also affected in individuals with MS leading to increased risk for falls. Balance deficits may be due to weakness, spasticity, loss of range of motion, and changes in the cerebellum, brainstem, and vestibular system and nerve. Even individuals with minimal impairment from MS were determined to have center of pressure measurements related to dynamic reaching that were abnormal when compared to age-matched individuals. The deficits in people with MS occurred in the limits of stability during maximal leans and in peak-to-peak center of pressure measurements in the anterior displacement (Karst et al, 2006). Multiple sclerosis is a progressive degenerative disease with multiple signs and symptoms leading to limitations in activity and participation. The disabling and progressive nature of the disease makes it imperative for people with MS to participate in exercise and/or physical therapy to maintain functional ability. Rehabilitation intervention in people with MS should include aspects to address weakness, decreased cardiovascular ability,

respiratory weakness, balance deficits and risk for falls, and flexibility. Concerns of rehab professionals regarding exercise in people with MS include the Uhtoff's phenomena, dysautonomia, and fatigue. Uhtoff's phenomenon is caused by an increase in core body temperature and is characterized by worsening of the person's signs and symptoms. This phenomenon is usually transient and subsides as the core body temperature reduces to normal (Howe & Gomperts, 2006).

Exercise in People with MS

There are several reasons for people with mild impairment related to MS to consider exercise as a part of their weekly routine. These include:

1. Improvement in aerobic or cardiovascular fitness (Rampello et al, 2007)
2. Improvement in strength
3. Reduction of risks for cardiovascular disease
4. Reduction in the risk of falls through improvement in balance
5. Enhancement of the overall quality of life

As MS progresses into the moderate phase, the disease burden continues to challenge all aspects of life leading to additional impairments, functional limitations and limitations in participation in normal activities. Rehab intervention, exercise, and maintenance of overall health and well-being must all be considered as part of daily activities and care. The importance of activity and exercise continues into the severe stage of the disease. These individuals are now severely disabled and consideration should be given to activities able to be completed in the wheelchair.

There has been a growing body of evidence identifying the benefits of exercise for everyone at every stage in his/her lifespan. A big emphasis in the treatment of people with MS has been to improve functional levels, decrease disabling symptoms and decrease problems associated with more sedentary lifestyles. There are also other important reasons to try to stay active for nervous system health and promotion of neural plasticity benefits. Exercise is known to promote brain chemical production, such as brain growth hormone (BGH) and nerve growth factor (NGF). BGH and NGF are known to increase nervous system tissue protection, repair and regeneration. Also, brain chemicals that help combat depression are released during consistent participation in exercise. Exercise is also known to increase neural reserve, important in neurologic treatment as we age. There has been a great amount of information on the importance of exercise in the treatment of neurologic conditions including MS. Despite this, it is sometimes difficult for people with MS to participate in these exercise and activity recommendations when they are experiencing increasing barriers on a consistent basis.

Exercises shown to be beneficial to individuals with MS include aerobic exercise, strength training, balance exercises, respiratory muscle training, endurance training, aquatics training, and combined programs (Cattaneao et al., 2007; Dodd et al., 2011; Fry et al., 2007; Hayes et al., 2011; Howe & Gomperts, 2006; Hulsinga et al., 2012; Rampello et al., 2007; Sabapathy et al., 2011; Salem et al., 2011). Specific exercise techniques shown to be beneficial in people with MS are:

- Aerobic training using the treadmill, the elliptical, arm and leg cycle ergometer, recumbent bike
- Freestyle swimming and shallow water calisthenics
- Combined training: warm up, stretching lower extremities, resistance training (LE), balance training, aerobics (treadmill, elliptical, rowing)
- Resistance training: upper body and lower body resistance training using body weight as the resistance, and core strengthening
- Balance exercises: using the NeuroCom Balance Master, standing balance exercises progressing in complexity
- Respiratory muscle training: inspiratory muscle training
- Aquatics: PT directed and community-based PT directed

Several studies support the use of exercise in people with MS, and many of these have investigated the effect of exercise utilizing traditional, land-based techniques. The benefits of these types of activities have been described in the literature and incorporate concepts of gravity and body weight resistance in the training. The use of aquatic exercise has similar benefits in the improvement of strength, endurance, cardiovascular ability, and balance (Salem et al., 2011; and Salem et al., 2011).

Research Summaries of Aquatic Exercise and MS

The use of aquatic therapy has been examined as a possible intervention for individuals with multiple sclerosis. A total of 10 studies that examined the effectiveness of aquatic therapy for individuals with multiple sclerosis were identified. Of these, three were case studies, five were single-subject design, one was a randomized controlled trial and one was an unpublished randomized controlled trial.

Gehlsen et al. (1984)	
Design:	Single-subject design
Participants:	10 ambulatory individuals with multiple sclerosis
Intervention:	10 weeks of water aerobics, 3/week for 60 minutes
Outcome Measures:	Muscle strength, endurance, work, and power
Results:	Aquatic training increased work capacity and fatigue resistance of the knee flexor and extensor muscles, and improved upper extremity work, force, and power

Gehlsen et al. (1986)	
Design:	Single-subject design
Participants:	11 ambulatory individuals with multiple sclerosis
Intervention:	10 weeks of water aerobics, 3/week for 60 minutes
Outcome Measures:	Cadence, stride length and joint excursion during gait
Results:	No changes in gait parameters

Stuifbergen (1997)	
Design:	Case study
Participants:	4 women with multiple sclerosis
Intervention:	6-week aquatic exercise class, 2/week
Outcome Measures:	SF36 and Human Activity Profile
Results:	Improvements in self-reported quality of life (QOL) and Human Activity Profile in the four women with multiple sclerosis

Sutherland et al. (2001)	
Design:	Randomized controlled trial
Participants:	22 individuals with multiple sclerosis - training group (n=11) and control group (n=11)
Intervention:	10-week water aerobic exercises, 3/week
Outcome Measures:	Health Related Quality of Life (HRQOL) and the Profile of Mood Status
Results:	Significant improvements in quality of life and psychological well-being in the training group as compared to the control group

Peterson (2001)	
Design:	Case report
Participant:	A 33-year-old female patient with multiple sclerosis during an exacerbation
Intervention:	6-week aquatic exercise program
Outcome Measures:	Muscle strength, fatigue and basic mobility function
Results:	Improvements in mobility and muscle strength and did not experience fatigue or any adverse change in neurologic status

Roehrs and Karts (2004)	
Design:	Single-subject design
Participants:	19 individuals with multiple sclerosis
Intervention:	12-week aquatic exercise program, 2/week for 60 minutes
Outcome Measures:	Short Form-36 (SF-36) and Multiple Sclerosis Quality of Life Inventory (MSQLI)
Results:	Significant improvements in the quality of life domains of social functioning and fatigue

Pariser et al. (2006)	
Design:	Case report
Participants:	2 individuals with multiple sclerosis
Intervention:	8-week aquatic training program, 2/week
Outcome Measures:	Cardiovascular fitness (VO2peak) and Fatigue Severity Scale
Results:	Improvements in cardiovascular fitness - changes in fatigue were equivocal for participants

Salem et al. (2011)	
Design:	Single-subject design – Pilot study
Participants:	11 individuals with multiple sclerosis
Intervention:	5-week aquatic program, 2/week for 60 minutes
Outcome Measures:	The 10-Meter Walk test, the Berg Balance Scale (BBS), the Timed Up and Go (TUG) test, grip strength, and the Modified Fatigue Impact Scale
Results:	Significant improvements in gait speed, BBS, TUG test, and grip strength

Salem et al. (2011)	
Design:	Single-subject design
Participants:	10 individuals with multiple sclerosis
Intervention:	10-week aquatic program, 2/week for 60 minutes
Outcome Measures:	The 10-Meter Walk Test, BBS, the TUG test, hand dynamometer, and the Modified Fatigue Impact Scale (MFIS)
Results:	Significant improvements in all outcome measures were observed. All participants reported that they enjoyed the program and had improved after the training

Salem et al. – Unpublished data	
Design:	Randomized controlled trial
Participants:	20 individuals with multiple sclerosis - assigned randomly to aquatic group (n=10) and control group (n=10)
Intervention:	10-week aquatic program, 1/week for 60 minutes
Outcome Measures:	Gait speed (10-MWT), BBS, TUG, grip strength, MFIS, and Multiple Sclerosis Quality of Life-54 (MSQOL-54)
Results:	Significant improvements in strength, mobility function and quality of life

The use of aquatic training for individuals with multiple sclerosis has received attention in recent years. Although there is a limited number of studies evaluating the effectiveness of aquatic exercise for individuals with multiple sclerosis, those that have been conducted consistently demonstrate positive outcomes. Research on the effects of aquatic therapy for individuals with multiple sclerosis suggests that aquatic therapy is effective for improving flexibility, range of motion, cardiovascular endurance, fatigue level, muscle strength, mobility function (including gait and balance), quality of life, and psychological well-being. In addition, none of the studies identified any exacerbation or reported adverse change in neurologic status.

In summary, there is a limited number of studies that examined the effectiveness of aquatic therapy in multiple sclerosis. The available literature suggests the beneficial effects of aquatic exercises with no adverse outcomes, and supports its use as a reasonable treatment option for individuals with multiple sclerosis.

Examination of a Person with MS

Participant examination and assessment are necessary first steps before any aquatic intervention or wellness programs are implemented. The aquatic professional completes this evaluation with current functional level, goals of the individual, and the local resources available to the participant. The aquatic professional needs to identify other medical conditions that may interfere with exercise in the aquatic environment. These medical conditions could include unstable cardiac conditions, seizure activity, severe or chronic ear infections, COPD, inability to generate heat needed while participating in exercise in an aquatic environment, unstable vital signs, high-risk pregnancies, open wounds, or even fear of water.

There is a continuum of rehabilitation and exercise/wellness programs that may benefit people with MS at different points in their lives and functional abilities. The assessments that are required could be very different depending on the program and outcomes expected. An individual with MS may have an examination by a physical therapist in order to determine the appropriate approach to individual care. The physical therapy examination of the person with MS is complicated by lack of a “typical” clinical presentation. The variety of signs and symptoms experienced by many people with MS requires a detailed systems review, and thorough testing of the many aspects from impairment to the ability to participate in life. The examination is further complicated by the fact that some impairments may be primary (i.e., due to MS pathology), secondary (i.e., a consequence of another impairment or activity limitation), or a combination of both. Consideration must be given when planning the examination to MS disease phenotype and severity, the healthcare setting, premorbid and comorbid conditions, the goals identified by the individual, issues raised during the history and interview, and any occult issues that may not be obvious at the outset. The PT must carefully evaluate the findings from the history and systems review in order to define which items should be examined.

A challenge among healthcare professionals is the lack of a common language when speaking about people with diseases leading to chronic disability such as MS. In 2002 the World Health Organization developed the International Classification of Functioning, Disability and Health as a system to begin to use a common language in the healthcare professions (Quinn et al, 2012). Commonly called the ICF, this globally known framework is a standard of classification for multiple health domains. The ICF has two parts, each with two components: Body Functions and Structure including Activity and Participation; and Contextual factors including environmental and personal factors.

Body function is the physiological function including psychological function. Body structure is the anatomical parts and their components. Impairment is an abnormality at the level of body system, tissue or organ. A handicap is an external barrier to activity participation. Activity is the performance of a task and participation is the involvement in life situations and the difficulties a person may experience in being involved in these situations. This model shows how a change in one area (body function) may lead to a change in another area (activity or participation). Use of the ICF framework can help guide the examination process in people with MS.

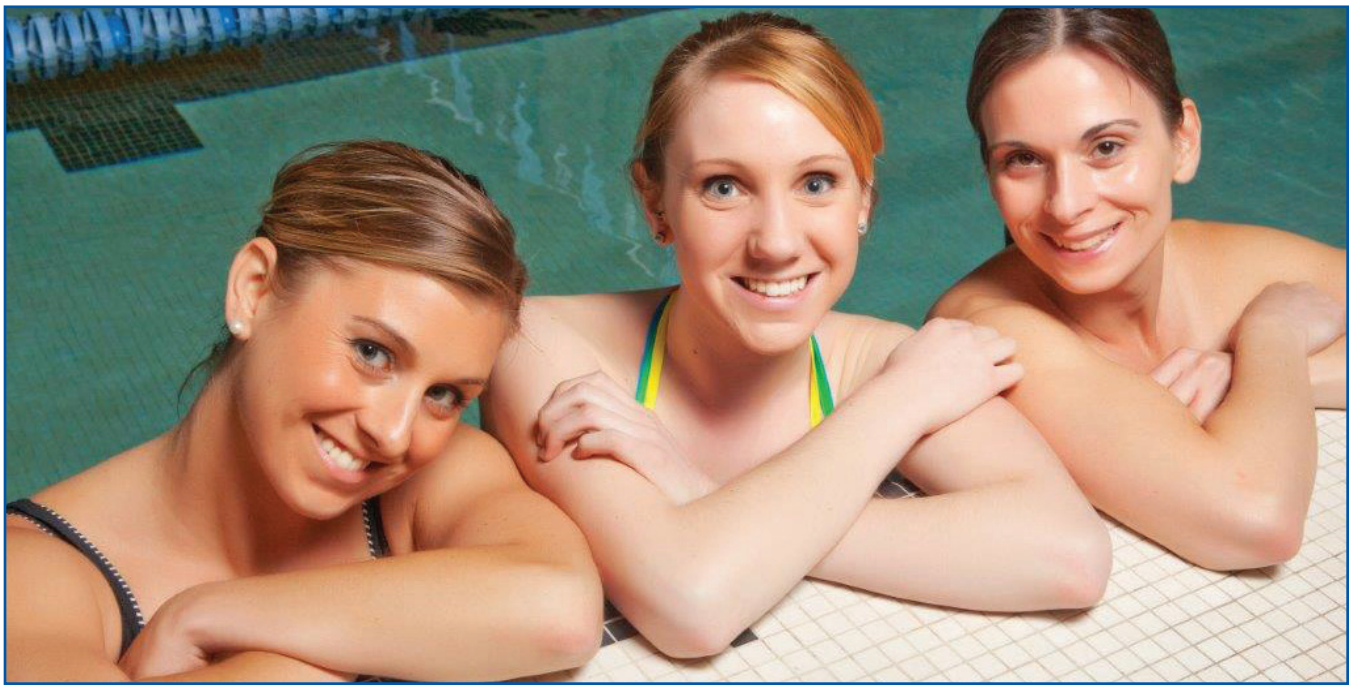
Domains of function	Domains of structure	Domains of activity and participation
Mental	Nervous system	Learning and applying knowledge
Sensory and pain	Eye, ear, and related	General tasks and demands
Voice and speech	Voice and speech	Communication
Cardiovascular, hematologic, immunologic, and respiratory systems	Cardiovascular, immunologic, and respiratory systems	Mobility
Digestive, metabolic, and endocrine system	Digestive, metabolic, and endocrine system	Self-care
Genitourinary and reproductive		Domestic life
Neuromusculoskeletal and movement related	Structures related to movement	Interpersonal interactions and relationships
Skin and related structures	Skin and related structures	Major life areas, community, social and civic life

In order to assist the PT in the examination process for someone with MS, the MS EDGE taskforce (Neurology Section of the APTA, 2011-12) performed a detailed analysis of the current literature and identified outcome measures valuable in assessing varying areas of involvement in people with MS. Their recommendations are available to the public on the Neurology Section, APTA website at **www.neuropt.org**. All outcome measures listed in the final recommendation of the MS EDGE taskforce are available on the website.

Below is a table of recommended measures using the EDSS as a guide. Each EDSS category has identified outcome measures assigned for assessment of level of impairment, activity, or participation.

Table 1. Examination Strategy Across EDSS Scores

Test/Measure	0-3.5	4-5.5	6-7.5	>7.5
Respiratory Strength				
Maximum Inspiratory and Expiratory Pressures: MIP/MEP		●	●	●
Fatigue				
Fatigue Scale for Motor and Cognitive Functions	●	●	●	●
Modified Fatigue Impact Scale: MFIS	●	●	●	
Visual Analogue Scale for Fatigue: VAS-F	●	●	●	●
Balance/Postural Stability				
Activities Specific Balance Scale: ABC	●	●	●	
Berg Balance Scale	●	●	●	
Dynamic Gait Index: DGI	●	●		
Four Square Step Test: FSST		●	●	
Functional Reach Test: FRT	●	●		
Trunk Impairment Scale		●	●	●
Gait				
Disease Steps	●	●	●	●
Multiple Sclerosis Walking Scale-12: MSWS-12	●	●	●	
Timed 25′ Walk Test	●	●	●	
Timed Up and Go: TUG	●	●	●	
6 Minute Walk Test	●	●	●	
Fine Motor Performance				
9 Hole Peg Test	●	●	●	●
Box and Blocks Test	●	●	●	●
Composite Measures of Activity				
Functional Independence Measure: FIM	●	●	●	●
Hauser Ambulation Index	●	●	●	●
Multiple Sclerosis Functional Composite: MSFC	●	●	●	●
Rivermead Mobility Index	●	●	●	●



Assessment for individual PT may be different than what might be required for participation in a community-based wellness program such as a community-based aquatics program. The assessment needed for individual therapy sessions require functional goals and documentation. This requires objective and measurable tests and information to document an individual's initial abilities, to track progress and determine discharge from the therapy. This is particularly important for insurance reimbursement issues. If a person with MS has the opportunity to participate in a physical therapy guided aquatics program, there is only one CPT code that can be used for aquatic treatment reimbursement, 97113 Aquatic Therapy.

A comprehensive, rehabilitation specialist examination for individuals with MS should include:

1. History, medications, current level of symptoms, report of current level of function
2. Discussion about living situation, house configuration, transportation issues, participation in ADLs, and self-care
3. Review of psychological reports or profiles including a depression scale
4. Screening assessments
    - Cerebellar
    - Cranial nerve
    - Fatigue
    - Pain
5. Impairment-based testing
    - Range of Motion
    - Manual Muscle Test
    - Sensation
    - Tone assessment
6. Balance testing, and history of falls
7. Vestibular
    - Oculomotor testing/screening
    - Vestibular screening
8. Gait assessment

Specific Assessments of a Person with MS for Aquatic Exercise

There are a few templates available to use for aquatic assessment that can utilize a large portion of the information received from the PT examination that are pertinent to the person with MS. Special attention to the neuromuscular and musculoskeletal systems is recommended and it is prudent to screen for other health issues that might interfere with the person's ability to participate in an aquatics exercise program.

The Aquatic Exercise Review Systems (AERS) is a template for assessment of individuals with MS before beginning an aquatics exercise program. The template is reprinted with permission from the American Physical Therapy Association's *Guide to Physical Therapist Practice*.

Aquatic Exercise Review Systems (AERS)			
System	**Evaluations and examinations**	**Tests and measures**	**Results/ date/ initials**
Cardiovascular and pulmonary	Dyspnea on exertion	Vital signs, EEG, exertion scales	
	Decreased endurance	Physiologic response to position changes: HR, BP, observations, lab values	
	Increased pulmonary response to low level activity loads	Increased CP responses to low load: breath/ voice sounds, cyanosis, respiratory pattern/ rate/rhythm, ventilatory flow/force/volume (spirometry, oximetry)	
	Increased cardiovasuclar response to low level activity loads	Increased CV responses to low load: CV signs/ symptoms: BP/HR/rhythm/sounds; angina/claudication/dyspnea; EEG	
	Impaired ventilatory forces and flow	Impaired ventilation: gas analyses from chart, observations, oximetry, airway clearance tests, pulmonary function tests	
	Impaired ventilatory volumes	Impaired ventilation: gas analyses from chart, observations, oximetry, airway clearance tests, pulmonary function tests	
	Integrity of tracheotomy	Observation, blood gas, oximetry	
Integumentary	Impaired sensation: abrasion injury from bottom/sides/ underwater lights	Observation: light touch, hot/cold, sensory integration, inspection of integument, augmented photography, thermography	
	Discontinuity of skin integrity: vascular disease–arterial/ diabetic/venous		
	Long term medication use		
	Lymphedema: skin integrity/drainage/ hydrostatic pressure effect		
	Skin lesions: trauma–burns/ frostbite, cellulitis, post radiation, s/p surgery		
Musculoskeletal	Strength/power/endurance: ability control COB, equipment use	Manual muscle test, dynamometry, performance tests, technology assisted analysis (PEAK biodex platform, etc), activities daily living scales, postural analysis grids, videography	
	Recent surgical episodes: passive/active/active assist		
	Fatigue issues: changing pre/post session; access in/out pool; during/after aquatic session		
Neuromuscular	Seizure activity (3-6 months)	Client/caregiver/medical record/review current medications	
	Alteration auditory/sensory/ somatosensory/position sense	Stereognosis, tactile discrimination, kinesthesiometry, observations, vibration, hot/cold	

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(continued)

Aquatic Exercise review systems (AERS) (continued)			
System	**Evaluations and examinations**	**Tests and measures**	**Results/ date/ initials**
Neuromuscular (cont'd)	Vestibular dysfunction: moderate to severe	Vestibular occular reflex, nystagmus	
	Decreased strength	Dynamometry, mmt, timed activities, physical capacity scales, emg	
	Dysfunction: recruitment/ timing/sequencing	Coordination, motor proficiency, motor planning, postural challenge tests	
	General deconditioning	Vital signs, perceived exertion scales, spirometer, aerobic capacity measurement	
	Postural control issues in varied positions	Observations, technology assisted analyses, grid measurement, functional assessment in pool--reposition head out of water independently	
	Oral motor control	Coordinated breath control, mouth closure, controlled exhalation/inhalation on request (blowing bubbles)	
	Peripheral nerve integrity	Motor and sensory integrity tests	
Psychological	Fear of water	Quality of life scales, orientation assessment, communication assessment, ability to follow directions: safety of client/staff/other clients and caregivers	
	Impulsivity		
	Aggression		
	Confusion		
	Short term memory issues		
	Attention to task difficulties		
Endocrine/ metabolic	Immune system compromise: H_2O/airborne infections		
	Systemic issues: DM, kidney function		
	Dialysis/chemo ports		
Gastrointestinal/ genitourinary	Bowel incontinence		
	Bladder incontinence		
	Unpredictable vomiting		
	Peg tube/stoma		
	Catheter care		
Obstetrical	Pregnancy (pre/post): water temp, infection risk, discharge into pool		
	Incontinence		
	Pelvic floor surgery: risk infection, discharge into pool		

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Another template utilized to assess an individual uses the basic ICF concepts as checklists for aquatic exercise structure, progression and objectives prior to aquatic exercise (e.g., Halliwick technique, Bad Ragaz Ring Method (BRRM) and Ai Chi). These techniques will be described in the section on aquatic exercise techniques.

	Assessment in conjuction with the ICF	Halliwick point	No difficulty (3) High quality-performance	Moderate difficulty (2) Medium quality	Severe difficulty (1) Low quality	Complete difficulty (0) Does not perform	Not applicable (0) Not assessed	Breath control included
Maintaining a body position-d415	Stand (30 s)	BIS						
	Sit (40 s)	BIS						
	Supine/oblique (15 s)	BIS						
	Floating up (5 s)	MI						
	Gliding supine (10 s)	TG						
	Gliding prone (5 s)							
Moving around, walking, and transferring oneself-d420, d450, d455	Walking (6 m or more)	MA						
	Changing direction	RC						
	Turning 360˚ (<4 s)	LRC						
	Jumping (and blowing, 5x)	MA						
	Swimming (15-25m)	BM						
	Swimming prone (15-25m)							
	Entry							
	Exit							
Using hands, arms, or legs or fine hand use-d435, d440, d445	Legs: pushing, kicking							
	Arms: pushing, pulling							
	Arms: reaching							
	Hands: passing an object							
Carrying objects-d430	Transporting objects							
Moving around using equipment-d465	Mask or goggles							
	Snorkel							
	Fins							
	Other							

A water safety screen may provide important information regarding the safety of a participant in a class setting, as well as for independent pool activities and utilization. The Water Orientation Test (WOTA2) is a 27-item test that measures a person's basic adjustment to the water, breath control, ability to float as a basic skill and up to basic swim abilities. Permission to use this tool is required from the Alyn Hospital, Israel. This assessment also determines the abilities of a person in the context of the Halliwick 10-point program.

Another type of assessment appropriate for use with people with MS who may be participating in a community-based aquatics exercise program is the AEA Health Risk Appraisal Template. A sample template is available in the *Aquatic Fitness Professional Manual*, Sixth Edition (Aquatic Exercise Association). This template includes a screen for health history, medications and fitness levels, including heart rate, BP, skinfold or BMI tests, flexibility, muscle strength, and current levels of mobility. A person with MS may require more in-depth questions for MS symptoms: spasticity, sensory changes, fatigue, heat sensitivity, skin issues, continence, personal-care needs, and transfer abilities (in the bathroom; to and from the pool; to and from their vehicle or transportation option). Other issues to consider are pain and cognitive abilities, important for following instructions and for safety. See Appendix 1 on page 35 for the AEA Health Risk Appraisal Template.

Documentation of sessions or progress can be efficiently recorded in a flow sheet. This sheet would include the exercises or activities, repetitions, sets, length of the session, equipment or resistance used, assistance required, water depth and environmental factors such as turbulence or pool surface changes. There is an Aquatic Exercise Toolbox available (Adam et al., 2006). Customized forms can also be designed to meet the needs of the specific aquatic professional and the facility.

Medical clearance and informed consent are important aspects of a PT-guided aquatics exercise program and a community-based aquatics exercise program. A physician may or may not realize the physiologic effects experienced when a body is immersed in water. A medical consent form will not only give the aquatic professional access to medical information, but also include current exercise and therapy participation, precautions and concerns for aquatic intervention. The person participating in an aquatics exercise program must provide informed consent. The informed consent should include the potential benefits and risks involved in aquatic exercise. The person needs to provide all current medical conditions, acknowledge that they were adequately presented with the risks and benefits, and that alternative exercise choices were discussed. See Appendix 2 on page 38 for an example of a medical consent form.

Aquatic Exercise Programs – the Unique Properties of Water

The topic of aquatic exercise is as broad and varied as the individuals with MS who might want to participate. There are a large number of treatment and exercise techniques useful to the therapist or aquatic exercise professional. These are really limited only by the creativity of the aquatic therapist or professional with a solid foundation in the utilization of hydrodynamic principles and how these influence the choices of treatment techniques and program planning.

Water is a unique environment. Therefore, the aquatic exercise specialist needs to have an understanding of the properties of water to appropriately select exercise and treatment techniques, as well as why to choose the aquatic environment for a particular person.

Buoyancy is the uplift force that is experienced when submerged in water. It is the sensation that upright movement is easier in water than on land, where gravity is a greater factor. A person is able to move more independently in water than on land due to the effects of buoyancy, which can assist movement, support movement, or resist motion. This can also increase the ease of assisting a person with MS while performing exercises (Ruoti et al, 1997).

Relative density is a ratio of the density of the object or person to the density of the water environment and can be seen in whether an object or person sinks or floats. This will be an important factor in appropriate choices of activities, participant position or posture, depth of the aquatic environment utilized, and equipment. For example, the participant with a flaccid limb has a lower relative density and would require less flotation for swimming or exercise. They may even require the use of a weight to be able to perform the activity with adequate control. The person with significant spasticity has higher relative density and may conversely require a flotation cuff or support to participate in swimming or other functional activities such as walking (Ruoti et al, 1997).

Another property of water is hydrostatic pressure, which is the concept that fluids exert pressure in all directions. The deeper a body is immersed in water the more pressure it experiences. The effects of hydrostatic pressure on the human body include a centralization of blood flow to the chest with increased blood volume making breathing more difficult. In an anxious person or a person with cardiac or respiratory dysfunction, deeper water immersion should be avoided, however; if used appropriately, immersion can assist in increasing cardiac and respiratory function. There are also dramatic shifts in kidney function and regulation with immersion, and these effects should be considered while working with people with compromised kidney function. The positive aspects of hydrostatic pressure include providing the individual the increased ability to stand, ambulate and balance. There may also be some improvements in edema, pain and sensory hypersensitivity of the submerged limb or body part (Ruoti et al, 1997).

Viscosity is a measure of a fluid's resistance to flow and describes the internal friction of a moving fluid. There is an attraction between all the molecules in a fluid. Different fluids have different amounts of friction between the molecules. The attraction is even greater at the fluid's surface and in contact with the air environment. A person submerged in water and moving through the water will sense resistance. It is a sense of the water being thicker or heavier than performing the same movement in the air. This becomes important in exercise prescription and progression. As the speed of a movement and surface area increases, the resistance also increases. This can be used to increase or decrease difficulty of exercises or activities. Viscosity also slows movement and gives more opportunities for higher-level skills and balance work than may be possible with a land exercise program. The increased resistance at the water's surface may need to be factored into any motions that break the water's surface, especially if the individual experiences shoulder problems or weakness (Ruoti et al, 1997).

In considering the properties of water, both refraction and reflection must be discussed. Refraction is the bending of light rays from a denser medium, such as water, to a thinner medium, such as air which may cause the person in the water to appear different to someone out of the water. The true body position may need to be confirmed for accurate analysis of movement. Reflection is the change of direction of a wave at the interface between two surfaces. Light reflecting off of the water may trigger or increase symptoms of dizziness and can also be problematic with a person prone to seizure activity. Lower lighting or use of sunglasses, as well as cueing to focus on land or nonmoving objects, may be helpful for the person participating in an aquatics exercise program (Ruoti et al, 1997).

The therapeutic use of water temperature is its ability to retain heat and its ability to transfer heat energy much more efficiently than air. Since many people with MS are heat intolerant, an appropriate temperature of water will facilitate greater success with exercise. Overheating can temporarily exacerbate MS symptoms. At this time there is not definitive research for water temperature guidelines for an MS exercise program. Currently, the general recommendation is for water temperature to be 86 F (30 C) or below. The National Multiple Sclerosis Society recommends a water temperature of 80 – 84 degrees F (26.7 – 28.9 C) to help keep the core body temperature low during exercise, and reduce the risk for overheating.

Streamlined or laminar flow of water is defined as a steady, continuous flow of water molecules in one direction. If the water movement increases its velocity, at a certain point there becomes more irregular movement of the water molecules, known as turbulence. Turbulence can be used to increase resistance in a progressive manner providing opportunities for balance, core stabilization and coordination exercises.

Movement of a body in water causes turbulent flow of water around and behind the body. Pressure is greater in front of the object and lessened behind the object. The area of reduced pressure behind the person is known as a wake. The water that flows into this low-pressure area is known as an eddy. This flow into the low-pressure area causes drag forces that pull the person or object

back into the area of low pressure. This principle can be used to increase and maximize the ability of people with disabilities in gait, balance, and standing. For example, the aquatic exercise professional could walk in front of the person creating an area of lower pressure. The individual is then able to walk or balance with greater ease. Conversely, walking beside or behind the person could increase the difficulty of these activities (Ruoti et al, 1997).

The use of streamlined (smaller and narrower) versus un-streamlined (broader surface and area) movements can provide a variety of different balance and stability training opportunities. Considerations for adding equipment to increase turbulence and un-streamlined flow should be performed in a systematic and logical progression.

In summary, the physical properties of the water provide individuals the opportunity to exercise in a reduced gravity environment. The buoyancy of the water reduces the influence of gravity on the body and can provide postural support in people with weakness and balance deficits, allowing these individuals the opportunity to exercise with greater ease. The properties of water, buoyancy, viscosity, resistance, and temperature may allow a person with MS the opportunity to perform various activities in a safe, supportive manner. Individuals with MS can perform exercises to improve cardiovascular endurance, strength, and balance. In addition, Uthoff's phenomenon can be avoided if the person with MS exercises in a cool pool.

Aquatic Exercise Programs

There are many different types of aquatic exercise programs from which to choose for either individualized or community-based aquatic exercise. The particular combination of activities is determined by the participants' abilities, the setting (individual or group), as well as the participants' goals.

Aquatic exercise sessions are usually goal oriented with analysis of individual deficits, problem solving and treatment for specific functional and physical limitations. Participation in an ongoing exercise group can help with compliance. Group exercise programs can also be very supportive, motivating and help with progression of activity levels. The aquatic environment offers numerous techniques and options for activity and exercise participation for almost all levels of physical abilities. An overview of some techniques will be shared. This is not an exhaustive list but will highlight helpful activities that an aquatic professional working with people with MS might find beneficial. Most of the techniques noted can be studied in depth with a variety of aquatic organizations.

The Halliwick technique and Water Specific Therapy originated in the 1950s in England. Initially the technique was to help disabled children learn to swim. The technique has evolved into more water-specific therapy, since therapists saw improvements in balance, postural control, and functional activities. The Halliwick technique teaches people how to balance and control their bodies (especially as their ability levels change) in water. The technique promotes body awareness and has a 10-point program based on hydrodynamic principles and the three stages of learning.

The technique is usually performed as an individual technique, although some aspects can be done in a group format with adequate assistants for each participant.

1. Mental adjustment is the ability to independently respond to different environments, situations or tasks in the water.

2. Balance control is the ability to maintain a position or change a position in a controlled manner.

    a. Sagittal rotation – Small shifts of the center of gravity as needed; side-to-side for swimming or adequate weight shifting with walking. Can help with walking sideways, changing directions or even righting and equilibrium reactions. Stimulates trunk elongation and dissociation.

    b. Transverse rotation – Head forward, reach forward motion. This is good to increase trunk flexor/extensor firing and control. Can be useful for sit-to-stand transfers, squatting and standing and ambulation control. This is also a key control movement for recovery skills in swimming or the aquatic environment to be able to go from a float to cube (a seated position with the feet on the floor and knees and hips bent, as if sitting in a chair) or stand position.

    c. Longitudinal rotation – Teaches appropriate body rotations needed for efficient ambulation and swimming techniques. Functionally can improve ability to roll over in bed, can reduce muscle tone that inhibits good trunk control with walking.

    d. Combined rotation – A combination of the above rotations, as needed, with righting reactions, balance and core stabilization with any functional use of the arms for reaching, lifting and carrying objects, or being able to ambulate and stop without loss of balance and good posture.

3. Movement is the ability to create effective, efficient and skilled activity.
    a. Swimming
    b. Balance
    c. Transfers
    d. Walking
    e. Reaching

Watsu technique is aquatic bodywork techniques developed by Harold Dull in the 1980s at Harbin Hot Springs, CA. Watsu is based on Zen Shiatsu. This is an individual passive technique that combines stretching, soft tissue mobilization techniques with slow gentle rotational movements through the water. The technique is effective to help stretch tight and restricted soft tissues anywhere in the body resulting from lack of movement, spasticity or pain from muscular imbalances. Muscle tone reduction is a benefit from Watsu. Benefits from the technique include pain and stress relief as well as profound relaxation. Mario Jahara studied with Harold Dull and developed his own style of aquatic bodywork, Jahara technique, using a short noodle for support of different body parts to facilitate flotation, relaxation and better body alignment and support. In a neurological setting the treatment sessions could begin with 10-15 minutes of stretching and relaxation. The technique is initiated with trunk and then leg and arm rotations, stretches and elongation to improve the ability to actively engage in functional and training tasks.

Bad Ragaz Ring Method (BRRM) was developed in Bad Ragaz in Switzerland in the 1960s. It is the use of PNF (proprioceptive neuromuscular facilitation) patterns applied to isokinetic and isometric movement patterns. PNF is a land-based group of techniques defined as a method of promoting or hastening the response of the neuromuscular system through stimulation of the proprioceptors (Knott and Voss, 1968). BRRM utilizes these concepts and modifies the movement patterns utilized for the aquatic environment. The person receiving BRRM treatment floats with a neck collar, rings around the hips, arms and legs. The therapist is the counterforce the person moves against as they use their own body and lever arm to move or hold a position in the water. The movements can be assisted or resisted in a graded manner through the change of manual contacts with the person. The technique is very effective for strengthening and proximal stability and control. The patterns are very specific combinations of spiral diagonals that require precise therapist handling. Patterns can be applied to the trunk, or to the legs or arms in unilateral or bilateral symmetrical, bilateral asymmetric or reciprocal movements. Use of treatment techniques such as rhythmic initiation, reversal of agonist, repeated contraction, hold relax, contract relax and timing for emphasis also help with the correct performance of the required patterns.

Ai Chi is a modified format of land-based Tai Chi developed for the aquatic environment by Jun Konno, of Japan. This technique combines the slow, fluid, rhythmic motions with breath patterns. The benefits of Ai Chi include improving balance, strength, weight shifting, body awareness, postural control and stress management. Similar to Tai Chi, the emphasis is on the ability to increase mind-body awareness. This technique also teaches a person how to move efficiently without over utilization of muscle force or energy. The technique begins with postural alignment and breathing. Next are the movement of the arms while maintaining breath and postural control, followed by trunk rotations, then moving into lunge stances and, finally, to single-limb balance and shifting activities. The sequence ends with full-body coordinated movements.

The Task Oriented Approach draws from motor learning and motor control theories, which saw increased utilization in the 1980s. Emphasis is on practicing functional tasks and complete skills instead of movement patterns. Tasks and goals are meaningful to the individual. The person is an active problem solver in the sessions, with limited therapist feedback. The technique incorporates upright postures and positions with appropriate trunk control and stabilization. Focus is on quick and reciprocal movement patterns and quick progression of the difficulty level as soon as a new skill is utilized. The individual with cognitive difficulties may require a little more feedback and structure. Any functional task could be practiced, such as walking and balancing while having to step over a variety of obstacles, or reaching and lifting activities without loss of balance, postural control or pain. Other examples include being able to participate in recreational activities such as tennis or golfing safely and independently.

AquaStretch™ is a newer technique, created by George Eversaul, which incorporates dynamic stretching, intuitive movement, as well as myofascial and soft tissue mobilization to decrease restrictions, edema and pain associated with physical functioning. There is some report of improved healing of areas of injuries through this technique. This technique includes a particular series of body and limb positioning and holds performed by the therapist. The person is stabilized at the edge of the pool with weights to the legs or trunk. The person is instructed to move however they feel is needed until pain or restriction is felt. The person holds in that position with pressure or movement applied to the area by the therapist. The sequence is then repeated.

The Unpredictable Command Technique is a series of familiar and unfamiliar movement patterns performed with quickly changing and random combinations. The theory is to increase somatic awareness, balance, equilibrium and righting reactions, as well as coordination. It combines a variety of novel movement patterns designed to increase use of multiple brain areas simultaneously. David Ogden, PT, the creator of the technique, recommends its use for people with both orthopedic and neurologic diagnoses.

Aerobic/endurance training includes participation in continuous, rhythmic movements of the larger muscle groups for a period of time to elevate heart rate and produce a cardiovascular training effect. The benefits include improving endurance for physical exertion, which may decrease complaints of fatigue. Activities consist of walking, running, aquatic aerobic programs, aquatic treadmills or bikes, swimming or modified swimming. The program should begin with proper pacing and reasonable amounts of activity that are challenging but not too fatiguing. Individuals need to be educated in appropriate guidelines for aerobic exercise as described by the American College of Sports Medicine (ACSM). The guideline suggests a warm-up phase of one to five minutes, followed by a prescribed amount of workout at the appropriate levels determined by evaluation of the person related to their cardiovascular ability. A method of identifying the person's cardiovascular/aerobic ability is through a graded exercise testing procedure similar to what is described by Gappmaire, (2012).

Recommendations for aerobic training are three to five times per week at 55-90% maximal HR, for 15-60 minutes in an individual with MS.

Resistance training can help to correct muscle weakness and improve muscle power and endurance. The use of the aquatic environment lends many options for resistance training, from the viscosity of the water, adjustments in body surface area and levers, and the use of added equipment (e.g., mitts, paddles, fins, buoyant hand bars, kickboards, buoyant cuffs, noodles, and rubberized resistance). In people with MS it is recommended to perform these activities two times per week, generally recommend eight to 12 reps with light to moderate loads and the ability to complete the full range of motion for each exercise. A weak and deconditioned person may have to start with three to five repetitions and work up to the eight to 12 reps recommended. ACSM recommendations are to lift until volitional fatigue. Termination of exercise would be recommended when movement quality and fatigue symptoms begin.

Recommendations for people with MS include at least daily stretching to help manage spasticity and loss of range of motion and improve function. Stretching exercises are often easier to perform in the aquatic environment because of the buoyancy, hydrostatic pressure and viscosity support. Exercises can be performed statically at poolside or more dynamically away from the wall. These include neck extension, rotation and lateral flexion; spinal flexion, extension, rotation and lateral flexion; shoulder external rotation, flexion and abduction; elbow extension; forearm supination; and wrist and finger extension. The lower extremities often need increased hip extension, external rotation, abduction; knee flexion; and ankle dorsiflexion and eversion.

As a person's physical abilities change, so does his or her ability to safely and independently swim or move in the aquatic environment. An aquatic professional or therapist who knows the basic mechanics of different swim strokes will be able to assist the person to achieve success in a swimming-based strengthening and aerobic exercise program. The aquatic therapist or professional needs to be able to adapt strokes to maximize the ability to move through the water and to decrease restrictions based upon physical abilities of the person. The choice of strokes may depend on the person's body shape, ability to float and to get the face clear for breathing consistently. The use of goggles, earplugs and a snorkel can decrease problems with prone immersion in the water. Choosing a supine posture (elementary backstroke or crawl) could decrease anxiety over breath control as long as back floating is independent and safe for the person. Fins can be used to increase the power produced by the legs; mitts or swim paddles can also be used to increase arm power. A person could alternate between arm and leg focus to decrease fatigue with the use of a kickboard and a leg float. Lack of balance or control can be improved by choosing strokes that are symmetrical versus reciprocal. Range of motion can be modified to allow for better movement, (i.e., elementary backstroke arm motion could be paired with freestyle leg kicks if this is easier to coordinate for the person).

The use of games is a nice way to increase social interaction and to add a fun aspect to a group setting. Some ideas include aquatic volleyball, relay races, green light/red light, and the hokey pokey. These activities have therapeutic benefits such as improvements in eye-hand coordination, vestibular challenges, balance, strength, multitasking, and coordination.

Specific Safety for People with MS Participating in an Aquatics Exercise Program

Multiple sclerosis is not a static disorder, and neurological signs and symptoms may change from day-to-day. Individuals need to be reassessed and exercises modified as appropriate (Brown & Kraft, 2005).

There is no evidence that exercise increases the exacerbation rate (Brown & Kraft, 2005). The available research did not report any adverse effects to aquatic exercises; however, the effects of exercise should be monitored. Exercises should be discontinued if there is any exacerbation or sudden changes in neurological status such as fatigue, general weakness, increased spasticity, decreased balance, blurred vision, or rapid eye movements.

To address fatigue issues commonly seen in people with MS, the exercise session should be intercepted with rest periods. The frequency and duration of rest periods should be varied according to the intensity of the exercises and the fatigue level of the participant.

Aquatic exercise is an appropriate environment to address heat sensitivity and elevation in body temperature during exercises in people with MS. However, it is important to check water temperature and encourage participants to drink plenty of water. Strenuous activities should be avoided especially during hot, humid weather.

Adequate staffing is another important factor to consider when designing an aquatic exercise program for individuals with MS. The aquatic exercise specialist should consider individual versus group, associated impairments, functional abilities, and cognitive function.

Most accidents involved in aquatic exercise occur while entering and exiting the pool. These accidents are likely to be caused by lack of balance. Special considerations should be given to the entry ramp, hand railing, nonslip surface, organization of the pool side, and locker areas. Rubber tips of the canes and walkers should be checked as they lose their grip on wet surfaces.

Selecting an Appropriate Facility

There are certain aspects of a pool facility to consider when recommending a person to a community-based aquatics exercise program. These include location, scheduling, staff, accessibility, pool temperature, and instructor qualification. Below is a brief description of all of these areas.

Location: A facility must be conveniently located within a reasonable driving distance, and with accessible parking, to assure regular participation. Facility location will also be a consideration for the aquatic professional.

Scheduling: Convenience is a factor in exercise compliance; the program must be available at a time that suits the individual's work schedule, travel issues (e.g., if they depend upon public transit or a caregiver to access the facility), as well as personal preference. Again, as the professional, can scheduling be adjusted to make the program feasible?

Scheduling at a facility can also affect the use of restrooms and changing areas. For example, if there is a 15-minute break between pool classes, and the changing room is small, the area may become overcrowded with the overlap of people from both class times.

Staff: In addition to providing a friendly and welcoming atmosphere, the aquatics staff should be well trained and certified to assure a safe and effective program that meets the needs of the individuals with MS. State and local regulations will determine the need for a lifeguard on duty, but even when not mandated, it is advisable to have an additional lifeguard. The aquatic professional leading the class or session can provide more focused attention to programming when he/she is not also responsible for overall pool safety concerns.

Facility Considerations: ADA guidelines provide specific details on how a pool must be constructed, or updated. Additional areas of consideration include the following:

- Location of restrooms/changing areas in relation to the pool (i.e., adjacent as opposed to a connecting hallway).
- Floor surfaces (changing areas, hallways, pool deck, pool ramps, or steps) should not be slippery, even when wet.
- Obstacles on the pool deck, such as benches, exercise equipment, sound systems, etc. that might create a hazardous situation.
- Proper operation of chair lifts. Even if your duties do not require you to provide assistance (i.e., another staff person or a caregiver may be responsible), be familiar with operating procedures.
- Equipment availability. If equipment is utilized in the class format or training session, is it available for all participants? If not, is the participant or the aquatic professional responsible for providing? Or, can the class be safely and effectively performed without the equipment?

ADA Accessibility
Fitness facilities, including swimming pools, which have been built or altered since 1990 must be accessible to individuals with disabilities as per the Americans with Disabilities Act (ADA). In 2004, the U.S. Access Board, an independent Federal agency, issued updated accessibility guidelines applying to new or altered facilities covered by ADA and the Architectural Barriers Act (ABA). These guidelines address a wide range of facilities, including both the private sector (places of public accommodation and commercial facilities) and public sectors. The guidelines explain requirements for accessibility by individuals with disabilities and apply to the design and construction of new facilities, as well as additions and alterations of existing facilities. Title III of the ADA specifically addresses public accommodations, commercial facilities and private entities that offer certain examinations and educational courses.

The ADA/ABA Guidelines for Buildings and Facilities provide the specific details for application and administration, as well as technical chapters. ADA Chapter 2 provides requirements for all areas of a facility, including parking facilities, entrances and exits, and restrooms. This can be accessed online at **www.access-board.gov/ada-aba/final.cfm#chapter2**. ADA Chapter 10 (Recreation Facilities) includes a section on swimming pools, wading pools, and spas. This can be accessed online at **www.access-board.gov/ada-aba/final.cfm#a1009**. Topics covered include pool lifts, sloped entries, transfer walls/platforms/systems, and pool stairs/railings.

Pool Temperature
Overheating can temporarily exacerbate MS symptoms. The National Multiple Sclerosis Society recommends a water temperature of 80 – 84 degrees F (26.7 – 28.9 C) to help keep the core body temperature low during exercise, and reduce the risk for overheating.

There are other environmental factors that will affect overall comfort of the individual in the pool, such as air temperature, humidity, air circulation, indoor versus outdoor pools, etc. It is also important to keep in mind that individuals will respond differently to water temperatures and exercise, and that each program will vary in the overall intensity. Additionally, the type of clothing worn can alter a person's thermic response during exercise (i.e., wearing a latex swim cap during vertical water exercise may increase the risk of overheating).

Since finding a suitable swimming pool is the initial limitation for accessibility of MS aquatic exercise programs, it may be prudent to suggest a slightly wider range of water temperatures until more definitive research has been conducted. Aquatic professionals should be knowledgeable and able to implement methods to modify intensity based upon specific environmental conditions to allow for a greater level of participation in this valuable exercise format.

Aquatic Professional Qualifications

The aquatic fitness professional is integral in the overall safety, effectiveness and enjoyment for group exercise, small-group training or personal training. If a participant with MS has previously participated in a therapy or a rehabilitation program, the aquatic professional may interact with the therapist and/or physician to gain additional insight and suggested guidelines for this individual. Other participants may never have participated in therapy, depending upon the level of progression of the disease, the extent and type of symptoms being experienced, and any physical limitations that have occurred. A physician's clearance would be advisable for individuals with MS prior to participating in an exercise program.

The aquatic professional choosing to offer water exercise programs should hold a nationally recognized certification in aquatic fitness, aquatic therapy and rehab, or both. It is imperative that the fitness professional understands basic anatomy and physiology, the principles of exercise, the physical laws and properties of water, muscle actions in relation to the aquatic environment, aquatic equipment, as well as class programming or personal training session formatting (depending upon the program being offered).

Recognized aquatic-specific certifications include:

- Aquatic Exercise Association (AEA) Aquatic Fitness Professional Certification
- Aquatic Therapy & Rehab Institute (ATRI) Certification
- Aquatics Section of the American Physical Therapy Association (certification program in development)

Certification implies a designated level of competency that must be maintained throughout one's career or practice. Typically, renewing certification involves obtaining a designated number of continuing education credit hours in appropriate areas. Education should be considered a continuum, as the health-wellness-fitness fields are ever changing, and medical advances through research occur continuously.

In addition to certification, the aquatic fitness professional should be knowledgeable in special populations with which he/she works. If offering personal training or small group training to individuals with MS, the fitness professional must have additional understanding of this condition, how exercise influences the symptoms and specifically how the water will impact safety and effective programming. Due to the prevalence of MS, most aquatic professionals will, at some point, work with individuals with this condition and need to understand exercise modifications and options. Aquatic-specific exercise as it relates to MS can come from many sources, including this manual.

Education and experience are key qualifications for any aquatic professional. Other attributes for the instructor/trainer planning to work with a special population, including individuals with MS, include:

- Enthusiasm
- Empathy
- Motivation
- Good Interpersonal Skills
- Adaptability
- Responsibility
- Sincerity

Class Considerations

The next step in finding the optimum aquatic program for an individual with MS involves the class or training session format. Water is a forgiving and comfortable medium that reduces joint impact, promotes balance between muscle pairs and enhances kinesthetic awareness. However, vertical aquatic exercise is a diverse field and not every format is going to be appropriate for each individual.

An experienced and well-trained aquatic professional has the knowledge and ability to modify movements to allow for various abilities to successfully participate together. However, each individual with MS will experience different symptoms and these symptoms fluctuate, possibly on a daily basis. The National Multiple Sclerosis Society (NMSS) discusses three different functional levels that can assist fitness professionals in providing options for movement modifications within a class setting. Recognize that these levels are not meant to categorize the participants.
The functional levels designated by NMSS are as follows:

- **Level 1** – No symptoms or mild symptoms that may not be outwardly visible. Walk independently or use a cane.
- **Level 2** – More motor-physical limitations and more dependent on assistive devices (e.g., walkers and wheelchairs). May require additional help getting into the pool and may require assistance with balance in class.
- **Level 3** – Greater functional impairment, may experience paralysis and spend most of their time in a wheelchair. May need personal attention and/or require an assistant.

Since fatigue is one of the most common MS symptoms, class length should be taken into consideration. A 30-minute class might be better tolerated than a one-hour format. Even when participating in a group exercise class, the individual needs to feel empowered to self-monitor and adjust exercise as needed. If the class format is too long, the individual can explain to the instructor that it may be necessary to leave the class early. The aquatic professional knowledgeable about MS will understand and provide suggestions for the individual (i.e., gradually reduce exercise intensity and incorporate static or dynamic stretching before exiting the pool). Open dialogue between the participant and the professional can assure a safe and enjoyable experience for everyone.

Aquatic group exercise classes specifically for participants with MS are typically a shallow-water format (mid-ribcage to mid-chest depth) due to common symptoms, such as spasticity, lack of coordination, loss of balance, gait difficulties, and vertigo. In a one-on-one format, the aquatic professional may safely opt for deep water to address specific goals and use appropriate flotation equipment as required.

Options exist for aquatic group exercise or small group training for individuals with MS. A group exercise program has many positive aspects. The components of the class can specifically target pertinent exercise needs. The aquatic professional should be well-trained and prepared to accommodate the various functional levels of participants, making adjustments in programming as needed. Camaraderie can be established among participants who understand, first-hand, what others are experiencing. The drawback is that it may be difficult to create a cost-effective program that is exclusive to individuals with MS. A hospital-based facility may have a better opportunity than the local community center to offer an MS-specific class.

A second option is to structure the class for individuals with various conditions that create barriers to participating in a mainstream exercise program. Although the class components may not be completely MS-specific, the exercises and progressions can still be user-friendly with regards to common symptoms of the group. The camaraderie will remain and may possibly be enhanced with a more inclusive class. This format can be more cost-effective by attracting a greater diversity of participants.

The mainstream aquatic program is the third possibility. This best suits the individual who is experiencing mild symptoms, yet is well aware of his/her personal limitations and requirements. Depending upon the facility, this may be the only option available for individuals with MS or other conditions. With an appropriate class format, options for movement modification, and an experienced, dedicated aquatic professional, this can prove successful. However, a deep-water, high intensity interval program or a shallow-water kickboxing class may not provide a safe, effective and enjoyable option. In this situation, the individual may be better served through one-on-one sessions offered by a qualified personal trainer knowledgeable about MS.

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Appendix 1

AEA Health Risk Appraisal Template: Information and Health History Form

Name _____ Date_____
Address _____
City/State/Zip Code _____
Home phone ( ) _____ Cell phone ( ) _____
Work phone ( ) _____ Fax number ( ) _____
Email _____
Employment (company, position) _____
Date of birth _____ Age _____ Gender: ____ Male ____ Female
Person to contact in case of emergency_____
Phone ( )_____ Relationship _____

Do you now or have you had in the past . . .

1. A history of heart problems in your immediate family (mother, father, sibling, grandparent)? ❑ Yes ❑ No
   If so, how old were they? _____
2. Cigarette smoking or other tobacco usage? ❑ Yes ❑ No
3. Elevated blood pressure or taking blood pressure medication? ❑ Yes ❑ No
4. High cholesterol, triglycerides, or on lipid lowering medications? ❑ Yes ❑ No
   What is your total cholesterol level? _____
5. Diabetes or thyroid condition, impaired fasting glucose? ❑ Yes ❑ No
6. Any chronic illness or condition? ❑ Yes ❑ No

Date of diagnosis and history of symptoms: _____

_____

Current symptoms or problems you experience: _____
Medications: _____

_____

Current mobility level/Do you need to use any assistive devices to walk? ❑ Yes ❑ No
If yes, please list: _____
Do you require any assistance for showering or dressing? ❑ Yes ❑ No
Do you notice any intolerance to heat or humidity? ❑ Yes ❑ No
If yes, how does it affect you? _____

(continued)

Do you experience bladder or bowel incontinence? ❑ Yes ❑ No

Do you have any complaints of pain? ❑ Yes ❑ No

If yes, please describe location, sensation and intensity 0 – 10 (burning, stabbing, aching):

_____

_____

_____

7. Difficulty or fatigue with physical exercise? ❑ Yes ❑ No
8. Advice from medical professional not to exercise or modify your exercise? ❑ Yes ❑ No
   If yes, please explain: _____
   _____
9. Recent surgery (within the last 12 months)? ❑ Yes ❑ No
   If yes, please list: _____
10. Pregnancy (now or within last three months)? ❑ Yes ❑ No
11. History of allergy, breathing, or lung problems? ❑ Yes ❑ No
12. Muscle, joint, or back disorder, or any previous injury still affecting you? ❑ Yes ❑ No
    If yes, please explain: _____
    _____
13. A heart condition or heart or vascular disease? ❑ Yes ❑ No
14. Do you have pain, discomfort, or other anginal equivalent in the chest, neck, jaw, arms, or other areas that might be caused by a lack of blood flow? ❑ Yes ❑ No
15. Shortness of breath at rest or with mild exertion? ❑ Yes ❑ No
16. Dizziness or fainting? ❑ Yes ❑ No
17. Troubled or rapid breathing at night or the need to sit up to breathe? ❑ Yes ❑ No
18. Ankle or leg swelling? ❑ Yes ❑ No
19. Rapid heartbeat or palpitations? ❑ Yes ❑ No
20. Calf or leg stiffness or cramping? ❑ Yes ❑ No
21. A known heart murmur? ❑ Yes ❑ No
22. Unusual fatigue or shortness of breath with normal daily activities? ❑ Yes ❑ No
23. Other concerns your fitness professional should be aware of? ❑ Yes ❑ No
    If yes, please list: _____

(continued)

What is your current level of activity (work and leisure pursuits)? _____

_____

Are you currently participating in a regular exercise program? ❑ Yes ❑ No

If yes, please describe: _____

_____

Are you taking any medication, drugs, vitamins, herbs, or other supplements? ❑ Yes ❑ No

If yes, please list type, dose, and reason: _____

_____

Current weight _____ What do you feel is your ideal weight? _____

Are you seeing a specialist or therapist? ❑ Yes ❑ No

Specialist or therapist's name _____

Phone ( ) _____

Office location _____

Physician's name _____

Phone ( ) _____

Office location _____

Does your physician or specialist know you are participating in this program? ❑ Yes ❑ No

What are your personal fitness goals? What do you hope to accomplish through your exercise program?

_____

_____

_____

Appendix 2

Physician's Consent Form

I, _____ , give permission to _____
to release my medical records and medical information to_____
for developing my fitness training program.
Signed _____ Date _____
Facility name _____ Date _____
Type of medication _____
_____

Effects:
The person named is planning to enroll in an aquatic exercise class: _____.
Movements and skills will be determined by his/her abilities and condition. To make appropriate plans for this individual and to provide a safe environment, we need the following information. Please identify any recommendations, limitations, or restrictions that are appropriate for your patient in this exercise program.

Medical/Physical Conditions:

Blood Pressure: ❑ Normal ❑ High ❑ Low
Cardiac: ❑ None ❑ Angina ❑ Congestive Heart Failure
❑ Pacemaker or other cardiac surgery
Diabetes: ❑ None ❑ Insulin Dependent ❑ Diet Controlled
Respiratory Disorders: ❑ None ❑ Restrictive ❑ Obstructive ❑ Asthma
Renal Dysfunction: ❑ Yes ❑ No
Seizure Disorder: ❑ None ❑ Clonic/Tonic ❑ Focal ❑ Unilateral ❑ Bilateral
Does this person need 1:1 attention in the pool? ❑ Yes ❑ No
Other Conditions: ❑ None ❑ Orthopedic ❑ Muscle Contractures ❑ Fatigue
❑ Swallowing ❑ Visual Impairments ❑ Cognitive Impairments
Other: _____

Continence:

Bladder: ❑ None ❑ Intermittent Catheterization ❑ Indwelling
❑ Suprapubic ❑ Diaper

Bowel: ❑ Constipation ❑ Diarrhea ❑ Bowel Program

Physical Abilities: No Movement Weak Fair Strong
Head/Neck
Right Arm
Left Arm
Trunk
Right Leg
Left Leg
Contraindicated Movement/Activities: _____

Thank You.

Fitness professional _____
Facility name _____
Phone number ( ) _____ Fax number ( ) _____
Email _____
_____ has my approval to begin an exercise program with the recommendations or restrictions I have indicated above.
Signed_____
Date _____ Phone ( ) _____

Appendix 3

Sample of Aquatic Exercises

Gait Considerations

The most common mobility limitation for individuals living with MS is difficulty with walking.

Water-Walking Progressions:

- Begin with one hand on the pool ledge to offer assistance with balance when walking forward and backward. When moving laterally, as in side-stepping, face the pool wall and place one or both hands on the ledge. The hand(s) will slide along the pool ledge helping the individual feel secure and stable. Using equipment (e.g., pool noodle, cane or walking stick) for balance, progress by moving individual farther away from the pool wall.
- Begin in deeper water (mid-chest) as it will offer more support; progress to shallower water. The shallower the water, the more body weight will be experienced. Make sure that the individual can maintain control during movements regardless of water depth.
- Add pauses into the walking pattern. Stopping and starting against the resistance and the movement of the water will help target and strengthen the core muscles, which in turn, will assist stability when walking.
- Progress to larger strides that accentuate dorsi flexion of the ankle – land on the heel and then push-off from the ball of the foot. Reverse the movement by walking backward, landing on the ball of the foot and pushing off from the heel.

Strength, Balance & Coordination/Lower Body Resistance Exercises

Resistance training can be beneficial for the individual with MS, as long as the individual does not become fatigued. Exercises that focus on balance aids in strengthening the core muscles. Stronger core muscles will allow the individual the ability to better handle activities of daily living. Adding in more complex movement patterns can help maintain coordination and perform purposeful movement.

The following exercises will help to strengthen the muscles of the hip, knee, ankle, and foot. Have the individual stand by the pool wall; progress from palm down on ledge, to the palm up on the ledge, to finally hand not touching the ledge, but ready if needed.

- **Toe Lift:** Strengthen the anterior tibialis with ankle dorsi flexion. Lift toes/balls of feet and onto the heels; return to start position. Begin with both feet performing this exercise at the same time; progress into one foot performing this exercise at a time (unilateral movement).
- **Heel Lift:** Strengthen the gastrocnemius with ankle plantar flexion. Rise up onto the balls of the feet, lifting the heels off the pool bottom; return the start position. Begin with both feet performing this exercise at the same time; progress into one foot performing this exercise at a time (unilateral movement).
- **Foot Rock:** Shift the weight forward onto the balls of the feet and then back onto the heels of the feet in a fluid motion. Begin with both feet performing this exercise at the same time; progress into one foot performing this exercise at a time (unilateral movement), and finally into opposition (bilateral reciprocal).
- **Ankle Circles:** Circle one foot clockwise and then counter-clockwise; repeat with opposite leg. **Option: Can also be performed in the water by sitting in a chair or on the pool step.*
- **Knee Flexion and Extension:** Bend and straighten the knee joint, either with the hip flexed (knee lift position) or hip extended (knee pointing to pool bottom). Progress this exercise by moving away from the wall. For variety, perform on alternating legs or complete a set of repetitions on one side then the other.
  **Option: Can also be performed in the water by sitting in a chair or on the pool step.*




- **Hip Flexion and Extension:** Lift one leg in front of the body, return to the pool bottom, and then move the leg slightly behind the body (keep movement in the hip joint and avoid lumbar hyperextension). Increase the intensity by changing from a bent-knee (short lever) to a straight-leg (long lever) movement. Progress this exercise by moving away from the wall. For variety, perform on alternating legs or complete a set of repetitions on one side then the other.
- **Squats:** Sit back in the water as if sitting onto a chair; then push up to standing. Progress to moving away from the pool wall and when ready, progress into a single-leg squat to increase intensity, as well as the balance challenge. **Option: Can also be performed by sitting in a chair in the water; rise up out of the chair and then sit back down into the chair. Progress the exercise by not returning to a fully-seated position.*


- **Lateral Step Ups:** This exercise uses an exercise step. Place the step in the water against the pool wall. With right side toward the edge of the step, place the right foot on top of the step; left foot remains on pool bottom supporting the weight of the body. Shift the body weight to the right foot, allowing the left foot to come off the pool bottom; pause at this point. Slowly return left foot to pool bottom and shift weight to the left leg. Repeat the exercise facing the opposite direction with the left foot on top of the step.




- **Hip Abduction and Adduction:** Facing the pool wall, laterally lift one leg into hip abduction; lead with the side of the foot rather than the toe. Return leg to standing position. By facing the pool wall, the exercise can be performed on both sides without repositioning the body.

Varied Stances to Enhance Balance

Balance and core strength can be improved by adjusting the stance of the body during upper-body resistance exercises. Begin at the pool wall with one hand on the wall for support while the other arm performs the designated exercise. Once able to achieve the upper-body exercise with good form, place the back against the pool wall allowing both arms to perform exercise simultaneously. This position helps to stabilize the body so that focus can be on execution and effort. There may be some instances that this position will not work but for the most part it is good for core stability during upper-body exercises.

Next, move away from the pool wall and utilize the traditional center stance (feet shoulder width apart) and lunge stance (stride position). To increase balance challenge for the center stance, bring the feet closer together. The lunge stance can progress to a tandem stance (like standing on a tight rope); gradually move the feet closer together until the toes of the back foot are touching the heel of the front foot.

Dynamic Balance and Coordination

- Alternating Side Tap to Forward/Backward Step: Tap the right foot to the right side then bring the right foot forward and shift the weight forward onto the right leg. Repeat with the left side, moving forward in the water. To travel backward, tap the foot then bring behind the body and shift the weight backward.
- Toe-Heel-Toe and Step. Right foot: Toe tap back-heel tap front-toe tap back and step forward on the right foot. Repeat with the left side. This pattern travels forward.
- Heel-Toe-Heel and Step. Right foot: Heel tap front-toe tap back-heel tap front and step backward on the right foot. Repeat with the left side. This pattern travels back.
- Walk the Plank with Rotation: Walk forward as if on a narrow board. Two options for the rotation:

  Option 1 – Step forward, then step feet together and pause. On the pause, rotate the upper body to one side while keeping the lower body facing forward. The head and eyes follow the upper body. Return back to center and repeat with rotation to opposite side.

Option 2 – Rotation is performed when the feet are apart in the step and not when the feet come together. The pause is now on the wide step.

- Side Step and Pause. Step laterally to the right three times and pause; repeat pause every third step for designated distance or repetitions. Then repeat to the left.
- Heel-Toe and Side Step. Right foot: Heel tap front-toe tap back-heel tap front-toe tap back and side step to the right two times; repeat for designated distance or repetitions. Then repeat to the left.

Stretching Activities

Stretching to improve flexibility in the early stages of MS can help to prevent contractures. Maintaining flexibility also allows for a greater level of functional independence.

When stretching, move to the point of tension only. If pain is felt, back off from the stretch. Each stretch should be held for 15-60 seconds as tolerated and repeated three to four times to reap the maximum benefits.

PNF Patterns

Proprioceptive neuromuscular facilitation (PNF) can be very beneficial and should be implemented in the early stages of MS. PNF involves movement patterns that are multi-planar, using diagonal and spiral patterns rather than linear movements in individual anatomical planes. PNF patterns may help to promote a greater range of motion and are similar to many activities of daily living.

PNF for the Upper Body

Begin in water that is chest depth, standing close to the pool wall for support as necessary. Then progress to standing away from the pool wall. The upper extremity and hand should be kept under water whenever possible. Movements can be performed on both sides.

- **PNF Diagonal 1 (PNF D1) – Seatbelt**

Helpful hint: this exercises starts on the same side and ends on the opposite side of the body.

Setting up for this position is as follows: Take the right arm and internally rotate at the shoulder. Straighten the arm back (shoulder extension) and out (shoulder adduction) with the palm turned out and flexed toward the side of the body (radial flexion).

Movement execution/reach for the seatbelt: Externally rotate the shoulder while at the same time making a fist with the right hand, pulling it into wrist flexion toward the radial side of the body. Continue to move the right arm up (shoulder flexion) and across the front of the body (adduction) taking the hand by the left ear.

Returning back to start position/buckle the seatbelt: The right arm returns back to start positioning by internally rotating at the shoulder while the wrist extends with the hand pulling back and toward the ulnar side of the body. Next the right shoulder extends the arm down and back across the body (shoulder abduction) returning to the start position.

- **PNF Diagonal 2 (PNF D2) – Sword**



Helpful hint: this exercise starts on the opposite side of the body and ends on the same side.

Setting up for this position is as follows: Take the right arm and internally rotate at the shoulder. The arm should be positioned down (shoulder extension) and across (adduction) the body positioning the hand above the left hip. The wrist is flexed and angled toward the ulnar side of the arm with the hand in a fist.

Movement execution/draw the sword: Externally rotate the right arm at the shoulder and at the same time extend the wrist, opening the hand and angling it toward the radial side of the arm. Continue moving the right arm into shoulder flexion and across (abduction) to the right side of the body.

Returning back to start position/put away sword: The right arm returns back to start position by internally rotating at the shoulder and bringing the hand into a fist with the wrist flexed and angled in toward the ulnar side of the arm. Continue moving the arm into shoulder extension and then bring the arm across (adduction) to the left hip returning to starting position.

PNF for the Lower Body

Begin in water that is chest depth, standing close to the pool wall for support as necessary. Then progress to standing away from the pool wall. Movements can be performed on both sides.

- **PNF Diagonal 1(PNF D1) – Soccer**

Helpful hint: this exercise begins on the same side and ends on the opposite side of the body.



Setting up for this position is as follows: The right leg is internally rotated at the hip with the leg placed to the back (hip extension) and out (abducted) to the same side. The foot is in plantar flexion along with eversion.

Movement execution/kick the ball: Externally rotate the hip of the right leg and at the same time pull the toes up, dorsi flex the ankle and invert the foot. Continue moving the right leg up (hip flexion) and across (adduction) to the left side of the body.

Returning back to start position/set up to kick: Internally rotate the right hip along with ankle dorsi flexion and inversion of the right foot. Next move the right leg across (abduction) and down (hip extension) to starting side.

- **PNF Diagonal 2 (PNF D2) – Curtsey**

Helpful hint: this exercise begins on the opposite side and ends on the same side of the body.



Setting up for this position is as follows: The right hip is externally rotated placing the right leg to the back (hip extension) and across to the leg side (hip adduction). The ankle of the right foot is in plantar flexion with the foot in inversion.

Movement execution/move out of curtsey: Internally rotate the right hip and move ankle and foot into dorsi flexion and eversion. Next move the right leg up (hip flexion) and across (hip abduction) moving from the left side out to the right side of the body.

Returning to start position/curtsey: Externally rotate the right leg at the hip and move the ankle and foot into plantar flexion and inversion. Next lower the right leg (hip extension) and move across from the right side to the left side of the body (adduction) returning to start position.

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