

## Hippotherapy: A Therapeutic Treatment Strategy

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In 2006, five U.S. soldiers and one airman, all with lower extremity amputations, were part of a pilot therapeutic riding program for wounded veterans at Walter Reed Army Medical Center in Washington, D.C.<sup>1</sup> Most therapists think of children with degenerative or neuromuscular disorders as the primary recipients of therapy on horseback. What researchers are finding, though, is that horseback riding can be beneficial for clients with many types of disabilities, including those with lower extremity amputation.

A therapist involved with the study at Walter Reed reported he had seen the riders “find a whole new center of balance, and a whole new sense of control during the program.”<sup>1</sup>

The horse is symbolic of strength and power and has been an integral part of the development of the industrial world. The horse and human interaction is evident in sport or pleasure activities, law enforcement, agriculture, entertainment, and warfare. The first evidence of the use of horses in warfare is from more than 5,000 years ago, and the value of using horses in therapy has been known for generations. In the 1950s, Liz Hartel of Denmark won the silver medal in dressage at the Olympics after rehabilitating herself from polio using horseback riding and training. Since then, the use of horses in therapy became increasingly prevalent in the United States.<sup>2,3</sup> Hippotherapy, a word of Greek origin meaning “treatment with the help of a horse,”<sup>2</sup> is defined by the American Hippotherapy Association (AHA) as “a physical, occupational, and speech-language therapy treatment strategy that utilizes equine movement as part of an integrated intervention program to achieve functional outcomes.”<sup>3</sup> It consists of one-on-one treatment sessions with a patient and therapist. Therapeutic riding, often used interchangeably with hippotherapy, is a more general term and encompasses any activity on or around a horse that a person with a disability participates in, using a therapist as more of a consultant or supervisor.

The North American Riding for the Handicapped Association (NARHA) defines the group of horse-based activities as equine assisted activity and therapy.<sup>4</sup> This group was founded in the U.S. in 1969 and was organized because of the increasing popularity of therapeutic riding and the evident need for a clearinghouse for this information.<sup>4</sup> Today, NARHA continues to promote research and education in equine therapies, including hosting an annual four-day conference with nearly 700 national and international participants and publishing a quarterly publication, STRIDES.<sup>4</sup>

Hippotherapy is recognized by the American Physical Therapy Association (APTA), American Occupational Therapy Association (AOTA), and the American Speech-Language- Hearing Association (ASHA), and also has its own body of representation. The AHA was founded in 1992, and became an official section of NARHA in 1993. The AHA is an organization that promotes the use and research of hippotherapy, and provides

a conceptual framework based on dynamic systems theory, integrated with principles of motor learning, sensory integration, and psycholinguistics,<sup>3</sup> in order to provide a more evidence-based model for hippotherapy. It is important to understand that hippotherapy is a skilled treatment performed only by a licensed physical therapist (PT), occupational therapist (OT), or speech language pathologist (SLP) who is specifically trained and registered, and the individual treatments are based on the achievement of functional goals.<sup>5</sup> The AHA sponsors courses for hippotherapy certification and continuing education for those therapists who have met specific education and practice requirements. Since 1999, therapists have been able to obtain a Hippotherapy Clinical Specialist (HPCS) designation.<sup>3</sup> Requirements include three years in the profession, at least 100 hours of hippotherapy practice within three years, and passing an examination. Recertification is necessary every five years. Finding qualified centers and practitioners is simple with the use of the AHA and NARHA websites [www.americanhippotherapyassociation.org](http://www.americanhippotherapyassociation.org) and [www.narha.org](http://www.narha.org). Currently, more than 730 NARHA-accredited facilities are in the U.S., with at least 5,000 specially screened and trained horses. To date, there are 37 physical therapists, 18 occupational therapists, and five speech language pathologists with the HPCS designation. Every year, approximately 38,000 individuals with disabilities benefit from hippotherapy services in the U.S.<sup>4</sup>

### What's This Ride Like?

Typical hippotherapy treatment sessions take place in an outdoor or indoor arena, which is set up with safety and ease of use in mind for both clients and practitioners. To increase sensory integration and help bond with the horse, the client who is physically able may brush and tack, or dress the horse. The equipment commonly includes a sheepskin pad, which has a girth, stirrups, and a sturdy handle, a halter, and a lead rope. The client wears a helmet, and mounts the horse from the ground, stairs, or a platform built to match the height of the therapy horse, with assistance for the transfer as needed.<sup>2</sup> Individuals involved in the process include the therapist, side walkers, and volunteers. The therapist is the director, either walking beside or sitting behind the client, depending on severity of postural instability or impulsiveness. The therapist also decides whether there will be one or two side walkers, who walk next to the horse during the treatment session to assist with stability and safety, and participate in the treatment sessions when needed. Volunteers lead, brush, and tack the horses, and clean up after the horses and therapists.

Treatment sessions run from 30 to 60 minutes and are planned based on goals set by the therapist. Therapists address impairments, functional limitations, and disabilities during hippotherapy by changing positions, gait speed, and direction of the horse. Varying the pace, direction, and speed of the horse can vary the degree of stimulus produced to elicit a weight shift response from the rider. Having the horse walk in circles, weaving through cones, and trail riding are all ways to do this. The bouncing of the horse during a trotting gait demands a heightened response to balance and increases the rider's sensory awareness.

The therapist may decide to change the position of the client on the horse to achieve different goals. By turning sideways, the lateral pelvic tilt of the rider is enhanced. It also diminishes the client's base of support with increased demands on the trunk muscles to

work harder to maintain an upright position. By riding backwards, postural reactions are enhanced because of limited visual input. Since the client cannot see where he or she is going, there is decreased anticipatory feed forward control. This position also provides the ability to weight bear through the upper extremities on the horse's hindquarters, which promotes co-contraction, stability, and may decrease tone.<sup>6</sup> The client may also lie in supine or prone, which are particularly good positions for increasing sensory input to the client for improving muscle tone and promoting an overall relaxing effect.<sup>6</sup>

There are multiple positions the therapist can incorporate with activities on the horse to challenge the client to achieve goals as well as to improve the ability to follow directions. The client may forward flex his or her trunk to touch the horse's neck or ears, or rotate the trunk to reach his tail.<sup>6</sup> Upper extremity movements challenge balance, trunk control and improve extremity range of motion. Other activities include reaching for cones, giving high-fives, tossing rings, and ball tossing, which require increased weight shifting, trunk mobility and stability, and gross motor control. Working with toys provides sensory stimulation through bright colored objects and textures and provides increased motivation for the client. According to one researcher, "Sometimes [the children] don't even realize they're working, because just sitting on a horse is comparable to working on a ball. Riding a horse presents constant, yet engaging balance and postural challenges."<sup>7</sup>

### The Rhythm Behind the Therapy

The physiological basis for hippotherapy lies in the movement patterns of the horse's gait on a human rider. The horse's movement pattern is multidimensional, variable, rhythmic, and repetitive.<sup>3</sup> In an 11-study review of hippotherapy research completed in 2007, it was found that:

1. The three-dimensional, reciprocal movement of the walking horse produced normalized pelvic movement in the rider, closely resembling pelvic movement during ambulation in individuals without disability;
2. The sensation of smooth, rhythmical movements made by the horse improved co-contraction, joint stability, and weight shift, as well as postural and equilibrium responses; and
3. HBRT (Horseback Riding Therapy) and hippotherapy improved dynamic postural stabilizations, recovery from perturbations, and anticipatory and feedback postural control."<sup>8</sup>

The sequence of the horse's gait pattern is left hind foot, left front foot, right hind foot, and right front foot. The push off the left hind foot initiates the initial swing phase. During this push off, the horse's pelvis tilts laterally on the left, causing a left lateral pelvic tilt in the rider. The trunk of the rider lengthens on the side of the leg that is swinging, the left side, and shortens on the weight-bearing side, the right side. For the swing leg to clear, the horse's spine must laterally flex, and the pelvis rotates forward. This causes forward rotation of the rider's pelvis as well. The swing phase also shifts the rider's weight posteriorly, causing a posterior pelvic tilt.<sup>9</sup> The strike phase begins as the left hind leg contacts the ground. As this occurs, the horse's center of gravity shifts to that side, causing right lateral pelvic displacement in the rider. This phase is considered the deceleration phase, which causes an anterior weight shift in the rider leading to an

anterior pelvic tilt.<sup>9</sup> The same sequence is repeated on the right side, and alternates continuously with the horse's walking gait.

The movements of the horse's hind legs, trunk, and pelvis are comparable to the human's trunk, pelvis, and legs.<sup>8</sup> The horse's pelvis laterally displaces 4 to 5 centimeters while the human's pelvis laterally displaces 7 to 8 cm. The horse's pelvis rotates 8 degrees while the human's pelvis rotates 3-4 degrees.<sup>9</sup> As the hindquarter rises and anteriorly tilts the pelvis during the stance phase, the rider's trunk shifts backward in order to avoid being displaced forward by the horse. As the horse's hindquarter falls and posteriorly tilts the pelvis during the swing phase, the rider's trunk shifts forward to avoid being displaced backward.<sup>10</sup> Other gaits that a horse is capable of include the trot, canter, and gallop. During the trotting gait, one front foot and its opposite hind foot come down at the same time, making a two-beat rhythm, averaging about 8 miles per hour. The legs are moving in unison in diagonal pairs, creating a very stable gait for the horse, but making it difficult for a rider to sit due to the dropping of the body of the horse between beats and bouncing up upon hoof strike. Trotting may be used during a hippotherapy session for improving core stability and balance, increasing sensory input, and encouraging prolonged attention span. Cantering (three-beat gait) and galloping (faster, four-beat gait) are not typically used due to the speed and compromised safety.

### Why Ride at All?

The benefits of hippotherapy include:

- \* Postural control and core stability
- \* Gait training
- \* Decreased muscle tone and spasticity
- \* Improved energy expenditure
- \* Sensory stimulation, including vestibular, somatosensory, and visual sensation
- \* Improved vocalization
- \* Better ability to follow directions
- \* Enhanced quality of life due to increased function.

Postural Control and Core Stability: Shifts in the center of gravity in response to the horse's movement cause the rider to exert control over the muscles required to maintain equilibrium and balance to stay in an upright posture on the horse.<sup>2</sup> The external perturbations occur up and down, side-to-side, and front to back,<sup>9</sup> with responding pelvic adjustments that stimulate dynamic postural stabilization for increased anticipatory and feedback postural control.<sup>8</sup> Research has indicated that the rider receives approximately 100 impulses per minute with the horse at a steady walk.<sup>11</sup> The movements of the horse also continuously produce vestibular, somatosensory, and visual feedback, which help the rider increase his or her awareness of the base of support, body alignment, and center of gravity.<sup>12</sup> These unpredictable conditions simulate the random use of balance and postural control of everyday tasks.<sup>13</sup> Continually responding to a changing environment that encourages adaptive behaviors or movement strategies to maintain postural control on a dynamic surface creates a foundation for normal gross motor skill.<sup>11</sup> The research supporting hippotherapy for postural stability has been strong. Evidence suggests that therapeutic riding improved sitting posture in individuals with disabilities.<sup>14</sup> Additional research maintains that the rider is constantly using dynamic postural stabilization

techniques to recover from the perturbations, which are not dependent on the patient's volition.<sup>15</sup>

In a typical physical therapy setting, the closest replication of an unstable surface that compares to a horse is the therapy ball. In the clinic, therapy balls are commonly used as a dynamic surface to develop postural control in lying or sitting positions.” However, because the movements of the ball are not as rhythmical and repetitious as the gait of a horse, and the ball cannot move in all three planes simultaneously, the movements of the pelvis while on the ball do not exactly replicate those during gait. Additionally, in hippotherapy, the rider is able to experience a sensation of moving forward through space, which is difficult to reproduce in the clinic.<sup>9</sup> Another weakness of the therapy ball is that it cannot provide as much sensory stimulation to the client because it does not transfer heat and cannot simulate the feeling of trotting. Also, sitting or lying on a ball in a physical therapy gym cannot provide as much motivation or social interaction as riding a horse on a farm.

**Gait Training:** The movement pattern of the horse’s pelvis on the human also promotes gait-related therapeutic benefits. One study found through a kinematic analysis of the rider’s trunk and the horse’s back during hippotherapy that the biphasic movement pattern that is present in healthy individuals during walking gait was mimicked by children with cerebral palsy (CP) who had altered gait while participating in this therapy. This led to improved coordination and functional mobility for the subjects.<sup>10</sup> Another investigation found significant reduction in energy expenditure and increase in gross motor function in children with CP after hippotherapy.<sup>12</sup> The reduction in energy expenditure contributes to increased motivation for walking, which can be associated with eagerness to participate in social and recreational activities and overall improved function.<sup>12</sup> Pelvic mobility elicited from the rider as a result of the horse’s movement patterns is necessary for a normal gait pattern. The repetition of pelvic movements in addition to the effect on multiple systems of the body at the same time may promote restructuring of the central nervous system, which can increase carryover to functional activities.<sup>11</sup>

**Tone and Spasticity:** The warmth of the horse coupled with its rhythmical movements not only help with motivation and social interaction of the client with the animal, but also reduce tone and spasticity in clients with hypertonia.<sup>6</sup> Research has found that after only 8 minutes of hippotherapy, patients with CP had significant improvement in muscle activity symmetry when compared to sitting over a stationary barrel, suggesting the movement of the horse, rather than the passive stretch, accounts for the improvements.<sup>16</sup> Others agree that hippotherapy helps to decrease tone by the movement causing a disassociation of the client’s pelvis and trunk and the warmth of the horse.<sup>13</sup> A study in 2003 reported a significant reduction in lower extremity spasticity with the use of hippotherapy in spinal cord injury (SCI). The investigators reported that the simple combination of straddling the horse (putting the client’s legs into a position of hip flexion, abduction, and external rotation) and the movement of the horse itself helped to inhibit spasticity in the client.<sup>17</sup> Another study done in 2007 reported 12 patients with SCI had significantly improved spasticity with hippotherapy when compared to those who sat on a Bobath roll or stool with a rocking seat.<sup>18</sup>

Other Benefits: The benefits of therapeutic riding are more than just physical. Hippotherapy has been found in clients with CP to increase the volume, quantity, and quality of vocalization; to increase coordination of breathing, swallowing, and sound production; and to encourage the client to move, explore and touch.<sup>19</sup> Visual and auditory gains can also be made. Besides visual stimulation from the toys used for activities, pictures can be posted or objects can be “hidden” around the arena, and the client’s attention can be directed to these as he or she rides. Other ways to incorporate visual and auditory stimuli into the treatments include singing and encouraging clients to participate in games that require visual and auditory input.<sup>20</sup> A case study of a 9-year-old with multiple disabilities found that after 10 weeks, the subject had not only better mobility, but also had an increase in visual attention span and fixation time, signs of greater verbal communication, and improved functional ability.<sup>20</sup> Therapy with horses can also be used during the grieving process. One study looked at a six-week program of therapeutic riding that included grooming for children who were mourning the death of a family member. It found that children who were initially hesitant began moving forward and finally took over the care of the horse. Confidence was built; the children overcame fear of the horse and developed a sense of independence translating

to improved self-esteem and self-confidence.<sup>21</sup> The children were then able to verbalize emotions and work through the grieving process with a healthier attitude.

A study of patients with SCI found that hippotherapy improved the short-term mental well-being of subjects.<sup>18</sup>

#### Application to Physical Therapy Treatment Session

Physical therapists can add motor tasks to the horse’s movement to address the motor needs of each patient and to promote functional outcomes in skill areas related to gross motor ability, such as sitting, standing, and walking.<sup>3</sup> During the initial evaluation for a hippotherapy client, subjective and objective measures are taken and an individualized plan of care is developed. The goals can include improved walking, posture, balance, and mobility.<sup>8</sup> Objective goals can be established and achieved for functional gains via hippotherapy.<sup>22</sup>

Objective tests that demonstrate the outcomes of hippotherapy include the Sitting Assessment Scale and Gross Motor Function Measure,<sup>23</sup> Berg Balance Test or Tinetti Performance-Oriented Mobility Assessment,<sup>13</sup> and Ashworth Scale.<sup>18</sup> Development of the frequency and duration of treatments, as well as treatment session length, are determined by the therapist. This has been an area of hippotherapy where research has been lacking. A group of researchers concluded that one of the most important tasks of a therapist practicing hippotherapy is to induce a movement dialogue between the horse and the client over time.<sup>24</sup> They found that the longer the client has contact with the horse, the better the outcomes. In terms of carryover, one study found that a group of developmentally delayed subjects who had therapeutic riding for seven weeks did demonstrate improvements in gross motor function that were maintained seven weeks after riding ceased.<sup>25</sup> Table 1, summarizes some reviewed articles on hippotherapy and therapeutic riding, the frequency and duration, treatment length, and outcomes.

[Chart Omitted]

## Who Benefits from Hippotherapy?

Clients who may benefit from hippotherapy range from slightly to severely impaired, and may be between the ages of 18 months<sup>7</sup> and adulthood. Clients involved with hippotherapy research tend to have commonly seen diagnoses, such as developmental delay,<sup>25</sup> cerebral palsy (CP),<sup>6,8,10,11,12,15,16,23,27,28,29</sup> multiple sclerosis (MS),<sup>13,26,30</sup> cerebellar dysfunction,<sup>31</sup> SCI<sup>17,18</sup> and traumatic brain injury (TBI),<sup>32</sup> as well as many other neurological disorders. Several studies from Germany in the last decade support hippotherapy for treatment of orthopaedic impairments. It can be used to increase core stability for patients after lumbar disc surgery,<sup>33</sup> lumbar instability,<sup>34</sup> and as part of a more generalized therapeutic exercise program.<sup>35</sup> One group has studied how increases in postural stability with the use of hippotherapy can be applied to patients who have lumbar instability, or even recent lumbar discectomy.

Results in a 1997 study indicated that patients in orthopaedic horseback riding therapy had increased self evaluation of their postoperative condition, as well as reduction of work disablement.<sup>33</sup> In the same year, a different report showed that hippotherapy helped to mobilize hypomobile segments as well as increase core muscular stabilization of hypermobile segments.<sup>34</sup> Another study on hippotherapy and Scheuermann's disease, a form of juvenile osteochondritis of the spine, demonstrated the benefits of horseback riding therapy on the vertebral column, and reports that hippotherapy does not put intervertebral discs at risk for damage due to pressure,<sup>36</sup> a risk that historically has been feared.

Contraindications to hippotherapy include patients who have increased symptoms of CNS damage while being treated, neoplastic disease, spinal instability, unstable spondylolisthesis, or inflammation of the bone and joint system.<sup>15</sup> Research has found that the heart rate of subjects with severe disabilities was higher during therapeutic riding than those who were not as disabled, leading to a potential need for heart rate monitoring during hippotherapy.<sup>30</sup>

Therapists should evaluate each client individually to determine benefit versus risk of this innovative therapy.

## Current Issues

Hippotherapy is one of the areas with the least amount of evidence in the rehabilitation professions. The United States in particular has been slow in accepting hippotherapy as a mainstream treatment. On one hand, many journal articles that demonstrate the utility of hippotherapy for patients with impairments such as orthopedic injuries are not translated into English, so that this therapy may not be as widespread in the U.S. as it might be if these studies were more available. On a bright note, current research is growing. Of the articles reviewed for this discussion, 21 out of 34 have been published since 2000. Time will tell if the research will continue to expand to broader areas. However, future investigation needs to increase study duration to determine long-term effects, reduce the amount of confounding variables, augment sample sizes, and add controls.<sup>8</sup>

Barriers to research design when studying hippotherapy include ethical restrictions when investigating children (even though more studies have addressed children than adults<sup>13</sup>), difficulty in standardizing research conditions and outcome measures, and a lack of involvement among therapists. Many therapists just don't know about hippotherapy and proper application of objective measures. A study in 2005 surveyed German physiotherapists and people with CP to determine the pattern of hippotherapy use in Germany and the U.K. and found scant use of outcome measures in the hippotherapy setting.<sup>37</sup>

Another factor that affects the quality of research is the misrepresentation of the word "hippotherapy."<sup>13</sup> Authors have used "hippotherapy" and "therapeutic riding" interchangeably, and therefore it is difficult to know which studies are controlled specifically for therapist-provided treatment.<sup>13</sup> Recently, researchers have been using the term more accurately.

The most amazing part of hippotherapy is that it challenges clients in a fun, dynamic way and allows them to self-generate and self-correct their motor plans and patterns and expand their repertoire in goal- and task-oriented ways. It contains everything a therapist could want for motor learning to be most effective<sup>38</sup>: external and internal feedback, self-correction, and multiple system integration, all important for long-term motor plan development. Information regarding hippotherapy or local hippotherapy providers, and therapeutic riding can be found at [www.narha.org](http://www.narha.org) or [www.aha.com](http://www.aha.com). Before recommending hippotherapy to an appropriate client, know what types of therapists are available, where the local facilities are located, what the costs are, and if there are any local programs where the person could become involved at a reduced cost.

1. Burgess L. Wounded veterans get back in the saddle. Stars Stripes. 2006.
2. Rolandelli PS, Dunst CJ. Influences of hippotherapy on the motor and social emotional behavior of young children with disabilities. Bridges. 1994;2:1-14.
3. Hippotherapy as a Treatment Strategy.  
<http://www.americanhippotherapyassociation.org>. Accessed March 3, 2009.

4. Equine Assisted Activity.  
[http://www.narha.org/PDFfiles/Center\\_Membership\\_Application.pdf](http://www.narha.org/PDFfiles/Center_Membership_Application.pdf). Accessed March 3, 2009.
5. Meregillano G. Hippotherapy. *Phys Med Rehabil Clin of N Am*. 2004;15(4):843-854.
6. Bertoti D. Effect of therapeutic horseback riding on posture in children with cerebral palsy. *Phys Ther*. 1988;68(10):1505-1512.
7. Borzo G. Horse Power. *Am Med News*. 2002;45:24-26.
8. Sterba J. Does horseback riding therapy or therapist-directed hippotherapy rehabilitate children with cerebral palsy? *Dev Med Child Neurol*. 2007;49:68-73.
9. Heine B. Topical therapy. Hippotherapy. A multisystem approach to the treatment of neuromuscular disorders. *Aust J Physiother*. 1997;43(2):145-149.
10. Haehl V, Giuliani C, Lewis C. Influence of hippotherapy on the kinematics and functional performance of two children with cerebral palsy. *Pediatr Phys Ther*. 1999;11(2):89-101.
11. Casady R, Nichols-Larsen D. The effect of hippotherapy on ten children with cerebral palsy. *Pediatr Phys Ther*. 2004;16(3):165-172.
12. McGibbon N, Andrade C, Widener G, Cintas H. Effect of an equine-movement therapy program on gait, energy expenditure, and motor function in children with spastic cerebral palsy: a pilot study. *Dev Med Child Neurol*. 1998;40(11):754-762.
13. Silkwood-Sherer D, Warmbier H. Effects of hippotherapy on postural stability, in persons with multiple sclerosis: a pilot study. *J Neurol Phys Ther*. 2007;31:77-84.
14. Land G, Errington-Povalac E, Paul S. The effects of therapeutic riding on sitting posture in individuals with disabilities. *Occup Ther Health Care*. 2001;14(1):1-12.
15. Lisinski P, Stryla W. The utilization of hippotherapy as auxiliary treatment in the rehabilitation of children with cerebral palsy. *Ortop, Traumatol, Rehabil*. 2001;3(4):538-540.
16. Benda W, McGibbon N, Grant K. Improvements in muscle symmetry in children with cerebral palsy after equine-assisted therapy (hippotherapy). *J Altern Complement Med*. 2003;9(6):817-825.
17. Lechner HE, Feldhaus S, Gudmundsen L, et al. The short-term effect of hippotherapy on spasticity in patients with spinal cord injury. *Spinal Cord*. 2003;41:502-505.
18. Lechner H, Kakebeeke T, Hegemann D, Baumberger M. The effect of hippotherapy on spasticity and on mental well-being of persons with spinal cord injury. *Arch Phys Med Rehabil*. 2007;88(10):1241-1248.
19. Baker L. Cerebral palsy and therapeutic riding. *NARHA Strides*. 1995;1.

20. Lehrman J, Ross D. Therapeutic riding for a student with multiple disabilities and visual impairment: a case study. *J Vis Impair Blind*. 2001;95(2):108.
21. Glazer H, Clark M, Stein D. The impact of hippotherapy on grieving children. *J Hospice Palliat Nurs*. 2004;6(3):171-175.
22. Latella D, Langford S. Hippotherapy: An effective approach to occupational therapy intervention. *OT Pract*. 2008;13:16-20.
23. Hamill D, Washington K, White O. The effect of hippotherapy on postural control in sitting for children with cerebral palsy. *Phys Occup Ther Pediatr*. 2007;27(4):23-42.
24. Dvorakova T, Peham C, Janura M. Pressure forces created by the contact of a rider's body on the horse's back during hippotherapy. *Clin Biomech*. 2008;23(5):670-670.
25. Winchester P, Kendall K, Peters H, Sears N, Winkley T. The effect of therapeutic horseback riding on gross motor function and gait speed in children who are developmentally delayed. *Phys Occup Ther Pediatr*. 2002;22(3-4):37-50.
26. Hammer A, Nilsagård Y, Forsberg A, Pepa H, Skargren E, Öberg B. Evaluation of therapeutic riding (Sweden)/hippotherapy (United States). A single-subject experimental design study replicated in eleven patients with multiple sclerosis. *Physiother Theory Pract*. 2005;21(1):51-77.
27. Bertoti DB. Effect of therapeutic horseback riding on extremity weightbearing in a child with hemiplegic cerebral palsy: a case report as an example of clinical research. *Pediatr Phys Ther*. 1991;3(4):219.
28. Snider L, Korner-Bitensky N, Kammann C, Warner S, Saleh M. Horseback riding as therapy for children with cerebral palsy: is there evidence of its effectiveness? *Phys Occup Ther Pediatr*. 2007;27(2):5-23.
29. Dirienzo L, Dirienzo L, Baceski D. Heart rate response to therapeutic riding in children with cerebral palsy: an exploratory study. *Pediatr Phys Ther*. 2007;19(2):160-165.
30. Mackay-Lyons M, Conway C, Roberts W. Effects of therapeutic riding on patients with multiple sclerosis: a preliminary trial... horseback riding. *Physiother Canada*. 1988;40(2):104-109.
31. Osborne M. Hippotherapy as an intervention modality for a patient with cerebellar dysfunction. *Phys The Case Reports*. 1998;1(1):58-60.
32. Keren O, Reznik J, Groswasser Z. Combined motor disturbances following severe traumatic brain injury: an integrative long-term treatment approach. *Brain Injury*. 2001;15(7):633-638.
33. Rothhaupt D, Laser T, Ziegler H, Liebig K. Orthopedic hippotherapy in postoperative rehabilitation of lumbar intervertebral disk patients. A prospective, randomized therapy study. *Sportverletz Sportschaden*. 1997;11(2):63-69.

34. Rothhaupt D, Ziegler H, Laser T. [Orthopedic hippotherapy--new methods in treatment of segmental instabilities of the lumbar spine]. *Wien Med Wochenschr* (1946). 1997;147(22):504-508.
35. Rothhaupt D, Laser T, Ziegler H. The orthopedic hippotherapy as part of a therapeutic exercise programme [German]. *Krankengym.* 1997;49(5):768-777.
36. Gottwald A, Biewald N. [New aspects in the treatment of Scheuermann's disease with hippotherapy (author's transl)]. *Z Orthop Ihre Grenzgeb.* 1981;119(4):351-355.
37. Debuse D, Chandler C, Gibb C. An exploration of German and British physiotherapists' views on the effects of hippotherapy and their measurement. *Physiother Theory Pract.* 2005;21(4):219-242.
38. Paez P. Northeastern University Senior Lecturer. Interview by e-mail July 17, 2008.