

The Effect of Hippotherapy on Postural Control in Sitting for Children with Cerebral Palsy

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ABSTRACT. The purpose of this single subject research study was to examine the effects of a once weekly, 10-week hippotherapy program for three children, ages 27-54 months, with cerebral palsy. Participants were rated as Level V on the Gross Motor Function Classification System. The Sitting Dimension of the Gross Motor Function Measure was used to establish a baseline of sitting abilities, and was administered every 2 weeks during intervention. The Sitting Assessment Scale and the Gross Motor Function Measure were administered before, after, and 4 weeks post-intervention. Parental perceptions of the hippotherapy intervention were assessed using questionnaires. None of the children made gains on any of the standardized outcome measures. Parental perceptions were very

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positive, with reported improvements in range of motion and head control.
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Hippotherapy is the use of a horse as part of an integrated treatment strategy for children and adults with movement dysfunction. Unlike therapeutic horseback riding, where riding skills are taught to individuals with disabilities, hippotherapy is a treatment strategy performed by health professionals, such as physical and occupational therapists, in which the horse is used as a therapeutic intervention (NARHA, 1998). The goals of hippotherapy are to improve the client's posture, balance, mobility, and function. The back of the walking horse imparts a three-dimensional movement to the pelvis of the rider that is thought to be similar to the human's pelvic movement during gait (Fleck, 1992). The therapist directs the movements of the horse while analyzing the client's responses. Modifications in the terrain, the horse's speed or direction, or the rider's position, or functional tasks can be made to provide an appropriate movement challenge. As indicated by the American Hippotherapy Association (www.americanhippotherapyassociation.org) persons who may benefit from hippotherapy include those with diagnoses of cerebral palsy (CP), developmental delay, Down syndrome, and traumatic brain injury.

According to a systems theory of postural control, "The task of postural control involves the body's position in space for (a) stability, defined as controlling the center of body mass within the base of support, and (b) orientation, defined as the ability to maintain an appropriate relationship between the body segments and between the body and the environment for a task" (Shumway-Cook & Woollacott, 2001, p. 190). Putting a child with movement dysfunction on a horse provides myriad opportunities for the child to respond to the movement of the horse while performing functional tasks like reaching. The rider must maintain the head, trunk, and arms (body mass) over the base of support (the pelvis), when sitting on a horse, and is presumed to be practicing postural control in the sitting position. The rider is an active participant who makes continuous

adjustments to maintain postural control on a dynamic surface. Responding to the movements of the horse requires both reactive and anticipatory postural adjustments, both of which can be impaired in children with CP (Shumway-Cook, Hutchinson, Kartin, Price, & Woollacott, 2003; Liu, Zaino, & Westcott, 2000).

There are many reported benefits of hippotherapy for children with CP including improvements in standing posture (Bertoti, 1988), symmetry of muscle activity (Benda, McGibbon, & Grant, 2003), gross motor function (Casady & Nichols-Larsen, 2004; Haehl, Guiliani, & Lewis, 1999), and self-perception (MacKinnon et al., 1995). Decreases in energy expenditure during ambulation have also been reported (McGibbon, Andrade, Widener, & Cintas, 1998). Several studies have indicated that hippotherapy may lead to improvements in standing balance, energy expenditure, and mobility skills for ambulatory children with CP (Bertoti, 1988; Casady & Nichols-Larsen, 2004; Haehl, Guiliani, & Lewis, 1999). However, results are mixed for children with CP with more severe levels of involvement, such as children who are non-ambulatory (Sterba, Rogers, France, & Vokes, 2002).

Bertoti (1988) conducted the first data-based study in the area of hippotherapy. Using a scale developed for the study, Bertoti examined posture in 11 children ages 2 years 4 months to 9 years 5 months with spastic diplegia or quadriplegia. The children participated in one-hour hippotherapy sessions conducted by the author twice weekly for 10 weeks. A repeated measures design with two baseline measurements taken 10 weeks apart and a post-test after the riding program was used. Three physical therapists observed and independently rated each child in standing, with the author providing support to the child as needed. A Friedman test between the three median scores was significant ($df = 2$, $p < .05$), with 8 of the 11 children demonstrating improvement in standing postural control. Subjective improvements in balance were also reported by parents and therapists. This study suggests a trend of greater improvement with the younger, less severely involved children with CP.

MacPhail et al. (1998) quantified postural reactions while riding in 6 children with CP (mean age 6.7 years) and seven children without CP (mean age 8.1 years). Children were videotaped in the frontal plane while riding the same horse at a walk. Children with CP showed significantly ($p < .001$) greater and more variable lateral trunk deviation than the children who were typically developing. Children with diplegia averaged smaller lateral movements (mean = 8.3 degrees) when compared to the children with quadriplegia (mean = 12 degrees) and responded with normal postural reactions more frequently (65-75% of the

time) than children with quadriplegia (10-35% of the time). In this study children were allowed to stabilize their trunks with their hands, and possible changes in postural reactions over time were not evaluated.

In 1999, Haehl et al. developed a kinematic tool to assess postural reactions in the sagittal plane in 2 subjects with CP, a 9 1/2-year-old child with spastic athetoid quadriplegic, a power wheelchair user, and a 4-year-old child who ambulated with a reverse walker. Both subjects were videotaped at the beginning of five one-hour hippotherapy sessions throughout their 12-week, once weekly, individualized hippotherapy program. While both children demonstrated improved postural reactions, only the child who was ambulatory showed significant (greater than 2 standard errors) gains in the Mobility and Social Function domains of the Pediatric Evaluation of Disability Inventory (Haley, Coster, Ludlow, Haltivanger, & Andrellos, 1992) after the riding program.

In 2002, Sterba et al. examined the effects of a one-hour-per-week, 18-week riding program using the Gross Motor Function Measure-88 item version (GMFM-88) (Russell et al., 1993). Seventeen children with a diagnosis of CP (12 with spastic diplegia, 3 with spastic quadriplegia, and 2 with spastic hemiplegia) with a mean age of 9 years, 10 months participated. Participants served as their own controls. Assessments were performed 6 weeks before riding began, at the onset of riding, every 6 weeks during the riding program, and 6 weeks following the riding program. There was a significant ($p < 0.04$) improvement in total GMFM-88 scores during intervention, and a significant ($p < 0.03$) change in the GMFM Dimension E (walking, running, and jumping) that lasted six weeks post-intervention. The five children who were non-ambulatory, however, did not demonstrate changes in total GMFM scores. Sterba et al. recommended further studies that include larger numbers of children with more severe disabilities.

Several limitations were identified in the research on hippotherapy. In all the studies, sample sizes were small and only one study (MacKinnon et al., 1995) utilized a control group. Content of the hippotherapy intervention was not always adequately described to allow for replication and tended not to be standardized across subjects. Descriptions for classifying subjects into groups were very general (e.g., ambulatory versus non-ambulatory) and did not necessarily provide homogeneity of groups. One important variable that was not always described was whether children were allowed to use their hands to stabilize their trunks, or how much support was given to the child to keep them safely positioned on the horse during hippotherapy. The task demands on the rider are dramatically changed if

the hands are not used for stabilization or if external support is not given while on horseback.

Although they often participate in hippotherapy programs, little research has been done on children with CP who require external support to maintain a sitting position. The purpose of this single subject research study was to examine the effects of hippotherapy for three young children with CP classified in Level V on the Gross Motor Function Classification System (GMFCS) (Palisano et al., 1997).

METHODS

Participants and Settings

A convenience sample of three children, 27-54 months of age, with a diagnosis of CP participated in this study. All participants met the following inclusion criteria: (1) age between 20 months and 5 years with a diagnosis of quadriplegia as confirmed by physician, (2) Level V on the GMFCS, (3) no previous participation in a hippotherapy or therapeutic riding program, (4) postural instability in all sitting positions as defined by obtaining a minimum score of 10% but less than 25% on the GMFM Dimension B (Sitting), (5) parental commitment to the study, and (6) no contraindications excluding them from involvement in a hippotherapy program (NARHA, 1998). For safety reasons, children with uncontrolled seizures or who were unable to wear a helmet were excluded from participating. Characteristics of participants (with pseudonyms) are given in Table 1.

TABLE 1. Participant Characteristics

Child	Gender	Age	Diagnosis	GMFCS* Level	Concurrent Therapies	Initial GMFM** Score (Dimension B)
Roger	M	4 yrs. 6 mo.	Mixed quadriplegic CP	V	OT, PT, Speech	15%
Beth	F	3 yrs. 6 mo.	Hypotonic quadriplegic CP	V	OT, PT	18%
Sam	M	2 yrs. 3 mo.	Dystonic quadriplegic CP	V	OT, PT	16%

*Gross Motor Function Classification System for Cerebral Palsy (Palisano et al., 1997).

**Gross Motor Function Measure (Russell et al., 1993).

Roger could indicate “yes” and “no” reliably with head movement, and communicated using single words. He was able to follow simple directions. Beth and Sam communicated using eye gaze to indicate wants, but did not respond to verbal directions. Sam was motivated to reach for desired objects. All participants could sit for 4-5 seconds in ring sitting on the floor while propping on their hands. All three children had manual wheelchairs with modifications including head, trunk, pelvis, and foot supports.

Children were recruited following referral to the hippotherapy program sponsored by a local birth-to-three center. When a child who met the inclusion criteria was referred, an informational flyer was mailed to their home, and the parent was instructed to contact the first author if they wished inclusion or if they had questions about the study. When parents contacted the first author and agreed to participate, a home visit was arranged. Informed consent was obtained and a screening conducted in the child’s home to insure all inclusion criteria were met before baseline data were collected. All hippotherapy sessions were conducted at a therapeutic riding center. This study was approved by the Institutional Review Board at the University of Washington.

Measures

The two standardized outcome measures utilized were the Gross Motor Function Measure-88 item version (GMFM-88) (Russell et al., 1993); and the Sitting Assessment Scale (SAS) (Myhr, 1993). Two parent questionnaires were developed, one for pre-intervention and one for post-intervention. Response options utilized a Likert scale and open-ended questions (described in Results section) were included to assess anticipated and perceived effects and perceived value of the hippotherapy program.

The GMFM-88 is an evaluative measure designed to quantify changes in gross motor function in children with cerebral palsy. It is divided into the five following dimensions: (A) lying and rolling, (B) sitting, (C) crawling and kneeling, (D) standing, and (E) walking, running, and jumping. Items are scored on a 4-point ordinal scale. Dimension scores and the total score is expressed as a percentage of the maximum score for that dimension (0-100%). A total score is obtained by adding the percentage for each dimension and dividing by 5. Several studies have documented reliability and validity (Bjornson, Graubert, McLaughlin, Kerfeld, & Clark, 1998; Russell et al., 1989, 1998, 2000; Trahan & Malouin, 1999),

including when scoring videotaped assessments (Nordmark, Haggland, & Jarnlo, 1997).

The SAS was designed to assess postural control and functional control of arms and hands for different sitting positions in children with CP. A 4-point ordinal scale is used for each of five areas (head control, trunk control, foot control, arm function, hand function) with a "1" indicating *no control/function* to a "4" indicating *good control/function*. Using Spearman's rank order correlation coefficients, inter-rater reliability coefficients on the SAS ranged from .78 to 1.0 for individual scale area scores, with intra-rater reliability coefficients ranging from .57 to 1.0 for inexperienced raters (Myhr, von Wendt, & Sandberg, 1993). No validity studies were found.

Baseline and Intervention Measurements

As it was not possible to start all children in the study at the same time, a non-concurrent multiple baseline design was used (Watson & Workman, 1981). Baseline data were collected across randomly assigned periods of two, three, or four weeks. The GMFM Dimension B (Sitting) was administered three times for baseline data collection in the child's home, every two weeks during the intervention phase at the riding center, and at a follow-up assessment four to six weeks post-intervention. The entire GMFM and the SAS were administered at home on the first and last days of the intervention phase, and at the follow-up assessment. Follow-up data were collected with some variability due to vacation schedules. The first author administered all measures throughout the study period. Written pre-intervention and post-intervention questionnaires were completed by the participants' parents.

One parent was present during all testing sessions. The GMFM and SAS were administered by the first author in the standardized manner described in the manuals, and a checklist was used to insure procedural reliability. Additional standardized procedures for the SAS for each child included placing blocks under the feet of two of the children (Beth and Sam) to provide stability, and an insert placed behind one child's (Beth) back to promote an upright trunk. The parent was allowed to closely guard and give support to the child for safety, when appropriate, and any assistance given was noted and recorded. Table height was adjusted to just below the level of the elbows. All data collection sessions were videotaped with a camcorder mounted on a tripod.

Inter-Rater Agreement

Three phases of inter-rater agreement were established using percentage of agreement calculated as the number of agreements divided by the total number of agreements plus disagreements multiplied by 100 (Kazdin, 1982). Prior to data collection and following a training session using videotapes, the first author reached a minimum of 90% inter-rater agreement with an “expert” physical therapist who had 9 years experience using the GMFM in a research setting. To examine inter-rater percentage of agreement for items on the GMFM, the expert physical therapist and first author scored from videotape one GMFM for each child. Percentage of agreement between the first author and the expert was 81.0% on the last data collection for Roger, 78.2% for Beth, and 83.8% for Sam.

Three occupational therapists with pediatric experience (Rater 1 = 4 years, Rater 2 = 25 years, Rater 3 = 3 years) scored videotapes for GMFM Dimension B and the SAS. Following a training period, each rater reached a minimum of 90% inter-rater agreement on the GMFM Dimension B and 100% inter-rater agreement on the SAS with the first author. After inter-rater agreement was established, each rater took the randomly ordered videotapes for one child home, and was instructed to complete the scoring of all tapes within one week. Raters were unaware of the purpose of the study and each independently scored one child’s videotapes. When a rater’s score differed from the first author on a specific item, an average of the two scores was used as final data.

Because the participants were unable to attempt many of the more challenging items, inter-rater agreement between the first author and the three raters on the GMFM Dimension B was calculated in two ways: (1) based on all possible items (20 items), and (2) based on the number of items attempted. Inter-rater agreements based on all possible items in Dimension B were acceptable (Kazdin, 1982) for all scores for all three children (Table 2). Agreements based on items attempted were slightly lower. Inter-rater agreement results for the Sitting Assessment Scale (SAS) were lower (range = .60-1.00) than for the GMFM Dimension B. Since there were only 5 items to score, a difference of one score lowered the percentage of agreement dramatically.

Hippotherapy Intervention

Following baseline, each participant began a 50-minute session of hippotherapy once weekly for 10 weeks. Sessions were conducted in an

TABLE 2. Item by Item Inter-Rater Agreement (Number of Agreements Divided by Total Number of Agreements Plus Disagreements Multiplied by 100)

	GMFM Dimension B*		Sitting Assessment Scale**
	Based on All Items in Dimension	Based on Items Attempted	
Roger			
mean	.94	.90	.80
median	.98	.96	.80
low/high	.80-1.0	.66-1.0	.80-.80
Beth			
mean	.99	.96	.87
median	1.0	1.0	.80
low/high	.95-1.0	.83-1.0	.80-1.0
Sam			
mean	.98	.94	.67
median	.98	.94	.60
low/high	.95-1.0	.88-1.0	.60-.80

*Gross Motor Function Measure (Russell et al., 1993).

**Sitting Assessment Scale (Myhr, 1993).

indoor arena and on outdoor trails as weather permitted. The same horse was used for all children for all sessions. All children used a saddle pad, lightweight approved helmet, and safety belt. Three people were needed to conduct all hippotherapy sessions; a physical therapist (first author) who conducted the session, a side walker, and a horse handler who led the horse according to the therapist's directions. The physical therapist had five years experience providing hippotherapy, was registered with the North American Riding for the Handicapped Association (NARHA), and was working toward her Hippotherapy Clinical Specialist credentialing through the American Hippotherapy Association.

Attempts were made to keep the participants positioned in midline on the horse. Riders were visually inspected on the horse from the posterior aspect every 5 minutes, and corrections were made by the physical therapist and side walker to manually align the midline of the horse and child as closely as visual inspection would allow. The horse handler was given instructions by the physical therapist as to changes of speed and direction in order to provide an appropriate challenge to the child. The North American Riding for the Handicapped (NARHA, 1998) contraindications, precautions, and safety rules were observed at all times.

A procedural checklist was developed prior to the sessions to insure as much consistency as possible. A log was kept of each session recording specifics of how much support was given, activities performed, attendance, and any other current relevant issues such as illness.

The hippotherapy intervention was individualized according to each child's abilities. (See descriptions below.) Children were given adequate support to insure safety and an optimal position on the horse. The physical therapist provided manual support as low as possible on the child's trunk to maximize the child's own postural responses. Due to the poor sitting abilities of the participants, all three children required external support given by the physical therapist to maintain an upright seated posture on the horse. All participants attended 100% of their intervention sessions.

Participant 1: Roger

The physical therapist stabilized Roger's trunk at the lower ribcage. Additionally, Roger held on to handles on a strap around the horse's girth during part of his sessions. His trunk control improved while reaching up for a ring or toy, enabling the therapist to withdraw manual trunk support for a few seconds at a time. This activity was repeated many times during a session to encourage trunk control. Roger tolerated facing forward, sideways, and backward on the horse. The horse was led at a moderate walking speed with gentle turns. Parents reported Roger became very ill between sessions five and six and lost 8 pounds. He appeared much less engaged in the hippotherapy sessions six through eight.

Participant 2: Beth

The physical therapist provided manual support at Beth's mid-torso. Beth worked on head control during sessions, especially holding her head up and looking to the right. She was able to prop on her arms with assistance. She tolerated facing forward, sideways, and backward on the horse and gentle turns. Beth was never able to sit without support of the physical therapists' hands around her torso at any time during any session.

Participant 3: Sam

Sam often needed manual support by the physical therapist at his mid-torso because of his tendency to hyperextend his trunk. He was very motivated to reach for objects and required less support at the trunk

when reaching up for toys and rings. This strategy was employed often in sessions to increase activity of trunk muscles as well as to work on reaching and grasping toys and reaching toward midline. He tolerated facing forward and sideways on the horse. The horse was led at a medium walk with gentle turns.

Data Analysis

Percentage scores for the GMFM-88 Dimension B, GMFM-88 total score, and the SAS raw scores were first put in tabular format. The results of the GMFM Dimension B were graphed for visual inspection and comparison. Parental questionnaires were summarized and results of the parental rating scale were reported as descriptive data.

RESULTS

GMFM-88 Dimension B

Baseline data for Roger and Sam ranged from 15 to 22.5%, Beth's scores were less variable (Figure 1). During intervention, all participants' scores were fairly stable with no trend change. When looking at participants' scores on an item-by-item basis, improvement on any given item did not change more than a single point, indicating stable performance. Visual inspection of the graphs shows no trend change during follow-up.

GMFM-88 Total Scores

For Roger, there was a slight upward trend between the pre- and post-intervention GMFM-88 total score, with a slight decline on follow-up testing (Table 3). Beth's scores reflected a slight downward trend from pre- to post-intervention. Sam's scores were very stable across all three testing sessions.

Sitting Assessment Scale (SAS)

Roger's scores across sessions showed a slight downward trend between pre- and post-intervention with a return toward baseline with the follow-up test (Table 4). A similar trend was noted for Sam. Results for Beth show almost identical scores across the three testing sessions.

FIGURE 1. Percent Scores for Sitting Dimension of Gross Motor Function Measure (88 item)

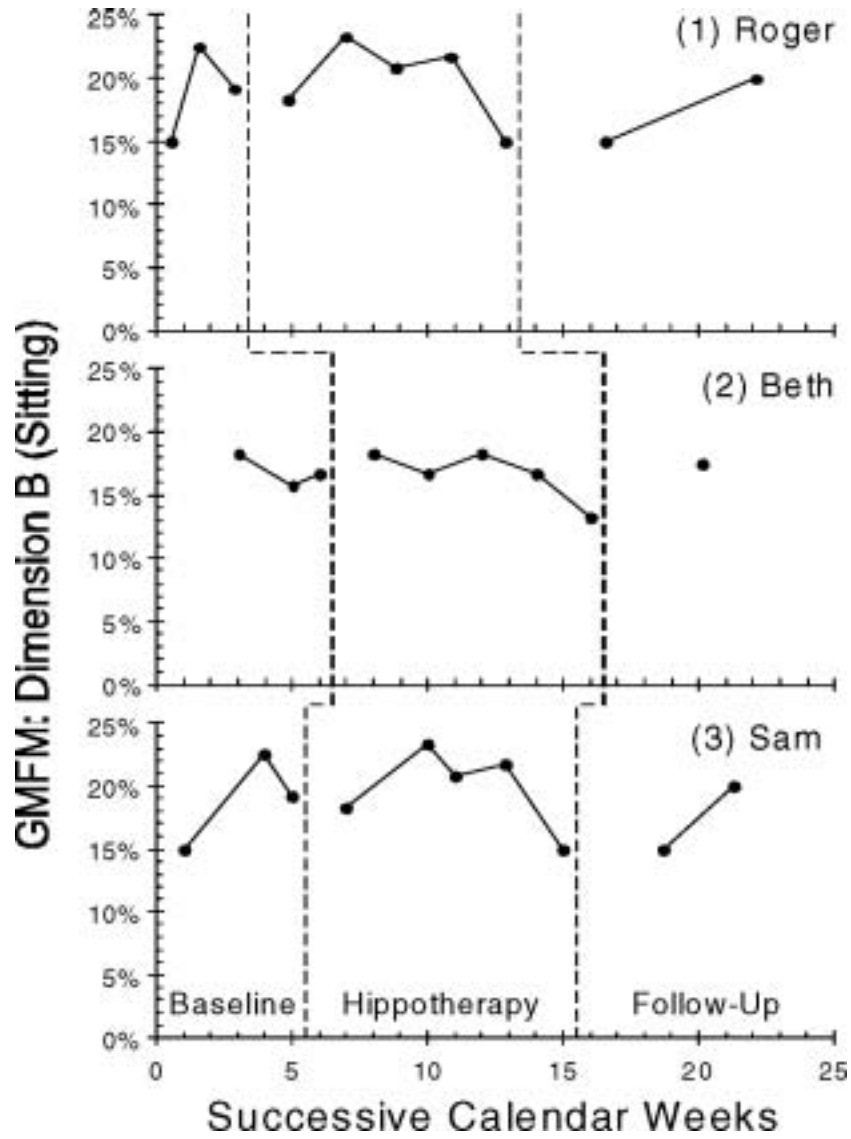


TABLE 3. Gross Motor Function Measure (GMFM-88) Total Percentage Scores of the Three Subjects

Child	Pre-Score	Post-Score	Follow-Up Score
Roger	14.6%	17.8%	16.9%
Beth	12.7%	9.7%	9.4%
Sam	11.4%	10.9%	12.0%

TABLE 4. Mean Raw Scores for the Sitting Assessment Scale (SAS)

Child	Pre-Score	Post-Score	Follow-Up Score
Roger	9.5	7.5	9
Beth	8.5	8	8.5
Sam	13	11	12.5

Raw scores for the SAS vary from 4 to 20.

Parent Questionnaires

Parents' comments indicated they had a good understanding of what hippotherapy was prior to the program starting. Their answers to the question "What do you believe hippotherapy is?" included the following: "A therapy that will help exercise his trunk muscles while on a horse," (Roger's mother); "It is a child learning to move with the movement of the horse," (Beth's mother); and "A therapy to help the child to have more control of his body (trunk and head)" (Sam's mother). When asked what effects they anticipated for their child through involvement in a hippotherapy program, all mothers mentioned improved trunk control or improved sitting, Roger and Beth's mothers mentioned improved head control, and Roger's mother added increased happiness and enthusiasm.

When asked to describe the effects the hippotherapy program had on their child, all three mothers felt their children had improved trunk control. Sam's mother talked about how her son's looser legs and better trunk control made handling him and assisting him in play much easier for her. Roger's mother felt her son was better at "following directions such as chin down, and sit up."

When asked, "Did what you thought would happen (in terms of how the program ran and how it affected your child) match what actually

happened?" Sam's mother wrote, "I had hoped to see improvement in his trunk muscles, which I did. I was happily surprised with the improvements in the flexibility in his legs." Roger's mother wrote, "My son is more happy. He feels secure and he is receiving more therapy which is helping his body to have better development." Beth's mother wrote, "She liked riding and I could see her working to hold her head up and try to sit up tall."

Using a 5-point Likert scale with "1" representing "very negative effect" and "5" representing "very positive effect," parents were asked to rate the effects that hippotherapy would have on their child both before and after the intervention. Parents' ratings increased from a "4" (positive effect) on the pre-hippotherapy questionnaire to a "5" (very positive effect) on the post-hippotherapy questionnaire. All parents scored a "5" ("absolutely worth the time and effort") in response to the question "Was involvement in a hippotherapy program worth the time and effort?"

DISCUSSION

The purpose of this study was to examine the effects of hippotherapy on three young children with CP who were unable to sit alone without external support. None of the children showed significant improvement on the SAS, GMFM-88 total score, or the GMFM-88 Dimension B. These findings support other studies (Bertoti, 1988; MacPhail et al., 1998; Sterba et al., 2002) suggesting that hippotherapy is less effective in improving overall gross motor function for children classified in Level V on the GMFCS.

One variable which could have affected the results of this study was that all children required support at the trunk or used their arms to support themselves in order to ensure safe and effective positioning on the horse. Attempts were made throughout the sessions to lessen the support given by adjusting the movement of the horse and having the child reach up for objects. These techniques were utilized with varying degrees of success, but the three participants were supported most of the sessions by the therapist or by their own upper extremities while holding handles or propping on arms. It is possible that beneficial effects of hippotherapy are related to the amount of time the child can actively make anticipatory and reactive adjustments to the horse's movement without external support. This possibility was hinted at in the study by

MacPhail et al. (1998) which looked at postural reactions of children with diplegic and quadriplegic CP. Children with quadriplegia hung on to handles and they performed less frequent postural adjustments in response to the horse's movement compared to children with diplegia. Thus, one possible predictor for hippotherapy efficacy may be the amount of trunk support a child requires.

Another variable which was not measured but may have had an effect is the cognitive ability of the child. This idea was discussed with a pediatric therapist who has been involved in hippotherapy for 18 years (B. Burtucio, personal communication, January 12, 2005). She felt that if a child could follow directions or requests made by the treating therapist, the chances for improvement were greater. Roger, the one child who did show some slight objective improvement, was the child who was most able to follow verbal directions. This ability to follow verbal instructions was not measured but might have been an important variable.

Assessment of parental perceptions of the hippotherapy intervention was included as a measure of social validity. Typically social validity measures evaluate whether the change produced in the target behavior has been sufficient to actually improve the life of the subject, and evaluate the acceptability or viability of the intervention for consumers, in this case, parents (Schwartz & Baer, 1991). Parents rated hippotherapy positively whereas objective measures failed to show any change in motor function. These results are consistent with the findings of MacKinnon et al. (1995) where parents reported improvements in functional motor skills such as walking, activities of daily living, and social skills despite lack of improvement on a variety of standardized measures.

There may be several reasons to explain this discrepancy between parental perceptions and objective findings. First, horseback riding is a recreational activity in which children who are typically developing participate. Perhaps seeing their child engage in an activity that children who are typically developing participate in is a positive experience for the parent. All the parents reported to the first author that their child liked the experience of horseback riding, including interacting with the animal, the movement of the horse, and going out on the trails. They also seemed to enjoy the attention of several adults during sessions. Since the hippotherapy sessions were covered by insurance, parents were able to provide an activity their child enjoyed at relatively low cost.

Parents wanted their children to continue in the hippotherapy program, indicating that it was worth the time and effort. From their comments, it is possible the mothers observed functional improvements that were not measured. Beth was learning how to drive a power chair and

her mother felt Beth improved in her ability to turn her head to the right and scan with her eyes to the right. Beth's mother felt this skill had significant functional implications for Beth because of the goal of becoming independent in driving a power wheelchair with a head switch. It is difficult to tell if head turning and visual tracking actually improved as they were not specifically measured. However, Beth's scores on the portions of the SAS and GMFM-88 which address head in midline actually declined.

Roger's mother also cited head control as one of the improvements for her child. Roger did show some improvement in the GMFM-88 total score with the most improvement shown in Lying and Rolling (Dimension A) on pre- and post-intervention testing. Sam's mother was very pleased about the fact that Sam's legs were much looser after therapy. She stated this benefit made handling and playing with Sam much easier. She also stated that reduction of tone in his legs would often last for several hours after a session and felt that there was a general reduction in tone over time.

Limitations

One threat to external validity is the fact that this study included only three children. The small number of participants limits generalizability of the results. There were some uncontrolled factors during the course of this study which could have affected outcome. Roger became very ill between the fourth and fifth week of intervention and lost eight pounds. Roger was less energetic and appeared to put less effort into the sessions for three to four weeks after his illness.

A potential limitation was the testing effect the repeated measure (GMFM-88 Dimension B) may have had on the individual children's performance during evaluation sessions. All three children's mothers felt that the repetitive evaluations had a positive or negative effect on their children but for different reasons. Beth's mother felt Beth gave her best performance on the early evaluation due to the novelty of the examiner and that she became less and less motivated to perform with each session. This child was the most severely involved child functionally and voluntary movement took the most effort for her to perform. Roger, on the other hand, became more and more comfortable with the examiner and would throw himself backward and laugh when asked to sit independently. He knew he would be caught and enjoyed this activity. However, he would become upset if asked to not "play around" and would cry. Evaluations became more and more difficult to do because

of this. As evaluations progressed, Sam became more fearful of feeling unsupported in sitting, and his startle reflex seemed to become more pronounced.

Another possible threat to internal validity is raised by Nordmark et al. (2000). The authors used both the PEDI and the GMFM to measure change 6 and 12 months post dorsal rhizotomy for children with CP. Both instruments detected change in children with milder severity, but only the PEDI showed change in children in the more severe group. These authors suggest that both the PEDI and the GMFM be used as outcome measures for children with CP and are complementary measures. However, the PEDI may not be the most sensitive measure of change for individuals at GMFCS Level V, since many items in the mobility domain of the PEDI, such as performing transfers and stair climbing, are beyond their physical capabilities.

All three raters in this study commented about the difficulty they had scoring the SAS, citing lack of clarity in definitions for scoring criteria. Although acceptable levels of inter-rater agreement were obtained for two of the three raters, the third rater's levels were lower, ranging from .60 to .80. Lower reliability and lack of evidence of validity are limitations for research purposes.

Implications for Practice and Research

To date, there is little evidence to indicate that children with CP who are non-ambulatory make improvements in their gross motor skills from the use of a horse as a treatment strategy. This is especially true for children who need external trunk support, and are not actively responding to the horse's movements. Potential changes in gross motor function were measured in this study by the GMFM-88, an evaluative tool designed specifically for children with CP. However, the GMFM-88 may have limited sensitivity in detecting change in children with severe limitations in motor function (Nordmark et al., 2000).

An alternative method of measuring clinically important changes over time for children at GMFCS Level V may be goal attainment scaling (GAS) (Brown, Effgen, & Palisano, 1998). This individualized, client-centered system incorporates the components of the behavioral objective, and can evaluate levels of activity and participation. Examples of criteria for measuring participation in meaningful activities can relate to consistency, efficiency of the activity, use of assistive devices, or degree of caregiver assistance. GAS has been shown to be responsive to change in individualized motor goals for infants with motor delays

(Palisano, Haley, & Brown, 1992). However, in a study of 24 individuals with severely limited physical and cognitive abilities, Brown et al. (1998) found that while goal attainment scaling (GAS) scores for gross motor goals improved in the therapy setting, these improvements did not transfer to recess and home settings. Generalization of motor skills across settings should be an important consideration both for therapists conducting research and those providing hippotherapy to children with significantly limited physical abilities.

The length of hippotherapy intervention reported in research varies from 8 weeks to 6 months. A survey conducted by McGibbon (2003) asked therapists registered with the American Hippotherapy Association to review their notes and estimate how long it took treating with a hippotherapy program to produce functional changes off the horse. Based on treatment notes from 95 patients with CP, the average length of time to produce notable changes was 10.27 weeks. Since clinicians typically are expected to document objective changes for insurance companies every three months, a treatment time of 12 weeks would be a reasonable amount of time to use as a standard for children with CP.

More research is needed that includes children with CP with limited motor function. As the task demands affect the amount of postural control required by the child, a quantifiable way to measure external support is needed. Researchers may gain valuable insights into selecting meaningful outcomes by consulting with family members when designing studies. Identifying goals that are functionally and contextually relevant to the primary caregiver and that incorporate GAS may prove a more responsive measure of change.

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