The Effect of Hippotherapy on Functional Outcomes for Children with Disabilities: A Pilot Study

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Purpose: The purpose of this study was to measure the effect of hippotherapy on functional outcomes using the Goal Attainment Scale (GAS) for children with physical disabilities. **Methods:** Participants included 4 children aged 5 to 9 years with physical impairments and/or documented motor delays. Individual measurable objectives were developed using the GAS for each child. Data were collected on each child every other week throughout the baseline and intervention phase over 1 year using a multiple single case experimental A-B design. **Results:** Three of the 4 children had a significant improvement in functional outcomes based on a standardized T-score formula from the GAS. Two of the 4 children had statistically significant results on the nonparametric binomial test following 6 months of intervention. **Conclusion:** This study represents an initial attempt to use the GAS in a single-case design with a variety of pediatric diagnoses. **(Pediatr Phys Ther 2008;20:264–270)** *Key words: case studies, child, developmental disabilties, goals, horses, physical therapy modalities, treatment outcome*

INTRODUCTION

Horseback riding for individuals who are disabled includes hippotherapy, therapeutic riding, and recreational riding. Hippotherapy is a treatment strategy used by physical therapists, occupational therapists, and speech therapists. In an effort to address impairments and improve functional outcomes, the therapist uses the horse as a modality in which the patient responds to the therapeutic effects of the horse.[1]

The hippotherapy research literature primarily discusses the physical and psychological benefits derived from hippotherapy. The physical effects of hippotherapy include improvements in balance, strength, coordination, spasticity, joint range of motion, weight bearing, posture, gait, and sensory processing.[1–7] The psychological effects positively influence self-confidence, self-concept, self-esteem, motivation, attention span, spatial awareness, concentration, interest in learning, and verbal skills.[1–12]

The movements of the horse combined with the warmth of the horse's body provide deep proprioception and other sensory input and facilitate tone reduction.[1,2] The horse's center of gravity is displaced during walking in a 3-dimensional pattern, which is similar to the action of the human pelvis during gait.[6,13] The movement of the horse elicits righting and balance reactions.[1,3,4,8,13] Facilitation of these balance reactions contributes to the necessary foundation for normal movements and functional skills.[11]

Research studies to date have focused on qualitative data, physiological benefits, studies of adults, and studies of children with cerebral palsy. The hippotherapy studies with children have had small sample sizes (<19) with most having less than 11. The research has explored the abovementioned benefits using various research methods. Biery[3] noted significant improvement in quadruped balance, improved trunk stability, and postural adjustments. Posture improved significantly in 11 children as reported by Bertoti.[2] Haskin et al[13] presented 2 case studies in which increased walking distance with simultaneous decrease in

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the use of ambulatory aids was noted. McGibbon[14] noted statistically significant improvement in the Energy Expenditure Index during gait and in Gross Motor Function Scores in 5 children with a diagnosis of cerebral palsy. Toffola[9] and MacKinnon et al[10]conducted the only studies to date to use a control group, but found no statistically significant results; however, it should be noted that the sample sizes in their studies were small.

Recommendations for future research have been noted in the literature. Calveley[9] refers to the need to look at the effect on changes in the everyday lives of children. Bertoti[2] challenges us "to examine the effects of therapeutic riding on different disabilities." MacKinnon et al[15] suggest "more rigorous research should focus on the development of measurement tools to assess relatively small changes in physical, functional and psychosocial well-being in the target population." Haehl et al examined the effects of hippotherapy on functional performance in children using the Pediatric Evaluation Disability Index as an assessment tool. In their case study of 2 children with a diagnosis of cerebral palsy, some improvement of function was noted in 1 child, but the authors suggest "controlled cases are needed before statements can be made suggesting the influence of hippotherapy on function."[8]

The review of the literature suggests the need to examine the effects of hippotherapy on children with disabilities other than cerebral palsy using measurement tools that assess functional changes. The purpose of this study was to measure functional changes using the Goal Attainment Scale (GAS) in individual children with a variety of diagnoses after a 6-month intervention period of hippotherapy. It was hypothesized that children would show significant improvement toward functional goals as measured before and after a hippotherapy program as compared with before and after an equal period of no riding. It was also hypothesized that parents would report improvements at home.

METHODS

Subjects

The University's Institutional Review Board approved the study. The children participated in a well-established hippotherapy program for children with disabilities. Inclusion criteria for subjects included (1) children between the ages of age of 2 and 10 years; (2) no hippotherapy within the last year; and (3) a documented physical impairment or motor delay (Table 1). The parents/guardians of the participating children signed a consent form as approved by the Institutional Review Board and the child's physician signed a medical referral. Identification numbers maintained confidentiality of the children's identities. No attempt was made to limit participation in other activities. The researcher recorded any changes in a child's activity as reported by classroom staff and parents. All children attended the same school and were enrolled in a special education classroom. All children received occupational therapy, physical therapy, and speech therapy as stipulated by Individualized Educational Plans within their school setting.

TABLE 1
Subject Demographics

Subject	Sex	Age (yrs)	Diagnosis
1	F	8.1	Cerebral palsy
2	F	7	Inversion of the 5th chromosome, developmental delay
3	M	5.3	Seizure disorder, microcephaly, developmental delay
4	M	7.8	Cerebral palsy, spastic quadriplegia

Hippotherapy Intervention

Four children participated in a 60-minute hippotherapy intervention 1 time a week for 6 months at a hippotherapy program. The design of the intervention was reflective of a typical intervention provided through the hippotherapy program. The hippotherapy intervention was individualized according to the child's needs and administered by 2 physical therapists with support from a riding instructor employed by the hippotherapy program. Support personnel included a person leading the horse and 2 side walkers. During the 60-minute hippotherapy sessions, the children participated in activities including active exercises, maneuvering through cones, riding up and down hills, and trotting, while simultaneously receiving the therapeutic benefits from the horse. The children participated in active exercises while riding on the horse, such as moving in and out of supine, backward and forward, sitting, and kneeling. The physical therapist employed by the hippotherapy program determined the type of saddles, saddle pads, and reins based on the child's needs, and documented changes in established hippotherapy goals at the completion of the 6-month hippotherapy intervention.

Procedures and Design

An A-B single-subject experimental design was chosen to capture the unique development of each child, and providing an opportunity to draw conclusions about the effects of treatment based on the responses of a single patient under controlled conditions.[16] The study was designed with 2 phases, a baseline and an intervention phase, with repeated data collection throughout both phases. The baseline and intervention phases provide a standard of comparison for evaluation of the potential cause-and-effect relationship between the intervention and targeted behavior. This study used 6 months for the baseline phase and 6 months for the intervention phase. The GAS was used to identify measurable behaviors for each child. Parents were given a questionnaire at the completion of the 6-month hippotherapy intervention (Appendix, available online at www.pedpt.com). The GAS was used to design measurable, quantifiable, and functional goals for the children in this single-subject design.[17] "The GAS provides a numeric index which reflects the clients' potential performance over time."[18] Goal attainment scaling has been found to be

a valid measure of motor change in infants with motor delays[19] and responsive to clinical change.[17,18]

Goal attainment scaling can be broken down into 6 steps: (1) identification of an overall objective; (2) identification of specific problem areas to be addressed; (3) specific identification of what behaviors or events will indicate improvement in each of the areas selected in step 2; (4) determination of the methodology to be used to collect the desired information; (5) selection of the expected level of performance; and (6) identification of the most favorable outcome, the least favorable outcome, and intermediate levels of the client's performance.[17] In addition to observable and recordable behaviors, the goal should be time limited. For the purpose of this study, a 6-month time limit for intervention (therapeutic horseback riding) was used for all subjects. Behavioral objectives were developed for each of the children. The researcher and classroom staff chose behavioral objectives that would reflect functional outcomes. Functional outcomes and skills are the essential activities required in the child's natural environments of home and school.[20] A 5-point performance scale was used for each goal/behavioral objective for scoring. The 5-point scale was used to score change in behavioral objectives with 0 as the baseline with a range from −2 to +2 to note change in a negative and positive directions, respectively. Behavioral objectives for each child are shown in Tables 2 to 5. Ottenbacher and Cusick[20] suggest that when using GAS in a research context the person who sets the goals should not be the person who provides treatment. In this study, the researcher and classroom staff established the behavioral objectives in the GAS, whereas the therapists at the hippotherapy program provided the intervention.

Data Collection

Data collection occurred from June 1999 to June 2000. To ensure confidentiality, each child was assigned a study participant number. The researcher collected measurable data, as developed by the GAS, at the children's school during the baseline and intervention phase. Data were collected 10 times during the baseline phase-A (6 months) and 11 times during the treatment phases-B (6 months). Data were collected less frequently during the baseline data phase due to the summer school program schedule. Changes in the daily activities and

TABLE 2
Behavioral Objectives for Subject 1: Goal Attainment Scale for Two Behavioral Objectives

Predicted Attainment	Score	Behavioral Objective 1 Crawling	Behavioral Objective 2 Maintained High Kneeling
Most unfavorable outcome	−2	Crawl 1 foot or less	Unable to maintain hi kneeling
Less than expected outcome	−1	Crawl 2 feet	Maintain with 1 arm support 1 min
Expected level of outcome	0	Crawl 3 feet	Maintain with 1 arm support 2 min
Greater than expected outcome	+1	Crawl 5 feet	Maintain without upper extremity support 1 min
Most favorable outcome likely	+2	Crawl 8 feet	Maintain without upper extremity support 2 min

TABLE 3
Behavioral Objectives for Subject 2: Goal Attainment Scale for Two Behavioral Objectives

Predicted Attainment	Score	Behavioral Objective 1 Stair Climbing (8 Stairs)	Behavioral Objective 2 Getting Up From the Floor
Most unfavorable outcome	−2	Holding railing and persons hand; with a step to pattern with feet	Push up from quadruped
Less than expected outcome	−1	Holding railing; step to pattern with feet	High kneeling and 2 hand support
Expected level of outcome	0	Holding railing; alternating feet	High kneeling-half kneeling and 2 hand support
Greater than expected outcome	+1	No hands; step to pattern with feet	On knees 1 arm-half kneel with support on stationary object
Most favorable outcome likely	+2	Stairs no hands; alternating feet	On knees to stand without arm support

TABLE 4
Behavioral Objectives for Subject 3: Goal Attainment Scale for Two Behavioral Objectives

Predicted Attainment	Score	Behavioral Objective 1 Stair Climbing (Assistance Required on 8 STAIRS)	Behavioral Objective 2 Getting Up From the Floor
Most unfavorable outcome	−2	One hand on rail, marching feet	Push up from quadriped
Less than expected outcome	−1	One hand on rail, alternating feet	High kneeling and 2 hand support
Expected level of outcome	0	No hands, alternating feet with minimal loss of balance	High kneeling-half kneeling and 2 hand support
Greater than expected outcome	+1	No hands, alternating feet with minimal loss of balance	On knees 1 arm-half kneel with support on stationary object
Most favorable outcome likely	+2	No hands, quickly alternating feet with good balance	On knees to stand without arm support

TABLE 5
Behavioral Objectives for Subject 4: Goal Attainment Scale for Three Behavioral Objectives

Predicted Attainment	Score	Behavioral Objective 1 Maintained Grasp	Behavioral Objective 2 Sitting on Bolster	Behavioral Objective 3 Commando Crawling
Most unfavorable outcome	−2	Reach and throw a toy	No measurable sitting	Pivots on Belly
Less than expected outcome	−1	Maintained grasp 2 seconds	Maintained sitting 1 minute	Move forward 1 foot
Expected level of outcome	0	Maintained grasp 5 seconds	Maintained sitting 2 minute	Move forward 2 feet
Greater than expected outcome	+1	Maintained grasp 7 seconds	Maintained sitting 5 minutes	Move forward 4 feet
Most favorable outcome likely	+2	Maintained grasp 10 seconds	Maintained sitting greater than 5 minutes	Move forward 6 feet

medical status of the children were reported to the research therapists throughout the baseline and intervention phase.

Data Analysis

The GAS *T* scores were calculated for the baseline (A) and intervention (B) phases using the formula developed by Kiresuk and Sherman.[21]

$$T = 50 + \frac{(10 \Sigma W_1 X_1)}{\sqrt{(1 - r) \Sigma W_1^2 + r(\Sigma W_1)^2}}$$

W_1 represents the weighting for a particular goal and X_1 represents the average outcome score for each behavioral objective (a value of −2–+2). Each goal received equal weights in the present study as recommended by Kiresuk.[21] The *r* value in the formula reflects the estimated average intercorrelation for the outcome scores of multiple goals, where *r* is assumed to have a correlation value of 0.30 between goals.[17] A mean *T* score was calculated for the baseline and intervention phase. Using the formula to compute the goal attainment provides a *T* value, which is a standardized score with a mean of 50 and a standard deviation of 10. "The *T* score is a better reflection of the client's performance than the simple raw score because it combines the outcome scores for all the goals, thus providing an overall measure of the client's improvement or lack thereof."[17]

Visual analysis of a graphic display is the most commonly used method to determine if behavioral changes occurred between baseline and intervention phase for single-subject experimental designs. The data are compared by examining the level, trend, and slope on points plotted on a graph. In the presentation of data, "level" is the mean or average value of the target behavior within a phase. "Trend" refers to the direction of the change within a phase and is described as accelerating, decelerating, stable, or variable. Trends can be linear or curvilinear. Changes in linear trend cross baseline phases, and a curvilinear trend is seen within the intervention phase. The "slope" refers to the rate of change within a phase. A "celeration line" is the product of a procedure used to estimate both the trend and slope within a phase.[16]

The binomial test is a statistical analysis of probability. The binomial test provides a *p* score, which is the probability if the observed values occurred due to change. The binomial nonparametric test statistically analyzes the visual data within and between each phase that has been plotted and graphed. A celeration line was created using the split middle technique,[18] which represents the expected outcome. The observed data were compared to the expected data, reflected by the celebration line with a resulting *p* score.

RESULTS

GAS T Scores

The *T* scores for the 4 subjects are shown in Table 6. The *T* score is a standardized score, which can be compared to a hypothetical normal distribution, with a standard deviation of 10. "A *T* score of greater that 50 reflects performance above the expected level and a score of less than 50 reflects performance below the expected level."[20] All four subjects scored a *T* score below 50 during the baseline

TABLE 6
Visual and Binomial Analyses of Subjects' (1–4) GAS Scores

Subject	Behavioral Objective	Level Baseline/Intervention	Trend Baseline/Intervention	Slope Baseline/Intervention	Binomial Results
1	1	0.16/0.7	Decelerating/curvilinear	2/2	$P = 0.016$
	2	−0.5/2	Variable/constant	0.6/0	$P = 0.016$*
2	1	−1.7/−0.3	Variable/curvilinear	0.75/2	$P = 0.113$
	2	0.2/0.7	Variable/accelerating	2/2	
3	1	0/0.75	Constant/curvilinear	0.75/2	$P = 0.031$*
	2	−1/−0.1	Variable/curvilinear	0/0	$P = 0.031$*
4	1	−0.5/−0.2	Decelerating/constant	−2/0	$P = 0.002$
	2	−0.25/−1.1	Variable/variable	0/0.5	$P = 0.016$†
	3	−0.25/−1	Variable/decelerating	0/−2	$P = 0.009$†

*Significant increase.
†Significant decrease.

phase. Subjects 1, 2, and 3 had *T* scores after intervention greater than their baseline scores and greater than 1 standard deviation indicating significant improvement. The *T* score of Subject 4 dropped below the baseline *T* score, indicating a decrease in his performance during the intervention phase.

Visual Analysis

The GAS biweekly scores were plotted on a graph. Analysis of the plotted graph data was done by using a celeration line and split middle technique as described by Portney.[18]

In Table 6, the level, accelerating trends, and slope at baseline and intervention phase and the nonparametric binomial test of the visual analysis are presented. The nonparametric binomial test using the visual analyses demonstrated that Subjects 1 and 3 had a significant increase in both of their behavioral objectives. Subject 2 has no significant change. Subject 4 had a significant decrease in the binomial test and a decrease in *T* scores (Table 7) on both of his behavioral objectives.

Hippotherapy Therapists' Evaluations

Table 8 summarizes the evaluations from the physical therapists who provided the hippotherapy intervention. There was no communication between the researcher and the physical therapists providing the hippotherapy intervention. The hippotherapy therapists noted measurable improvements for all 4 subjects based on the goals for the 6-month period intervention phase.

Parents' Evaluations

At the completion of the 6-month intervention phase, parents were given a questionnaire to complete (Appendix, available online at www.pedpt.com). Three parents noted moderate improvement and 1 parent noted substantial improvement from the hippotherapy riding program in a variety of activities and functional tasks in the home environment (Table 9). The parent who noted substantial improvement in a variety of functional tasks in the home environment highlights a discrepancy between the parent's observation and the *T* score and visual analysis for the same child (Table 7). Two of the 4 parents expressed interest in continuing the hippotherapy program when the research study was completed. The parents' evaluations reflect improvements as noted by the GAS and the *T* scores.

TABLE 7
GAS T Scores at Baseline and after Intervention

	Baseline T Score	Intervention T Score
Subjects 1	47.9	66.8
Subjects 2	40.3	50.2
Subjects 3	43.7	53
Subjects 4	38	31.7

The GAS T scores were calculated for the baseline (A) and intervention (B) phases using the formula develop by Kiresuk and Sherman. The T score is a standardized score with a mean of 50 and a standard deviation of 10. The T score combines the outcome scores for all the GAS goals, thus providing an overall measure of the client's improvement or lack thereof.

TABLE 8
Hippotherapy Physical Therapist's Goal Summaries

Subject	Intervention Goals
Subject 1	Increase the number of times posting on the horse in succession without stopping
	Month 4: Post 56 times
	Month 6: Post 150 times
Subject 2	Decrease side walker assistance
	Month 1: 2 side walkers
	Month 6: Close guard of 1 side walker
Subject 3	Decrease the amount of assistance needed to change position on the horse
	Month 1: Max assist
	Month 2: Min assist
	Month 3: High kneel on horse with mod/max assist
	Increased stability on stairs
	Month 1: Mod assist and/or max assist
	Month 6: Min assist
Subject 4	Increase trunk support
	Month 1: Back rider
	Month 6: 2 side walkers with min assist

Mod, moderate; Min, minimum; Max, maximum.

DISCUSSION

This research study is the first to examine the functional effects of hippotherapy for children with variety of diagnoses using a single-subject experimental design and the GAS as a measurement tool. The GAS was an effective tool in this study, which allowed adjustment for each child's individual development and for assessment of small changes that are typical for children who have a diagnosis of developmental delay.

This study is notable for the 6-month intervention period. A long-term intervention of 6 months is more likely to capture the slow rate of growth and development of

TABLE 9
Parents' Evaluations

	Parent's Evaluation	
Subject	Moderate Improvement	Substantial Improvement
1	Move/walk better	
2	Ability to move	Climb stairs
	Walk better	Balance during dressing
	Participate in dressing	
	More engaged in toys	
	Increased verbal output	
	Increased vocalizations	
	More involved with others	
3	Ability to walk	
	Engage in toys	
	Hand to mouth eating	
	Increase vocalizations	
	More involved with others	
	Happier	
4	Walk better	
	Increase in fine motor	

children with cerebral palsy and developmental disabilities. Siebes et al[22] noted that 60% of studies examining children and hippotherapy were short-term studies with durations of less than 6 months.

The researcher chose a limited number of measurable objectives using the GAS due to the constraints of the length of the study and the frequency of measuring the objectives. Choosing more objectives would enable a researcher to be able to have a more representative sampling of functional activities. Parents and school staff noted anecdotally that some of the children made improvements in areas that were not measured by the GAS (improved eye contact, ability to get in and out of a chair, the amount of support needed to ambulate). The behavioral objectives of the GAS were developed with minimal parental input because of scheduling conflicts. Parental input combined with an increase in the number of objectives is recommended to create objectives that might have greater capacity to detect functional changes in the lives of children.

The researcher documented general medical status and school and personal activities. Subject 4 had uncontrolled seizures with frequent upper respiratory infections throughout the duration of the study. No significant changes were noted in the standardized *T* scores or the nonparametric binomial test for this child. Subject 4 was nonambulatory with greater impairments than those demonstrated by the other 3 subjects. Subject 2 had uncontrolled seizures. Subject 2 was noted to have a significant change in his *T* score, but not a statistical change in the nonparametric binomial test. Palisano noted the level of motor delay that can affect the *T* score.[19] In this study, medical status and motor delay appeared to affect improvements of children more than did the specific diagnoses.

Differences were noted between the GAS, the evaluations from the hippotherapy therapists, and the parents' perceptions. Because the psychometric properties of the parent questionnaire have not been evaluated, it is possible that the identified differences are associated with a lack of validity. The lack of a goal development by a team including parents is a limitation. This highlights the need to work collaboratively as a team for optimal outcomes for children.

Subject 4 did not have a statistical change in the standardized *T* score or the nonparametric binomial test. Parental observation noted significant improvement. Literature has determined discrepancies between qualitative and quantitative assessments. Further work needs to explore the potential sources of discrepancies.

The A-B design was limited by a lack of an equal period of 6 months without treatment after the treatment stopped. An A-B-A design would eliminate the possibility that the progress that the children made was due to maturation rather than the intervention of the hippotherapy.

The single-case design is criticized for not having good external validity and minimal capacity for generalizing the results to a larger population. Although far reaching generalizations cannot be made from this study, we are able to examine the process of effective goal development for functional outcomes in children. The single-case design can be applied in clinical research to examine individual differences, which is an effective design when dealing with individual child development and maturation.

CONCLUSION

This study represents an initial attempt to use a single-case design for children with a variety of diagnoses and to examine the effects of hippotherapy on functional outcomes. In this preliminary pilot study, 3 of 4 children had improvements in functional outcomes as noted by their standardized *T* scores after 6 months of hippotherapy intervention. Two of the 4 children exhibited statistically significant improvements as shown by the nonparametric binomial test following 6 months of hippotherapy intervention. The findings from this study suggest that hippotherapy can be an effective intervention to improve functional outcomes for children. The author proposes that the GAS is a useful tool for goal development and in assessing functional changes in a single-subject experimental design. This study challenges physical therapists to examine appropriate goal development in physical therapy interventions. Physical therapists must also be able to quantify outcomes to determine the effectiveness of interventions. Future studies should explore the discrepancies between qualitative and quantitative results, and examine the effects after intervention is withdrawn.

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