International Journal of Aquatic Research and Education

Volume 4 | Number 4 Article 8

11-1-2010

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Recommended Citation
Chetlin, Robert D.; Wheeler, Steven; Crane, Shelby; Morris, Cheryl W.; and Sherlock, Lori A. (2010) "The Effects of Combined Aquatic and Occupational Therapy in Stroke Patients: A Retrospective Study," *International Journal of Aquatic Research and Education*: Vol. 4 : No. 4 , Article 8.
DOI: https://doi.org/10.25035/ijare.04.04.08
Available at: https://scholarworks.bgsu.edu/ijare/vol4/iss4/8

International Journal of Aquatic Research and Education, 2010, 4, 422-431

The Effects of Combined Aquatic and Occupational Therapy in Stroke Patients: A Retrospective Study

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The purpose of this retrospective pilot study was to determine if aquatic therapy (AT) intervention concurrent with occupational therapy (OT) yielded greater functional gains in stroke patients than OT treatment alone. A retrospective chart review was conducted evaluating subjective data from an inpatient rehabilitation hospital in Morgantown, WV. Thirty-nine stroke survivor charts were examined. Patients who received OT with or without concurrent aquatic therapy were included. Differences were examined in the Functional Independence Measure (FIM) scores in patients who received (a) AT plus conventional OT or (b) conventional OT alone. Discharge bed/chair transfer ($p = 0.009$) and locomotion ($p = 0.01$) scores were higher for people who received OT and AT versus patients only receiving OT. Linear regression indicated AT treatment predicted discharge bed/chair transfer FIM score ($p = 0.02$), discharge locomotion (walking) FIM score ($p = 0.002$), discharge stairs FIM score ($p = 0.04$), and change in bed/chair transfer FIM score ($p = 0.02$). These findings indicate that AT, combined with OT, may predict success on specific FIM outcomes (e.g., bed/chair transfer FIM score, locomotion [walking] FIM score) in stroke patients.

Cerebrovascular Accident (CVA)

Cerebrovascular accidents (CVA) or strokes are the leading cause of mortality in the world. The occurrence rate of stroke in the United States is at least 730,000 cases per year (Lloyd-Jones et al., 2009), while approximately four million stroke survivors must be cared for annually (National Institute of Neurological Disorders and Stroke, 2005). Total cost to treat and care for stroke patients is estimated at about 40 billion dollars per year (Lloyd-Jones et al., 2009). Depending on the level or severity of the CVA, some motor and sensory deficits may include loss of consciousness, cognitive deficits, speech dysfunction, limb weakness, hemiplegia, vertigo (dizziness), diplopia (double vision), lower cranial dysfunction, gaze deviation, ataxia (lack of coordination), hemianopia (loss of vision in one half of visual field), and

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aphasia (language disturbance; American Health Assistance Foundation, 2006; American Stroke Association, 2004; Duncan et al., 2005; Gillen, 2001; Leonard, Miller, Griffiths, McClatchie, & Wherry, 1998; National Stroke Association, 2006; Skidmore & Katzan, 2002). Secondary to the described systemic effects, stroke may impair performance of activities of daily living (ADLs) or basic self-care tasks, instrumental activities of daily living (IADLs), or activities that permit independent living, leisure activities, vocational activities, and participation in other meaningful performance areas (American Health Assistance Foundation, 2006; American Stroke Association, 2004; Duncan et al., 2005; Gillen, 2001; Leonard et al., 1998; National Stroke Association, 2006; Skidmore & Katzan, 2002). Numerous complex cognitive, psychological and sensorimotor performance components necessary to engage in desired activities or occupations may all be affected (American Health Assistance Foundation, 2006; American Stroke Association, 2004; Duncan et al., 2005; Gillen, 2001; Leonard et al., 1998; National Stroke Association, 2006; Skidmore & Katzan, 2002). Experienced deficits may include, but are not limited to, decreased balance, unilateral neglect (attention deficit to one side of the body), motor apraxia (loss of ability to carry out desired, planned movements), decreased muscle strength, decreased range of motion, abnormal sensation, and hemiparesis (weakness of one side of the body; American Health Assistance Foundation, 2006; American Stroke Association, 2004; Duncan et al., 2005; Gillen, 2001; National Stroke Association, 2006; Skidmore & Katzan, 2002). These deficits, if left untreated, may restrict participation in important life activities (e.g., ADLs, IADLs) and could lead to the development of comorbidities (Pedersen, Jorgensen, Nakayama, Raaschou, & Olsen, 1996).

Due to the diversity of the population who suffer CVAs, treatment strategies and clinical interventions may vary between medical or therapeutic disciplines, professional practices, and facilities (Lewis, 2003; Pedretti & Early, 2001a, 2001b). For stroke survivors, effective and efficient treatment is important to have the greatest chance of a highly functional recovery. The inclusion of physical therapy (PT), occupational therapy (OT), and aquatic therapy (AT) in the treatment of cerebrovascular accident allows for diversity, effectiveness, and movement repetition. Movement into neglected space, simultaneous movement of the patient's arms, practicing movements related to specific goals, and movement repetition may contribute to expedited recovery of movement in CVA patients (Ma & Trombly, 2002; Richards et al., 2005; Wolpaw, 1994). Kinesthetic awareness of one's environment, upper extremity control, and competent motor performance of specific movements are all important performance components contributing to successful completion of ADLs. While restoration of such tasks may prove difficult with a client in a traditional clinical setting, especially if there are limitations such as pain, spasticity, or weakness, treatment in an aquatic setting may facilitate desired exercise effects (Fischer et al., 2001).

AT utilizes a treatment approach that may help stroke patients improve certain rehabilitative outcomes. Improvement in physical, cognitive, psychosocial, and leisure progression have all been attributed to participation in aquatic exercise (Becker, 1995; Binkley & Schroyer, 2002; Logan, Gladman, Drummond, & Radford, 2003; Manners & Scifers, 2003; Ruoti, Troup, & Berger, 1994; Sorensen & Leuken, 1999; Suomi & Collier, 2003; Weiss & Jamieson, 1987). The use of the aquatic environment for therapy may potentially improve overall health in stroke patients through respiratory training, buoyancy-assisted movements, reduction of edema, and movement in a supportive environment that allows increased independence (Driver, Lox, O'Connor, & Rees, 2003). Exercising in water may also improve overall health in stroke patients. In other research conducted by Driver, O'Connor, Lox, and Rees (2004), these authors stated that external pressure on the lungs owing to the density of the water environment forces deeper respiration, thus improving ventilation. This action in turn may increase vital capacity and cardiorespiratory efficiency. Such positive adaptations to cardiorespiratory mechanics may also significantly decrease the risk of stroke recurrence. Improved vital capacity and cardiorespiratory performance may contribute to increased muscular strength and endurance as a result of increased supply of oxygen and nutrients to working muscles, thereby reducing perceived exertion. Collectively, these physical and physiological improvements could contribute to perceiving work to be submaximal, thus resulting in the feeling that repeated performance of functional activities is "easier." By exercising in the water, people who have suffered a stroke may increase their muscle strength, increase their range of motion, enhance otherwise difficult kinematic patterns such as gait, and attempt different movements with less fear of falling or weakness (Booth, 2004; Douris et al., 2003; Noh, Lim, Shin, & Palk, 2008). Water exercises may specifically improve a patient's ability to effectively perform ADLs and IADLs by augmenting strength, endurance, and overall physical condition. Exercise in the aquatic environment has been shown to increase endurance, strength, range-of-motion, and decrease blood pressure and risks for other health problems (Geytenbeek, 2002; Prins, 2009).

It is the duty of clinical scientist to identify treatment efficacy to aid those allied health professionals responsible for treatment implementation, thus assuring the most appropriate plan to best assist the hemorrhagic (ruptured blood vessel) or ischemic (blocked blood vessel) stroke survivor during his or her recovery process. Therefore, the purpose of this study was to determine if the combination of AT and OT provides additional functional benefit for stroke patients, as established by chart review versus land-based OT alone. We hypothesized that AT concurrent with OT treatment, including conventional strength and endurance training, was associated with improved ADL performance in elderly adults who have had a hemorrhagic or ischemic stroke versus OT treatment alone.

Method

Participants

Participants were recruited through records maintained at a rehabilitation hospital in Morgantown, West Virginia. Eligible cases ($n = 39$) included those subjects who were 50 years and older and who had received treatment for ischemic or hemorrhagic stroke over a designated two-year period.

Two groups were designated for this retrospective study: patients who had previously participated in AT in addition to a conventional stroke treatment program and patients who did not receive AT as part of their prior OT stroke rehabilitation program.

Aquatic Therapy Sessions

The exact training variables (i.e., mode, duration, frequency, volume, intensity, progression) were not available through retrospective chart review for each individual patient. It was generally determined that aquatic therapy sessions consisted of 30–60 min (2–4 units) of aquatic therapy five days per week. The sessions contained exercises relevant to each patient's particular stroke-related deficiencies. These included gait training, balance exercises, coordination enhancing exercises, as well as strength, flexibility and endurance training. An example program might have included walking in chest depth water focusing on both technique and endurance, double leg stance with resistance or turbulence, maneuvering through an obstacle course to focus on coordination, hip and knee ROM exercises with ankle paddles (surface area equipment), and Bad Ragaz to enhance both flexibility and ROM. One therapist worked with a single patient during the exercise session, providing supervision and instruction on performance and goals.

Data Collection

Approval for patient record review was obtained from the Institutional Review Board for the Protection of Human Subjects (IRB) at West Virginia University. Retrospective data were compiled from the charts of those subjects selected for analysis. Data obtained from subject files were categorized as follows: hemisphere of patient stroke, type of lesion, site of lesion, length of stay in rehabilitation hospital, and FIM scores for admission and discharge from the facility. These FIM variables included feeding, grooming, bathing, upper body dressing, lower body dressing, toileting, toilet transfer, tub or shower transfer, bed/chair/wheelchair transfer, locomotion-walking/wheelchair, and stairs. Demographic data including height, weight, body mass index (BMI), age, and gender were also recorded.

Data Analysis

A 2 × 2 factorial analysis of variance (ANOVA) with repeated measures was used to examine admission versus discharge FIM scores and OT versus AT-OT treatment groups. Where statistical significance was found, Cohen's *d* was calculated to determine effect size. The Pearson product moment correlation examined the relationships among patient demographic, FIM variables, and length of stay in the facility. Bivariate correlation (Kendall's tau) was used to examine the relationship between gender and treatment regimen and the listed variables. Linear regression was used to predict the effect of AT on length of stay at the rehabilitation facility and FIM outcomes. Statistical analyses were performed using SPSS, version 11.0.

Results

Thirty-nine charts were found and reviewed for potential inclusion in this retrospective study. Two participants were removed from the data analysis due to the length of time that had passed since their stroke occurred. Descriptive data for all patients are found in Table 1. The patients were predominantly male ($n = 27$) and patients' average age was 67.0 years old. Length of stay ranged from eight days

Table 1 Subject Demographics (Mean ± *SD*)

	All Subjects (*n* = 37)	Men (*n* = 27)	Women (*n* = 10)	Aquatic Therapy (*n* = 24)	No Aquatic Therapy (*n* = 13)
Age (years)	67.0 ± 10.7	66.8 ± 9.9	67.6 ± 13.1	63.8 ± 10.0	72.9 ± 9.7*
Height (inches)	67.9 ± 3.9	69.7 ± 2.2†	62.3 ± 1.8	67.8 ± 4.2	68.0 ± 3.1
Weight (pounds)	194.1 ± 50.6	200.0 ± 42.3	178.3 ± 68.5	207.5 ± 46.9*	169.3 ± 49.4
Body Mass Index (BMI)	29.9 ± 8.2	28.9 ± 5.9	32.8 ± 13.0	31.9 ± 7.9*	25.9 ± 7.5
Length of stay (days)	27.4 ± 12.7	24.3 ± 11.4	35.7 ± 12.7*	29.0 ± 11.7	24.3 ± 14.4

* $p < 0.05$, † $p < 0.001$

to 58 days, with a mean of 27.4 days. Ischemic strokes were most common in the patients group (n = 27) with three patients surviving hemorrhagic strokes and no data available from the seven remaining patients. Right hemisphere strokes were most prevalent in the patient group (n = 20) with 13 patients incurring left side strokes, three patients with no data available, and one patient with damage to both hemispheres.

Female participants had a longer length of stay at the facility than the male participants (35.7 ± 12.7 days vs. 24.3 ± 11.4 days, $p = 0.01$). The average age of participants enrolled in AT services was 9.1 years younger than those individuals not referred for AT services (63.8 ± 10.0 years old vs.72.9 ± 9.7 years old, $p = 0.01$). The average weight of participants was 194.1 pounds, with a mean BMI of 29.9. Patients who were enrolled in AT services had significantly higher weight ($p = 0.03$) and BMI values ($p = 0.03$) compared with patients not receiving AT.

There were no statistical differences in the total admission or discharge FIM scores between those patients who received AT and those who did not (Tables 2 & 3). There were also no statistical differences in the admission scores for any one FIM category between those patients enrolled in AT and those who were not. Examination of FIM scores upon discharge showed that subsections for bed-to-chair transfer ($p = 0.009$) and locomotion ($p = 0.011$) were significantly higher for patients enrolled in AT. The calculated effect size (Cohen's d) for discharge bed-to-chair transfer FIM score was moderate (d = 0.6, $r = .3$), while discharge locomotion FIM score effect size was large (d = 0.9, $r = .4$).

Bivariate correlation (Kendall's tau) revealed a significant positive correlation between gender and increased length of stay at the facility, indicating that women experienced longer stays versus men ($r = 0.34$, $p = 0.02$). Pearson product moment correlations determined that higher BMI was found to be positively correlated ($r = 0.37$, $p = 0.03$) with a longer length of stay at the facility. Scores on the toileting section of the FIM at discharge were inversely correlated with length of stay ($r = -0.36$, $p = 0.03$). FIM scores in the locomotion ($r = 0.50$, $p < .01$) and

Table 2 FIM Score Means at Admission (± *SD*)

Admission FIM Scores	No Aquatic Therapy (n = 13)	Aquatic Therapy (n = 24)
Feeding	4.1 ± 1.1	4.3 ± 0.64
Grooming	3.4 ± 1.4	3.5 ± 1.1
Bathing	1.9 ± 1.3	2.1 ± 1.0
Upper Body Dressing	2.8 ± 1.5	2.8 ± 1.4
Lower Body Dressing	1.9 ± 1.1	2.1 ± 1.1
Toileting	2.2 ± 1.1	2.3 ± 1.1
Toilet Transfer	2.5 ± 1.2	2.8 ± 1.1
Shower/Tub Transfer	0.85 ± 1.1	0.54 ± 1.0
Bed/Chair Transfer	2.3 ± 1.1	2.3 ± 1.0
Locomotion (walking)	1.2 ± 0.44	1.7 ± 1.2
Stairs	0.46 ± 0.88	0.79 ± 1.1
Total	23.5 ± 2.7	25.3 ± 1.5

Table 3 FIM Score Means at Discharge (± *SD*): Aquatic Therapy vs. No Aquatic Therapy

Discharge FIM Scores	No Aquatic Therapy (n = 13)	Aquatic Therapy (n = 24)
Feeding	5.3 ± 1.1	5.5 ± 1.0
Grooming	5.1 ± 1.4	5.1 ± 1.3
Bathing	3.9 ± 1.4	4.2 ± 1.3
Upper Body Dressing	4.7 ± 1.4	4.9 ± 1.8
Lower Body Dressing	4.2 ± 1.7	4.4 ± 1.8
Toileting	4.5 ± 1.9	4.7 ± 2.0
Toilet Transfer	4.4 ± 1.4	4.7 ± 1.8
Shower/Tub Transfer	3.8 ± 1.2	3.8 ± 1.5
Bed/Chair Transfer	4.9 ± 1.2	5.7 ± 0.7*
Locomotion (walking)	4.1 ± 1.6	5.4 ± 0.8**
Stairs	3.7 ± 1.9	4.8 ± 1.3
Total	48.4 ± 13.8	53.1 ± 12.3
Total Change in Scores	24.9 ± 9.1	27.8 ± 12.0

* $p = 0.009$; ** $p = 0.011$

bed-to-chair transfer ($r = 0.38$, $p = 0.02$) sections were positively correlated with enrollment in AT.

Linear regression did not predict length of stay in patients who had AT used as part of their treatment. Use of AT in treatment for these patients did predict discharge bed/chair transfer FIM scores ($p = 0.02$), discharge locomotion (walking) FIM scores ($p = 0.002$), discharge stairs FIM scores ($p = 0.04$), and change in bed/chair transfer FIM scores ($p = 0.02$).

Discussion

The most important finding from this retrospective pilot study is that combined AT and OT improved some lower extremity dependent discharge FIM scores in stroke patients. In addition, the use of AT predicted a beneficial change in these FIM scores though length of stay within the rehabilitation setting was not affected. These results, therefore, support the hypothesis that AT, combined with OT, may improve functional outcomes in those patients who have experienced a stroke. The current research demonstrated that AT may help those who have had a stroke to increase independence with functional ambulation and lower extremity-based ADL performance. We found that discharge bed/chair transfer and locomotion scores were higher for people who received AT versus those patients who did not. This significant finding supports the plausibility of poststroke independence for patients that have participated in AT along with conventional rehabilitation. The ability of the patients to perform ADLs and IADLs subsequent to a stroke is imperative for independent living and competent daily function in home, work, or leisure activities. This research suggests that AT may provide a novel mode of therapeutic treatment to augment traditional poststroke interventions designed to restore, or partially restore, functional independence in these patients.

The study results may be due to the water environment permitting strength training of the lower extremity in a gravity-attenuated environment, thus reducing a fear of falling in these patients. The literature indicates both that lower extremity strength is an important determinant of balance and fall-related self-efficacy in stroke survivors (Belgen, Beninato, Sullivan, & Narielwalla, 2006) and that the aquatic environment can produce significant improvements in balance scores (Noh, Lim, Shin, & Palk, 2008). The discharge FIM scores that were significantly higher in the AT group all primarily involved use of the lower body (e.g., transferring from a bed or chair, walking). This finding provided supporting evidence that lower extremity trainability in the aquatic environment may assist in performance of desirable ADLs needed for the patient's successful discharge. These increases in performance ability may also have been due to attenuated fear and occurrence of falling in these stroke patients (Arnold, Busch, Schachter, Harrison, & Olszynski, 2008; Booth, 2004; Douris et al., 2003; Means, Rodell, O'Sullivan, & Cranford, 1996; Noh et al., 2008; Shumway-Cook, Gruber, Baldwin, & Liao, 1997; Simmons, & Hansen, 1996). Stroke patients may be reluctant to train the lower body in a gravity-dominated environment, owing to a lack of strength, fear of falling, or both. This contention appears to be supported by Lin, Davey, and Cochrane (2004), who found that a 12-month community-based water exercise strength-training program significantly improved functional ambulation and ROM measures versus those who did not receive AT in 66 older adults with osteoarthritis of the lower limb. Other researchers have concluded that regular strength training for stroke patients should be included in rehabilitative interventions to improve lower extremity-based performance (Belgen, Beninato, Sullivan, & Narielwalla, 2006).

Another explanation for the improved discharge FIM scores may involve muscle recruitment required for specific types of activities. A simple activity analysis may indicate why these scores were significantly higher at discharge, while scores like dressing, toileting, and feeding were unaffected by the addition of AT treatment. Transfers and locomotion primarily involve gross motor movements of the body, whereas other FIM items rely predominantly upon fine motor coordination. Despite the variations in muscle recruitment and contraction that occur due to the buoyancy-dominated aquatic environment, gross motor activities and exercises performed in the water promote increases in patients' muscle strength. Therefore, it may be reasonable to presume that AT treatment had a greater effect on gross motor skills, especially those of the lower extremity, than on fine motor skills associated with upper extremity FIM scores.

The present research demonstrated that combined AT and traditional rehabilitative interventions, may help patients improve specific functional abilities. Other investigations appear to support our observations (Eversden, Maggs, Nightingale, & Jobanputra, 2007). Our research has shown that AT, in conjunction with OT, may prove beneficial in improving lower extremity function (e.g., transfers, walking) in stroke patients beyond traditional OT intervention alone. Use of the lower extremity in many ADLs is critical for the maintenance of functional independence.

Although we have introduced novel information, this study did have some limitations. Primarily, the retrospective convenience sample of the current pilot study did not adequately represent the entire population of adults who have had a stroke. Those individuals who had combined AT-OT treatment were significantly younger in age and had higher BMIs than did the OT-only patients. The extent to which these demographic variables influence the effectiveness of AT or combined AT-OT should be further investigated. In addition, the retrospective pilot investigation did not permit the level of control normally associated with randomized clinical trials.

Despite some acknowledged weaknesses, this retrospective study revealed that AT, combined with traditional OT, was an effective treatment that improved lower body emphasized ADL function in recovering stroke patients. The use of AT may also predict effectiveness in some lower body discharge FIM scores. Future research should include a larger, more diverse participant population enrolled in randomized clinical trials, to possibly detect additional differences in performance and discharge scores not observed in the retrospective pilot study currently reported.

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