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| **CRITICALLY APPRAISED TOPIC** |

**FOCUSED CLINICAL QUESTION**

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| In ambulatory children (5-14 years old) with cerebral palsy, is hippotherapy more effective than traditional physical therapy for improving static and dynamic balance? |

**AUTHOR**

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**CLINICAL SCENARIO**

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| While completing one of my last rotations in the school system, I realized that at least 50% of my patient case load involved students with cerebral palsy. During an Individualized Education Plan (IEP) meeting one afternoon, the mother of a particular patient asked my CI and myself what we thought about hippotherapy to help her son with his balance. As a former volunteer at the North Carolina Therapeutic Riding Center, I provided her with the information I had gained from the experience, describing some of the success stories along with the caveat that every child’s experience is going to be different. Cerebral palsy is a neurological disorder that often results in a patient’s inability to maintain static or dynamic balance secondary to limitations in postural control that are a result of irregular muscle activation and unsuccessful movement strategies.1 Hippotherapy incorporates the movement of a horse into the treatment strategy.2 The overall goal of treatment with hippotherapy is to influence functional tasks off of the horse through strength, balance, and posture training while riding the horse.2 Considering my interest in pediatrics, the aim of my investigation of this topic is to determine if hippotherapy is effective for improving static and dynamic balance in child with cerebral palsy who are ambulatory. |

**SUMMARY OF SEARCH**

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| * Nine studies were identified that met the inclusion/exclusion criteria. Three studies of higher relative quality were chosen for review and discussion.
* No studies to date have explicitly examined whether hippotherapy is more effective than conventional physical therapy for improving static and/or dynamic balance among children with cerebral palsy. Limited evidence exists supporting the use of hippotherapy in isolation with regards to improving aspects of balance, as hippotherapy is more frequently part of a comprehensive plan of care.
* The most statistically significant improvements following 8-12 weeks of hippotherapy (30-45min per session, 1-2 times per week) were reported by Shurtlef, Standeven, and Engsberg (2009) and Kwon et al (2011) with regards to head and trunk stability (as measured by head angle movement variability and range of motion data) and stride length, respectively.8,11 However, the clinical significance of these findings with regard to balance improvement remains unclear.
* Future research should examine correlational relationships between postural control/balance and functional changes while utilizing valid and appropriate outcome measures. Large RCTs with adequate blinding and long-term follow up are warranted.
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**CLINICAL BOTTOM LINE**

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| To answer the focused clinical question, evidence suggests that hippotherapy may be an effective treatment strategy for improving head and trunk stability and gait characteristics, but more research is needed to determine whether hippotherapy aids in improving dynamic and static balance among ambulatory children with cerebral palsy. At this time, research suggests that hippotherapy as an intervention can be recommended as an adjunct to, rather than a replacement for, traditional physical therapy. More conclusive high-level evidence demonstrating the effectiveness of hippotherapy remains to be published. In order to better understand the clinical significance and efficacy of hippotherapy, future research should be conducted. Randomized control trials with greater samples sizes and greater methodological rigor may provide better insight into the applicability of hippotherapy to a general population of children with cerebral palsy. |

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| ***This critically appraised topic has been individually prepared as part of a course requirement and has been peer-reviewed by one other independent course instructor*** |

**SEARCH STRATEGY**

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| **Terms used to guide the search strategy** |
| **P**atient/Client Group | **I**ntervention (or Assessment) | **C**omparison | **O**utcome(s) |
| ChildrenPediatricAdolescentCerebral PalsyChild\*  | Hippotherapy Horseback riding therapyEquine-assisted therapyHorse therapyTherapeutic horseback horse | Traditional physical therapyConventional physical therapy | Static DynamicBalance balanc\* |

**Final search strategy:**

**PubMed (n=5)**

#1 Search “cerebral palsy” AND (child\* OR pediatric OR adolescent\*) (n=15953)

#2 Search “cerebral palsy” AND (child\* OR pediatric OR adolescent\*) Filters: Human; English; Child: birth-18 years (n=10990)

#3 Search hippotherapy OR horseback riding therapy OR equine assisted therapy OR horse therapy OR therapeutic horseback or horse (Filters activated: Humans; English, Child: birth-18 years) (n=1311)

#4 Search traditional physical therapy OR conventional physical therapy or physiotherapy (Filters activated: Humans; English, Child: birth-18 years) (n=14915)

#5 Search static AND dynamic AND balanc\* (Filters activated: Humans; English, Child: birth-18 years) (n=169)

#6 Search #2 AND #3 AND #4 AND #5 (n=0)

#7 Search #2 AND #3 AND #5 (n=0)

#8 Search #2 AND #3 (n=37)

#8 Search #2 AND #3 AND balanc\* (n=12)

#9 Search #2 AND #3 AND balanc\* (n=9)

#10 Search #2 AND #3 AND balanc\* NOT simulat\* (n=7)

#11 Search #2 AND #3 AND balanc\* NOT simulat\* NOT artificial (n=5)

***\*Note: all filters described (English, Human, Child: birth-18years) were active for searches #6 – #11.***

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| **Databases and Sites Searched** | **Number of results** | **Limits applied, revised number of results (if applicable)** |
| **PubMed: (“Most” relevant searches) 1. “Cerebral palsy” terms + hippotherapy-related terms 2. “Cerebral palsy” terms + hippotherapy terms + balanc\* (limits: years 1990 to 2014)3. “cerebral palsy” terms + hippotherapy terms + (balanc\* OR stability) 4.”Cerebral palsy” terms + hippotherapy terms + balanc\* NOT simulat\* OR artificial5.”Cerebral palsy” terms + hippotherapy terms + balance\* + comparison terms (conventional PT, etc)** | **1. 42** **2. 10****3. 10****4. 5** **5. 0** | ***(All searches) Applied limits: English, Child: birth-18 yrs*****2. Removed date limits: 12 results** |
| **CINAHL1. Final Search: with comparison terms2. Final search + NOT simulat\*** | **1. 3 2. 1** |  |
| **Cochrane Library>Using “cerebral palsy” terms + hippotherapy + balanc\*** | **4** |  |
| **Pediatric APTA Journal****1. ”hippotherapy” and “cerebral palsy” 2. ”horse” and “cerebral palsy”**  | **1. 43 2. 15** | **-Applied limit: articles only (excluded images, podcasts, videos, blogs): 27 results-Database did not have a good way to search articles with multiple Boolean terms – had to read through titles/abstracts to find appropriate articles (sorted by relevance)** |
| **EMBASE1. cerebral AND palsy AND hippotherapy NOT simulat\*2. cerebral AND plasy AND hippotherapy NOT (simulator OR mechanical OR simulated OR artificial) AND [English]/lim** | **1. 272. 23** | **-Limits: human + adolescent or child + article or review** **-Sorted articles by relevance** |

## INCLUSION and EXCLUSION CRITERIA

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| **Inclusion Criteria** |
| * English publications
* Published between 1999 to present
* Peer reviewed publications
* Randomized control trials, cohort studies, case control studies
* Studies involving ambulatory children
* Outcome measure used before and after intervention
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| **Exclusion Criteria** |
| * Abstracts, dissertations
* Case reports and expert opinion
* Articles published before 1999
* Studies not related to the population or outcome of concern
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**RESULTS OF SEARCH**

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| A total of  | 9 | relevant studies (2 with separate phases) were located and categorized as shown in the following table based on Levels of Evidence, Centre for Evidence Based Medicine (2011) and “Critical Review Form – Quantitative Studies”quality assessment rating scale.3 |

**Summary of articles retrieved that met inclusion and exclusion criteria**

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| **Author (Year)** | **Study quality score** | **Level of Evidence** | **Study design** |
| **Benda, McGibbon, Grant (2003)4** | **12** | **1b** | **Small RCT, pre-posttest design** |
| **Bertoti (1988)5** | **11** | **4** | **Pre-experimental: Single group time-series design (no control)** |
| **Drnach, O’Brien, Kreger (2010)6** | **10** | **4** | **Pre-experimental: Single subject time-series design (no control)**  |
| ***Haehl, Giuliani, Lewis PHASE 1(1999)7*** | ***9*** | ***4*** | ***Pre-experimental: kinematic data collection*** |
| **Haehl, Giuliani, Lewis PHASE 2 (1999)7** | **12** | **4** | **Pre-experimental: Single group time-series design (no control)** |
| **Kwon, Chang, Lee, Ha, Lee, Kim (2011)8** | **13** | **2b** | **Nonrandomized prospective controlled trial** |
| **MacKinnon, Noh, Macphail, Allan, Laliberte (1995)9** | **10** | **1b** | **RCT** |
| **McGibbon, Benda, Duncan, Silkwood-Sherer PHASE 1 (2009) 10** | **15** | **1b** | **RCT** |
| **McGibbon et al PHASE 2 (2009)10** | **12** | **4** | **Pre-experimental: Single group time-series design (no control)** |
| **Shurtleff, Standeven, Engsberg (2009)11** | **12** | **2b** | **Quasi-experimental; *repeated measures pre-posttest design (without blinding or randomization)*** |
| **Shurtleff and Engsberg (2010)12** | **12** | **2b** | **Quasi-experimental; *repeated measures pre-posttest design***  |

**BEST EVIDENCE**

The following 3 studies were identified as the ‘best’ evidence and selected for critical appraisal. Reasons for selecting these studies were:

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| * **Shurtleff and Engsberg (2009)11 :** This study is of good quality (12/15) based on my assessment and is a relatively higher level of evidence (2b) compared to the other studies I found. While this study may seem of lower quality than a few of the other options I had to chose, I found that it better fit my criteria and looked more closely at the outcomes I want to consider for my CAT.
* **Kwon et al (2011)8 :** This article proved to be high quality (13/16 = “very good” based on my assessment) and is a relatively higher level (2b) of evidence compared to some of the articles I found. While the study was nonrandomized, blinding did occur. Furthermore, the study had a control group that included children undergoing PT (NDT) versus the experimental group that was getting hippotherapy and PT.
* **Benda et al (2003)4 :** This study was of good quality (12/16) and higher level of evidence relative to other articles I reviewed. While it only included one single session of hippotherapy, I thought that it would be interesting to include considering it was well designed and, while they were not chosen, multiple other articles I reviewed also involved a single session of therapy.
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**SUMMARY OF BEST EVIDENCE**

**(1) Description and appraisal of “Changes in Dynamic Trunk/Head Stability and Functional Reach After Hippotherapy” by Shurtleff TL, Standeven JW, and Engsberg JR (2009)11**

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| **Aim/Objective of the Study/Systematic Review:** |
| The objective of this study was to measure and quantify changes in the stability of the head/trunk and upper extremity functional reach among children with spastic diplegia cerebral palsy after hippotherapy intervention.  |
| **Study Design** |
| Quasi-experimental; repeated measures pre-posttest design (without blinding or randomization). Outcomes measured at baseline (pretest 2 weeks prior to intervention), 12 weeks post-intervention, and 12 weeks after the completion of the intervention (washout period). Age-matched, nondisabled children were used for normative data comparison to the experimental group, but did not undergo any treatment. |
| **Setting** |
| Intervention location included three local therapeutic riding centers near St. Louis, MO (Therapeutic Horsemanship in Wentzville, MO; Ride-on St. Louis in Kimmswick, MO; and Exceptional Equestrians of the Missouri Valley in Washington, MO)11Testing center location: Human performance lab at Washington University School of Medicine in St. Louis, MO |
| **Participants** |
| Participants within the intervention group: * n=11
* Ages 5-13 years (average 8 years)
* Diagnosis of spastic diplegic CP (ability to sit upright on a static surface), GMFCS levels I-IV
* 6 boys, 5 girls
* Able to communicate, follow directions, abduct hips to sit on a horse, no recent botulinum toxin injections or surgery (including planned interventions during research study time frame), no “significant history of riding,” no additional neuromuscular, cognitive, sensory, psychological, or attention impairments.11(pg1186)
* One participant dropped out after the 1st post-test (during the washout period)
* Participants were recruited for the study, but authors do not indicate how or where from.

Age-matched normative comparison group:* n=8
* Ages 5-13 years (average 8 years)
* No disabilities
* 5 boys, 3 girls
* Participants were recruited for the study, but authors fail to indicate how. Control group participants were compensated for their participation ($25).
 |
| **Intervention Investigated** |
| *Control - no treatment;* ***normative comparison*** *group.* |
| Age-matched non-disabled children completed the battery of testing (by unspecified researchers) related to the study for normative data comparisons to the experimental group. However, this group did not undergo the treatment. Furthermore, they were not retested at posttest 1 or posttest 2.  |
| *Experimental – hippotherapy group.* |
| * *OT/PT evaluated to determine specific impairments and to “develop a unique treatment”11*
* Intervention was provided by either an OT, PT, or Occupational Therapy Assistant. All therapists received training from the American Hippotherapy Association, and were registered as level II hippotherapy therapists with the North American Riding for the Handicapped Association (aka PATH).11
* Intervention consisted of 45 minutes mounted on a mobile horse, during which time the therapist assisted and coached the children on UE reaching activities, positional changes on the horse, stretches, games, and exercises while the horse varied it’s speed and gait to provide rhythmic movement.11
* Sessions occurred 1 time per week for a total of 12 weeks (9 hrs of therapy total) at one of three therapeutic riding centers in the St. Louis area (all Premier Accredited Centers with PATH).11
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| **Outcome Measures** (Primary and Secondary) |
| Tests were administered in a lab by researchers (unspecified) in the Human Performance Laboratory (Washington University School of Medicine in St. Louis, MO), and did not involve healthcare providers who administered the intervention. For both tests, maximum scores or ranges were not specified; however, scores from the age-matched non-disabled children were to be used for comparison. **Barrel Test11: Used to gather head angle (movement variability, range of motion, and minimum head angle in saggital plane) and anterior-posterior translation data*** A mechanical barrel 18-inches in diameter was used to assess head/trunk control. Foam blocks placed around thighs and hips were used to stabilize the rider’s pelvis during testing for safety and proper positioning. The barrel moved on wheels on a steel track.
* While using surface markers (19 total) on multiple points of the rider’s head and trunk and 4 markers on the barrel to be used as a frame of reference, the mechanical barrel moved in a “precisely reliable testing motion to challenge and test trunk/head stability.”11(pg1188)
	+ Subjects rode for 2 trials at a speed of 1 Hz while a “6-camera video capture system” measured the movement relative to the surface markers on the rider, thereby creating a “stick-figure” image.11(pg1188)
	+ During the tests, children were given a small object to hold at their abdomen with both hands (to prevent supporting themselves with their UEs) and were also directed to look at a specified target (spot on the wall, their parent) to keep them facing forward with their head stable during video capture.1

**Upper-Extremity Functional Reach Test11: Used to gather data on reach path and elapsed time*** Subjects sat on a static surface (without back support) while wearing 9 surface markers (4 placed on floor to establish frame of reference). A shoulder height target with a reflective marker was set at an initial distance where the child could reach towards the object without eliciting trunk movement.
* Starting with hands resting on his/her thighs, the subject was then asked to research towards and touch the marker with his/her index finger. This was repeated 3 times to each side within the frontal plane.
* After completing the more simple reaching tasks, targets were moved 10cm and 15cm for younger (5-9y) and older (12-13y) participants, respectively. This extension of the reach required subjects to elicit trunk movement and recover back to a resting position.
 |
| **Main Findings** |
| *{Priori significance level of alpha = 0.05 used for a repeated measures analysis of variance, independent t-tests compared data at 3 points in time for the experimental group.}** Mean change values for head angles (ROM) and movement variability (SD) were reported (Table 4).
	+ Pre to posttest 1: mean change = -0.38; ROM effect size = 1.14 (P<.05); SD effect size = 0.93 (P<.01)
	+ Pre to posttest 2: mean change = -0.18; ROM effect size = 0.66 (P<.01); SD effect size = 0.91 (P<.01)
	+ Posttest 1 to 2: mean change = 0.24; ROM effect size = -0.54; SD effect size = -0.10
	+ These results demonstrate large effect sizes for ROM and SD and suggest significant change in head control between pre and posttests, which was maintained post-washout period. There was no significant change between the posttests.
* Results for anterior-posterior translation analysis revealed that there was a “reduction in movement for all participants as the markers moved away from the barrel and towards the head.”11(pg1190) Researchers described the following two key findings: (1) “significant reduction in horizontal translation at C7, at the Cyclops eye, ad the Vertex”; and (2) the results demonstrated by group of children with CP after intervention brought their data closer to the comparison group (but the results “remained statistically different” from the comparison group post-intervention at P<.05).11(pg1190-1191)
* Changes in reach/path ratio were significant from pretest to posttest 2, as well as between posttest 1 and posttest 2 (no significant change between pretest and posttest 1). Changes in elapsed reaching time between pretest and posttest 1, pretest and posttest 2, and posttest 1 and 2 were all significant. For both variables, the differences between the experimental group and comparison group remained significant (P<.01).
* Data for 11 out of the 11 children with CP was included in the analysis of data from the pretest and first posttest; however, there was one dropout during the washout period and data for 10 of the 11 children with CP was analyzed for the second posttest.
* No adverse events reported.
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| **Original Authors’ Conclusions** |
| Based on the results of this study, researchers concluded that the improvements demonstrated in dynamic stability among children with spastic diplegic cerebral palsy suggest that hippotheray can improve motor control of the trunk and head in addition to upper extremity functional reaching. The results suggest that maintenance of these skills after 3 months post-intervention may allow for improved performance of functional tasks.  |
| **Critical Appraisal** |
| **Validity** |
| * The Critical Review Form – Quantitative Studies3 clinical evaluation tool score: 12/16
	+ All scores are out of 16 total points possible. Poor scores are considered below 8 points; fair: 9-10; good: 11-12; very good: 13-14; excellent: 15-16. Items on the form for which this article scored poorly include the following: absence of bias (no); sample size justified (no); outcome measures valid (no); significant difference between groups clinically meaningful (no).
* Potential for bias secondary to lack of blinding (of participants, healthcare professionals, and assessors administering tests), lack of randomization, and purposive sampling method
* No true control group used in this study to compare intervention effects, therefore difficult to compare hippotherapy to “placebo.”
* Recruitment methods were not specified (where, how).
* Children involved in this study were still allowed to undergo normal therapies (OT, PT), therefore making it difficult to determine if hippotherapy is effective alone. No descriptions of frequency of outside therapies were provided.
* The manner in which the results were presented was more narrative in nature, with only bits and pieces of appropriately useful statistical information provided. Examples include:
	+ Effect sizes were calculated and included in Table 4 for head angles and movement variability. No effect sizes were mentioned for anterior-posterior translational data or functional reach data (P values provided).
	+ Graphs were provided to display the differences between values at baseline, posttest 1, and posttest 2. Graphs for head angle data (head angle, range of motion, and movement variability) do not include the data from the comparison group (figs 5-7), unlike the other graphs provided for anterior-posterior translation and functional reach (figs 8 and 9).
	+ Differences between the comparison group and experimental group were not discussed at all in the results section for head angle data.
	+ “[P]ooled standard deviation” is mentioned, however, no value is provided anywhere in the article.11(pg1190) Unfortunately, without the standard deviation, an appropriate confidence interval and statistical power cannot be calculated.
	+ No raw data reported on individual subjects/variables, which may have allowed for calculation of appropriate statistics.
* Small sample size, with no justification provided.
* While GMFCS levels were listed in Table 1 (“Participant Recruitment Table”), authors did not discuss GMFCS scores of the study participants further or stratify scores for the intervention.11(pg1186) *[According to Palisano et al, children ages 4-6 who are classified as GMFCS level III can “sit on a regular chair but may require pelvic or trunk support to maximize hand function.”13 Furthermore, Palisano et al makes distinctions between levels III and IV, indicating that children in level III may sit independently, while children in level IV can “function in sitting” but usually require support.13 It is difficult to determine how these children may be classified for generalization purposes for future research.]*
* While the testing procedures could be replicated based on the level of detail provided by the article, it may be difficult to replicate the intervention as specifics regarding hippotherapy sessions are not clearly defined. Examples of activities are provided.
* Researchers stated that “marker placement reliability” and test-retest reliability using surface markers was excellent. No discussion of the validity of the outcome measures is provided, however.
* The UE Functional Reach test used in the study is not a true functional test and has therefore not been validated.
* Authors discuss limitations of the study, including confounding variables secondary to lack of a second preintervention baseline test (i.e. to look at effect of maturation, other therapies).
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| **Interpretation of Results** |
| The results of this study suggest that there may be some evidence that hippotherapy improves head/trunk stability. Overall, the data demonstrates significant changes from baseline to posttest 1 and posttest 2, and, moreover, demonstrates large effect sizes for head angle movement variability and range of motion, specifically. However, the difference between the experimental group and the comparison group “remained significantly different.”11(pg1191) No significant difference was found for any of the variables between posttest 1 and posttest 2, suggesting that children maintained treatment effects after the 12 week washout period. While changes in scores for each variable were considered statistically significant from baseline to both posttests, it is difficult to determine clinical significance based on the overall shortcomings of this study as a result of how the researchers chose to report their findings. Without data on the confidence intervals, standard deviations, power, or minimal clinically important difference, it becomes difficult to truly interpret these results and determine significance. While the authors did not fully explain the validity of their measures, it is likely that the study assumes validity. Unfortunately, data on validity of these measures was unreported, making it difficult to apply this to a patient population, as it is unclear what amount of change is clinically meaningful. |

**(2) Description and appraisal of “Effects of Hippotherapy on Gait Parameters in Children With Bilateral Spastic Cerebral Palsy” by Kwon JY, Chang HJ, Lee JY, Ha Y, Lee PK, and Kim YH (2011)8**

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| **Aim/Objective of the Study/Systematic Review:8** |
| The objective of this study was to assess how hippotherapy effects spatial and temporal parameters as well as hip and pelvic kinematics of gait among ambulatory children diagnosed with bilateral spastic cerebral palsy.  |
| **Study Design** |
| Quasi-experimental; nonrandomized repeated measures pre-posttest design with examiner blinding. Outcomes measured at baseline prior to intervention and after 8 weeks of hippotherapy intervention. Control group received conventional physical therapy, but did not undergo hippotherapy intervention.  |
| **Setting8** |
| Hippotherapy intervention was provided in an 18x27m indoor riding arena located in the small city of Gunpo, Kyunggido, Republic of Korea. Conventional PT was provided to both the control and experimental group at a “local gymnasium” near Gunpo, Kyunggido, Republic of Korea via Samsung’s Riding for the Disabled Program.8(pg775) Testing center for gait analysis: Department of Physical and Rehabilitation Medicine, Sungkyunkwan University School of Medicine, Samsung Medical Center, Seoul, Republic of Korea.  |
| **Participants8** |
| Characteristics of all participants (intervention and control group): * Diagnosis of bilateral spastic diplegia associated with cerebral palsy (GMFCS levels I-II; 1:3 ratio of level I: level II)
* Purposive sample of children recruited for this study from “outpatients at Samsung Medical Center” between October 2008 to June 2010; however, authors do not indicate how participants were recruited.8(pg775)
* Participants were required to weigh no more than 35kg (approximately 77lbs), as the limit of the child’s body weight was determined to be “20% of the horses weight” per recommendations of the North American Riding for the Handicapped Association.8(pg775)
* Subjects were excluded if they had a history of recent botulinum toxin injection (within 6 months prior), recent selective dorsal rhizotomy or orthopedic surgical procedure (within 1 year prior), moderate to severe cognitive disability, uncontrolled seizure disorder, or poor visual or hearing acuity.8(pg775)
* No dropouts were reported during the course of the study.

Participants within intervention group:* n=16
* Ages 4-9 (average 6.4 +/- 1.7 years)
* 11 boys, 5 girls
* Average body weight: 21.8kg (+/-6.9kg)
* Previous surgery (>1 year s/p): n=3

Participants within control group: * n=16
* Ages 4-9 (average 6.1 +/- 1.7 years)
* 10 boys, 6 girls
* Average body weight: 19.8kg (+/- 5.5kg)
* Previous surgery (>1 year s/p): n=4
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| **Intervention Investigated** |
| *Control - Conventional PT group (no hippotherapy).*  |
| Subjects allotted to the control group underwent conventional physical therapy only. Licensed physical therapists provided PT at a local gymnasium. Sessions were two times a week, with 30 minutes of neurodevelopmental therapy (NDT) provided. Therapy was delivered for the duration of the study (8 weeks). The authors did not address specific NDT techniques/protocols delivered by the therapists.  |
| *Experimental - Hippotherapy plus conventional PT group.*  |
| Subjects in the intervention group received 30 minutes of hippotherapy two times a week for the duration of the study (8 weeks) in addition to conventional physical therapy (two times a week, 30 minute sessions of NDT, for 8 weeks). Licensed physical therapists delivered hippotherapy treatment sessions at an indoor arena in Gunpo, Kyunggido, Republic of Korea via Samsung’s Riding for the Disabled Program. All therapists were American Hippotherapy Association certified (level I or II). Experienced horse trainers and two volunteer side walkers assisted with therapy sessions. At each session, two participants were grouped together, but received therapy from separate therapists. Ponies were matched to children as best as possible based on size and functional status. All riders used a fleece soft saddle for maximum subject-pony contact, and all participants donned safety helmets. Hippotherapy protocol from McGibbon et al was implemented and included “muscle relaxation; sustenance of optimal postural alignment of head, trunk, and lower extremities and independent sitting; and active exercises (stretching, strengthening, dynamic balance, postural control)…”8(pg775),14 Furthermore, exercise intensity was tailored to each participants ability in order to successfully enable postural control. Throughout each session, subjects were encouraged via assistance from side walkers (as needed) to sustain postural alignment with all activities.  |
| **Outcome Measures** (Primary and Secondary) |
| Gait analysis was performed by researchers (not specified) in the Department of Physical and Rehabilitation Medicine (Sungkyunkwan University School of Medicine) using the Vicon 612 Motion Analysis System.8(pg775) PTs who administered treatments were not involved in testing. For two of the secondary outcome measures (GMFM scores and PBS scores), the same blinded examiners tested the children before and after hippotherapy intervention. For all measures, including standardized outcome measures, maximum scores and/or ranges were not discussed. Temporospatial and kinematic analysis of the primary outcome measures and one secondary measure (hip and pelvic kinematics) utilized the Vicon system and Plug-in-Gait marker systems.8(pg775) Bodily landmarks (including ”anterior superior iliac spine, sacrum, lateral thigh, lateral femoral condyle, lateral tibia, lateral ankle malleolus, posterior calcaneus, second metatarsal head”) were used that reflected infrared light on the lower extremities.8(pg775) Children were instructed to walk “as you would normally walk” at a self-selected speed, barefoot along a 6m pathway.8(pg775) Children were able to practice several times to familiarize themselves with the path until three “’good’ trials were achieved.” 8(pg775) A “good” trial was defined as one in which the markers were not obstructed for “accurate 3-dimensional reconstruction.” 8(pg775) One of those three trials was then selected to “best represent the gait for each participant,” and movement analysis was performed using the Vicon Clinical Manager software. 8(pg775) Further statistical analysis was performed on the more affected lower extremity, identified as the limb with the shorter stride length. 8(pg775) **Primary Outcome Measure:** Temporospatial Parameters Using the Vicon system, the following parameters were examined before and after hippotherapy intervention: * Stride length (cm)
* Cadence (steps per minute)
* Single limb support (percentage)
* Walking speed (cm per second)

**Secondary Outcome Measure**: Pelvic and Hip Kinematics Using the Vicon system and analysis performed by a single physician, children in both groups who had “clinically significant” pelvic anterior tilt (>15o) were selected for analysis (hippotherapy group: n=12; control group: n=11). 8(pg775-76) * Parameters compared included the following: “average pelvic anterior tilt, pelvic anterior tilt at initial contact, pelvic anterior tilt at terminal stance, pelvic range of motion, maximal hip extension at terminal stance, hip flexion at initial contact, and range of hip flexion/extension” 8(pg775)

**Secondary Outcome Measure**: GMFM ScoreThe GMFM-88 was administered to all participants before/after intervention and converted to GMFM-66 scores with the Gross Motor Ability Estimator. 8(pg775) This outcome measure evaluates gross motor function among children with cerebral palsy in 5 domains, including “(A) lying and rolling, (B) sitting, (C) crawling and kneeling, (D) standing, and (E) walking, running, and jumping.” 8(pg775) Additional components of the measure were not specified. **Secondary Outcome Measure**: PBS ScoreThe PBS (Pediatric Balance Scale) is “a modified version of the Berg Balance Scale.” 8(pg775) This test was administered to all participants before/after intervention by the same blinded examiner. Details regarding components of this measure were not discussed. |
| **Main Findings**8(pg776-78) |
| *[Significance was considered at P<0.05. Statistical analysis conducted using paired t-test and repeated measures two-way analysis of variance. The intervention was used as the covariate for ANOVA calculations of within and between-group differences.]* * All participants were determined to be similar based on “age, sex, GMFCS level, weight, height, and history of surgery.” 8(pg776) At baseline for all outcome measures, there were no statistically significant differences between the intervention and control groups.
* Temporospatial parameters:
	+ Walking speed (cm/s) increased among both the intervention and control groups, with statistically significant differences observed between pre and post test speeds (p<0.05).

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| **Walking Speed** | **Pre** | **Post** | **P Pre-Post** | **P****Interaction** | **Effect Size(Cohen d)** |
| Control | 48.6 +/- 0.1  | 60.7 +/- 0.1 | .002\* | 0.815 |  0.085 |
| Hippotherapy | 55.0 +/1 0.2 | 68.0 +/- 0.2 | .004\* |

\*Statistically significant difference between pre/post tests. * + The hippotherapy group demonstrated statistically significant improvements in stride length compared to control (p<0.05). Furthermore, the data demonstrates a statistically significant interaction (P interaction = .004) between the hippotherapy and control groups, and a large effect size (1.106).

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| Stride Length | Pre | Post | PPre-Post | PInteraction | Effect Size (Cohen d) |
| Control | 51.1 +/- 0.1 | 53.9 +/- 0.2 | .360 | .004 | 1.106 |
| Hippotherapy | 52.9 +/- 0.1 | 68.0 +/- 0.1 | <.001\* |

\*Statistically significant difference between pre/post tests. * + No significant change in cadence was observed within the hippotherapy group (p<0.05). In contrast, the control group demonstrated a significant change in cadence. Data demonstrated a significant interaction (P interaction = 0.010) and large effect size (0.976) as well.

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| Cadence | Pre | Post | PPre-Post | PInteraction | Effect size (Cohen d) |
| Control | 114.0 +/- 19.8 | 128.5 +/- 18.7 | 0.013\* | 0.010 | 0.976 |
| Hippotherapy | 121.3 +/- 26.1 | 117.0 +/- 22.4 | .351 |

\*Statistically significant difference between pre/post tests.* + Neither group demonstrated statistically significant change for single leg support (hippotherapy: 35.5 +/- 0.1 [p=.660] versus control: 35.6 +/- 0.1 [p=.993]; p<.05).
* Pelvic and Hip Kinematics
	+ No statistically significant differences were found for either group from pre to post-testing.
	+ When authors analyzed data regarding subjects with significant anterior pelvic tilt (>15o) statistically significant interaction was found for average pelvic anterior tilt, pelvic anterior tilt at initial contact, and pelvic anterior tilt at terminal stance.
	+ Among the subset of participants with anterior pelvic tilt >15o, authors noted decreased average pelvic anterior tilt during gait, at terminal stance, and at initial contact only among participants in the hippotherapy group. Data for these three parameters demonstrates statistically significant interaction between the two groups as well as large effect sizes (p<0.05). Authors did not report p values (Pre-Post test) for these parameters. Other changes in hip/pelvic kinematics were not statistically significant.

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| **Variable** | **Pre** | **Post** | **P****Interaction** | **Effect Size****(Cohen d)**  |
| Average pelvic anterior tilt (deg):* Control
* Hippotherapy
 | 20.2 +/- 5.423.6 +/- 23.6 | 21.0 +/- 6.417.1 +/- 7.0 | 0.032 | 0.967 |
| Pelvic anterior tilt at initial contact (deg):* Control
* Hippotherapy
 | 18.5 +/- 4.721.5 +/- 6.8 | 19.1 +/- 5.915.9 +/- 6.8 | 0.045 | 0.903 |
| Pelvic anterior tilt at terminal stance (deg):* Control
* Hippotherapy
 | 16.1 +/- 5.118.9 +/- 7.5 | 16.6 +/- 7.012.1 +/- 6.0 | 0.033 | 0.958 |

* GMFM and PBS Test Scores
	+ Authors found no significant interaction between the two groups for total GMFM-88 scores and dimension D of the GMFM after the 8-week study. However, significant interactions were observed for dimension E scores on the GMFM, total scores for GMFM-66, and scores for the PBS. Large effect sizes were reported for GMFM-66 scores and PBS scores, and a medium effect size was reported for GMFM dimension E. P-values (pre-posttest) were not reported for this data set.

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| Variable | Pre | Post | PInteraction | Effect size(Cohen d) |
| GMFM: “E”* Control
* Hippotherapy
 | 65.3 +/- 20.067.2 +/- 17.5 |  66.9 +/- 20.174.6 +/- 19.3 | 0.042 | 0.753 |
| GMFM-66* Control
* Hippotherapy
 | 69.8 +/- 8.770.4 +/- 7.4 | 70.1 +/- 8.173.7 +/- 8.6 | 0.003 | 1.138 |
| PBS * Control
* Hippotherapy
 |  41.0 +/- 10.441.7 +/- 8.8 |  41.5 +/- 10.645.8 +/- 8.6 | 0.004 | 1.120 |

* No adverse effects reported.
 |
| **Original Authors’ Conclusions** |
| Based on the study’s results, authors concluded that hippotherapy may be used in concert with conventional physical therapy among children with bilateral spastic cerebral palsy, GMFCS level I or II, for improving gait and balance. Authors state that this was the first prospective controlled clinical trial to demonstrate hippotherapy’s favorable effects on temporospatial factors and pelvic motion during the gait cycle among children with cerebral palsy.  |
| **Critical Appraisal** |
| **Validity** |
| * The Critical Review Form – Qualitative Studies3 clinical evaluation tool score: 13/16.
	+ Areas of concern for this study include a lack of discussion of the validity of outcome measures, potential for bias, and insufficient details regarding specific interventions.
* Potential for bias secondary to lack of blinding (of participants, healthcare professionals, and some of the assessors performing gait analysis), lack of randomization, and purposive sampling methods. Only the assessors who administered the GMFM and PBS measures were blinded. Reporting bias may additionally be of concern for this article secondary to the lack of p-value report associated with some of the outcomes measured, including outcomes for pelvic and hip kinematics as well as GMFM and PBS test scores.
* Authors do not discuss how participants were recruited, but do mention the facility they were recruited from. The authors do not state whether all referrals were from one doctor or a single clinic. Understanding how participants were recruited is important for establishing the internal validity of this study, and for ensuring that the study population is representative of the general population of children with bilateral spastic cerebral palsy.
* Authors in this study failed to address the validity and reliability of the GMFM-88, GMFM-66 and the PBS tests among a population of children with bilateral spastic cerebral palsy. Furthermore, authors analyzed gait parameters, but did not discuss the validity of using said parameters among a population of children with cerebral palsy.
	+ GMFM-88 scores were obtained, but converted to GMFM-66 scores. Authors do not discuss their reasoning for score conversion.
	+ Authors did not provide any discussion of normative data values, GMFM/PBS maximum or minimum scores, or a range of expected values for gait parameters and hip/pelvic kinematics.
* Children in both groups of the study participated in PT. Researchers point out that they “did not restrict participation in conventional physiotherapy.” 8(pg779) Statistically significant interaction effects were demonstrated by multiple parameters in this study, suggesting that hippotherapy used in combination with conventional physical therapy enhanced the score outcomes at post-test.
* While a thorough description of the gait analysis procedure is provided, it may be difficult to replicate interventions used in this study as specifics of conventional PT (NDT) and hippotherapy sessions are not indicated. Authors reference McGibbon et al in relation to the hippotherapy treatment protocol utilized in the study, but do not sufficiently describe number of sets or repetitions of the “active exercises” performed by participants.8(pg775),14
* Small sample size (total n=32) with only 16 participants per group. However, authors justify this through their discussion of their *a priori* power analysis. Sample size calculations were performed using the “mean value for the absolute difference in stride length between sessions in children with hemiplegic cerebral palsy” obtained from previously reported values established in the Mackey et al study. 8(pg775),15 When designing the study, authors determined 13 children were needed for both groups for a “detection of a difference of 6cm or more between the 2 groups with 10% [alpha] error level and power of 80%.”8(pg775) It is unclear if the previously reported values utilized for this analysis were appropriate based on the characteristics of the study sample utilized (hemiplegic versus bilateral involvement). Furthermore, it could be argued that sample size was only calculated with regard to stride length and not for the additional outcome measures/parameters examined in this study. Large effect sizes were found for multiple variables that were not statistically significant (based on no report of p-values). Type I Error is possible.
* Validity for using gait parameters and hip/pelvic kinematics as outcomes has not been established, nor was normative data discussed by the authors. Hip/pelvic kinematics was only examined in children in the sample who had pelvic anterior tilt greater than 15o – not all children (because 15o considered clinically significant).
* No information was provided regarding session attendance, but all participants were included in post-test measurements.
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| **Interpretation of Results** |
| There is some evidence supporting the use of hippotherapy in conjunction with conventional physical therapy for improvement of gait parameters, particularly with regards to stride length. Statistically significant change and large effect size were observed in the hippotherapy group with respect to the stride length variable. While authors report large effect sizes for cadence, anterior pelvic tilt kinematics (average tilt, tilt at initial contact, and tilt at terminal stance), GMFM-66 scores, and PBS scores, p-values were either not reported or not significant with respect to the hippotherapy group, which leads one to question the overall statistical significance of the authors’ findings. Statistical significance and a large effect size were reported for cadence within the control group only; however, it is worth noting that increased cadence is a typical compensation for maintaining or increasing speed among individuals with gait disorders.8 Interestingly, mean cadence decreased (but was not statistically significant) among the hippotherapy group while stride length increased. Furthermore, it is important to note that sample size was calculated through *a priori* power analysis for only the stride length variable, which further supports the robustness of the author’s findings with regards to this parameter. However, it is unclear if the sample size used in the study reached the appropriate level of power for other parameters such as outcome measure scores (GMFM, GMFM-66, PBS) and pelvic/hip kinematic data. Large interaction values and effect sizes were reported for multiple variables, suggesting that hippotherapy used in conjunction with conventional PT may be more effective for improving gait and balance than conventional PT alone. However, statistical significance was not reported for many of these variables (no p-values), making it difficult to determine the overall clinical significance of these findings. Since standard PT was provided to both groups, it is difficult to isolate the effects of hippotherapy alone based on the design of this study. Additionally, as the authors failed to discuss the validity of their measures, it must be assumed that this study assumes validity. Unfortunately, it is unclear what amount of change is necessary based on data and discussion provided by the authors for any of the outcome measures to determine whether the results (excluding results for stride length) are clinically meaningful. The study location (Republic of Korea) and the shortcomings observed regarding data report limit the generalizability of the results to the general cerebral palsy population in the United States.  |

**(3) Description and appraisal of “Improvements in Muscle Symmetry in Children with Cerebral Palsy After Equine-Assisted Therapy (Hippotherapy)” by Benda W, McGibbon NH, and Grant KL (2003)4**

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| **Aim/Objective of the Study/Systematic Review:** |
| The objectives of this study were to assess the changes in muscle activity following a single hippotherapy session upon a moving horse, and compare those effects to that of sitting on a stationary barrel.  |
| **Study Design** |
| Small randomized control trial using a pre-posttest design immediately before and after intervention. Subjects were randomized to either the treatment (hippotherapy) or control (stationary barrel) group using a “balanced design.” 4(pg819) Participants were blinded to which group they would be in until “after enrollment and electrode placement.”4(pg819) |
| **Setting** |
| All testing was conducted at Therapeutic Riding of Tuscon (TROT), Tuscon AZ. [*EMG surface testing was performed in the natural outdoor setting using remote telemetered surface EMG equipment.]* |
| **Participants** |
| Characteristics of all participants (n=15)* 4-12 years old
* Unknown number of male/female subjects
* Diagnosis of spastic cerebral palsy; GMFCS not reported
* Able to sit independently without back support, feet flat; stand and walk with/without an assistive device; and follow verbal directions. Participants also had sufficient hip abduction range of motion to sit on a horse or barrel. Subjects could not have a history of selective dorsal rhizotomy; uncontrolled grand mal seizure disorder; allergies to testing equipment or horses; surgical procedure or botulinum toxin injection within 12 months prior to study; uncorrected visual impairment; moderate to severe cognitive impairment; or hearing impairment. 4(pg819)
* All subjects recruited through physician, physical therapist, and local pediatric clinic referrals.

Participants in the hippotherapy group:* n=7
* No dropouts reported.

Participants in the control group:* n=8
* Two children in the control group had to be dropped from the study because their EMG leads would not stay on, leading to inaccurate readings.
 |
| **Intervention Investigated** |
| *Control – Barrel Group* |
| Subjects were randomly allocated to this group. During testing, barrel group subjects sat astride a stationary barrel for eight minutes. The barrel was made “from a 55-gallon drum approximating the girth of a horse” which was fashioned with a fleece pad and set on supports to approximate the average height of a horse.4(pg820-21) While on the barrel, subjects watched a video of a horse and were encouraged to “maintain forward attention and quiet sitting.” 4(pg821) After the testing, subjects were rewarded with a ride on a horse. |
| *Experimental – Hippotherapy Group* |
| Subjects allocated to the hippotherapy group received eight minutes of therapy while sitting astride a moving horse. Two trained therapy horses with similar stride lengths, one of medium build and the other of smaller size, were chosen to accommodate the varying sizes of the children in the group. The horses were fashioned with “a fleece pad and flat surcingle (a belt to secure the pad).” 4(pg820) Children were mounted facing forward on the horse, and a horse handler, physical therapist, and assistant walked around a track at a “steady” pace for four minutes clockwise, and four minutes counter-clockwise. 4(pg820) Neither the PT nor the assistant provided postural support for the child. |
| **Outcome Measures** (Primary and Secondary) 4(pg819-20) |
| All testing was performed at the TROT center using remote telemetered surface EMG equipment under the direction of a physical therapist who was certified as a “Hippotherapy Clinical Specialist” through the American Hippotherapy Certification Board. 4(pg819) Electrodes were placed “symmetrically and bilaterally to the posterior cervical (C4 paraspinals), posterior thoracic (T12 paraspinals), posterior lumbar (L3-4 paraspinals), and adductor and abductor muscle groups of the upper thigh” based on standard positioning guidelines. 4(pg819) Each child wore a helmet, regardless of group placement. Participants were asked to sit still on a bench without back support and feet flat on the ground while EMG recordings gathered data for 10 seconds. Data recordings were repeated for 10 seconds with the child in quiet standing and while walking along a flat, 10-foot board. The child did not receive any assistance from researchers, but was permitted to use his/her assistive device as needed. Left- and right-sided muscle activity was measured for each muscle group before and after intervention. Primary outcome measures were asymmetry scores recorded at pre/post tests, from which researchers calculated the absolute difference in mean (mV) values between left and right muscle groups. |
| **Main Findings**4(pg822-23) |
| *[Authors reported that 2 children from the control group had to be dropped from the study after their leads would not remain in place, which led to inaccurate EMG readings.]* * Cervical paraspinal data was not analyzed because participants were unable to maintain a neutral head/neck position during the testing, therefore making the recordings “unreliable” as voluntary motion of the head/neck would result in asymmetry of thoracic musculature. 4(pg823)
* “Highest PreTest Asymmetry Score” (Table 1) was reported for each child (excluding 2 drop outs). 4(pg822) Muscle groups with the “greatest difference” in activation (mV) varied between each subject, with eight out of 13 children demonstrating the greatest difference in muscle activation during walking. 4(pg822-23)
* No baseline mean values or percentages reported.
* Authors reported “Percentage Change in Asymmetry Score” (Table 2), and found a 64.6% (standard deviation of 28.3%) percentage improvement from pretest to posttest in the hippotherapy group versus 12.8% (standard deviation of 88.8%) improvement for the children in the barrel group. 4(pg823) Mean change in asymmetry scores for the hippotherapy group was 55.5 +/- 82.5, and 11.9 +/- 29.9. P-values were reported for mean change in scores (p=0.24) and percentage improvement (p=0.051), but no alpha level or confidence level was established. (pg823)
* No statistical difference between groups was reported.
 |
| **Original Authors’ Conclusions** |
| Authors concluded that eight minutes sitting on a moving horse improved muscle symmetry among children with spastic cerebral palsy. Authors state that the motion from the horse is responsible for improvements in symmetry rather than the passive stretching that occurs while the child sits astride the horse. |
| **Critical Appraisal** |
| **Validity** |
| * The Critical Review Form – Qualitative Studies3 clinical evaluation tool score: 12/16
	+ Areas of concern for this study include no justification provided for choice of sample size, sample characteristics not described in detail, outcome measures not valid, and potential for bias.
* It appears that participants and researchers were initially blind to group allocation, but were no longer blind once the intervention began and as the researchers gathered results. Lack of blinding and purposive sampling methods could contribute to potential bias.
* Based on the information provided, authors did not clearly describe the sample.
	+ The number of male and female participants was not reported.
	+ GMFCS levels were not reported or stratified. However, considering the inclusion criteria and the fact that subjects were allowed to use assistive devices for standing and ambulating, GMFCS levels I-III were likely included. Based on GMFCS level distinctions, children at GMFCS level IV may be able to ambulate short distances with physical support, thus making it difficult to conclude that children at GMFCS level IV were or were not included in the study.13
* Calculated scores of mean change in asymmetry and percentage change demonstrated large standard deviations. While this can happen with data, it is possible that data could be considerably skewed secondary to outliers or high variability. Authors admit that one outlier may have affected the baseline data for the barrel group, which “appeared to show less asymmetry of muscle activity prior to testing.”4(pg824) However, no additional discussion of potential outliers is provided.
* Baseline data was not included in a discussion of the results.
* Authors did not discuss a power analysis (a priori or post-hoc). Therefore, it is likely that the very limited sample size failed to achieved adequate power.
* Authors did not report a confidence level or alpha level for data. If 95% confidence or alpha=0.05 can be assumed, the reported p-values (p=0.24 and p=0.051) suggest that there was likely no statistically significant difference between the intervention and control groups.4(pg823) Therefore, the differences demonstrated by the data could likely be due to chance versus the intervention itself.
* Despite valid use of surface EMG data, other aspects of internal validity are questionable.
	+ Participant/examiner bias possible
	+ Two subjects dropped out in the barrel group
* External validity: poor generalizability to more general population of children with cerebral palsy. Unclear how representative this sample was due to missing information.
* No follow up performed to examine lasting results/effects after the eight minutes of therapy.
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| **Interpretation of Results** |
| Based on the evidence provided in this article, it would be appropriate to interpret Benda, McGibbon, and Grant’s findings with caution. While authors claim hippotherapy intervention resulted in significant reductions in asymmetry, particularly with regards to hip adductor symmetry scores, it is unclear based on the validity of this study if these results can be generalized to a larger population of children with cerebral palsy. While authors discuss how hippotherapy provides a repetitive challenge to postural control based on evidence from other hippotherapy studies, this paper does not establish a causational association between muscle symmetry and postural control/balance through statistical substantiation. The authors did not discuss determining which changes in EMG data (mV) are clinically meaningful. Authors did not establish a confidence/alpha level for statistical significance and reported p-values were greater than 0.05, suggesting that results were not statistically significant at the traditionally accepted level and are potentially due to chance. Furthermore, it is difficult to determine the magnitude of hippotherapy’s effect without discussion of effect size. Attrition may have unbalanced the groups in this study such that disparities in group characteristics inappropriately influenced the study’s results. Without knowing more information about patient characteristics (specifically, sex and individual GMFCS scores), it is difficult to determine attrition’s effect on reported data. Moreover, statistical power could be further diminished due to the reduction in sample size. Lack of long-term follow up further limits our understanding of hippotherapy’s impact in this population. In summary, this study provides weak evidence in support of hippotherapy for improving balance among children with cerebral palsy. |

 **IMPLICATIONS FOR PRACTICE and FUTURE RESEARCH**

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| **Implications for clinical practice:** The evidence reviewed in this paper provides some support for the use of hippotherapy as an intervention for children with cerebral palsy; however, hippotherapy’s effect on static and dynamic balance among this population remains unclear. Considering balance and equilibrium are often abnormal in children with cerebral palsy, connecting hip and trunk kinematics, muscle symmetry, and trunk stability as influences of balance appears theoretically sound.4,8,11 Furthermore, hippotherapy requires patients to utilize multiple bodily systems (sensory, motor, and cognitive) and adapt their posture simultaneously while riding a moving horse that is essentially providing a dynamic base of support.4,8,11 Critical reviews of articles by Shurtleff, Standeven, and Engsberg (2009), Kwon et al (2011), and Benda, McGibbon, and Grant (2003) revealed that there is a limited body of evidence that provides only weak support for the use of hippotherapy among ambulatory children with cerebral palsy to improve static and dynamic balance.4,8,11 Furthermore, none of the articles suggest replacing traditional physical therapy with hippotherapy, but some evidence supports using hippotherapy in conjunction with other therapies.8 Practitioners should recognize that the results of these studies only demonstrate relatively short-term benefits, as long-term effects of hippotherapy (i.e. >6 months, >1 year post-intervention) were not described. Despite a lack of high-level conclusive evidence, hippotherapy should not be discarded as a potential adjunct therapy to recommend to children with cerebral palsy. Currently, this form of therapy is offered throughout North Carolina and Virginia to children with cerebral palsy.16 If a child is deemed appropriate for hippotherapy, there is no harm in his or her participation. Not only does the intervention have the potential to improve gross motor outcomes, hippotherapy can offer “cognitive, emotional, and social stimulation” to a child with a neuromuscular disorder.4(pg823) Hippotherapy could conceivably provide new physical and mental experiences that have not been offered through more conventional treatment strategies.4 While no adverse effects were reported among any of the three studies, patients and families should be made aware of the risks associated with interacting with a horse.Provision of hippotherapy is currently limited to specialized horse riding centers and is not offered in a typical clinical setting. Furthermore, reimbursement for hippotherapy treatment is currently not covered by many major insurance providers, which results in an additional expense for families considering this as a treatment option. Affordability becomes another factor to consider, as out-of-pocket costs associated with hippotherapy vary.17-19 As the body of knowledge surrounding hippotherapy intervention grows, it is important that current and future physical therapists are aware of the potential value of this form of therapy. For those interested in becoming certified hippotherapy PTs, certification courses are available through the American Hippotherapy Association.20 All therapists providing hippotherapy should have experience in the field, with the appropriate knowledge and skill to provide safe interventions to achieve established goals. When recommending hippotherapy to patients, practitioners and student physical therapists alike should consider the current evidence surrounding hippotherapy. Clinical judgment, the child’s subjective and objective data, and patient/family preferences should additionally be reflected upon for making an informed, appropriate decision for recommending hippotherapy. **Future Research:**Conclusions derived from each study reviewed suggest that future research is necessary for understanding the effectiveness of hippotherapy among a population of children with cerebral palsy. Future research should include randomized control trials with greater sample sizes and greater methodological rigor to provide evidence for the clinical significance and efficacy of hippotherapy. Correlational studies on hippotherapy that assess the connection between postural control and functional change would be advantageous. Dosage (intensity and/or duration) and long-term effects need to be considered during future research studies to determine appropriate, effective intervention plans. More suitable outcome measures that are sensitive to changes that accompany hippotherapy intervention should also be identified and validated for this intervention among a population of children with cerebral palsy. Kwon et al proposes the use of force plates for measuring center of gravity positions that may better reflect changes in postural control and balance.8 Cost-effectiveness should also be considered and studied, as maintenance of horse riding centers and the inherent need for a greater amount of assistance (i.e. physical therapist, side walkers, etc) may increase out-of-pocket costs for families, thus acting as a barrier to utilizing this form of therapy.  |

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