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Aquatic Physical Therapy Techniques for Neurologic Symptoms

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AQUATIC PHYSICAL THERAPY TECHNIQUES FOR NEUROLOGIC SYMPTOMS

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This Independent Study, submitted by Jennifer Nicole Skjefte in partial fulfillment of the requirements for the Degree of Master of Physical Therapy from the University of North Dakota, has been read by the Faculty Preceptor, Advisor, and Chairperson of Physical Therapy under whom the work has been done and is hereby approved.

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ABSTRACT

Aquatic physical therapy (APT) has been defined as a comprehensive therapeutic approach that benefits a person physically, emotionally, and psychologically through active participation in an individualized pool program. The purpose of this study is to review the literature regarding aquatic therapy and neurologic symptoms to provide physical therapy students and professionals with techniques and exercises that can be used to treat persons who present with neurologic disorders.

The history of hydrotherapy, the relative properties of water, the contraindications, precautions, and indications of aquatic exercise, and the definitions and treatments of specific neurologic symptoms will be addressed. The symptom specific techniques and exercises presented will assist physical therapists and students in implementing aquatic neurorehabilitation into their practice.

CHAPTER 1

INTRODUCTION

Documented history has revealed several uses of the mechanical, thermal, and cleansing effects of water dating back to Greek, Roman, and Asian times.[1,2,3] However, the popularity of aquatic therapy has fluctuated through the ages, and is only recently regaining momentum.[1,2,3] Considering that over three-fourths of our planet is covered with water, it is surprising that it has taken modern medicine so long to rediscover the vast therapeutic effects of aquatherapy.

As early as 2400 BC, recorded history reveals that the Proto-Indian culture used water for hygiene purposes, and the Egyptians, Assyrians, and Mohammedans found curative means for mineral waters.[4] Around 1500 BC, the Hindus were believed to have used water for fever reduction. For the next one thousand years, there was little evidence of therapeutic water usage until Hippocrates (c460 - 375 BC) was believed to have treated muscle spasms and joint diseases through the use of contrasting hot and cold baths.[5] One hundred years later, the Romans created a system of therapeutic baths.[2,3,4,5] By AD 339, these Roman baths were used for the sole purpose of treating rheumatic disease,

paralysis, burns, and various other injuries.[4,5] Unfortunately, with the fall of the Roman Empire, there was a similar decline in the use of the therapeutic application of water.

The diminished use of water therapy lasted throughout medieval times, and slowly began to regain momentum in the fifteenth, sixteenth, and seventeenth centuries.[4] The physical and psychological properties of water which form the basis for aquatic physical therapy began to gain attention during the early twentieth century. It was at this time that the first hubbard tank was invented causing a heightened awareness of using underwater exercise and immersion therapy as a rehabilitation means for a wide variety of conditions. Stemming from the popularity hydrotherapy gained in treating surgical, neurological, and psychological conditions, the use of water as a therapeutic medium began to evolve into our current definition of aquatic therapy.

Aquatic therapy quickly became a prominent therapeutic approach in various medically advanced countries around the world. Research in the field of aquatherapy by the personnel at the Orthopaedic Hospital in Los Angeles, California, attracted the attention of the American health care system.[2,5,6] Founder of this hospital, Charles Lowman, and Susan G. Roen, Physical Therapist, came to be known as the forerunners in the trend toward pool therapy

and aquatic exercise. Shortly there after, President Franklin D. Roosevelt heard of an account in which warm spring water aided in the fight against post-polio.[5,6] After personal success in treating his polio symptoms with aquatherapy, the President became a major advocate for pool therapy and sparked great fame for this therapeutic approach. This national attention led to the implementation of therapeutic pools in major medical facilities across the country by the 1950's.[5]

The acclaimed cure for polio, as well as new inventions of electrical and mechanical modalities for treating a vast variety of symptoms, caused pool therapy to be abandoned during the 1960's and 1970's.[6] However, the 1980's and 1990's have been an age of rebirth for aquatic therapy. Research in the field of aquatic therapy has been the key to regaining momentum for this form of therapy. The physical and psychological properties of water have been shown to improve relaxation, pain relief, mobilization, general fitness, strength, balance, and coordination.[6,7,8] These stress relieving effects of water combined with innovative applications in rehabilitation allow individuals functional options in a safe environment.

In 1992, the American Physical Therapy Association (APTA) established the aquatic physical therapy (APT) section which defined and established standards for the therapeutic application of water used in physical therapy.[6]

Aquatic physical therapy includes a broad group of procedures performed in an aquatic environment that relate specifically to the physical, emotional, and psychological needs of the individual in order to achieve the projected outcomes.[3,6,9] Based on the belief that any and every person will achieve their discharge goals faster when pool therapy is used in conjunction with land based physical therapy, the aquatic component of therapeutic exercise allows for a more rapid learning and progression of activities which should ultimately enhance land based activities.[9] Discharge planning from a formal aquatic therapy program encourages the individual to locate a community pool in which they can continue their therapeutic activities.[9,10] Enhanced patient compliance has been the result, which is not only a benefit to the patient, but also to the third party payer.[10] Satisfaction is gained by the patient, as is prevention of further injury at a reduced resultant cost for both the patient and third party.[8,11] Therefore, this comprehensive therapeutic approach leads to shorter formal rehabilitation time and less dollars spent, making it a practical rehabilitative approach as we embrace the age of managed care and a future of health care reform that emphasizes fewer treatments, more patient education, early discharge, and greater utilization of community resources.[9]

Aquatherapy provides relief for a great number of orthopaedic, rheumatic, neurologic, and pediatric conditions.[4,6] However, within this paper only the benefits that pertain to neurologic symptoms will be discussed. By addressing neurological signs and symptoms rather than each neurologic condition, each exercise program can be individualized based on the specific needs of the individual rather than according to typical disease characteristics. The purpose of this study will be to review the literature regarding aquatic therapy and neurologic symptoms to provide physical therapy students and professionals with techniques and exercises that can be used to treat persons who present with neurologic disorders. It will provide a quick reference for symptom specific aquatic techniques that can be utilized to individualize treatment programs based on each persons neurologic presentation.

CHAPTER 2

PROPERTIES OF WATER

An individual moving through calm water experiences twelve times the amount of resistance that the same individual would encounter if moving at the same velocity on land during a calm day.[12] On land, wind and gravity alter resistance to motion; however, in an aquatic environment, the various properties of water play into the amount of resistance experienced. Unlike the wind which blows from only one direction, hydrodynamic principles cause water resistance to be multi-directional. Because the intensity of an aquatic exercise can be influenced by these various factors, the key to progressively overloading the system while maintaining target heart rate is to control how surface area, type of movement and velocity of movement interact.[6,13] In order to do so, one must understand the properties of waters and their application to aquatic exercise. It is these properties that guide the integration of therapeutic activities in an aquatic environment and account for many of the associated benefits that can be gained from hydrotherapy.[9] Therefore, this chapter will focus on the definitions and

applications of the properties of water and their role in development of an individualized aquatic exercise program.

Buoyancy

Buoyancy forces form a major portion of the scientific basis for aquatic therapy.[1] Contrary to the downward force of gravity on land, buoyancy is an uplifting force encountered in aquatic environments.[1,4,8,13,14,15] The discovery of buoyancy has been traced back to the Greek mathematician Archimedes, Archimedes (287 - 212 BC).[1,8,12,13,16] Archimedes principle describes buoyancy as a force that water exerts against an object equal to the weight of the water displaced, or pushed aside, by the object.[1,8]

Buoyancy can be assistive,supportive, or resistive.[1,14,15] Aquatic therapy utilizes buoyancy's assistive qualities to facilitate upward motion of submerged limb or unweight painful joints. Buoyant forces help to support the a body segment during active assistive range of motion exercises (AAROM) or the entire body weight during prone or supine floating activities. The resistance of buoyancy is encountered when moving in a downward motion away from the water surface.

The amount of reduced joint compression that is attributed to buoyant forces is indirectly proportional to water depth.[1,14,15] A water level of waist depth or lower exerts greater impact, approximately 50% of the body's gravity weight,

on the submerged joints during vigorous activity. Water that is axilla level or above tends to increase buoyancy to a stage that is more difficult to control because only about 10% of our gravity weight is experienced. The appropriate water level for each patient must be individualized to fit the goals of their therapy. As improvement occurs, the water level should be progressively lowered, forcing the feet to support greater weight and more closely simulate on land activity.[14,17]

An individual's center of buoyancy (COB) has an additional effect on development of a personalized exercise program.[14] The COB is the point on an individual through which buoyant forces act, and mimics the center of gravity (COG) on land. Both are affected by the weight and position of all body parts at any given moment. Commonly, the COG is located in the pelvic region and the COB is located in the chest region. Center of buoyancy can be influenced by inhalation and exhalation and must be taken into when designing a aquatic therapy program because the amount of air in a person's lungs alters their ability to float.

Specific Gravity

Specific gravity (SG) is the ratio of a person's body weight to the weight of the water they displace.[13] Because pure water at four degrees celsius has a specific gravity of 1.0, it is the standard against which other objects are

compared. An object with a SG less than 1.0 will float, while an object with a SG greater than 1.0 sinks. Because, an individual 's SG is determined by their body composition, it is easy to deduce why some people float easier that others.

Adipose tissue has a SG less the 1.0; however, bone and muscle have a SG greater that 1.0.[13] Therefore, a person's body composition will influence the amount of support needed in supine, prone, and upright positions. Aquatic exercises must be carefully chosen to minimize the risk of submersion, especially in fearful individuals. Fortunately, an aquatic exercise program can be appropriately individualized by keeping in mind the general body composition guidelines. Average female have 21-24% body fat allowing them to float more easily than males who average 15-20% body fat. The very young and the elderly tend to have more fatty tissue and less lean body tissue than do young adults.[13,14]

Although, one cannot quickly or easily change their body composition, they can alter their SG.[13] The SG of the average body with air in the lungs is 0.974, which would allow the average individual to float more easily with heightened inhalation. On the other hand, the average body without air in the lungs is 1.1, thus exhalation causes sinkage.[14,18] Keep in mind that vital signs and signs of distress must be closely monitored when altering a person's normal breathing pattern.

Drag Forces

The amount of drag force experienced is a major contributor to the resistance encountered.[3,13] Drag is the term used when molecules decrease in speed and cause a resultant pressure which slows the object.[13,14] Streamlining refers to the body position achieved through bilateral arm and leg adduction which exposes the least amount of body surface area to the water.[13] Maintenance of this sleek and narrowed position causes a reduction in the drag forces and associated energy expenditure.

Drag forces additionally influence aquatic exercise through Newton's law of inertia.[13] The concept of static inertia is that a body at rest tends to stay at rest. To start and stop motion or change the direction of movement, force is required. This surge of energy needed to begin a movement can be utilized to enhance the difficulty level of a workout by incorporating frequent starts and stops.

Turbulence

Turbulence is the velocity of water at a given point which varies in magnitude and direction.[13] It can be artificially created in a pool setting by advancing the speed of an aquatic exercise or splashing. Turbulence places greater demand on an exercising muscle to move the body segment in the desired motion. The associated increase in heart rate, oxygen consumption, and

need for metabolic requirements can either be a positive or negative effect of turbulent forces depending on the individual's condition. For example, a heightened energy expenditure can enhance cardiovascular endurance, however, it can be devastating to individuals with little endurance to begin with.

In addition to increased resistance, muscular work, and endurance, turbulence provides sensory input for persons with sensation abnormalities, and promotes awareness of body parts for individuals presenting with perceptual and spatial impairment, arousal problems, or ataxia.[13]

Surface Tension, Cohesion, and Viscosity

Surface tension is the strong bond that occurs between molecules on the top of the water and can be utilized for strengthening purposes by those who exercise against it.[12] On the other hand, for severely weak persons, this aquatic property makes exercising just below the surface of the water slightly easier.

Cohesion is the tendency for molecules to adhere to each other, while viscosity is the internal friction within a liquid.[12] As cohesion increases, the similar fluctuation in viscosity causes an intensified amount resistance for an individual to contend with.

Hydrostatic Pressure

According to Pascal's Law, when a resting body part is submerged, water will exert equal pressure on all surfaces at a given water depth.[12] The pressure of the water against the body can be utilized for support of the body in altering muscle tone and resistance to chest wall expansion in persons with respiratory difficulties. Because the pressure gradient between the surface and the water increases 22.4 mmHg for each 30.5 cm of increasing depth, a person in an upright position will experience the most resistance at their ankles. The resultant venous return causes a reduction of edema and increased blood circulation which enhances endurance, healing, and pain relief.

Thermal Properties

The thermal properties of water can alter an individual's muscle tone, pain level, and emotional state.[17] Each of these characteristics must be controlled before the resistive forces of water can be beneficial to a person. The recommended temperature for a pool used for aquatic physical therapy is 90-100 degrees fahrenheit. A lower temperature may be required to better suit pregnant women or individuals who have reduced thermal sensation, certain disease processes such as multiple sclerosis, acute edema, or are planning to exercise at a high intensity level.[4,17]

The warmth of water stimulates the release of endorphins and helps to bombard the nervous system with stimulus to disrupt the pain cycle.[4] Pain reduction increases relaxation which promotes efficient breath control. The warmth of water also causes dilatation of the blood vessels which improves tissue oxygenation and nutrition and promotes a faster healing rate and lessens fatigue.[19]

Within a pool environment, removal of the heat source is not required in order to perform a stretch as in most heating modalities.[12] Submersion in warm water allows all surfaces of a body part to be heated simultaneously which lessens the opportunity for heat loss via conduction. Therefore, heat is conducted to the deeper tissues where it contributes to the elongation of deep tendons, capsules, and nonelastic tissues. Reduced muscle spindle activity results and helps to decrease tone.[20] An associated alteration of the systemic system has been known to occur resulting in fluctuations in blood pressure and heart rate. Drastic homeostatic changes are controllable through a well ventilated room that is cool enough to allow adequate body heat to escape, yet warm enough to avoid chilling upon entering or exiting the pool.[12,19]

High intensity exercises or aerobic activities are usually performed in moderately cold water. Cold water triggers sensory receptors on the skin and

causes a reflex response of the cardiovascular system.[13,21,22] The resultant shunting of blood from the skin to the internal circulation causes increased cardiac output through greater venous return. Cold stimulation of sympathetic nervous system results in enhanced autonomic function which allows an individual to exercise at a higher intensity level due to increased blood circulation which improves oxygen delivery to the working muscles.

The properties of water combine to provide a psychologically and physiologically stress relieving environment for individuals to safely exercise in at an earlier rehabilitative stage than land based physical therapy. Buoyancy can be utilized as assistance, support or resistance in aquatherapy techniques depending on the desired therapeutic goals. The properties of specific gravity, drag, turbulence, surface tension, cohesion, viscosity and hydrostatic pressure allow a person to control exercise progression through graded resistance. Warmth promotes relaxation and breathing exercises which are essential components of most aquatic activities. By understanding the properties of water, a physical therapist should be able to properly modify land based therapeutic exercises for implementation into a aquatic environment without needing formal knowledge of specific aquatic physical therapy activities.

CHAPTER 3

INDICATIONS, CONTRAINDICATIONS, AND PRECAUTIONS

As with all forms of physical therapy, there are indications and contraindications to aquatic exercise and precautions that should be taken into consideration in order to ensure the participants safety. Each individual's vision, balance, sense of direction, spatial and depth perception, muscular control and endurance must be taken into consideration when planning an individualized aquatic exercise program.[18]

Indications

Aquatic exercise therapy is indicated for various orthopedic and neurological conditions; however, with respect to the purpose of this paper, only the indications pertaining to neurologic symptoms will be discussed in this section. Aquatic neurorehabilitation is a treatment option if the physical therapist's assessment includes any of the following desired goals: tone alteration, improved range of motion, reeducation or stimulation of righting reactions, retraining of rotational or reciprocol movement patterns, sensory integration, muscle coordination, breath control, spatial orientation, strength

gains, enhanced sensory discrimination, pain reduction, improved psychological or social status, advanced cardiovascular endurance, or restoration of functional movement patterns.[6,8,11,12,23,24]

Contraindications

Persons presenting with the following absolute contraindications should not participate in an aquatic exercise program: cardiac failure, severe peripheral vascular disease, uncontrolled bowels, urinary infection, lung infections, contagious skin conditions, infectious disease, fever, unresolved wounds, bleeding or hemorrhage, or acute edema.[2,3,12] An individual with a vital capacity of less than one liter should not participate due to the advanced likelihood of respiratory distress.[2] Reduced thermal sensation or the inability to express overheating or overcooling is a contraindication, but may be accommodated for by exercising in water between 80 and 98 degrees fahrenheit or by limiting time in the water or the amount of body area submerged.[12] Pregnant women should avoid use of a pool if the temperature is greater than 92 degrees fahrenheit, especially during the first trimester.[13] It is also unsuitable for a person to partake in aquatherapy if they develop an adverse reaction to the presence of chemicals and disinfectants in the water.[2,3]

Excessive fear of the water is a contraindication to aquatic exercise.[12] However, apprehension of water is a precaution owing to the amount of confidence the patient has in his/her physical therapist.[2] The risk of unexpected submersion can be reduced through utilization of a non-slip surface flooring and/or assistive devices, prevention of overcrowding, and designated swimming areas.

Precautions

Precautions discussed will pertain to general neurological or medical conditions. Specific precautionary measures associated with each neurologic symptom will be addressed along with the respective treatment in the next chapter.

A person must never be left unsupervised during or after an aquatic therapy session.[12] In particular, additional caution must be taken when supervising a person with a history of epilepsy, seizure disorder, hypertension, hypotension, or perceptual difficulties.[2,12] Safety precautions for specific medical conditions should follow the physician's recommendation. An individual with swallowing difficulties is not a likely candidate for aquatic therapy because treatment techniques may involve submersion of the mouth under water.[24] If the person has a gastrostomy or nasogastric tube, they may be taken into the water

by clamping the tube and wrapping the respective area in plastic wrap. Pool therapy for an individual with urinary incontinence may require a catheter with a leg bag and/or additional chlorination of the water.[2] For persons with abnormal sensation, the therapist should check their skin before and after each aquatherapy session.[24] Patient education is necessary to make individuals aware of wet surfaces within in pool environment and the importance knowing his/her own exercise limitations.

Knowledge of the indications, contraindications, and precautions of aquatic physical therapy is necessary to ensure the safety of the patient. As with any form of physical therapy, constant monitoring and reassessment of the individuals response to treatment is needed. If alterations in the persons condition are noted, proper modifications or discontinuation of the therapeutic activity should be made in an attempt to restore a comfortable physical, mental, and emotional state.

CHAPTER 4

NEUROLOGICAL SIGNS AND SYMPTOMS

When dealing with a person who presents with neurological symptoms, the first step to understanding their condition is to localize the pathology and then to determine the etiology. Most often the cause of the disorder will be due to one or more of the following insults within the central nervous system (CNS) : 1) a vascular disruption which will present abruptly and have a transient or indefinite deficit; 2) a trauma which will show immediate loss and progress either with regeneration or degeneration; 3) a neoplasm in which the progression of symptoms will depend on the velocity of the tumor growth; 4) an inflammatory disease; or 5) a degenerative metabolic disease which presents with symmetrical symptoms and is progressive.[25] Although there are numerous varying neurological signs and symptoms that could result from each neurologic condition, this chapter will focus on those that are deemed the most responsive to aquatic therapy.

Pain

Pain in persons with neurological conditions is most often caused by stretching of contractures, active inflammation of nerve sheathes or meninges, or the accumulation of metabolites in the associated area.[25] The quality of neurogenic pain is often a burning sensation unless it is the result of peripheral nerve damage. Pain from peripheral nerve damage either presents and resolves insidiously as distinctive intermittent stabbing pain or becomes a continual superficial or deep soreness or aching. Regardless of the source, neurological pain is often referred along the course of the nerve and its branches. Certain positions may cause fluctuations in the pain radiation. An assessment of beneficial and detrimental positions will help guide diagnosis and treatment.

To be classified as having chronic pain, a person must have persistant pain for more than six weeks.[25] More often than not, there will not be an identifiable pathology. On the other hand, acute pain is almost always related to an active pathology and is often helpful in differentiating the diagnosis.

Circulatory Insufficiency

Circulation can be impaired by the lack of voluntary movement or a disruption in the sympathetic fibers of the nervous system.[2] Visual clues often include cyanotic limb color, reduced skin temperature, hairlessness, and dry skin.

Abnormal Sensation

Sensory disturbances such as pain, tingling, and numbness, are the most common neurological symptoms.[25] Due to the subjectively of this part of the exam, when analyzing symptoms of abnormal sensation one must look at the big picture and rationalize the presentation of symptoms based on anatomical and physiological principles. Central neuroanatomy and peripheral neuromuscular anatomy must be understood in order to grasp the complexity of sensory disturbances.

In general, disturbances of the lateral spinothalmic pathway result in pain and temperature perceptual alterations on the contralateral side below the level of the lesion.[25] Tactile discrimination occurs in the dorsal columns of the spinal cord and leminscal system of the brainstem. Damage to one or the other of these areas may result in changes in ipsilateral deep touch, proprioception, vibration, and two point discrimination below the involved level. Crude touch and light pressure sensations can be affected by lesions of the anterior spinothalamic pathway, but are so diffuse they are often not useful in determining the level of insult.

All facial sensation is supplied by the trigeminal nerve.[25] Pain and temperature disturbances of the face are a result of damage to the spinal nucleus

and tract of the fifth cranial nerve on the contralateral side. Touch and pressure alterations occur as a result of harm done to the contralateral chief nucleus of cranial nerve five. Changes in stationary position and kinesthetic sense of the face stem from injury to the mesencephalic nucleus of the trigeminal nerve on the ipsilateral side.[26]

Tactile Defensiveness

Tactile defensiveness is a hypersensitive response to a normal light touch situation that most persons find nonthreatening.[27,28,29] It usually occurs in persons with neurologic disorders secondary to faulty sensory processing or modulation by the brain.[27,28] Symptoms are usually manifested through a protective or withdrawal response such as negative emotional or attitude reactions, avoidance of noxious stimulus, rubbing, or scratching.[27,28,29] Affected persons are often intolerant to change, are inflexible, and easily distractible.[27,28] These negative qualities may in turn interefere with self help activities.[28]

Perceptual and Spatial Problems

Perceptual and spatial disorders are most often the result of cerebral infarction.[25] A commonly seen deficit is neglect in which the person will ignore the hemiplegic side of their body and may ignore visual stimuli in visual field of the involved side. Neglect is sometimes referred to as "Right Parietal Syndrome"

resulting from damage to the right cerebral cortex. Since the right side of the brain is better equipped to deal with spacial perception, involvement of this side results in various deficits. Symptoms from right brain damage may include: 1) inability to copy simple drawings; 2) inability to construct a map of a familiar area; 3) disorientation in familiar and unfamiliar surroundings; 4) difficulty with functional activities due to their disorientation in space; and/or 5) inability to make proper corrections.

Impaired Balance and Equilibrium Reactions

Balance is the ability to to maintain one's COG over their base of support (BOS).[4,30] It is accomplished through the integration of sensory detection of body motion, sensorimotor perception, and musculoskeletal responses. Sensory elements contribute to equilibrium. Somatosensory input relays information regarding body movement and orientation relative to the support surface and is achieved through stretch reflexes, flexor withdrawal and crossed extension reflexes and automatic postural reactions. The visual component involves detection of body position in space and external environmental organization. If the supporting surface is disturbed, visual stimuli aid correction through righting reactions. The vestibular system detects acceleration and deceleration forces on the head and provides an internal orientation of the head in relation of gravity.

During perturbation of both vision and the support surface, vestibular input resolves sensory conflict through gaze stabilization during head motion, righting reactions, and regulation of muscle tone and postural control.

The limits of stability are the maximal anterioposterior and mediolateral limits a person can tolerate without a displacement of balance.[30] Musculoskeletal responses to a loss of balance include stretch reflexes, equilibrium reactions, automatic postural synergies, and automatic postural reaction.[31] Reflexes are assumed to be the foundational units of motor skill acquisition. Just as they are learned during infancy and early childhood, they can be utilized in neurological reeducation for persons of any age who are unable to voluntarily control their movements. Disequilibrium is the inability to maintain orientation of the body in relation to space. It may result from an inappropriate orientation sense or movement strategy due to a disorder of the central or peripheral vestibular pathways, the cerebellum, or the sensory pathways involved in proprioception.[26,30] Postural synergies include ankle, hip, stepping, and suspensory strategies which involve distinct timing and intensity of leg and trunk muscle contraction.[30] Automatic postural reactions are movement adjustments made by any part of the body in order to regain equilibrium after a balance disturbance.

Ataxia and Lack of Muscle Coordination

Disorders of balance often lead to some form of ataxic gait. Persons with ataxia demonstrate a bizarre gait with unusual posture that is not the result of muscular weakness.[25,26] During stance, presentation involves a wide base of support and an unsteadiness that lends itself to a loss of balance when close to physically supportive people or objects.[25] Ataxia is caused by cerebellar, sensory, or vestibular disorders.[26]

The three functionally different lobes of the cerebellum in conjunction coordinate motor activity.[25,26] The middle lobe, appropriately named the vestibulocerebellum, coordinates eye movement and accounts for the postural and tone changes associated with alterations in body motion. The anterior lobe, or spinocerebellum, receives information via the ventral and dorsal spinocerebellar tracts and utilizes it to control posture and muscle tone. The posterior lobe is referred to as the neocerebellum and coordinates voluntary motor activity.

Cerebellar hypotonia accounts for the poor postural maintenance often accompanying ataxic gait.[25,26] Additional cerebral symptoms such as dysmetria, movement decomposition, and intention tremors also play a large role in affecting movement disturbances.

Sensory ataxia is the result of damage to proprioceptive pathways.[26] Polyneuropathies or posterior column lesions symmetrically affect the legs leading to gait disturbances. Patient report often reveals impairment of joint position and movement sense, a reduced vibratory sense, and numbness or tingling sensations in the legs. Other compensatory sensations allow the patient to experience improved balance when watching their feet or using an assistive device during ambulation.

Vestibular ataxia is the result of peripheral vestibular lesion or a central lesion of the brain stem vestibular nuclei or their connections.[26] This form of ataxic gait is not seen in gravity-eliminated positions and commonly presents with with unilateral nystagmus.

Abnormal Tone

Muscle tone is the resistance of a muscle to passive joint motion.[26] The amount of tone encountered depends on the degree of muscle contraction and on the mechanical properties of the muscle and connective tissue. A large amount of resistance to passive motion is referred to as hypertonia and encompasses spasticity and rigidity.

Spasticity presents as heightened muscle tone and tendon jerk hyperreflexia that results from a disorder of the spinal proprioceptive reflexes.[20] It

is most common in the upper extremity flexors and the lower extremity extensors. The type and intensity of stimulation influences the amount of tone present. The amount of spasticity increases proportionally to the speed of stretching. Other factors that can trigger spastic muscles are internal and external temperature, emotions, and stress.

Rigidity is a sustained contraction of both the agonist and antagonist and therefore is independent of the direction of motion.[26, 31] Leadpipe rigidity is a smooth, constant resistance to motion, whereas, cogwheel rigidity is a jerky motion due to alternating contraction and relaxation of the agonist and antagonist. Both are due to a lesion of the basal ganglia.

Hypotonia is more commonly referred to as flaccidity and is characterized by a reduced resistance to passive motion.[26,31] Care must be taken because the excessive floppiness of the distal limb allows for hyperextension of affected joints.

Reduced Respiratory Function

Respiratory dysfunction may be a direct or indirect effect of a neurologic disorder. It often leads to a reduction in ventilation and oxygenation as a result of decreased lung or thoracic muscle compliance, or respiratory muscle weakness, paralysis, incoordination or reduced endurance.[32]

Impaired Oral and Facial Control

Unilateral facial weakness is due to either a complete or incomplete lesion of the facial nerve or a cerebral vascular accident.[25] Whereas, bilateral facial weakness is due to one of the following: 1) a muscle disease which is slowly progressive such as muscular dystrophy; 2) a disorder of the neuromuscular junction resulting in varying degrees of weakness depending on the time of day as in myasthenia gravis; or 3) Guillian Barre syndrome.

Impaired Head and Trunk Control

Impaired head and trunk control causes abnormal posture and leads to inefficient and poor quality movement of the peripheral limbs or head.[4] Stability of the trunk and head provides the basis of reciprocol limb patterns of movement needed for functional locomotion. Control of normal trunk patterns of movement and posture can be best learned when the body does not have to work to neutralize the effects of gravity.

Limited Range of Motion

Limited joint motion resulting from a neurologic condition is often the result of disruption of the upper or lower motor neurons.[2] Reduced joint motion often causes a preventable skeletal deformity.[16] The resultant deformity hinders voluntary power and can influence body symmetry and posture.[2,16] Tight or

shortened muscles often interfere with an individuals functional level and associated activities of daily living.[16]

Muscle Weakness

Muscular weakness may result from one or more lesions in various anatomical sites.[25] Damage to the motor cortex may produce monoparesis or monoplegia. Disruption of the descending corticospinal tract leads to contralateral hemiparesis. If the disruption of the tract occurs in the motor cortex or midbrain there is also a risk of bilateral limb weakness. A lesion of the descending tract in the pons region could cause ipsilateral facial palsy. In the medulla, tract destruction may result in weakness of the ipsilateral tongue. When a spinal cord lesion occurs high within the cervical region, it is typical for the person to present with quadriplegia. Damage to the spinal cord below the eighth cervical vertebrae often results in paraplegia.

Harm done to the motor nuclei causes weakness and atrophy of the muscle supplied by the respective neurons.[25] Injury to the cranial nerves results in flaccid weakness or paralysis of the innervated muscle. Damage to the spinal nerve roots lead to flaccid weakness or paresis and a reduction of the associated tendon reflex.

Peripheral nerve involvement is referred to as a neuropathy.[25] Mononeuropathy is the result of a partial or full lesion of a single nerve causing decreased of deminished motor control respectively. Polyneuropathy is a generalized peripheral nerve condition characterized by flaccid weakness and atrophy beginning in the distal muscles and progressing proximally. A partial or complete lesion will result in loss of power during voluntary and reflex contractions.

A condition of the neuromuscular junction often results in generalized muscular debilitation causing wasting or paralysis which is neither symmetrical nor universal.[25] Involvement at the skeletal muscle level is progressive, commonly symmetrical and not generalized. Specific muscle involvement depends on the characteristics of genetic or nongenetic disease process. A lack of use eventually will lead to muscle atrophy.

Reduced Cardiovascular Endurance

A reduced cardiovascular endurance is a common indirect effect of any pathology due to the transient and reversible nature of training.[32] Metabolic and exercise capacity declines rapidly within two weeks of stopping activity. Bed rest is a reduction in exercise level even if the only activity the individual usually experiences is their daily functional routine. Decreased endurance often leads to

a vicious cycle of inactivity, deconditioning, heightened symptomology, and further activity reduction to avoid discomfort.

Impaired Functional Ability

The loss of functional ability, whether physical, mental, emotional, or social, is often the reason persons suffering from neurological symptoms seek rehabilitation.[30] Impaired function may hinder an individuals daily living, recreational or occupational activities. Both temporary and permanent losses require some degree of lifestyle modification, whether it be physically, emotionally, or psychologically.

Depression

Depression is often a result of any diagnosis as the person and their family must learn to adjust to their physical, mental or emotional losses. It generally leads to a reduction in energy, initiative, sleep, libido and appetite.[25] As a result, the person who does not overcome their feelings of depression may become socially and functionally debilitated.

No two individuals will have the same neurological presentation. By recognizing and understanding the neurological signs and symptoms addressed in this chapter, an individualized treatment plan can be designed to meet the

specific goals of each person. Symptom specific aquatic neurorehabilitation options will be presented in the following chapter.

CHAPTER 5

BENEFITS AND TREATMENT

Aquatic physical therapy allows individuals to meet and overcome both physiological and psychological challenges by achieving success, recognition, and a sense of accomplishment.[4,13] Pool exercises enhance an individual's functional level by improving relaxation, flexibility and mobility, muscular strength and endurance, aerobic capacity and coordination.[2,8,13]

In order for an individual to participate in an aquatic therapy program they do not need to know how to swim, although some stroke fundamentals are utilized.[13] Most exercises are performed in the vertical position with the head out of water.[3,13]

Aquatherapy goals and progression are the same as any rehabilitation program. Goals are aimed at preventing dysfunction and enhancing development, improvement, restoration or maintenance of normal function.[8] There are three major benefits of aquatherapy that assist in accomplishment of aquatic physical therapy goals: 1) gradual advances in weight bearing improve range of motion without painful compressive forces, 2) graded resistive activities

improve strength and endurance, and 3) the reduced gravity environment allows for early rehabilitation and functional recovery.[3]

In order to achieve the established aquatic therapy goals, treatment initially focuses on reducing pain and inflammation and then successively includes ROM, general flexibility strength, endurance, speed, skill, and overall maintenance activities.[2,3] In general, aquatic therapy exercises include hydrodynamic breathing activities, relaxation techniques, stretching, stabilizations, repeated contractions, and mobilizations.[4] There are four formally recognized aquatic exercise programs that can be used in combination with each of these therapeutic activities.[6,10]

Water Shiatsu (WATSU) is a passive muscle reeducation approach that relaxes the patient through the support of water and continual rhythmic movement.[6,10] It is especially useful during the warm-up period of a treatment session to improve motion.[6]

Bad Ragaz Ring Method (BRRM) is an active muscle reeducation technique that incorporates the principles of proprioceptive neuromuscular facilitation (PNF) with the properties of water and progressive resistance to improve strength and ROM.[4,6,10,33] Through unilateral or bilateral arm, leg, and trunk motions individuals develop the skill to move smoothly and reciprocally.[6,33]

The Halliwick Method is similar to neurotherapeutic facilitation therapy (NDT) aimed at facilitating the development of postural strategies for improved balance.[4,6,10] The therapist initially helps the person achieve balance during stillness and then gradually disengages as the individual becomes more skilled.[6] The final challenge requires the person to achieve balance amidst turbulence created by the therapist.

Task Type Training Approach (TTTA) was formerly referred to as a functional training approach and is for individuals have had a stroke or brain injury.[6] The emphasis of this form of aquatic rehabilitation is on functional skill reaquisition. It encourages individuals to become active problem solvers rather than passive recipients.

Pain

Both the warming and resistive properties of water help to relieve pain.[2,11] Warm water promotes relaxation and improves circulation. As a result, the pain cycle is disrupted and accumulated metabolites are flushed out of the area. Pain reduction may be associated with a reduced perception of stretch due to sensory distraction through bombardment of the nervous system by hydrostatic pressure, warmth, and turbulence.[11,23] Caution must be taken not to exercise too vigorously and cause heightened post-exercise fatigue and muscle soreness.[2,11] Buoyancy

reduces muscle guarding and joint compression while supporting the body which increases ROM and strengthening capabilities.[11]

Treatment is directed at symptomatic relief.[4,11] Progressive relaxation techniques, floating, breathing exercises and pendulum motions promote pain reduction. Increased mobility can then be achieved through AROM, mild stretching activities, aerobic fitness, postural alignment and strengthening exercises.

Circulatory Insufficiency

Water temperature greater than 93 degrees fahrenheit causes vasodilitation of superficial blood vessels and contributes to the nutrition of the skin.[2,11] The deep circulation is improved through movement and the hydrostatic pressure of water. Hydrostatic pressure is proportionally related to water depth and helps to improve skin color, enhance venous return, reduce edema, and improve blood flow to the muscles of the submerged limb.

Initially, an aquatic exercise program should be comprised of slow active movements. Progression may gradually increase in amount of aerobic activity and intensity. When working with this type of individual, handling precautions must be strictly adhered to because trophic changes may lead to skin break down and an impaired healing rate.[2] Due to the possible seriousness of circulatory

insufficiency, vital signs must be carefully monitored in these individuals in order to reduce the risk of congestive heart failure.[11]

Abnormal Sensation

The turbulent drag forces of water heighten sensory input.[6,11] Splashing or slapping the surface of the water or active movement through the water creates artificial trubulence.[11] Tactile stimulation is further facilitated by rubbing the area of sensory deficit with a wash cloth or sponge, or by pouring water over the affected part.

Cues from water turbulence and body position lead to proprioceptive retraining.[2,3] Aquatic exercises to improve proprioception begin with unilateral standing initially with support and then without. Progression may be accomplished through occlusion of vision, and forward, backward, and sideways water walking.[3]

Because of the nature of sensory deficits, extreme water temperatures, pool underwater lights, and rough surfaces must be avoided.[11] Careful inspection of the insensitive area must be done during and after pool therapy to monitor tropic changes or skin breakdown.

Hypersensitivity and Tactile Defensiveness

Treatment goals for tactile defensiveness are proprioceptive discrimination, tactile-pressure sensitivity, and desensitization.[29] Aquatic exercise therapy can be used to effectively achieve these goals. Proprioceptive-tactile treatment techniques for modification of hypersensitive touch include systematic desensitization, firm pressure, vibration, and the touch-bombardment approach.

Slow entry into the aquatic environment and smooth, slow, rhythmical movements assists with desensitization.[11] Hydrostatic pressure allows for graded amounts of compressive forces and allows the person to control the amount of pressure tolerable.[29] Gradual progression from calm water to more turbulent water raises the hyperresponsive threshold.[11,29] The turbulence of water closely mimics the vibratory techniques used in land based therapy. Bombardment is caused by the warmth of the pool and the constant sensory input created by waters resistive and buoyant properties. These treatment techniques reduce the persons sensitivity to touch and force adaption of the proprioceptive-discriminatory touch system and associated motor system components.

Perceptual and Spatial Problems

Perception can be stimulated through visual and auditory input, as well as skin proprioceptors and heat.[4] Since the resistance of water is multidirectional, it enhances body awareness by stimulating all body parts at once.[11]

Patient education is a key component in an aquatic therapy program for persons with perceptual problems because light refraction visually distorts body parts under water.[11] Initial aquatic therapy sessions for these individuals should focus on supine floating activities to improve postural and body awareness.[4] Successive activites include bilateral limb exercises, PNF patterns of the upper extremities to encourage the crossing of midline, retrieval games which require reaching, squatting, and diving, and maneuvering through an obstacle course.

Abnormal Tone

Treatment goals for a patient with hypertonia are aimed at developing reciprocal inhibition, reducing the stimulus intensity necessary to evoke a reflex response, and controlling the resultant excessive reflex phenomenon.[20] Harnessing the power of the remaining spinal cord circuitry will enable the person to use it to their advantage at will to restore functional motion.

The constant sensory stimulation caused by the aforementioned properties of water promotes adaption, which contributes to tone reduction.[11] The

amount of tone is directly proportional to the perceived exertion needed to achieve the desired motion. Since buoyancy and hydrostatic pressure help to support the individual, minimal amounts stress are experienced by the patient and the physical therapist during positional changes.[4,11] The percieved weightlessness experienced by the individual reduces the amount of effort required for movement and allows for early weight bearing which decreases tone.[11] The warmth of the water decreases gamma fiber activity which reduces muscle spindle activity and the associated tone.

Tone reduction is achieved through slow rhythmical swinging, rocking, or rotation motions.[2,4,24] Passive aquatic physical therapy for reducing tone in a supine position involves floating, movement of the lower extremities on the trunk and movement of the head and trunk on the hips.[4,24,33] Movement of the lower limbs and hips on the trunk is accomplished through backwards walking by the physical therapist in a lazy 's' shaped path causing lower extremity drag and lateral trunk flexion.[4,33] Movement of the head and trunk on the hips is accomplished as the physical therapist moves the patient slowly in an arc causing trunk rotation.[4,24,33] Passive rocking with small amplitude head displacement is performed in sitting.[4]

Active physical therapy techniques to reduce tone may begin with Bad Ragaz techniques to promote relaxation.[4,6,10,11,33] Trunk rotation during reaching activities in supine, sitting, kneeling, and standing positions actively promotes anterior and posterior pelvic mobility.[18] Swimming strokes decrease tone through repetitive trunk rotation.[11,13]

On the other hand, facilitation of tone can be accomplished through rapid movements against water's resistance.[4] Turbulence can be helpful in stabilizing the patient as they perform flutter kicking, sculling and repetitive extremity exercises.[4,11,13]

Reduced Respiratory Function

A reduction of hypertonia in the abdominal and neck musculature is a prerequisite to efficient breath control and can be accomplished through the thermal properties of water.[3,8] Warmth relaxes chest and trunk musculature which leads to improved trunk mobility. The hydrostatic pressure of water resists chest expansion and works to increase the work of the intercostals and strengthen the muscles of breathing.

The desired goals for persons with reduced respiratory function are aimed at learning proper breath control, dyspnea positions, relaxation, energy conservation techniques and work simplification modifications.[32] Associated

treatment options include diaphragmatic or resistive breathing exercises, shoulder and trunk exercises to mobilize the chest, and moderate to high intensity aerobic activities to increase respiratory muscle strength and endurance. Each of these activities can be effectively carried out in the pool. Specific aquatic therapy exercises focus on the chest and abdominal musculature in a supine position to control the rate and length of inspiration and expiration.[24] It is important to encourage breathing and relaxation techniques throughout the duration of the aquatherapy session.[3,8] Deep breathing activities are useful for improving ROM of the costal joints and the spine. Caution must be taken not to over fatique the individual or progress too quickly.

Impaired Oral and Facial Control

Treatment goals for persons presenting with impaired oral control are aimed at strengthening the oral musculature for speech and feeding purposes.[4] Hydrostatic pressure improves trunk and respiratory support which assists with the following aquatic activities: blowing bubbles, blowing lightweight plastic objects across the surface of the water, blowing through a straw, noise-making games, and breath control during swimming strokes.

Impaired Head and Trunk Control

Water is an ideal medium for improving trunk control because it provides a gravity eliminated environment which assists the work of weak muscles, activates righting reactions, and retards the loss of balance.[4,6] Aquatic therapy techniques for improved head and trunk control incorporate Bad Ragaz techniques for trunk alignment and stability, balance and righting reaction activities, prone exercises, and swimming strokes which stimulate and strengthen trunk musculature.[4,11,33] Initial aquatherapy exercises include log rolling, hip hiking, active recoveries and facilitation of movement from supine-to-sit.[4,11,24] Progression to wall sitting isometrically works the abdominals, quadriceps, and hamstrings.[23] Wall crunches isometrically enhance the same muscles as wall sits with the addition of the ipsilateral hip flexors and rotational abdominals. Water walking forward enhances isometric contraction of the abdominals, assists in maintenance of upright posture, and isotonically works the muscles required during gait. Backward walking in water reaps the same benefits as forward walking with the addition of improved paraspinal conditioning. Sculling simultaneously strengthens the upper and lower extremities with maximal stress of the gluteal, shoulder, and paraspinal musculature.

Impaired Balance and Equilibrium Reactions

The supportive properties of water lessen an individuals sense of imbalance and fear of falling.[11,24] By slowing the rate of a persons loss of balance, a greater response time is allotted to recruit equilibrium reactions.[11] The equilibrium responses kick in at an advanced rate due to vestibular stimulation created by the buoyant properties of water.[4] Within this reduced gravity environment it is easier to achieve head and trunk righting. Keep in mind that normalization of tone is a prerequisite to implementing aquatic techniques for enhancing righting reactions and balance.[4]

Treatment goals for poor balance are aimed at restoration of safety and function.[30] The ability to make an appropriate musculoskeletal response is accomplished through biomechanical realignment, reeducation of postural patterns, proper weight distribution, and sensory organization.

Biomechanical realignment in the aquatic environment can be achieved through active head righting on the trunk during passive lateral displacement of the hips and trunk in a seated position.[4] Aquatic exercises for reeducation of postural patterns include active unilateral upper extremity shoulder flexion with active head rotation to the contralateral side in a supine position, rolling over in the water, and maintenance of static sitting, kneeling, and standing postures.[4,11]

Proper weight distribution can be achieved by sitting on a kick board or performing front-to-back and side to side weight shifting.[8,11]

Once static balance is achieved, aquatherapy can be progressed by dynamic head motion, unilateral arm movement, bilateral arm activities, and then unilateral leg maneuvers.[4] Sensory organization can be further challenged though maintenance of sitting, kneeling, and standing balance in turbulent water, reduced water depths, and situation requiring reaching.

Ataxia and Lack of Muscle Coordination

Patients with sensory and vestibular ataxia rarely gain positive benefits from aquatic therapy due to the increased difficulty of maintaining their balance against the buoyancy and turbulence of water.[4,6] However, they may demonstrate a considerably diminished amount of ataxia while the limbs are kept under water due to the positive influence of the aquatic environment on ataxia-associated problems such as weakness of proximal muscle groups. Therapeutic goals include improved proprioception, posture, and an appropriate heel-toe gait.[3] Initial aquatic therapy begins in the supine position and focuses on complete relaxation and breath control before initiating coordination training through rhythmic stabilization.[4] Strengthening of selective extensors is then implemented.[4] Advancement is made through progressive positional changes from sitting to

standing with the addition of turbulence after mastery of static balance is achieved in each respective stage. Ball games can be initiated in each position after dynamic balance is achieved. Finally, controlled walking and turning activites are practiced initially in calm and then in turbulent water.

Limited Range of Motion

The fundamentals of stretching in an aquatic environment follow the same progression as land-based therapy.[8,11,16] The warmth of water will assist in reducing muscle tightness and perceived pain; however, if motion is limited by pain, ROM must not progress beyond the painfree range.[2,6,11] As improvements in voluntary motion are made, passive movement is gradually progressed to active assistive and active exercises.[2] Buoyant forces may be assistive, supportive, or resistive respectively.[11,15,18,24] Additionally, buoyancy reduces joint compressive forces which allows for pain free movement and lessens disuse atrophy. Breathing activites encourage relaxation and should be encouraged throughout the duration of the aquatherapy session.[11] During the initial aquatherapy sessions, Bad Ragaz is helpful in reduction of synergistic patterns.[33]

Passive aquatic exercises require a rapid passive thrusting of the involved limb into the water with buoyancy facilitated return of the limb toward the surface while in a seated or supine position.[4,24] The benefits of passive range of motion

(PROM) in an aquatic environment include earlier rehabilitation, prevention of contractures and maintenance of joint movement in the presence of flaccidity, reduced tone in spasticity or rigidity, pain inhibition, comfortable positioning, and improved body awareness, relaxation, and circulation.[8]

Active range of motion (AROM) implemented in aquatherapy affords the following benefits: slowed muscle atrophy, maintained or improved flexibility, painfree strengthening in a reduced gravity environment, sensory feedback from contracting muscles, reduced edema and enhanced relaxation, circulation, and coordination.[8] Most often participants in an aquatherapy program are able to return to their home environment because the pool allows early acquisition of independent functional daily living skills. When performing active motions with assistance, horizontal movement in the water neutralizes buoyancy.[15,18] Advancement to active movements without assistance requires an active downward force of the body segment against the resistance of buoyancy.[8,15,18]

Muscle Weakness

Treatment for muscular weakness may require development of a maintenance program to prevent further deconditioning in a person with a manifesting degenerative disease, or an enhancement program for restoration of normal function in a person undergoing regeneration.[26] Developing muscle

strength improves endurance, power, resistance to fatigue, and posture in addition to protecting the associated joints from injury.

The pool provides an excellent medium for muscle strengthening through the buoyant properties of water.[4] As previously mentioned, buoyancy is utilized as assistance for weak muscles and progresses to a supportive mechanism with gains in muscle power. Strengthening can be achieved with downward motions of the extremities resisting the uplifting buoyant forces.[6,18,33] To maximize strength gains, the individual may add floatation devices, broaden the shape of the body part, or increase the velocity, intensity, duration, or number of repetitions performed.[15,18,34]

Specific aquatic techniques include postural alignment exercises, wall push-ups, recoveries from supine-to-sit and supine-to-stand, and AROM, weight shifting and walking activities in a variety of positions, planes, and patterns.[11] Since the resistive forces of water are multidirectional, there is an enhanced amount of muscle activity with every movement in the aquatic environment.[11,34]

Reduced Cardiovascular Endurance

With improved cardiovascular endurance the heart can pump more blood during each beat.[13] As a result of enhanced aerobic capacity the person may experience a lower resting heat rate and blood pressure, a shorter recovery time,

an increase in blood circulation, an improved ability of the muscles to utilize oxygen, and a reduction in blood cholesterol and post-exercise muscle soreness and fatigue.

Buoyancy supports an individual's body weight and reduces joint compressive forces resulting in an increased ease of movement.[3] The resistive properties of water reduce the person's fear of falling and allows the individual to grade the intensity of exercise. Hydrostatic pressure increases blood circulation and assists in reducing the individual's heart rate. Water greater than 95 degrees fahrenheit will rapidly fatigue or overheat a person during their initial pool session; therefore, a lower pool temperature may have to be considered.[11,13]

Aquatic exercise prescription should initially focus of large muscle groups and gradually increase according to the tolerance of the individual for continuous activity.[32] Intensity an be advanced through increasing depths of water, or greater repetitions, speed, force, ROM, and time of activity. It is the physical therapist's role to structure the components of exercise mode, intensity, duration, and frequency to fit the patient's interests, abilities, limitations, motivation, and lifestyle. Popular aquatic activites to improve cardiovascular fitness include walking, aquajogging, and swimming.[11] Specificity of training should be kept in mind in order to tax the specific muscles frequently utilized and achieve a

cardiovascular stress level equivalent to the type and level of activity the individual is expected to return to following discharge from the formal rehabilitation program.[32]

Impaired Functional Ability

The ultimate goal of rehabilitation is enablement of the person to return to as healthy and fulfilling of an independent lifestyle as possible through psychological adjustment, functional skills training, health maintenance and vocational and recreational adaption.[30] Accomplishing the highest level of functional independence possible requires knowledge, ability, and attitude. Treatment for restoration of functional abilities should focus on maximizing the persons abilities to compensate for their disabilities.

In order to make gains in ones functional ability, independence must be achieved in performing the individual components of motion before an advanced activity requiring combinations of movement will be successful.[11] Functional reeducation often involves three phases. First, the general idea is accomplished through visual demonstration, auditory instructions, and manual guidance. Secondly, organization of the task process is achieved via heightened concentration and interpretation of feedback. Finally, refinement occurs when cognitive processing of environmental cues is replaced by automatic reactions.[4]

The succession of functional aquatic exercise begins with positional recovery, and then progreses to encompass sitting balance, sit-to-stand transfers, and ambulation.[24] Reciprocal patterns of movement contribute to the rhythm and smoothness of functional patterns of locomotion.[4] In order to achieve rotary motion, the patient is supported in supine and is encouraged to flex and extend bilateral lower extremities. Advancement of this activity includes active sidebending with controlled coordination, velocity, and rhythm of movement. From a prone position the individual can actively extend his/her hips while maintaining knee extension in order to facilitate awareness of the neck, trunk, and limb extensors. During standing, active adduction and abduction of the lower extremities, active abduction and adduction of th upper extremities, and coordination of all four limbs facilitates functional upright activities. Bad Ragaz techniques are useful for preparation of weight bearing during gait.[33]

Four phases of progressive intensity have been identified for aquatic physical therapy.[3] The goals of the first phase are to overcome the buoyant and resistive forces of water by maintaining spinal stabilization and demonstrating symmetric improvement in flexibility. The second phase focuses on improving spinal stability and flexibility while developing addition to developing strength and proprioception. The third phase incorporates extensibility, strength, and

endurance activities for the chest and thigh musculature with gait skills and walking strength. The ultimate goal of this phase is to achieve painfree walking in waist deep water for five minutes while maintaining an upright posture. The fourth phase advances the patient to walking in chest level water and eventually on land. Continued gains in flexibility, strength, proprioception, and endurance are encouraged through symmetric ROM and resistive strengthening exercises.[18] Keep in mind that any pending neurological complications may cause variations in the times and rates of skill acquisition due to changing body dimensions, age, level of physical and mental activity, motivation, and emotional and social support.

Depression

Psychological growth is an enormous benefit of preventing the possibly disastrous effects of depression.[13] The common human tendency to crave a sense of well-being and self-confidence can easily be fulfilled through the goals met in aquatic therapy whether they are great or small achievements.[6,13] Enhanced self image and motivation are often the result of the individual's goal achievement or positive reinforcement from others within a group setting and lessens the impact of the disability.[2,6,11,12,13]

The aquatic physical therapy goal for a person suffering from psychological distress is movement through water by his/her own voluntary control.[4] The amount of assistive equipment should be kept to a safe minimum in order to enhance independence. Independent mobility in the water contributes to a psychological boost because movements that are difficult or impossible on land can be achieved and minimize the difference between the persons with and without disability.[3,11,13]

The pool therapy environment commonly increases socialization and interaction within peer groups because body type, physical disability, and socioeconomic status are invisible when under water.[3,7,11,12] Mainstreaming includes people with disability in the same activities as people without disability.[13] The decision to mainstream a person is on an individual basis based on the advantages and disadvantages mainstreaming may have on the particular individual. Advantages include an increased opportunity for participation, group interaction, stronger self-concept, and peer contact. The lack of individual attention and peer sensitivity are the main disadvantages of mainstreaming.

Caution must be taken when assuming the effects of pool therapy on an individual's emotional status because the positive feelings of their perceived abilities in the pool may not be carried over to land activities and may result in

discouragement.[13] Disappointment may similarly arise when the reality of how the individuals body looks, feels, and acts when in water is not the same as in everyday life. Hydrotherapy allows for a safe release of frustration while having a good time kicking, pushing and splashing in the water.[11,13]

CHAPTER 6

CONCLUSION

The future of health care reform emphasizes fewer treatments, more patient education, early discharge, and greater utilization of community resources.[9] Aquatic physical therapy is a comprehensive therapeutic approach that demands active participation in a specialized pool program designed to meet the projected goals of the individual and their rehabilitation team.[3,6,9] The pool provides a safe environment for earlier acquisition of independent functional daily living skills than land based therapy due to the physical and psychological stress relieving properties of water.[4,6,12,13] Buoyancy can be utilized as assistance, support or resistance in aquatherapy depending on the desired therapeutic goals. The properties of specific gravity, drag forces, turbulence, surface tension, cohesion, viscosity, and hydrostatic pressure allow a person to control exercise progression through graded resistance. The warmth of water promotes relaxation and breathing activities.

The results of earlier rehabilitation are beneficial physically, emotionally, and financially for the patient.[6,9] Aquatherapy provides relief for a number of

orthopedic, rheumatic, neurologic, and pediatric conditions which have many of the same indications, contraindications and precautions. However, this paper only discussed those which pertained to neurological symptoms and were associated with aquatic physical therapy for tone reduction, improved ROM, reeducation and stimulation of righting reactions, retraining of rotational or reciprocal movement patterns, sensory integration, muscle coordination, breath control, spatial orientation, strength gains, enhanced sensory discrimination, pain reduction, improved psychological or social status, advanced cardiovascular endurance, and/or restoration of functional movement patterns.

A quick reference for symptom specific aquatic techniques was created in order to individualize a treatment program based on each person's neurological presentation. Activities included were directed towards preventing dysfunction and enhancing development, improvement, restoration, and maintenance of normal function. The specific pool exercises outlined can promote faster recovery than land based therapy alone and can contribute to enhanced patient satisfaction with the rehabilitative process.

The advanced rate of rehabilitation directly reduces physical therapy costs.[6,9] Indirectly, the high costs of therapeutic intervention are decreased through enhanced patient compliance with an independent pool program. This

results in greater utilization of community resources and lessens the need for additional medical and rehabilitative services.[3,11,13] Thus, the financial burden of health care is reduced for both the patient and the third party payer.

As we embrace the era of managed care and the future of health care reform, physical therapist's are challenged to create a treatment plan that ensures the participant reaps the optimal therapeutic benefits with respect to the allowed number of treatment sessions and available dollars. Aquatic physical therapy is a promising therapeutic option to bring persons with neurological symptoms into the full spectrum of their abilities within the imposed time and dollar constraints.[6,9]

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