**PICO QUESTION**

For children with neuromotor impairments, is hippotherapy more effective than conventional physical therapy in improving physical and psychosocial function?

**INTRODUCTION**

 Children with neuromotor impairments, whether of developmental or acquired origin, often receive physical therapy to maximize their function. Historically, physical therapy for children with neuromotor impairments has involved conventional clinic-based interventions like functional training or strengthening exercises, which have been effective in improving functional outcomes.9 More recently, though, complementary physical therapy interventions have gained popularity. Hippotherapy (HPOT) is a complementary physical therapy intervention that “utilizes equine movement as part of an integrated intervention program to achieve functional outcomes”.1 Hippotherapy has been recommended for children with neuromotor impairments associated with a variety of conditions including acquired brain injury, cerebral palsy, developmental delay, Down syndrome, spinal cord injury, and spina bifida.1 Furthermore, HPOT has been proposed to have positive effects on physical and psychosocial outcomes.13In HPOT, the child is positioned on the horse, and the horse’s movement is directed to influence the child’s sensory and motor responses. While the child is atop the moving horse, tasks can be incorporated to work on functional goals related to attention, cognition, communication, and fine and gross motor skills.1

 While HPOT’s positive effects on functional outcomes have been reported,**7,8,13** costs associated with operating a HPOT program can be high and access to programs can be limited. Hippotherapy is a labor-intensive intervention involving a specially trained team comprised of a physical therapist, horse handler, side walker, and equine. Most hippotherapy programs are located in rural areas and often have wait lists, and some programs only accept private payment; therefore, access can be difficult. When potentially less costly and more accessible conventional physical therapy interventions are available, HPOT may be hard to justify; however, if HPOT is more effective in achieving improvements in physical and psychosocial function in children with neuromotor impairments, efforts should be made to improve service availability and access.

The purpose of this review is to critically appraise the HPOT literature and to determine whether

HPOT is more effective than conventional physical therapy interventions in improving physical and psychosocial function in children with neuromotor impairments.

**COMPARING THE EVIDENCE**

***The Effects of Hippotherapy on Function in Children with CP***

 Cerebral palsy is “a group of permanent disorders of the development of movement and posture, causing activity limitation, that are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain”. **18** Cerebral palsy is the most common cause of motor disability in children and the most common neurologic condition seen by pediatric physical therapists,**2,4** so it is not surprising that seven of the ten studies included in this review involve children with cerebral palsy, and the four that follow recruited only children with CP.

In the first HPOT study of sound methodological quality, McGibbon et al. used a repeated measures design to examine the effects of HPOT on gait parameters, energy expenditure and gross motor function in ambulatory children with CP.16 The Energy Expenditure Index, observational gait analysis and Gross Motor Function Measure (GMFM) were used to assess outcomes. Five children with diplegic and hemiplegic CP between the ages of nine and 11 years participated. Intervention involved 30 minute HPOT sessions twice a week for eight weeks. While there was a trend toward increased stride length and decreased cadence, there were no statistically significant changes in gait parameters. There were, however, statistically significant improvements in energy expenditure and gross motor function related to walking, running and jumping.

 Casady and Nichols-Larsen also employed the repeated measures design to examine the effects of HPOT on functional performance but recruited ambulatory and non-ambulatory children with CP.3 Ten children ages two to six years with varying forms of CP participated in 20 to 30 minute HPOT sessions once a week for 10 weeks. Functional performance was measured using the GMFM and the Pediatric Evaluation of Disability Inventory (PEDI). The researchers reported statistically significant improvements in GMFM and PEDI total scores and concluded that HPOT may have a positive effect on functional performance in young children with CP.

 Chang et al. continued the trend of using the repeated measures design in a larger study recruiting 33 children with cerebral palsy (Gross Motor Function Classification System levels I, II, III, and IV).6 The children, whose mean age was 73 months, participated in 30 minute HPOT sessions twice a week for eight weeks. Outcomes of interest were gross motor function as measured by the GMFM and the Pediatric Balance Scale. The researchers reported statistically significant improvements in gross motor function and concluded HPOT was an effective intervention to improve gross motor function in children with varying severity levels of CP. In contrast to the first two studies,3,16 Chang et al. reduced the potential for measurement bias by using different physical therapists to administer outcomes and provide intervention.6

Though Casady and Nichols-Larsen reported statistically significant improvements on the PEDI Social Subscale,3 psychosocial function was not a primary outcome of interest in first three studies reviewed. 3,6,16 After searching the literature, only one quantitative study was found that included psychosocial function as an outcome. Frank et al. examined the effects of HPOT on functional skills, participation and perceived self-competence and social acceptance in a six-year old girl with mild ataxic CP GMFCS level I.12 The child participated in 30 minute HPOT sessions twice a week for eight weeks. The following outcomes were assessed: the GMFM, the Pediatric Outcomes Data Collection Instrument (PODCI), and the Pictoral Scale of Perceived Competence and Social Acceptance for Young Children (PSPCSAYC). Significant improvements were reported for function and participation as measured by the GMFM and PODCI and for psychosocial outcomes of physical competence and maternal and peer acceptance as measured by the PSPCSAYC. This case report demonstrated the potential for HPOT to impact psychosocial function and the need for larger, more rigorously designed studies.

 While the first four studies provided support for HPOT to positively affect physical function and highlighted the need for studies to explore the potentially positive effects on psychosocial function,several limitations were noted. 3,6,12,16 The studies by McGibbon et al, Casady-Nichols Larsen and Frank possibly introduced measurement bias, which can affect internal

validity.3,12,16 Future studies should minimize this risk by having different therapists administer outcomes and provide intervention. While most HPOT studies have involved participants with

CP, HPOT has been recommended for children with neuromotor impairments associated with a variety of conditions. It is, therefore, important to review the evidence for children with other conditions.

***The Effects of HPOT on Function in Children with Other Conditions***

 Using a repeated measures design Murphy et al. recruited children with CP and developmental delay to measure the impact of HPOT on physical function, which was assessed using the Goal Attainment Scale (GAS).17 The four participants ages five to eight years participated in 60 minute HPOT sessions once a week for six months. The results were mixed; two children showed significant improvements, one child had no change, and one child had a decline in function. The researchers suggested medical instability was a factor negatively impacting outcome. In contrast, parents suggested the GAS did not capture improvements in function they observed at home.

 In the next two studies, the researchers again used the repeated measures design but recruited children who had a variety of conditions with related neuromotor impairments.19,10 First, Silkwood-Sherer et al. recruited 16 children with documented balance impairments associated with autism, cerebellar hyperplasia, CP, developmental coordination disorder, developmental delay, and visual impairment that ranged in age from five to 16 years.19 The purpose of the study was to determine the effects of HPOT on balance and functional performance in daily life skills. The children participated in 45-minute HPOT sessions twice a week for six weeks. Pre and post intervention scores from the Pediatric Balance Scale (PBS) and Activities Scales for Kids-Performance (ASKp) were compared, and significant improvements were reported. Next, Encheff et al. recruited 11 children with neurological impairments related to brain injury, Guillian Barre syndrome, CP, and cerebrovascular accident and used three-dimensional motion analysis to assess the effects of HPOT gait kinematics.10 The children, who were between the ages of three and 12 years, participated in 45 minute HPOT sessions once a week for 10 weeks. The researchers reported moderate and large effect sizes for more upright trunk posture and decreased anterior pelvic tilt, respectively.

 Champagne and Dugas were the first researchers to focus specifically on HPOT’s effects on postural control in children with Down syndrome.5 The case reportsinvolved two young children with Down syndrome ages 28 and 37 months who participated in 30 minute HPOT sessions for

11 weeks.Gross motor function and postural control were assessed pre, mid and post intervention using the GMFM and accelerometers, respectively. Both children had significant improvements on GMFM dimension E (walking, running and jumping scores), but the results from accelerometer testing were mixed with one child having improvements in head control and the other having improvements in trunk control. Of note, technical problems with the accelerometer post intervention necessitated comparison of pre and mid intervention accelerometry data; therefore, the potential effects from several more weeks of HPOT were not captured.

 While the four studies reviewed provide favorable support for using HPOT to improve physical function in children with a variety of conditions, two limitations were identified and were related to the outcomes of interest and the conditions represented by the samples.5,10,17,19 First, none of the studies included psychosocial function outcomes. While the study by Silkwood-Sherer included the ASKp, which potentially captures aspects of participation in daily life skills (personal care and self-care), psychosocial function was not a primary outcome of interest.19 To address all aspects of the International Classification of Functioning, Disability and Health’s enablement model, future studies should include outcomes related to psychosocial function. Second, with the exception of the case reports by Champagne and Dugas,5 the other studies either had small samples sizes without power analysis or included children with chronic and non-chronic conditions with differing rates of recovery and potentials for change in function.10,17,19 With few children representing each condition, the generalizability of the results to a larger population of children with a specific condition is limited.

***Studies Comparing Hippotherapy to Conventional Physical Therapy Intervention***

 Thus far, the studies reviewed have used case reports or repeated measures designs with participants serving as their own controls and HPOT as the only independent variable. Case reports represent low-level evidence and have weak external validity. In comparison, repeated measures designs represent a higher level of evidence with reduced error variance and increased power. Although eight studies have been presented, none have compared HPOT to other interventions using a control group. Citing this need, Kwon et al. conducted a controlled trial to evaluate the effects of HPOT on gait in children with spastic diplegic CP.15 The primary outcome of interest was temporospatial gait parameters as measured by three-dimensional motion analysis. Secondary outcomes included pelvic and hip kinematic gait parameters as measured by three-dimensional motion analysis, gross motor function as measured by the GMFM and balance as measured by the Berg Balance Scale (BBS). Physical therapists administering the outcomes were blinded to intervention. Thirty-two children between the ages of four and 10 years with GMFCS levels I and II participated and were allocated non-randomly to an intervention group receiving 30 minutes of HPOT plus conventional physical therapy (neurodevelopmental therapy) or a control group receiving 30 minutes of conventional physical therapy; both groups received intervention twice a week for 8 weeks. While the intervention and control groups had statistically significant increases in walking speed, the control group had significant increases in cadence, and the intervention group had significant increases in stride length and decreases in anterior pelvic tilt, and improvements in GMFM and BBS scores. The researchers concluded HPOT plus conventional physical therapy had a beneficial effect on gait compared to conventional physical therapy alone; however, the unequal treatment time between the intervention and control groups (60 minutes and 30 minutes per session, respectively) potentially overestimated the effects of HPOT. Furthermore, the absence of random allocation potentially introduced confounding effects. These limitations threaten the study’s internal validity; therefore, the results should be interpreted with caution.

 In one of the few randomized controlled trials from the HPOT literature,Kang et al. examined the effects of HPOT on sitting balance in children with severe CP.14 Forty-five children between the ages of six and nine years with diplegic or hemiplegic CP were recruited and randomly allocated to one of three groups: HPOT plus traditional physical therapy (HTG), traditional physical therapy (PTG), or no intervention (CON). The outcome of interest was sitting balance assessed by force plate measures of center of pressure pathway (COP) and velocity. The researchers reported significant decreases in COP pathway and velocity for the HTG group and concluded that HPOT plus traditional physical therapy was more effective than traditional physical therapy alone in improving sitting balance in children with CP. Despite being the largest study included in this review and random allocation to intervention and control groups, the study had several methodological limitations. First, little information was provided about participants’ baseline sitting balance, and from a clinical practice standpoint, the relationship between laboratory and functional measures of sitting balance were not explored. Second, it was not clear whether the researcher collecting data was blinded to intervention. Third, the timing of pre and post intervention assessments was not reported, and whether participants demonstrated stability prior to intervention or whether confounding variables were introduced between the last session and post-intervention assessment is unknown. Last, though HPOT treatment time was not reported, the HTG group received HPOT plus 30 minutes of traditional physical therapy. Once again, the greater overall treatment time for the HTG group compared to the PTG group potentially led to an overestimation of the effects of HPOT.

 In summary, the studies by Kwon et al. and Kang et al. represent a shift towards using more rigorous research designs, but considerable methodical limitations influence the interpretation of results.14,15 Neither study provided sufficient detail about the conventional physical therapy interventions. References were made only to “neurodevelopmental therapy” and “stretching and strengthening exercises”. Additionally, combining HPOT with conventional physical therapy, limits conclusions about HPOT alone being responsible for improvements in function.

**CONCLUSION AND DISCUSSION**

***Critical Analysis of the Evidence***

 While the evidence reviewed provides preliminary support for HPOT to improve aspects of physical function, critical analysis revealed several issues that limit conclusions and application to clinical practice. The issues were related primarily to sampling, study design, intervention dosage, and outcomes. The majority of studies involved small samples and recruitment of children with CP. All studies recruited samples of convenience and sample size justification was only performed in three studies.6,15,19Only four of the ten studies included children with neuromotor impairments related to conditions other than CP, and there were few children representing each condition.17,19,10,5 Given these limitations results cannot be generalized to all children with neuromotor impairments. The repeated measures design was most commonly used.3,6,10,16,17,19 While the repeated measures design eliminates potential between group differences and increases the study’s power, without a comparison group, conclusions cannot be drawn about HPOT’s effectiveness over conventional physical therapy interventions. Across studies, HPOT treatment time, frequency and duration were variable, which limits conclusions about optimal dosage for HPOT. With respect to outcomes, only one study focused on the outcome of psychosocial function.12 Current physical therapy research and practice should reflect the widely accepted International Classification of Functioning, Disability and Health’s

biopsychosocial model of enablement.**11** In this review of the literature, HPOT shows promise as an intervention to have positive effects on body structure and function and activity but limited evidence is available for its effect on participation and related psychosocial function.

***Recommendations for Future Research***

 Despite encouraging evidence for HPOT to positively impact function, it cannot be concluded that HPOT is more effective than conventional physical therapy intervention in improving physical and psychosocial function in children with neuromotor impairments. To answer this question, RCTs are needed. Future research should target populations of children most commonly seen by pediatric physical therapists; provide detailed descriptions of comparison interventions and protocols; select clinically meaningful, psychometrically sound outcome measures related to physical and psychosocial function; blind raters to intervention; and provide adequate post-intervention follow-up.

***Application to Clinical Practice and Capstone Project***

 To determine whether HPOT or conventional physical therapy intervention is the more appropriate for a child with neuromotor impairments, physical therapists should use available evidence, their clinical judgment, subjective and objective data, and child and family preferences in the decision making process. From a clinical standpoint, HPOT is rarely used in isolation and is more often part of a comprehensive plan of care that includes other interventions to achieve functional goals. If the goal is to improve postural control, factors associated with gait, gross motor skills, and functional performance in daily life skills, HPOT is supported by the evidence and is an intervention to consider.

 In closing, physical therapists that provide HPOT should have training to safely and effectively carry out intervention. In seven of the 10 studies reviewed, the physical therapists providing HPOT had American Hippotherapy Association training.3,5,6,10,15,16,19 For reasons related to safety, knowledge and skill, parents and other healthcare providers should be educated about finding qualified HPOT providers. This literature review provides a starting point for a capstone project aimed at educating health care providers, patients and families about HPOT as an intervention to improve function in children with neuromotor impairments.

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