NORTHERN ILLINOIS UNIVERSITY

The Effects of Land and Aquatic Based Physical Therapy for Children with Cerebral Palsy

A Thesis Submitted to the

University Honors Program

In Partial Fulfillment of the

Requirements of the Baccalaureate Degree

With Upper Division Honors

Department Of

Health and Human Sciences

By

Rachel Wurster

DeKalb, Illinois

May 2012

Abstract

I have set out to research various aspects of physical therapy and how it affects children with cerebral palsy. I wanted to find how land-based physical therapy and aquatic-based physical therapy effects the outcomes of children with cerebral palsy and if there is a difference between the two therapies. I have found many studies showing improvements in posture, balance, gait, muscle strength, and endurance. Constraint induced therapy is shown to improvements in motor skill in children with hemiparesis and promoted an increase in movement on the affected side of the body. It is also shown that muscle strength can be improved through the use of isokinetic, isometric, isotonic, and a combination of weight machines and isotonic exercises. Strength training also provides benefits for children with spastic cerebral palsy. Hippotherapy is a great way for children to improve their posture, balance, relaxation, and reduce high muscle tone. Water therapy is also used to modify aerobic exercise and strengthening activities because of its resistive forces of buoyancy and viscous drag. Aquatic therapy also helps with children who have unstable joints. In researching the effects of land and aquatic based physical therapy I have found that there is substantially less information found for aquatic therapy compared to land based therapy. In the little information I have found on aquatic therapy it is shown to be very useful when used along with land based therapy. I believe that for best results aquatic therapy should be used along with land therapy in order to build strength in the pool so that land exercises are easier.

Cerebral Palsy

According to the Center for Disease Control and Protection (CDC, 2011) cerebral palsy is the most common motor disability in childhood and has an average prevalence of 1 in 303 children. Cerebral Palsy "is a general term for a group of disorders that affect the control of movement and posture" (University of Iowa, 2005). Cerebral Palsy occurs when the part of the brain that is in charge of voluntary movement is damaged. Damage to this part of the brain can occur before, during, or a few months after the baby is born. According to the University of Iowa (2005) "some causes of congenital cerebral palsy can be an infection during pregnancy (like German measles in the mother), jaundice in the infant, Rh incompatibility of the blood, and severe oxygen shortage in the brain or trauma to the head during labor and delivery." Jaundice is most commonly found in newborns and is a yellow pigmentation of the skin or whites of the eyes. The yellow pigment is caused by a byproduct of old red blood cells which is called bilirubin. Rh incompatibility most likely will not be a problem if it is a mother's first pregnancy because the fetus' blood will not enter the mother's circulatory system during pregnancy unless there is some sort of abnormality. Although during pregnancy it is not normal for the fetus' blood to normally enter the mother's circulatory system, it is possible for the mother's and baby's blood to mix together during delivery. "If this happens, the mother's body recognizes the Rh protein as a foreign substance and can begin producing antibodies (protein molecules in the immune system that recognize and later work to destroy foreign substances) against the Rh proteins introduced into her blood" (Rh Incompatibility, 2011). Cerebral palsy can also arise from brain infections or head injuries right after birth or within the first few years. The Cerebral Palsy Alliance states that males have a greater risk of having the disorder than female. There is also a major correlation between premature babies and cerebral palsy (CP). Although cerebral

palsy is chronic, the disease does not progress as the children grow and continue to develop into adulthood.

Three types of cerebral palsy can occur; spastic, kyskinetic, or ataxic. Within the spastic type of cerebral palsy sub categories including hemiplegia, diplegia, and quadriplegia can occur. Spastic hemiplegia occurs when cerebral palsy only affects the arm, hand, or leg on one side of the child's body which will then make the side affected appear shorter and thinner. Spastic hemiplegia generally causes children to "walk later and on tip-toe because of tight heel tendons" (CDC, 2011). In spastic diplegia cerebral palsy muscle stiffness occurs more so in the legs than the arms and face. Hyperactive tendons may occur and toes point up. "Tightness in certain leg muscles makes the legs move like arms of a scissor" (CDC, 2011). The most severe form of cerebral palsy is spastic quadriplegia in which moderate to severe mental retardation is associated. A child with moderate mental retardation has an IQ level of 35-40 or 50-55 and can benefit from vocational training. They can acquire communication skills at an early age and "can also benefit from training in social and occupational skills but are unlikely to progress beyond the second grade level in academic subjects" (American Psychiatric Association, 2000). A child with severe mental retardation has an IQ level of 20-25 or 35-40 and will acquire a little to no communicative speech. "They profit to only a limited extent from instruction in pre-academic subjects such as familiarity with the alphabet and simple counting, but can master skills such as learning sight reading of some 'survival' words" (American Psychiatric Association, 2000). Dyskinetic cerebral palsy "is characterized by slow and uncontrollable writhing movements of the hands, feet, arms, or legs" (CDC, 2011). Dyskinetic cerebral palsy may also cause each child affected to drool or grimace due to hyperactivity in the muscles of the face and tongue. Children may find it difficult to walk, sit straight, or coordinate muscle

movements for purposes of speaking. Unlike spastic quadriplegia, in dyskinetic cerebral palsy intelligence is rarely affected. The last form of cerebral palsy is ataxic. This is a very rare type of cerebral palsy and will affect balance and depth perception. "Children will often have poor coordination and walk unsteadily with a wide-based gait, placing their feet unusually far apart" (CDC, 2011). Gait is the "pattern of how person walks". Children are also capable of having mixed types of cerebral palsy and experience symptoms from varying types. Signs of cerebral palsy may be noticed when a child has a delay in their "milestones" such as rolling over, sitting, crawling, or walking. These delays may be due to abnormal muscle tone such as feeling relaxed and loose or very stiff. In order to be diagnosed, a child would need to take numerous tests such as computerized tomography (CT) scans, magnetic resonance imaging (MRI) scans, or ultrasounds. In order to specify a type of CP IQ tests, EEG tests and tests for vision and hearing can be taken. The tone of the child's muscles and movements are also tested when diagnosing. Although there is no cure for CP, there are treatment options available to help each child overcome whatever developmental disabilities they may be facing. Treatments may include: medications, braces or other aids, surgery and/or physical, occupational, speech, and behavioral therapies.

Physical Therapy

Physical therapy is "therapy for the preservation, enhancement, or restoration of movement and physical function impaired or threatened by disability, injury, or disease that utilizes therapeutic exercise, physical modalities (as massage and electrotherapy), assistive devices, and patient education and training—called also *physiotherapy*" (Medical Dictionary, 2011). One of the first studies to attempt to examine the effect of physical therapy on children with cerebral palsy was done in 1962. Three types of cerebral palsy were examined in this study

and included: spastic hemiparesis, tetraparesis, and extra-pyramidal. 177 patients were used in the studied and were divided into two groups, one being a control group and the other receiving treatment. The physical therapy used stretching exercises, muscle training, in order to teach patterns of movement and range of motion in joints. It was found that the patients with mild spastic hemiparesis obtained better motion with or without therapy. The moderate to severe hemiparesis patients had better gait and less contracture. The patients with spastic tetraparesis had a poorer prognosis than the patients who had hemiparesis. Since this paper was published, "neurodevelopmental pediatricians who focus on the interdisciplinary evaluation, diagnosis, and management of chronic encephalopathies have engaged in clinical studies not only to determine therapy effectiveness in cerebral palsy but also a wide array of developmental disorders...." (Capute, 1998). Research still continues to examine the effects of physical therapy on children with cerebral palsy.

Land Based Therapy

A systematic review was done by Antilla et. al. in order to learn the effectiveness of physical therapy interventions for children with cerebral palsy in 2008. A search was conducted from 1990-2007. Randomized controlled trials on Physical Therapy interventions in children diagnosed with cerebral palsy were included. When using cardiovascular fitness and aerobic programs an improvement was made with each child's weight control and on "peak aerobic power". There was a positive effect on bone mineral density in an "eight-month weight -bearing physical activity program" (Antilla, 2008). Another study was taken on constraint induced therapy, which is a type of therapy used to help gain movement on an affected side of the body. Results were found to show an increase in the frequency and quality of hand use functionality and new behavior compared to a non-therapy group. Constraint-induce therapy "with a sling had

positive effects on functional hand use, time to complete tasks, and speed and dexterity but no effects on sensibility, handgrip force, or spasticity" (Antilla, 2008).

Taub et. al. took part in a study in order to determine the applicability of constraint-induced therapy (CI) in children with cerebral palsy. The method for this study was taking a randomized controlled clinical trial of pediatric CI therapy in which 18 children who had been diagnosed with hemiparesis, were assigned to receive either pediatric CI therapy or conventional treatments. "Pediatric CI therapy involved promoting increased use of the more-affected arm and hand by intensive training (using shaping) of the more-impaired upper extremity for 6 hours/day for 21 consecutive days coupled with bivalve casting of the child's less-affected upper extremity for that period" (Taub, 2004). The subjects were treated for six months and the upper extremity functionality skills were measured in a lab and at home before, after, and three weeks post treatment. Just like the previous study, constraint induced therapy was shown to improve functions of children with cerebral palsy. Results of this study showed great improvement in motor skill in the children who had gone through the constraint induced movement therapy.

Another study done by Fowler et. al. was used to observe the effect of quadriceps femoris muscle strengthening exercises on spasticity in children with cerebral palsy. In this study "knee muscle spasticity was assessed bilaterally using a pendulum test to elicit a stretch reflex immediately before and after three different forms of right quadriceps femoris muscle exercises during a single bout of training" (Fowler, 2001). " The pendulum test is most sensitive to spasticity of the quadriceps femoris muscles, which is an important muscle group for functional activities and the focus of many of the studies examining strengthening exercises in people with CP" (Fowler, 2001). The pendulum test consisted of the examiner extending the subject's knee until it reached maximum extension while holding onto the heel and then letting go of the heel

which let the leg to swing freely and drop in a flexion state. The outcomes of the pendulum tests included; "(1) first swing excursion, (2) number of lower leg oscillations, and (3) duration of the oscillations" (Fowler, 2001). This study showed that there is not enough evidence showing that maximum effort exercises increase the spasticity levels in children with cerebral palsy. Although there is no evidence showing an increase of spasticity levels, through the use of different exercises including; isotonic, isometric, isokinetic and a combination of weight machines and isotonic exercise, there were improvements in muscle performance. The isotonic exercise used was performing knee extension with the use of cuff weights around the ankle. Isometric exercise was performed with the knee having 60 degrees of flexion and held for five seconds. Isokinetic exercises contained knee extensions of 60 degrees per second. " Starting from a relaxed, gravity-neutral position of approximately 90 degrees of knee flexion, the subjects were instructed to extend their knee as rapidly and as far as possible" (Fowler, 2001). The maximum joint range of motion of motion for extension and flexion of the knee were the end positions on the machine. According to this study, (Fowler, 2001), "It was felt that the patient's primary problem in producing a voluntary movement was antagonist restraint, not agonist muscle weakness". This study shows that muscle strength can be improved through the use of isokinetic, isometric, isotonic, and a combination of weight machines and isotonic exercises can improve muscle strength in children with CP.

A review was done by researchers David Lehman, PT, PhD, Amanda Garban BS, SPT, Lauren Scott BS, SPT, and Candice Tant BS, SPT in order "to resolve the controversy related to resistance training and its relationship to the improvement of gait in children with spastic CP, and to synthesize a clear clinical decision to support future evidence-based practice..."(Lehman, 2008). The database EBSCO host was used to access articles relating to the topic of interest and

nineteen articles were approved to correctly answer the question "should resistance training be used as an intervention for the treatment of gait dysfunction in children with spastic cerebral palsy?" (Lehman, 2008). After reviewing the evidence collected it was ruled that there are no disadvantages related to resistance training with spasticity. In fact, it was found that strength training is able to provide benefits for children with spastic Cerebral Palsy such as improving ambulation which is the ability to walk around.

An improvement after strength training was also seen in a study done by Blundell et. al. This study involved seven children who had spastic diplegia and one spastic/ataxic quadriplegia. Each child took part in an exercise class that was held after school for an hour twice a week. The class was set up with different stations, each involving intensive repetitive practice of an exercise and was used as group circuit training. The stations consisted of treadmill walking, step-ups, sit-to-stands, and leg presses. These exercises were used to help improve balance, strengthen the lower limbs, and to improve segmental control over the upper limbs. Each station included exercises that could be increased or decreased depending on the severity of the child's cerebral palsy and the exercises "were performed intensively to an individualized maximum number of repetitions in order to promote motor learning and improve muscle strength and endurance" (Blundell et. al, 2003). A baseline measurement was taken with a pre-test taking place two weeks after before the training period. The children were then tested right after the training period and the children were re-tested again eight weeks after the training period. A hand held dynamometer was used in assessing isometric strength of the hip, knee, and ankle flexors and extensors, which were all held in positions that were gravity independent. Each of the muscles were tested until three consistent measurements were reached. The lateral step up test was used to measure the child's lower extremity functional strength. This was tested by the number of

step up a child could do in fifteen seconds. Functional motor performance was tested "using the Motor Assessment Scale sit-to-stand item, minimum chair height test, the timed 10-m walk and the 2 minute walk tests" (Blundell et. al., 2003). After all results were analyzed the effect of the training showed various improvements. A significant increase was seen in isometric strength. This study was also able to show great improvements for the lateral step up test, motor assessment scale, stride length, minimum chair height test, and time taken to walk ten meters. These results were all maintained eight weeks after the training period. This shows that task-specific strengthening exercise for children with cerebral palsy can improve strength and performance and can be maintained.

An interesting treatment used to help better posture, reduce abnormally high muscle tone, and help with relaxation in children diagnosed with cerebral palsy is known as hippotherapy. Hippos is a Greek word meaning horse. Using a horse as a part of therapy can really help keep the attention of the child and making it more fun and interesting for them. According to the American Equestrian Alliance, "therapeutic benefits of the horse were recognized as early as 460 BC". According to Bertoti (1988), "A general goal of physical therapy for children with CP is to decrease the influence of abnormal muscle tone while simultaneously facilitating the emergence of normal postural and movement components". The horse is used as an alternate modality for therapy balls and bolsters. Bertoti (1988) describes the rationale for therapeutic riding in "that the horse's movement imparts a precise, smooth, rhythmical pattern of movement to the rider. As the horse walks, its center of gravity is displaced three-dimensionally with a movement very similar to the action of the human pelvis during gait. Bertoti completed a study to test the theories of hippotherapy. Eleven children diagnosed with cerebral palsy were chosen to take part in a therapeutic riding program. Three pediatric physical therapists were chosen who were not

involved in riding therapy programs to measure each child's posture in a pre-test post-test design. After taking pre-test measurements each child took part in a therapeutic riding program that lasted for ten weeks. "Each riding session stressed the achievement of reduced spasticity and reduction of postural compensations with subsequent facilitation of normal movement skills such as trunk control, weight shift, rotation through the body axis, and dissociation at the shoulders and pelvis" (Bertoti, 2008). At the end of the study, hippotherapy was seen to help with improvements in weight shift, balance and rotational skills, postural control, and decreased spasticity.

Aquatic Based Therapy

As most physical therapy treatments occur on land, an interesting twist is therapy taking place in water. Aquatic therapy is a useful way to improve mobility, function, and balance due to the buoyancy and lack of gravity it the water, which reduces pressure when doing exercises. Exercise is used as an intervention therapy to help increase gross motor function, aerobic capacity, and muscle strength in children with Cerebral Palsy. In aquatic exercise, "the resistive forces of buoyancy and viscous drag permit a variety of aerobic and strengthening activities that can be easily modified to accommodate the wide range of motor abilities of children with CP" (Kelly, 2005). Working in the water can also help children who have unstable joints because the water reduces levels of joint loading. Kelly (2005) states that aquatic exercise indicates positive effects such as improvements in flexibility, respiration function, muscle strength, gait, and gross motor function. There are certain factors that should be considered when working with children with CP in the water for exercise. Factors may include keeping adequate intensity and duration, whether group or individualized interventions are more effective, and that the pool environment is safe. A study was done by Maria Fragala-Pinkham MS PT, Stephen Haley PhD PT, and

Margaret O'Neil PhD MPH PT, in order to examine the effectiveness and safety of group aquatic aerobic exercise programs for children with disabilities. The study was examined using an A-B design and consisted of sixteen children aged six to eleven years and had diagnoses including autism spectrum disorder, myelomeningocele, cerebral palsy, or other developmental disabilities. The program was held twice a week for fourteen weeks. Tools used for strengthening exercises included water resistance, bar bells, and noodles. The children were measured on "half-mile walk/run, isometric muscle strength, timed floor to stand, 3-meter test, and motor skills" (Fragala-Pinkham, 2008). The pool environment showed to be safe for the children and there were no complaints of pain or injuries related to the water therapy. After the fourteen week program results showed an improvement in times for the half-mile walk/run and an increase in the ability to exercise longer period of time in their target heart rate zones.

Yeshayahu Hutzler et al. (1998) completed the study *Effects of a Movement and Swimming Program on Vital Capacity and Water Orientation Skills of Children with Cerebral Palsy* in order to evaluate the effect of a 6-month movement and swimming program on respiratory function and water orientation skills of children with CP. Forty-six children aged five to seven years were split into either treatment or control groups. The intervention program included swimming lessons twice a week and group physical activities once a week. Each session lasted for thirty minutes, and the program lasted for six months. The control group was treated with Bobath physical therapy. The results showed that children diagnosed with CP had reduced lung function when compared to normative data for children of the same ages. "The treatment program improved baseline vital capacity results by 65%, while children in the control group improved only 23 %" (Hutzler, 1998). The combination of swimming and aerobic exercise shows a better effect than a physical therapy routine consisting of respiratory exercise

alone. It is therefore strongly recommended that aquatic exercise sessions should be included in therapeutic programs for children with CP.

Land and Aquatic Based Therapies Used Together

Cincinnati Children's Hospital has also stated that if land-based physical therapy and aquatic-based physical therapy were combined over six months, there is a great chance that children with cerebral palsy will show improvements in respiratory function, specifically vital capacity. The children's hospital also lists recommendations for physical therapy, both land and aquatic based, geared towards children with cerebral palsy. The purpose of these recommendations is to allow the therapy to be a safe environment and allow for greater improvements. For land-based physical therapy" it is recommended that strength training be task specific" (Burch, 2010). A recommendation that is also made includes a strength training program that targets the muscles of the lower extremity. The program should be used for children who have a goal of standing or ambulation, and "ambulatory individuals with hemiplegic CP who demonstrate greater than 10% asymmetry in strength between the lower extremity muscle groups of the affected side and the non-affected side" (Burch, 2010). Upper extremity muscle strength training is used for children who could benefit the most with upper body strength such as children who used manual wheel chairs. Lastly, a recommendation for land-based therapy is that "an individualized progressive strengthening program include exercises of sufficient specificity, intensity, frequency, training weight or load, and duration be performed to increase muscle force" (Burch, 2010). Aquatic therapy is recommended to be used for children with hemiplegic CP who may have neurological and/or musculoskeletal impairments. Aquatic therapy is also recommended for children with CP who have endurance deficits and want to improve those deficits with set goals. It is also important that to make a

child's aquatic experience and outcomes the best they can be, the physical therapist should receive specialized training in aquatic therapy.

Discussion

There are many ways physical therapy can be used in order to improve range of motion, muscle strength, endurance, gait, vital capacity, decreased spasticity, postural control, and range of motion. Constraint-induced therapy seemed to be a very popular way to improve motor function and movement in the affected side of the body in children with hemparesis cerebral palsy. Constraint-induced therapy using a sling showed improvements in functional hand use, time to complete tasks, and speed and dexterity. Muscle performance improvements were seen with the use of exercises including isontonic, isokinetic, and isometric exercises as well as weight machines used in addition to isontonic exercises. Strength training is very helpful for children with cerebral palsy because it allows improvements in ambulation. Children with spastic diplegia and spastic/ataxic quadriplegia showed a significant increase in isometric strength and performance after taking part in task-specific strengthening exercising. In addition to the normal land-based physical therapy techniques and exercising, hippotherapy offers an interesting twist in therapy. This therapy taking place on horseback offers a unique experience to children with cerebral palsy. This therapy is used to improve posture, reduce abnormally high muscle tone, and help with relaxation. Another twist to physical therapy is aquatic therapy which is used for its unique properties such as resistive forces of buoyancy and viscous drag. Aquatic therapy is very useful for children with unstable joints and allows a gravity free zone to exercise. Just like land-based therapy, aquatic therapy helps improve flexibility, respiration function, muscle strength, gait, and motor function. It is strongly recommended that aquatic

exercise sessions should be included in therapeutic programs for children with CP because together they provide strong improvements.

Bibliography

American Equestrian Alliance. (n.d.). *American Equestrian Alliance*. Retrieved November 1, 2011, from http://www.americanequestrian.com/hippotherapy.htm

American Psychiatric Association. (2000). Mental Retardation. *Diagnostic and statistical manual of mental disorders: DSM-IV-TR* (Fourth ed., pp. 42-44). Washington, DC: American Psychiatric Association.

Anttila, H., Autti-Ramo, I., Suoranta, J., Makela, M., & Malmivaara, A. (2008). Effectiveness of physical therapy interventions for children with cerebral palsy: A systematic review. *BMC Pediatrics*, *8*(14). Retrieved September 20, 2011, from http://www.biomedcentral.com/1471-2431/8/14

Bertoti, D. (n.d.). Effect of Therapeutic Horseback Riding on Posture in Children with Cerebral Palsy . *Physical Therapy* . Retrieved November 1, 2011, from http://www.physther.net/content/68/10/1505.short

Blundell, S., Shepherd, R., & Dean, C. (2003). Functional Strength Training in cerebral palsy:a pilot study of a group circuit training class for children aged 4-8 years. *Clinical Rehabilitation*, *17*, 48-57. Retrieved November 29, 2011, from http://web.ebscohost.com/ehost/pdfviewer/pdfviewer?sid=2576ec78-6e5c-4842-99f5-9425a994abbf%40sessionmgr114&vid=2&hid=105

Burch, C., Colvin, S., et.al. (2010). Strengthening (progressive resistive exercise) for the individuals with Cerebral Palsy age 4-20 years who demonstrate muscle weakness. *Cincinnati Children's Hospital,* 1-9.

Capute, A. J. (1998). On the treatment of cerebral palsy: The outcome of 177... *Pediatrics*, *102*(1), 233.

CDC Features - Cerebral Palsy: Signs and Causes. (2011, March 21). *Centers for Disease Control and Prevention.* Retrieved November 3, 2011, from http://www.cdc.gov/features/cerebralpalsy/

Cerebral Palsy Alliance | About CP - Basic Guide to Cerebral Palsy . (n.d.). *Cerebral Palsy Alliance*. Retrieved October 15, 2011, from http://www.cerebralpalsy.org.au/about-cerebral-palsy/basic-guide-to-cerebral-palsy

Cerebral Palsy: Health Topics: University of Iowa Health Care. (n.d.). *UI Health Care Home*. Retrieved October 30, 2011, from http://www.uihealthcare.com/topics/geneticsbirthdefects/gene4591.html

Conner, S., Maignan, S et. al. (2010). Aquatic Therapy for Children with Hemiplegic Cerebral Palsy. *Cincinnati Children's Hospital*, 1-4.

Fowler, E., Ho, T., Nwigwe, A., & Dorey, F. (2001). The Effect of Quadriceps Femoris Muscle Strengthening Exercises on Spasticity in Children With Cerebral Palsy. *Physical Therapy Journal, 81*(6), 1215-1223.

Fragala-Pinkham, M., Haley, S., & O'Neil, M. (2008). Group Aquatic Aerobic Exercise for Children with Disabilities. *Developmental Medicine & Child Neurology, 50*(11), 822-827. Retrieved October 15, 2011, from http://onlinelibrary.wiley.com/doi/10.1111/j.1469-8749.2008.03086.x/full

Hutzler, Y., Chacham, A., Bergman, U., & Szeinberg, A. (1998). Effects of a Movement and Swimming Program on Vital Capacity and Water Orientation Skills of children with Cerebral Palsy. *Developmental Medicine & Child Neurology, 40*, 176-181. Retrieved October 15, 2011, from http://onlinelibrary.wiley.com/doi/10.1111/j.1469-8749.1998.tb15443.x/abstract

Kelly, M., & Darrah, J. (2005). Aquatic Exercise for Children With Cerebral Palsy. *Developmental Medicine & Child Neurology, 47*, 838-842. Retrieved November 1, 2011, from http://www.ispub.com/ostia/index.php?xmlFilePath=journals/ijpn/vol9n1/training.xml

Lehman, D., Garban, A., Scott, L., & Tant, C. (2008). The Use of Resistance Training as an Intervention for the Treatment of Gait Dysfunction in Children with Cerebral Palsy. *The Internet Journal of Pediatrics and Neontology, 9*(1). Retrieved November 1, 2011, from http://www.ispub.com/ostia/index.php?xmlFilePath=journals/ijpn/vol9n1/training.xml

Medical Dictonary. (n.d.). *MedlinePlus Merriam-Webster*. Retrieved November 1, 2011, from http://www.merriam-webster.com/medlineplus/physical%20therapy

Naylor, C., & Bower, E. (2007). Modified Constraint-Induced Movement Therapy for Young Children with Hemiplegic Cerebral Palsy: A Pilot Study. *Developmental Medicine & Child Neurology, 47*(6), 365-369. Retrieved November 13, 2011, from http://onlinelibrary.wiley.com/doi/10.1111/j.1469-8749.2005.tb01155.x/pdf

Rh Incompatibility . (n.d.). *KidsHealth - the Web's most visited site about children's health*. Retrieved November 13, 2011, from http://kidshealth.org/parent/pregnancy

Taub, E., Ramey, S. L., DeLuca, S., & Echols, K. (2004, February 1). Efficacy of Constraint-Induced Movement Therapy for Children With Cerebral Palsy With Asymmetric Motor Impairment . *Pediatrics* . Retrieved November 1, 2011, from http://pediatrics.aappublications.org/content/113/2/305.full.pdf+html

Walking abnormalities: MedlinePlus Medical Encyclopedia. (2011, November 7). *National Library of Medicine - National Institutes of Health.* Retrieved November 13, 2011, from http://www.nlm.nih.gov/medlineplus/ency/article/003199.htm

Willis, J. K., Morello, A., Davie, A., Rice, J. C., & Bennett, J. T. (2002). Forced Use Treatment of Childhood Hemiparesis. *Pediatrics*, *110*(1), 94.

University Honors Program

Capstone Approval Page

Capstone Title (print or type)

The Effects of Land and Aquatic Based Physical Therapy for Children with Cerebral Palsy

Student Name (print or type) Rachel Wurster

Faculty Supervisor (print or type) Rebekah Wagner , MPT

Faculty Approval Signature Rebekah Wagner, PT

Department of (print or type) Physical Therapy

Date of Approval (print or type) 12-2-11

HONORS THESIS ABSTRACT
THESIS SUBMISSION FORM

AUTHOR: Rachel Wurster

THESIS TITLE: The Effects of Land and Aquatic Based Physical for Children with Cerebral Palsy

ADVISOR: Rebekah Wagner, MPT

ADVISOR'S DEPARTMENT: NIU Physical Therapy

DISCIPLINE: Academic Coordinator of Clinical Education

YEAR: 2011

PAGE LENGTH: 18

BIBLIOGRAPHY: Attached

ILLUSTRATED:

PUBLISHED (YES OR NO): NO

LIST PUBLICATION:

COPIES AVAILABLE: Hard Copy with additional video (CD)

ABSTRACT (100-200 WORDS): Attached