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Aquatic Therapy Use in Occupational Therapy

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Running head: Aquatic Therapy Use in Occupational Therapy:

Aquatic Therapy Use in Occupational Therapy: A Literature Review

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Aquatic Therapy Use in Occupational Therapy

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Aquatic Therapy is proven in the literature to provide positive therapeutic results for varying physical and psychosocial disabilities. Therapist use of water's physical principals can have positive psychological, physiological, and cardiovascular results. Aquatic Therapy is a beneficial adjunct to the delivery of Occupational Therapy. Working from a theoretical base of Biomechanics, Occupational Science, or from the Model of Human Occupation, Occupational Therapists can facilitate patient improvements in a water environment. The need for more research by Occupational Therapists using Aquatic Therapy is increasing due to our professions ever-present state of having to justify itself. Occupational theory applies to Aquatic Therapy therefore it is an area of practice that Occupational Therapists can readily expand into.

Table of Contents

1. Introduction

Aquatic therapy (Johnson, 1988), hydrotherapy/swimming therapy (Campion, 1990), and water therapy/water physiotherapy (Smith, 1992) are some of the terms used in the literature describing the use of water in therapeutic goals for treatment. As aquatic therapy seems to be the most prevalent term in the literature this will be the term used throughout the paper. When reviewing this subject matter, the terms hydrotherapy, swimming therapy, water therapy, and water physiotherapy cannot be overlooked in their relevance to using water therapeutically. For purposes of this paper, the term aquatic therapy shall mean any water exercise and experience used in a therapeutic manner by a trained professional for rehabilitation of a disability and/or to improve quality of life (i.e., wellness).

The warm water environment has many advantages for treating the adult patient (Garrett, 1995), while this same environment is an excellent way to keep the pediatric population engaged during therapy time (Harris, 1978). Many different types of professionals such as Occupational Therapists, Physical Therapists, Physiotherapists, Recreational Therapists, Medical Doctors, Psychologists, and Exercise Physiologists report the use of warm water as an intervention in the literature. Water Safety Instructors, Nurses, and Physical Education Teachers are also widely involved in aquatics and have proven to be valuable adjuncts in the compilation of literature on aquatics.

Campion (1990) suggests that swimming can be an important part of treatment due to its social and life-long fitness possibilities. Examples of the benefits of swimming when used in aquatic therapy include: increased bone density (Benedict & Freeman,

1993), increased heart rate and perceived exertion (Burke & Keenan, 1984), improved muscular strength and endurance (Gehlsen, Grisby, & Winant, 1984), decreased asthma morbidity (Huang, Veiga, Sila, Reed, & Hines, 1989 ;Oded & Omri, 1992), increased exercise tolerance (Edlund, French, Herbst, Ruttenburg, Ruhling, & Adams, 1986), improved range of motion and flexibility (Whitlatch & Adema, 1996), and finally decreased pain for chronic back pain suffers (Langridge & Phillips, 1988). Whatever the expected outcomes of individualized aquatic therapy treatment are, one recurrent theme comes forth in the literature: an aquatic environment in therapy promotes activity completion (Broach, Groff, & Dattilo, 1997; Harris & Thompson, 1983; Joe, 1998; Johnson, 1988; Levin, 1991; Peaganoff, 1984; Wade, 1996).

Based on the findings reported in the literature, aquatic therapy appears to be an intervention suitable for use by Occupational Therapists to improve physical and psychosocial aspects in patient's lives. The American Occupational Therapy Association's (AOTA) Uniform Terminology sets the language of practice for individual Occupational Therapists (Dunn, 1994). AOTA's Uniform Terminology clearly identifies examples of performance areas, components, and contexts that can be effectively treated with aquatic therapy by Occupational Therapists. Throughout this paper, we will explore water as a modality, and as a productive environment for therapeutic intervention.

2. History of Aquatic Therapy

Water use/aquatic therapy has a long-standing history in treating disabilities and improving the wellness of individuals. Many ancient cultures used water for therapeutic purposes such as the Assyrians, Egyptians, and Moslems (Campion, 1990; Finnerty &

Corbitt, 1960; Krizek, 1963). Medical men in Japan were using mineral baths as a healing agent a thousand years before the birth of Christ (Finnerty, et.al.). Hippocrates (460-375 BC) used hot and cold-water immersions to treat many pathologies including: muscle spasms, rheumatism, jaundice, and paralysis (Finnerty, et.al; Krizek, et.al.). For bathing and recreation, the Greeks developed public spas near natural sources of water such as springs, lakes, and rivers (Campion, et.al.). Widespread public use of water spas for therapy and recreation peaked during the Roman Empire exemplified by the baths of Emperor Caracalla, which covered 1 square mile. With the decline of the Roman Empire came the decline of spa use, and by 500 AD they were no longer in existence (Lowman & Roen, 1952.).

In the 16th and 17th centuries, a scientific rebirth of water as means for therapy and healing came about through some early writings on the subject. Sir John Floyer in 1697 wrote a paper titled "An Inquiry into the Right Use and Abuse of Hot, Cold, and Temperate Baths" and John Wesley, founder of Methodism, wrote the book "An Easy and Natural Way of Curing Most Diseases" in 1747 (Campion, 1990; Finerty & Corbitt, 1960). In the 18th century, men from different backgrounds developed and practiced various medical uses of water. Vincent Plriessnitz, a Silesian peasant, developed water treatments that utilized cold outdoor baths (Campion, 1990). Sebastian Kniepp, a Bavarian priest, used full and partial baths that would alternate between hot and cold. Kniepp also became well known for the "Kniepp cure" (a general cure for all aliments) which consisted of drenching the body by hose alternating between hot and cold water (Franke, 1963).

American aquatic therapy use dates back to European explorers witnessing Native Americans using water for curative purposes (Kamenetz, 1963). According to Kamenetz, American settlers first recorded the use of water treatments in spas at Warm Springs, Virginia, where in 1761 it was documented that many people suffering from forms of rheumatism went for relief of symptoms. Spa use grew in America, and by the 19th century it had become fashionable to tour from spa to spa in the northeast to the Midwest. As spa use grew so did the incorporation of therapeutic and healing principals by doctors who frequently owned and operated these spas.

During the late 18th century Doctor Winterwitz, an Austrian professor, begin to establish an empirical physiological basis for water use in healing. Doctor Winterwitz, established the Institute for Hydrotherapy in Vienna which has been credited for the beginning uses of whirlpool baths and underwater exercise (Krizek, 1963). One of the first Americans devoted to aquatic therapy was Dr. Simon Baruch. Baruch taught hydrotherapy at Columbia University during the late 19th and early 20th centuries while authoring 3 books on the subject: "An Epitome of Hydrotherapy", "The Uses of Water in Modern Medicine", and "Principles and Practice of Hydrotherapy" (Finerty & Corbitt, 1960).

At the turn of this century, most neuro-psychiatric institutions in America began to use hydrotherapy as more and more of the medical establishment deemed it acceptable as a therapeutic modality. Since the First World War, forms of aquatic therapy have been provided in swimming and therapeutic pools (Reynolds, 1976). President Franklin D. Roosevelt himself promoted the use of qualified medical personal in aquatic therapy, as therapeutic swimming was used to treat his own Polio (Lowman, 1937).

Despite continued developments in the field, aquatic therapy was still slow to develop in this country because of a lack of accredited qualifications in the people who trained, administered, and promoted water use for healing. It wasn't until 1937 that the American Congress of Physical Therapy investigated and reported on the conditions of aquatic therapy in this country (Kamenetz, 1963). This committee's findings created standards for aquatic therapy and later became an advisory committee to the Council of Physical Medicine and Rehabilitation of the American Medical Association.

By the 1950s and 1960s, Polio had been controlled and Veterans of the second World War were no longer receiving rehabilitation services, so aquatic therapy use again declined (Irion, 1997). Irion, states that the new forms of medical reimbursement including: Medicare, Medicaid, and private insurance were more likely to pay for newer technologies for use in rehabilitation.

By the 1970s, there was a whole new generation of war victims to rehabilitate from Vietnam. A resurgence in aquatic therapy to meet these rehabilitation needs and the popularization of "water aerobics" in the 1980s increased the public's opinion on water use for therapy (Irion, 1997). Rehabilitation of superstar athletes such as Joe Montana, Bo Jackson, and Michael Jordan have also expanded the publics awareness of aquatic therapy (Levin, 1991). Today, over 400 Occupational Therapists are included in the AOTA's Aquatic Therapy Network, which is dedicated to the advancement and use of aquatics by Occupational therapists (Joe, 1998)

3. Physical principals of water

Aquatic therapy is believed to have multiple benefits for the wellness of an individual (Campion, 1985; Morris, 1995). Aquatic therapy provides therapeutic properties that do not exist in other non-aquatic modes of therapy such as buoyancy, hydrostatic pressure, cohesion/viscosity, and turbulence (Duffield, 1976). These inert properties allow for strengthening exercises in water to improve patient function, while avoiding muscular and joint damage commonly encountered with land exercises.

Duffield (1976) defines buoyancy as, " the force experienced as an upthrust which acts in the opposite direction to the force of gravity". Buoyancy of water allows a person to be in a decreased weightbearing environment as opposed to a totally gravity dependent environment such as on land. Joint wear and tear is minimized due to the effect of buoyancy when exercising in water. Additionally, buoyancy of a body in water, is also affected by the amount of air carried in the lungs determined by inhalation and exhalation (Elkington, 1971).

The second therapeutic property of water is hydrostatic pressure. Duffield defines it as, "molecules of water thrust upon each part of the surface area of an immersed body". Duffield further states that hydrostatic pressure increases with greater water depths making exercises at greater depths more resistive. This pressure external to the body reduces edema by enhancing circulation throughout the body.

The final inert property of water we will define is turbulence. Turbulence itself is defined as "eddies that follow in the wake of an object moving through water" (Campion, 1997). Campion goes on to say that the greater size and speed of the object, the greater energy produced and drag caused. Turbulence is a force of water utilized by a therapist

for assistive or resistive training in varying movements. Some examples are, gaining/maintaining trunk balance and upper/lower extremity strengthening. Morris, 1994, states that "turbulence in water heightens sensory feedback to movement which may assist patients motor problem solving". The safe and effective use of turbulence across many different orthopedic diagnoses is a good example of a therapeutic level of physical intervention distinctly differing aquatic therapy from land exercise.

4. Water's physiological effect on the human body

Water temperature plays a large role in aquatic therapy with its varying effects on the body. Heat is transferred from water to the human body through conduction. The intensity of this transfer of heat energy is dependent on water temperature, body temperature, adipose tissue, and skin dermal density (Nave & Nave, 1985). Warm water immersion at temperatures between 96 and 104 degrees Fahrenheit can increase tissue temperature and blood flow throughout the body (Duffield, 1976; Michlovitz, 1990).

Exact water temperatures suitable for therapy have been debated (Campion, 1990; Franchiomont, Juchmes, & Leccomte, 1983; Garvey, 1991). Exercise in water at 40 degrees Celsius or 104 degrees Fahrenheit causes cardiac output to increase significantly in healthy individuals resulting in the potential for heat illnesses (Choukroun & Varene, 1990). It is reasonable to believe that if healthy individuals can become ill exercising in heated water then people with compromised health may be at an increased risk for developing heat illness, perhaps even faster than at lower water temperatures. The anticipated therapeutic outcomes will assist in the determination of temperature needs for treatment (Duffield, 1976). For example, Garvey (1991) states, " if the temperature is too

cool, the patient may experience an increase in muscle spasms, or, if the temperature is too warm, an increase in the rate of fatigue."

Heated water, along with its natural forces of buoyancy, hydrostatic pressure, cohesion/viscosity, and turbulence provide an environment for treatment that has shown to be beneficial for many people with disabilities (Broach, Groff, & Dattilo, 1997; Hurly & Turner, 1991; McHugh, 1995; Peganoff, 1984; Templeton, Booth, & O'Kelly, 1996). The special combination of buoyancy and resistive movement in warm water can be a better means to accomplish therapeutic goals than similar therapeutic exercises on land (Hurly & Turner, 1991).

Physiological responses to being immersed in warm water are important pieces of information for the Occupational Therapist to be aware of. Different physiological responses occur when the human body is at rest and during exercise. At rest, large groupings of physiological characteristic changes are due to the cardiovascular response of centralized blood flow (a decrease in peripheral blood flow). Centralized blood flow has a vast effect on cardiovascular function including: cephalad redistribution of blood flow (Arborelius, Balldin, Lilja & Lundgren, 1972), right atrial venous pressure increases due to the Frank Starling Mechanism (myocardial fiber length at beginning, during, and completed contractions) (Arborelius,et. al., 1972; Begin, Epstein, Sackner, Levinson, Doughtry, & Duncan, 1976; Farhi & Linnarsson, 1977), stroke volume increase from 32-79% (Arborelius, et. al. 1972; Christie, Sheldahl, Tristani, Wann, Sagar, Levandoski, Ptacin, Sobocinski & Morris, 1990; Farhi & Linnarsson, 1977; Lin, 1984), cardiac volume increases from 27-44% (Christie, et. al. 1990; Lange, Lange, Echt & Gauer, 1974).

Although centralized blood flow causes increased right atrial pressure, stroke volume, and cardiac volume, heart rate remains unchanged (Arborelius, et. al. 1972; Farhi, et al., 1977; Lange, et al., 1974; Lin, et al., 1984). The heart is beating at the same rate, filling and delivering more blood efficiently. Warm water external to the body acts as an internal vasodilator changing blood flow and decreasing peripheral blood pressure. (Arborelius, et al., 1972; Epstein, Preston & Weitzman, 1981). Renal and hormonal effects have also been known to occur after prolonged periods of at rest water immersion (Epstein, 1978).

Exercise in water includes positive cardiovascular responses such as improved ventilation, oxygen uptake, and respiratory quotient (Bishop, Frazier, Smith & Jacobs, 1989; Butts, Tucker & Smith, 1991; Eyestone, Fellingham, George & Fisher, 1993). Improved heart rate with a corresponding increase in blood lactate concentration has also been reported in the literature (Svedenhag & Seger, 1992).

Researchers have documented how these positive physiologic reactions have demonstrated multiple health benefits to those who exercise in water. Templeton, Booth, & O'Kelly (1996) ran an aquatic therapy study on patients with decreased joint flexibility and impaired functional status due to rheumatic diseases. By showing improvement in these areas, their purpose was to quantify the use of aquatic therapy. Thirteen subjects were chosen, having an assortment of rheumatic diseases including: osteoarthritis, fibrositis, fibromyalgia, degenerative arthritis, lupus erthematous systemic, and sjogren's syndrome. Active range of motion and functional status index scores of needed assistance with accompanying pain were taken before and after the study was conducted. It was

found that aquatic therapy increased joint flexibility and reduced difficulty with activities of daily living by reducing pain.

Whitlatch & Adema (1996), conducted a study involving older adults in a structured exercise program in 94 degrees Fahrenheit (34 degrees Celsius) water. Range of motion, manual muscle testing, walking speed, and health status data(including reported pain, physical function, and general health perceived) was collected before, midway, and after the 12-week exercise program was completed. Whitlatch & Ademas compared the pre and post average results from the study. They are as follows: 10% increase in shoulder adduction, 17% increase in shoulder extension, and a 15% increase in hip flexion. Shoulder strength (primarily, anterior deltoid) increased by 25%, with quadriceps strength increasing 58%. Treadmill-walking speed increased by 40%. While there was no evidence of increased physical function or perceived general health, there was a decrease in the amount of reported pain by participants.

5. Aquatic Therapy as a modality

Aquatic therapy in the use as a modality shall be defined for the purposes of this paper as the utilization of the physical principals of water for isolated healing with no gross movements required on the patients' behalf. Aquatic therapy as a modality deserves attention as it is a practice widely used by occupational therapists.

Water has been used for site specific wound healing such as pressure ulcers and dermal burns. Burke (1998), conducted a study involving stage 3 & 4 grade pressure ulcers. He ran two groups, one with conservative treatment and one with conservative treatment plus whirlpool use for 20 minutes, one time daily. Burke (1998), concluded, the

whirlpool group's pressure ulcers healed at a significantly faster rate ($P<0.05$), than the non-whirlpool, conservative only treatment group.

Celikoz (1998), conducted a two-year retrospective chart review of dorsal hand burn treatments at the University of California-Irvine Medical Burn Center. The severity of burns determined the course of treatment at the center. All third degree burns required skin grafting by a surgeon with follow up in occupational therapy. All first and second-degree burns were treated solely by an occupational therapist that incorporated aquatic therapy into the healing process. Celikoz found that all first and second degree burn patients treated with range of motion exercises in water (aquatic therapy) returned to a previous level of function, had a positive cosmetic outcomes and had no complications what so ever from treatment.

From pressure ulcers to large areas of partial/full thickness burns, physically getting a patient in and out of aquatic therapy maybe problematic. Dorsal hand burns are simplistic to treat because the patient can just put their arm in a tank of water. Thanks to improvements in engineering rehabilitation equipment, accessibility improvements have been made for whole body water immersions(Walk, Himel, Batra, Baruch, O'Connor, Tanner, & Edlich, 1992; Herrick, Herrick, & Ward, 1995).

6. Aquatics as a therapeutic intervention

Aquatics can be used as therapeutic intervention providing many physical and psychosocial opportunities. Aquatics as a form of therapy has been well documented in therapeutic literature. The following sections will show documentation in aquatic therapy research.

Physical Interventions

The aquatic therapy environment has been used effectively to treat physical dysfunction in: older adult patients (Benedict & Freeman, 1993; Ruoti, Troup & Berger, 1994), spinal cord injuries (Broach, Groff, & Dattilo, 1997), patients with cystic fibrosis (Edlund, French, Herbst, Ruttenburg, Rushling, & Adams, 1986), patients with multiple sclerosis (Gehlson, Grisby & Winant, 1984; Fawcett, Sidney, Hanson, & Riley-Lawless, 1994), patients with cerebral palsy (Harris, 1978; Peganoff, 1984), deaf-blind children (Harris& Thompson,1983), patients with amyotrophic lateral sclerosis (Johnson, 1988), arthritic patients (Levin, 1991), asthmatic patients (Oded & Omri, 1992), and patients with rheumatic diseases (Templeton, Booth, & O'Kelly, 1996).

Aquatic therapy has been used to promote postural stability in older adults. Simmons, (1996), conducted a water exercise study to improve postural stability measured by functional reach. Fifty-two adults with a mean age of 80 were divided into four groups: water sitters, land sitters, water exercisers, land exercisers. All groups met for 45 minutes, two times a week supervised by a physical therapist. Sitting groups just sat in water or at a table and were encouraged to socialize. Both exercising groups completed a low impact upper and lower extremity movement regime in their assigned environments: on land or in water. The sitting groups resulted in no changes in functional reach while the land exercise group showed some improvements in functional reach. The water exercise group showed significant improvements in functional reach with an average improvement of 35 centimeters per participant.

Some promising studies have been conducted using aquatic therapy in early intervention to treat neurologically compromised infants. Attermeier (1983), describes a case of water used as a treatment modality for an infant with mild neurological dysfunction. The infant displayed the following motor delays: Consistently turning and tilting head to the right while neglecting the left side, hand sucking and reaching more frequent to the right, thumbs abnormally adducted, plantar grasps bilaterally, response to tactile stimulation was better on the right compared to the left side, and overall tone was higher than normal. Aquatic therapy treatment occurred in two phases. First, the mother followed a motor stimulus regime during bathtime twice a day. The second phase occurred in a baby pool at a local park using a therapist prescribed exercise program. Neglect of the left side over the right diminished, thumb adduction only occurred during new developmental skill attainment, response to tactile stimulation normalized, fine pincer grasp presented bilaterally with only occasional left handed thumb adduction, and overall tone increases became only inconsistently detectable.

Sweeney (1983), conducted a study using aquatic therapy with 3 high-risk neonates in an intensive care nursery setting. The babies were immersed in 99 - 101 degrees Fahrenheit (37.2 - 38.3 Celsius) for ten minutes at a time. Mean heart rate, mean blood pressure, and behavioral states were all monitored at 5-minute intervals. Improvements included: decreased abnormal muscle tone, increased visual and auditory orientation responses, and improvement in feeding behaviors.

Psychosocial Interventions

Psychosocial outcomes of an aquatic therapy environment cited in the literature include: increased body image and morale (Benedict & Freeman, 1993; Peaganoff, 1984), improved mood (Berger & Owen, 1992), decreased anxiety and depression (Stein & Motta, 1992), and sense of achievement (Trussell, 1971). Aquatic therapy links with overall wellness of an individual have been established in the literature to promote swimming as a lifetime leisure activity contributing to good psychosocial health of an individual (Beaudouin & Keller, 1994). A sense of community by patients in group aquatic therapy has been reported in the literature (Satterfield, Yasumara, & Goodman, 1984). Sweeny (1983), reports that parents and children who participate together in aquatic therapy can foster parent-child bonding.

It is the multiple physical and psychosocial effects of therapy in a water environment that drives patients to activity completion. Once a patient achieves completed purposeful activities, it enhances patients abilities to make therapeutic gains (Huss,1981). As we shall see in the case studies to be analyzed by occupational theory, an improved physical performance can facilitate improved psychosocial occupational well-being.

7. Rehabilitation techniques in Aquatic Therapy

Rehabilitation techniques in the aquatic therapy environment vary and are only limited by the knowledge base of the practitioner. Some of the more common interventions reviewed will include: Bad Ragaz Ring Method, Water Shiatsu (WATSU),

the Hallick Method, Neurodevelopmental Treatment (NDT) in water, and finally the Task Type Training Approach (TTTA).

Bad Ragaz Ring Method

The Bad Ragaz Ring Method (BRRM) was developed over time but was initiated in Bad Ragaz, Switzerland in the 1930s (Boyle, 1981). BRRM was later developed to incorporate principals of proprioceptive neuromuscular facilitation (PNF), a technique previously used on land only (Morris, 1995). With the inclusion of PNF, BRRM now utilizes three-dimensional diagonal movements in unilateral and or bilateral patterns to increase strength and range of motion. BRRM begins with the patient supine in water with the therapist constantly close by applying holds and giving resistance. Rings and or floatation devices are used to help support the body at the neck, pelvis (S_2), and ankles (Boyle, 1981). The size and weight of a person determines the amount of buoyancy assistance needed. The level of isotonic or isometric resistance needed will determine how high onto the water's surface the patient will float. At a minimum, the patient's eyes and ears need to be above the water's surface for communication to occur between therapist and patient. Boyle (1981), goes on to state that BRRM exercises are divided into three major groups: hip or lower-limb patterns, trunk patterns, and the upper-limb patterns. These three groups following PNF principals of maximal resistance, approximation, traction, and correct holds with short precise commands used for "optimal contraction of major muscle components". BRRM is an accepted way to address therapeutic goals that include general mobilization and strengthening but is inappropriate

in cases of acute pain and any instances where water use would increase abnormal tone (Morris, 1995).

Water Shiatsu

Water Shiatsu (WATSU) was developed in 1980 by Harold Dull at Harbin Hot Springs, California (Dull, 1993). Dull describes the technique as Zen Shiatsu principles applied to people floating in water. While floating in water, the therapist coordinates their own breathing to match the patients to begin a state of relaxation. During a succession of therapist led positions, it is believed that the body's meridians (pathways of energy) are altered, allowing energy to be released, thereby returning proper energy flow to occur at a more natural position in the body. Transitioning between positions is as important as the positions themselves. WATSU is based on the smooth continual rhythmical flowing of positions. Jerky movements will disrupt the Relaxation State. The patient is passive during WATSU and reportedly experiences profound relaxation from coordinated breathing, water's warm temperature, and therapist lead positions supported by water's buoyancy. Flow of WATSU positions in water are similar to a contemporary therapy session in that there is a warm up, a series of stretches, and finally a cooling down. What ever one believes about eastern medicine's belief in meridians, WATSU positions are a form of PROM (Passive Range of Motion) and guided relaxation. Little is written in the therapeutic literature to support Dull's claims but, WATSU has been shown to be a reasonable warm-up in therapy for low back pain patients (Morris, 1993).

Halliwick Method

James Halliwick who was a fluid mechanics engineer developed the Halliwick Method in the 1930's. The method is based on water's inert properties and principals of human development (Martin, 1981). Over the years therapists incorporated activities, specific interventions, and refined hand placement for therapeutic outcomes while still utilizing the basic framework of the Halliwick Method (Morris, 1995). The Halliwick Method is taught in four phases, including: (1) "Mental adjustment", (initially adapting to the water), (2) "Balance Restoration", (utilizing postural muscles to initiate upright control in water), (3) "Inhibition", (utilizing postural muscles to maintain verticality in water), and (4) "Facilitation", (patient desired and controlled movements in water) (Cunningham, 1997). An example of phase four would be, movement in water from standing to supine floating dependent on movement at the hips with no help from arm movements. Extensor muscles are used, moving into supine floating, while flexor muscles are used when going back to standing. The therapist using manual facilitation at the hips can grade the amount of flexor/extensor muscle activity. The trunk balance necessary to accomplish this move is dependent on the first three Halliwick Method phases: mental adjustment, balance restoration, and inhibition. Physical therapeutic intervention here has included: AROM/AAROM at the hips, strengthening of trunk flexor and extensor musculature, and increased synergy of movement due to water's inert properties. Campion, (1997) has found that aquatic therapy using the Halliwick Method is beneficial to those with malfunctioning muscle synergies, such as the severely disabled and strongly supports its use.

Neurodevelopmental Treatment

Neurodevelopmental Treatment (NDT) in water is the process of facilitating normal muscle tone and movement by inhibiting abnormal tone and movement through specific swimming strokes (Harris, 1978). Harris, goes on to identify that the breast and elementary back strokes are good for use in children with cerebral palsy for two reasons: (1) the strokes do not facilitate abnormal postural reflex patterns and (2) promotes abduction, not hypertonus and adduction. Harris also reports that if the child is relaxed in water, head control skills in midline can be gained by inhibiting Asymmetrical Tonic Neck Reflexes (ATNR).

Task Type Training Approach

The Task Type Training Approach (TTTA) can best be described as a set of treatment principles for individuals in water. It is a task oriented approach with patients working in functional positions doing functional activities. Morris, (1994), puts forth TTTA's six general principles: "1. Work in the most shallow water tolerated." , "2. Practice functional activities as a whole.", "3. Systematically remove external stabilization provided for patients.", "4. Encourage stabilizing contractions in upright positions with movement of selected body segments.", "5. Encourage quick, reciprocal movement.", and finally "6. Encourage active movement problem solving.". Many of TTTA's treatment principals are closely related to occupational therapy principals. TTTA is a way for occupational therapists to substantiate their treatment time in an aquatic environment.

8. Contraindications to Aquatic Therapy practice

Safety precautions need to be taken before entering into the water with a patient. Some general considerations include: (a) is the patient afraid of water? (b) is the pool capable of safely accommodating persons with disabilities? (c) is the pool properly attended to and or supervised by someone other than the treating therapist? Adams, (1991, p.241), identifies some other general contraindications: "Infectious diseases in the active stage, i.e., a person has an elevated temperature, chronic ear infections, chronic sinusitis, allergies to chlorine, skin conditions such as eczema, open wounds such as draining decubitus ulcers (in a community pool setting), and severe cardiac conditions".

Although swimming is considered to be a part of aquatic therapy, there is a danger in untrained professionals prescribing swimming "therapy." Under water movement with or without adaptive equipment is a form of resistive strength training (Frey & Smidt, 1996). As rehabilitation specialists, Occupational therapists understand the possible dangers in exercise misuse. For example, over strengthening already abnormal muscle synergies can result in increased muscular deformities causing decreased function (Finnerty & Corbit, 1960). Another misperceived notion about water exercise is that one can become stronger faster. Joint protection is superior during water exercise, but not as effective for regaining large muscle group strength as land exercises (Tovin, Wolf, Greenfield, Crouse, & Woodfin, 1994).

Other concerns involve qualifications of practitioners (Campion, 1990; Elkington, 1971), specific instances of contraindications per a specific disease process (Gehlsen et.al., 1984; Oded, 1992), and program models of methodology (Dully, 1983). The general consensus reported in the literature is that aquatic therapy administered in a safe,

supervised environment by knowledgeable, competent professionals is appropriate for making therapeutic gains and generally improving the quality of life for individuals with disabilities.

9. Qualifications of Aquatic Therapy practitioners

The AOTA does not have guidelines for aquatic therapy in practice. AOTA does however publish a code of ethics that determines ethically correct actions and an expected level of professional behavior (Hansen, 1998). Specifically, Section 4.2 states "When generally recognized standards do not exist in emerging areas of practice, occupational therapy personnel must take responsible steps to ensure their own competence"(Hansen, 1998, p.2). Any person can do activities in a pool, but for an occupational therapist to treat patients and achieve therapeutic outcomes under occupational theories, a basic level of competence must be gained.

A multidisciplinary committee entitled the Aquatic Therapy and Rehab Institute (ATRI) has come together to compile and promote rules of conduct for aquatic therapy practitioners (Stancliff, 1996). The six main standards include: First, a knowledge base of human anatomy, physiology, and kinesiology. Second, a knowledge base of water's inert properties and how to use such properties for the rehabilitation of the patient. Third, a strong understanding of indications and contraindications of water use in therapy. Fourth, displaying and maintaining professional responsibility in the treatment process. Fifth, a knowledge base of all state and local bathing codes and regulations pertaining to pool use. Sixth, a knowledge base of all laws pertaining to rehabilitation and base competencies within the medical system (Stancliff, 1996).

10. Occupational theory in Aquatic Therapy practice

Swimming be it for exercise, leisure, or therapeutic purposes is a valid occupation. Swimming is usually engaged in a form of non-work, except in the rare cases of professional athletes. The inherit meaning and purpose for swimming differs for each individual. Swimming is not for everyone and should not be utilized in an aquatic therapy setting if the person-environment fit is not appropriate.

Investigation in the occupation of swimming as a useful means for therapeutic intervention is two case studies conducted by occupational therapists. Three occupational theories: Biomechanics, The Model of Human Occupation, and Occupational Science, will be presented to assess the benefits and validity of aquatic therapy.

A. Case Study One

Johnson (1988) describes a 62- year old man (Charlie) who has been diagnosed with amyotrophic lateral sclerosis (ALS). Before aquatic therapy began, problem areas were identified, such as: respiratory weakness, diminished upper and lower extremity muscle strength. Aquatic therapy was carried out for ten weeks (2 times a week, 45 minute sessions) with the expectation to increase strength, flexibility, and conditioning. Recreation and socialization were also expected to have positive results on Charlie in the aquatic environment. Charlie made magnificent gains during the ten weeks. He went from not being able to swim at all, to being able to swim 26 lengths of an Olympic-size pool using an adapted vest and using minimal assistance from the therapist. Johnson concluded that aquatic therapy for Charlie increased his endurance, strength, and energy level.

Charlie was able to enjoy a leisure activity while increasing his own sense of self-efficacy. Johnson concludes that aquatic therapy is a reasonable alternative for patients with ALS to maintain fitness and wellness while working on rehabilitation goals in a leisure setting.

1. Biomechanics Frame of Reference

The Biomechanics frame of reference has been defined as, " an approach applied to those patients who have lost range of motion, strength, or endurance due to illness or trauma that affects muscles, joints, skin, or other connective tissue" (Trombly, 1989). Charlie began this swim program to improve muscle strength, endurance, and overall respiratory capacity. He was able to achieve these goals with assistance from the therapist. An adapted life jacket was used to compensate for Charlie's spasiticity in order to use water's buoyancy effectively. Hands on facilitation helped Charlie's body move through the water fast enough for propulsion to occur. Muscular strength and endurance were built up by Charlie's motion against water's resistance. After ten weeks of aquatic therapy, Charlie achieved and exceed his Biomechanical goals.

2. Model of Human Occupation

Gary Kielhofner's (1980) theory of Human Occupation takes the form of a model titled, the Model of Human Occupation (MOHO). In MOHO, Kielhofner states that "providing opportunities for directed experiences in activities with the presence of adaptation is at the core of human occupation. Decreased occupational performance is a

threat to overall health and well-being." Kielhofner (1980) believes that volition, habituation, and performance are essential components for occupational task completion.

Kielhofner, (1992), defines the volitional subsystem of MOHO as "an interrelated set of energizing and symbolic components that together determine conscious choices for occupation". Volition drives occupational performance while successful completion of activities, in turn, enhances volition. The value placed on swimming by Charlie enhanced his desire to perform the activity. His successive participation not only resulted in identified biomechanical gains but also increased positive attributions towards the occupation of swimming. To swim laps for Charlie was a way to gain success and master an environment that previous to his disease process, held interest for him. Since Charlie was able to gain a mastery over swimming laps, it naturally gave him a personal feeling of success and a yearning to continue with swimming.

Kielhofner, (1992), defines the habituation subsystem as "A collection of images that trigger and guide the performance of routine patterns of behavior.". Charlie in attending aquatic therapy, was able to assume the leisure role of swimming, a experience associated with benefits. This swimming role gave Charlie the opportunity for activity success of completing pool laps. In the accomplishment of this feat, Charlie developed swimming and the components of swimming as habits. Kielhofner, (1992), states that habits are "Images that trigger routine performances in lesser spheres of everyday life". Turning swimming into a routine habit gave Charlie ease and satisfaction in completing his therapeutic goals. Swimming became a meaningful component of his daily activities thusly maintaining a valued occupation.

Kielhofner, (1992), states the performance subsystem to be "A collection of images and biological structures and processes organized into skills and used in the production of purposeful behavior.". All performance is skill based under this subsystem. For Charlie, performance in swimming took refinement of perceptual motor skills through therapist guidance. Charlie underwent a learning process in which he selected and interpreted sensory information that effected coordinated purposeful movement. The outcome translated into learned skills that allowed him to perform an adapted swimming technique.

3. Occupational Science

Occupational Science in an academic discipline studying humans as occupational beings (Clark, 1991). Occupational Science is a meta theory and, unless translated into a model form, cannot be used solely to analyze case studies. The faculty at the University of Southern California have devised an occupational science model titled: Model of Human Subsystems. This model is a heuristic to explain and organize knowledge about occupation (Clark, 1991). The subsystems include physical, biological, information processing, sociocultural, symbolic, and transcendental subsystems. The model indicates that all of these human subsystems are important precursors to a meaningful life. Adaptive skills learned in the water are discussed through each subsystem.

The physical subsystem is defined as " the physical and chemical processes required to sustain the other levels of the human system such as musculoskeletal system, the cardiovascular system, the nervous system, and other anatomical structures and physiological processes" (Primeau, 1993). Charlie showed an increase in his

musculoskeletal system as noted by an increase in upper and lower extremity strength. Charlie's cardiovascular system improved by the ability to swim multiple pool laps, with assistance. This was most likely due to Charlie's increased respiratory quotient from a more efficient oxygen uptake due to cardiovascular activity. Charlie's physical subsystem was strengthened due to the benefits of aquatic therapy.

The biological subsystem is defined as "living systems that directly relate to biological adaptation" (Clark, 1991). The biological subsystem focus is on those human processes that seem to have biological origins such as the innate drive for activity (Primeau, 1991). Since Charlie was placed in an environment where physical activity was possible (buoyancy support of water, adapted life vest, and hands on assistance from the therapist), his drive for activity took over and propelled him into task completion (swimming laps).

The information processing subsystem is defined as "cognitive structures and processes used in the organization of occupational behavior such as learning, memory, rule formation, and planning."(Clark, 1991). The occupation of swimming for Charlie took time and practice to complete. At the beginning of the ten weeks Charlie could not swim without maximum assistance from the therapist. Charlie had to learn compensatory movement strategies in the water. This took cognitive awareness, motor memory, and physical planning on Charlie's part of his own body in water. The Aquatic Therapist facilitated this process but the results are clear, Charlie's mind and body directed him to task completion by swimming multiple laps in a swimming pool.

The sociocultural subsystem is defined as "a person's perceptions of social and culture expectations for occupational behavior"(Clark, 1991, p.307). Charlie has

Amyotrophic Lateral Sclerosis (ALS), which is a physically debilitating disease process. Humans by nature are physical beings. It is within our society and culture to use our physical bodies for task completion in work, leisure, and self-care. As a result of ALS, Charlie remains dependent on others for completion of physically demanding tasks. The fact that Charlie can swim 26 laps after ten weeks of aquatic therapy gives him the ability for task completion utilizing his own physical body where he could not do before. Charlie's sociocultural subsystem is validated in that he can still perform a physical occupation.

The symbolic-evaluative subsystem is defined as "the social systems used in the personal assessment of the value of an occupation" (Clark, 1991). This subsystem focuses on language, communication, arts, science, value systems, and human emotion that affect positive mental health (Primeau, 1991). Upon completion of aquatic therapy, Charlie was noted to have more energy and held a more positive attitude towards activities of daily living. His general mood and participation in life's activities increased as reported by his wife and empirically noted by his therapist.

The transcendental subsystem is defined as "meaning attributed by the individual to his or her life experiences and the will that impels him or her through life." (Clark, 1991, p.300). Primeau, (1993), adds to the definition "The life satisfaction, quality of life, purpose, and meaning gained by the individual through engagement in occupation". In the case study, Charlie could have chosen any aquatic activity he wanted. Biomechanical goals could have been met in a non-aquatic environment, but he chose to swim laps because it had meaning for him. Charlie's will helped him to succeed in swimming multiple laps. Charlie took great joy and pride in the completion of swimming laps as an

occupation. This occupational success facilitated improvements in other psychosocial aspects of his life, proving that mastery of an occupation can increase general quality of life.

B. Case Study Two

Peganoff (1984), describes a 14-year old girl with spastic right hemiparesis who participated in aquatic therapy for 8 weeks (2 times a week for 45 minutes). Peganoff's focus was to incorporate swimming as a purposeful leisure activity while addressing rehabilitation goals. Some areas of needed improvement included: range of motion, functional coordinated use of the right upper extremity, bilateral integration, balance and equilibrium skills, and self image. At the conclusion of eight weeks, the girl showed an increase in shoulder range of motion along with increased spontaneous functional use of the right upper extremity during activities of daily living. Bilateral integration was reported to have increased as well as an improved sense of awareness of her right side during treatment activities. Balance and equilibrium improved during gait. Peganoff states however that the area of most improvement was an increased self esteem exemplified by a decreased frustration during movements in the water. This 14-year old girl (who had to be coaxed out of the locker room on her first day), went from not wanting to be seen in a bathing suit by anyone to actively and independently carrying on swimming activities with family and peers outside of aquatic therapy time.

1. Biomechanics Frame of Reference

Under the Biomechanical frame of reference, the 14-year old girl can note many therapeutic gains. At the conclusion of eight weeks of aquatic therapy, the girl showed a 15 degree increase in shoulder flexion, and a 10 degree increase in shoulder abduction of the right upper extremity actively and passively. Bilateral use of her arms increased during activities as well as greater instances of bringing her right arm to midline. Improvements in balance and gross coordination were noted as exemplified in an improvement of the swing phase of the upper extremity during gait. Equilibrium was still noted to be inconsistent but improved from the initial assessment.

2. Model of Human Occupation

Next we will analyze Peganoff's case study using Kielhofner's Model of Human Occupation (MOHO) and its three subsystems of: volition, habituation, and performance. The 14-year old girl showed volition for aquatic therapy in that she started to ascribe value to swimming and actively began to participate and plan aquatic therapy sessions using different pieces of pool equipment. Body image continued to be a concern for the girl but due to an increase in personal causation, she allowed family and friends to observe her in the pool, where she hadn't in the past. Kielhofner (1992), defines personal causation as "an individual's beliefs about his or her effectiveness. These beliefs include the degree to which an individual feels in control, the identification of personal skills, and the sense that those skills are efficacious for one's life situation".

The 14-year old girl habituated to aquatic therapy as swimming became a new role in her life. Because of the positive effects of a swimming role, she acquired new adaptive

behaviors during activities. For instance, she gained increased awareness of her right side during functional activities as noted by spontaneous use of her right upper extremity during activities of daily living. Additionally, she pursued her swimming role outside of aquatic therapy time with family and friends, providing for a new set of positive leisure behaviors.

Aquatic therapy provided new performance abilities for the 14-year old girl. She carried over an increase in automatic movements for on land activities. Through her increased ability to execute motor planning skills, a decreased overall level of frustration was noted during movements. The girl became so proficient in learning swimming skill components that she mastered the front crawl, backstroke, and sidestroke all at a beginners level.

3. Occupational Science

Finally, the paper will analyze Peaganoff's case study using the Model of Human Subsystems (an Occupational Science Model). The subsystems include: physical, biological, information processing, sociocultural, symbolic-evaluative, and transcendental. The 14-year old girl's physical subsystem improved in that her musculoskeletal capacity for shoulder range of motion quantifiably increased. The biological subsystem was satisfied in that the swimming activity became a goal for her to be competent in thus driving the girl towards activity completion. The information processing subsystem improved in that the girl took an active part in planning swimming activities. The girl's sociocultural subsystem benefited from the fact that she was participating in an activity that she previously had not done with family and friends.

Finally, the transcendental subsystem blossomed in that the girl now was participating in activities outside of swimming in more productive ways. She carried over meaningful work in activities from swimming, which eventually will benefit other facets of this girl's life.

C. Occupational Theory Conclusion

This paper has reviewed two published case studies of Occupational Therapy intervention using aquatic therapy as the primary method of treatment. Unfortunately, a comprehensive review of the literature has found a limited number of published reports of Occupational Therapists using aquatic therapy in treatment. More research in this area needs to occur for the validation of Occupational Therapy's role in aquatic therapy. However, the two case studies analyzed both showed multiple positive therapeutic outcomes under Biomechanical, Occupational Science, And MOHO frame of references.

11. Studies in Aquatic Therapy

The types of research will vary depending upon the goals for treatment. The use of quantitative and qualitative research continues to be omnipresent in scholarly work. Clark, (1991), states "quantitative multivariate-causal modeling analyses may be appropriate for a wide spectrum of research problems in occupational science (p.1011)", However she went on to say:

> Existing methodologies that allow detailed description and analysis not only of the overt manifestations of occupation but also the phenomenological experience of the doer while engaging in occupation

> become those most likely to prevail in occupational science. The methods used, however, will depend on the kinds of research questions asked (p1012).

Such a statement refers to the fact that, within occupational science, analysis outcomes are multidimensional. Because of this, qualitative type design studies (such as case studies) appear to be more of a descriptive match for the outcomes desired in occupational science.

Kielhofner, (1992, p.156), stated that, "both traditional qualitative and quantitative research designs will have a place in occupational therapy research," but even Kielhofner,(1992, p.234) admitted that, "a researcher may want to know what a particular activity means to an individual, or how persons interpret the impact of disability on their daily occupational routines. For these questions, qualitative methods are best suited.". Where a Biomechanics frame of reference lends itself to quantitative research because of empirical results found, The Model of Human Occupation and Occupational Science frame of references supports a qualitative research method due to its multidimensional nature of inquiries.

The two qualitative research design case studies produced by occupational therapists were analyzed in this paper using occupational theories. The two case studies are listed in Table One (P.51). Johnson, (1988), studied an ALS patient who was involved in a therapeutic swim program. Johnson described improvements in functional abilities, quality of life, and number of laps swam. Peganoff, (1984), studied a Cerebral Palsied adolescent who also was involved in a therapeutic swim program. Peganoff measured improvements in range of motion and also described increases in functional tasks.

No quantitative research design studies about aquatic therapy have been published by occupational therapists. Table Two (p.52) is a listing of controlled studies that can provide a template for future occupational therapists that want to contribute to the literature base of aquatic therapy. Table Two authors' used different methods to collect therapeutic information on aquatic therapy. Benedict, (1993), compared three groups of older adults ages 55 to 85 who were (1) members of a swimming program, (2) non-swimmers who attend a senior citizens center, or (3) neither attended a senior citizen center nor was a swimmer. Physical and psychosocial measures were used to determine levels of health.

Burke, (1991), compared the effects of hydrotherapy on pressure ulcer healing. Burke randomly assigned 18 patients to a conservative treatment group and 24 to the conservative treatment plus whirlpool group. Circumference measurements of ulcer sites were used to determine the effectiveness of the two forms of treatment.

Meeker, (1998), studied the relationship between whirlpool use and postoperative surgical pain. Meeker's sample consisted of two groups. Group one involved thirty-two subjects who did not use a whirlpool postoperatively, and group two involved thirty-one subjects who did. Four dependent variables were used to determine pain levels postoperatively across the two groups.

Melton-Rogers, (1996), studied cardiorespiratory responses of patients with rheumatoid arthritis. Melton-Rogers took eight patients ages between thirty and forty and ran them through two separate cardiorespiratory tests. Measurements were taken while

the same patients were riding a bicycle in one test and running in water on the second test. Data from the two tests was analyzed using a paired *t* test with significance set at the .05 level.

Finally, Tovin, (1994), compared the effectiveness of water exercise on patients with intra-articular anterior cruciate ligament reconstructions. Twenty subjects were randomly assigned to either a land or water exercise group. Measurements were taken to determine the level of rehabilitation that had occurred when comparing the data from the two groups.

12. Conclusion

Occupational Therapists using aquatic therapy should be practicing at a level of competence related to the therapeutic goals to be achieved in a water environment. Therefore, aquatic therapy is not to be used by every Occupational Therapist. It is not a form of treatment typically taught in training programs. A comfort level working in water alongside a patient is a basic necessity. Further more, an understanding of, and experience in, the physical properties of water, adaptations for individual patients, and facilitation techniques to improve therapeutic goals are all crucial to the successful use of aquatic therapy as an intervention strategy for Occupational Therapists.

This paper has reviewed the historic uses of water and its growth into a modern form of therapy. Water's physiological effect on the body itself contributes therapeutic properties not found with therapy done on land. Aquatic therapy can be used as a specific treatment modality treating isolated areas of the body with no gross movements necessary on the patients' behalf or it can be implemented as a comprehensive intervention utilizing

specific treatment approaches completing specific treatment goals. The treatment approaches and rehabilitation techniques used in aquatic therapy are only limited by the knowledge and skill of the practicing occupational therapist. Formal qualifications of the occupational aquatic therapist are limited to general practice requirements of our code of ethics. Practice qualifications including: physical principals of water, water's physiological effect on the human body, and contraindications of water use are all important factors to aquatic therapy's effectiveness. Occupational theories have a productive and therapeutic role within aquatic therapy. More research applying occupational theory to aquatic therapy will further justify its use by occupational therapists.

The aquatic therapy environment is a wonderful place to achieve therapeutic goals. There is room in occupational therapy for aquatic therapy to grow and flourish. Occupational therapists must increase practice and research in the water environment for the continuing acceptance of aquatic therapy.

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Table One:

Author	Year	People Studied	Number of Subjects	Measures	Outcomes
Johnson	1988	ALS patient	1	Descriptive analysis of functional abilities, quality of life and # of laps swam	26 laps of a pool swam with assistance, a general increase in functional abilities and an overall improvement in quality of life
Peganoff	1984	Cerebral Palsied Adolesc-ent	1	ROM, clinical observations, functional task observations	Increases in ROM, ability to perform functional tasks, and therapists noted increased self-esteem

Table Two:

Author	Year	People Studied	Number of Subjects	Measures	Outcomes
Benedict	1993	Older Adults mean ages 55-85	Aquatic Therapy (AT) group: 73 Control group: 73	x-ray of the femoral neck; morale & depression scales (Morale Scale & the Center for Epidemiologic Studies Depression Scale)	AT group: increased bone density, morale & decreased depression
Burke	1991	Pressure Ulcer Patients	AT: 24 Control: 18	Measurement of ulcer site	AT group: Larger decreases in circumference of ulcer sites
Meeker	1998	Postoperat-ive pain & wound healing patients	AT: 31 Control: 32	McGill-Melzack Pain Questionnaire, Pain Rating Scale, Wound Assessment Inventory	AT group: decreased wound inflammation and observable pain behaviors compared to control group
Melton-Rogers	1996	Rheumat-oid Arthritis Patients	AT: 8 Land: 8	Graded maximal exercise test of: Vo2, HR, RPE, Ve, Vt	The water environment allowed for improvements in the exercise test in a safe environment.
Tovin	1994	Intra-articular anterior cruciate ligament reconstru-ction patients	AT: 10 Control: 10	Thigh girth, joint effusion, knee PROM, Lysholm scores, and Isokinetic/ Isometric measurements of thigh muscle	AT group: Higher Lysholm scale scores, no differences in knee PROM, thigh girth, or thigh muscle performance & Less joint effusion