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Therapeutic Recreation: Effects of a Riding Protocol on a Child with Cerebral Palsy

The purpose of our research project was to

- Evaluate the effect of a six week exercise program using AMBUCS therapeutic tricycles on flexibility and endurance
- Determine whether Lower Extremity tricycles are more effective than Upper Extremity tricycles for the parameters measured

Our parameters being measured included flexibility, strength, and endurance.

When first creating the outline of our experiment we created two primary hypotheses to build our procedure around
The first hypothesis states that:

- Subjects using the **upper extremity bikes** would show greater gains in endurance measures

The second hypothesis states that:

- Subjects using the **lower extremity bikes** would show greater gains in lower extremity range of motion

The reasoning for to determine effectiveness within the population is to make evidence-based recommendations on the most suitable and beneficial adaptive tricycle for a child with spastic diplegia CP

The recommendations are beneficial to parents, schools and healthcare providers.

Theoretical Framework:

NEUROPLASTICITY:

- Neuroplasticity – the ability of the brain to change with learning
    - The brain's ability to reorganize itself by forming new neural connections throughout life. Neuroplasticity allows the neurons (nerve cells) in the brain to compensate for injury and disease and to adjust their activities in response to new situations or to changes in their environment.
    - It is a process of brain reorganization and creation of new motor pathways via axonal sprouting
    - New motor pathways are formed to create new connections to compensate for injury or changes in environment.

Therapeutically based exercise in a child with CP could also take advantage of the neuroplasticity of the young brain promoting increased development of movement based pathways. The tested hypothesis for this study is based on a modification of constraint-induced movement therapy (CIMT), a type of therapy in which an unaffected limb of a patient with neurological deficits is made temporarily unavailable, isolating the affected limb. In these studies it has been shown that CIMT is a useful tool to encourage neuroplasticity, or the capacity of

neurons and neural networks in the central nervous system to modify their connections and behavior in response to new information, sensory stimulation, development, or injury. By using only the upper or lower extremities during tricycle riding, a type of CIMT is being utilized.

CIMT - Constraint-induced movement therapy (CI) forces the use of the affected side by restraining the unaffected side.

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- By using only the upper or lower extremities during tricycle riding, a type of CIMT is being utilized.

The design of our study consisted of was a case series

- Subjects:
  - 3 children
  - **Ages:** 6-12 years old
  - **Diagnosis:** Spastic Diplegia
    - (classification by GMFCS)
    - The GMFCS is an observation scale for self-initiated movement with emphasis on sitting, transfers, and mobility. It is defined by age, use of assistive device, quality of movement, and level of dependence or burden of care.

Our subject were determined thru a specific set of inclusion and exclusion criteria

The inclusion criteria consisted of

- Child between the ages of 6-12 presenting with spastic diplegia
- Physical ability to perform the task at hand – riding an adaptive tricycle +/- minimal cueing
- Have the ability to follow verbal commands
- Receive medical clearance to participate in the activity per their pediatrician
- Commitment by subject and parent for engaging in a study – Each guardian signed a consent form and verbal assent was received by each participant.

The exclusion criteria consisted of

- Modified Ashworth Score
  - greater than 2
- Need individual attention due to medical or behavioral issues
- History of orthopedic surgery
  - within the past 6 months
  - scheduled within the period of the study
- Currently own or use an AMBUCS tricycle

Methods:

Participants:

Three children with a diagnosis of spastic diplegia cerebral palsy between the ages of 6-12 were recruited for this study. This group was targeted because children at this age would

likely be most compliant with using the equipment as this is an age appropriate activity. Tricycle riding intentionally crosses the "line" from therapeutic intervention to therapeutic recreational activity and .

To recruit subjects, the investigators sent out flyers to physical therapy clinics, community wellness programs, and support groups in Connecticut to invite children to be part of the study. The flyer invited parents and guardians of children with cerebral palsy between the ages of 3-8 to contact the investigators for a screening examination.

The principal investigator screened individuals who responded to this flyer for inclusion and exclusion criteria. Inclusion criteria are: 1) child between the ages of 3-8 presenting with spastic diplegia, 2) have the physical ability to perform the task at hand, 3) have the ability to follow commands, 4) receive medical clearance to participate in the activity per their pediatrician, and 5) commitment by subject and parent for engaging in a study. Individuals will be excluded if 1) they receive a score of greater than two on the Modified Ashworth Scale, 2) if they need individual attention for medical or behavioral issues, 3) history of orthopedic surgery within the past 6 months or scheduled during the time of the study, and 4) if they currently own or use an AMBUCS tricycle.

Participants were alternately assigned to the upper extremity or lower extremity groups. The parent or guardian of each participant signed an informed consent form prior to enrollment in the study and the child was asked for verbal assent that they are willing to participate. Primary screenings were performed over the phone, and then a second in-person screen was scheduled at the participant's convenience.

At the second in person screening a more in depth history was taken and initial resting vial signs were assessed. Muscle length measurements of the adductors, hamstrings, iliopsoas, and gastroc-soleus. An overall tone assessment of the upper and lower extremities is assessed and an evaluation of

Subject 1 (Robert) was a 10 year old male subject who presented with mild - moderately involved spastic diplegia. The Gross Motor Function Classification System for cerebral palsy (GMFCS) is a self-initiated movement scale was used to determine the motor function in level of severity on cerebral palsy. The level is determined with consideration of sitting and trunk control and ambulation status. Subject 1 would qualify under the level III designated as the ability to walk indoors or outdoors on a level surface with an assistive mobility device. Depending on functional strength and degree of spasticity the patient may be able to climb stairs holding onto a railing. The patient may relay on a wheelchair , manual or power, for long distance transportation or outdoors on uneven terrain. He presented with decreased tone within his neck and trunk. He currently takes Trileptol at time of experimental protocol. At the time of evaluation his level of function was highly presented was able to transfer with min assistance sit to stand. This patient ambulates with rolling walker independently and with bilateral loftstrand crutches with supervision. Patient was very active and enjoyed being involved in many activities, such as basketball. Patient does own a standard wheelchair but rarely uses it for mobility, but rather relies on his walker for ambulation. Patient was highly distractible, had difficulty attaining pattern of reciprocal motion, and required contact supervision and verbal queuing for mobility when on the adaptive tricycle. He also presented with hyperesthesia in right lower extremity, which made him non-compliant with his bilateral AFO's at times. He received 3 hours of functionally based physical therapy at a privately owned physical therapy clinic a week along with therapy that he receives during the school day.

Subject 2 (Adam) was a 12 year old male subject who presented with moderately involved spastic diplegia. This participant also was classified under level III in the GMFCS. He presented with decreased tone within his neck and trunk. He was on Baclofen to lower high adductor tone. At the time of evaluation his level of function was highly independent in mobility, but required minimal assistance or contact guard for transfers. He was able to transfer floor to stand and stand to tricycle with minimum assist. He currently owns a power wheelchair for use in school and longer distances, a manual wheel chair at home. Patient ambulates independently with walker for use at home and in school, and also has benefit with bilateral AFO's to help maintain his foot in proper positioning When fit for the adaptive tricycle he required additional support straps on tricycle seat back for added security. This patient required the use of the adductor cushion. Patient required multiple verbal cues throughout therapeutic riding sessions to maintain proper head position. He required supervision for mobility when on the adaptive tricycle. He received 2 hours of functionally based physical therapy at a privately owned physical therapy clinic a week along with therapy that he receives during the school day.

Subject 3 (Zach) was a 9 year old male subject who presented with highly involved spastic diplegia. According to the GMFCS he would qualify under level IV for involvement. Level IV is described as maintaining the level of function achieved before age 6. Children in Level IV function in supported sitting but independent mobility is very limited. At this level they are more apt to rely more wheeled mobility at home, school, and in the community, using a power wheelchair. He presented with decreased tone within his trunk. Increased tone was found within his upper extremities, measuring a 1 on the modified Ashworth scale, but it varied with his level of excitement. He was taking Baclofen for overall tone reduction and increased functional mobility. At the time of evaluation he was very dependent in mobility. Patient relied mainly on the use of motorized wheelchair. His caregivers also facilitated the use of a medical stroller, an adaptive chair, and a stander. Patient was non- ambulatory and is dependent with all transfers. He required contact supervision and verbal queuing for mobility when on the adaptive tricycle. He presented with decreased motor control in both the upper and lower extremities and difficulty to maintain hand position on handlebar of lower extremity driven tricycle. This patient was very highly distractible and had difficulty with motor planning and progressing with reciprocal motion of the cycle. He received 3 hours of functionally based physical therapy at a privately owned physical therapy clinic a week along with therapy that he receives during the school day. He was currently working on increasing his ambulation status with the use of a heart walker in the school and therapy settings.

<u>Summary of participants:</u>

Subject 1 –

- 10 y.o. male
- **GMFCS**
  - Level 3
- Decreased tone in the neck and trunk
- **Medications**
  - Triliptol
- **Functional Status**
  - Min assist sit to stand
  - Independent with rolling walker
  - supervision with bilateral loft strands
- **On the tricycle:**
  - Highly distractible
  - Difficulty attaining reciprocal motion

- Required contact supervision and verbal cueing

Subject 2 –

- 12 y.o. male
- **GMFCS**
  - Level 3
- Decreased tone within his neck and trunk.
- **Medications**
  - Baclofen
- **Functional Status**
  - highly independent in mobility
  - required minimal assistance or contact guard for transfers
  - ambulates independently with walker for use at home and in school
- **On the tricycle:**
  - transfer walker to tricycle with minimum assist
  - additional support straps on tricycle seat back
  - adductor cushion
  - Verbal cuing for head position
  - supervision for mobility

Subject 3 –

- 9 y.o. male
- **GMFCS**
  - Level 4
- Decreased tone in trunk, increased tone in all extremities
- **Medications**
  - Baclofen
- **Functional Status**
  - dependent in mobility, non- ambulatory
- **On the tricycle:**
  - contact supervision and verbal cueing for mobility
  - highly distractible
  - difficulty with motor planning and progressing with reciprocal motion of the cycle

Measurements and Instrumentation:

Descriptive statistics were calculated for pretest and posttest muscle length and endurance measurements. To examine the primary purpose of this investigation, treatment effectiveness in both the upper extremity group and lower extremity group, the intervention will be considered a success if an increase in flexibility is measured. Range of motion will be measured using a standard 12" goniometer. Treatment will also be considered effective if endurance, as measured by the heart rate, respiratory rate and the ability to ride without rest is increased. Heart rate will be measured at the radial pulse pre and post exercise. Respiratory rate will be measured through observation of breaths pre and post exercise. The amount of time during which the participant rides non-stop and the number of necessary rest breaks will be calculated during the first and last exercise sessions.

The participants also assessed their perceived exercise exertion levels using the Pictorial Children's Effort Rating Table (PCERT - Appendix C) on initial and final exercise session. Prior to treatment sessions, the participants will be instructed on the PCERT. PCERT is a measure of

perceived exercise intensity measured on a 1-10 scale with corresponding pictorial representations of a child walking up stairs and verbal cues "very, very easy – so hard I am going to stop". (ROEMMICH, M. Yelling) Increases in PCERT and OMNI scale scores were correlated with increases in VO2 (r = 0.90 and 0.92) and heart rate (r = 0.89 and 0.92) representing a positive correlation with energy expenditure and work performed. (ROEMMICH)

During the intervention phase of this experiment, subjects were required to meet with the examiners twice a week for 30 minutes each. Subjects were either assigned an upper body adapted tricycle or a lower extremity AMBUCS adapted tricycle and were asked to ride for approximately 30 minutes, with breaks as needed. Exercise sessions using the AMBUS tricycles will begin one week after the initial evaluation. Heart rate and respiratory rate was taken prior to riding, then child was instructed to ride for as long as they could until they get tired, the time was then recorded. Heart rate and respiratory rate was re-measured following the ride. The participant continued to ride until fatigue during the 30 minute intervention session. The constant exercise time and the number of breaks necessary were also recorded. Muscle length of lower extremities was recorded at the initial treatment session and at the end of the 6 week period.

Outcomes used to measure the change in status over the 6 week - Descriptive Statistics we taken at the initial evaluation prior to the 6 week trial and posttest measurements were taken at the conclusion of the 6 weeks

- ROM of lower extremities
  - Goniometer

Pretest and posttest muscle length and range of motion were measured using a standard 12" goniometer. The intervention will be considered a success if an increase in flexibility is measured.

- Cardio-respiratory endurance
  - PCERT
  - Stopwatch
  - Heart Rate

Treatment will also be considered effective if endurance, as measured by the heart rate, respiratory rate and the ability to ride without rest is increased. Heart rate will be measured at the radial pulse pre and post exercise. Respiratory rate will be measured through observation of breaths pre and post exercise. The amount of time during which the participant rides non-stop and the number of necessary rest breaks will be calculated during the first and last exercise sessions.

Endurance and perceived exercise exertion was determined levels using the Pictorial Children's Effort Rating Table (PCERT - Appendix C) on initial and final exercise session. The scale was taught to them at the initial evaluation session.

PCERT is a measure of perceived exercise intensity measured on a 1-10 scale with corresponding pictorial representations of a child walking up stairs and verbal cues "very, very easy – so hard I am going to stop". (ROEMMICH, M. Yelling) Increases in PCERT and OMNI scale scores were correlated with increases in VO2 (r = 0.90 and 0.92) and heart rate (r = 0.89 and 0.92) representing a positive correlation with energy expenditure and work performed. (ROEMMICH)

The intervention consisted of

- Ride AMBUCS tricycle
  - 2x per week
  - 30 min each

- Instructed to ride for as long as they can
- Recorded (at baseline and 6 week follow up)
    - Constant exercise time
    - Number of breaks
    - Heart Rate

During the intervention phase of this experiment, subjects were required to meet with the examiners twice a week for 30 minutes each. Subjects were either assigned an upper body adapted tricycle or a lower extremity AMBUCS adapted tricycle and were asked to ride for approximately 30 minutes, with breaks as needed.

Exercise sessions using the AMBUS tricycles began one week after the initial evaluation, and continued 2x a week for 6 more weeks.

Heart rate and respiratory rate was taken prior to riding, then child was instructed to ride for as long as they could until they get tired, the time was then recorded. Heart rate and respiratory rate was re-measured following the ride. The participant continued to ride until fatigue during the 30 minute intervention session.

Results:

For one patient:

Subject 1, a 10 year old male rode the upper extremity tricycle. During the 6 weeks of riding, this subject missed 0 sessions.

1. Endurance Measures

Heart Rate

During the baseline testing, Subject 1 had an increase of 36 bpm. This improved after the 6 weeks of exercise as his heart rate only increased by 24 beats per minute.

Respiratory Rate

During the initial baseline test Subject 1's respiratory rate increased by 7 breaths per minute. After the 6 week exercise program, his breathes only increased by only 4 breaths per minute.

Number of Breaks

During the baseline riding test, subject one took 5 breaks. After the six weeks of riding, he requested no breaks during riding.

Continuous Ride Time

During the initial baseline riding test, Subject 1 rode for only 13 minutes and 56 seconds before he became fatigued. After riding for the 6 week program, he was able to complete 30 minutes with no complaint of fatigue at the end of the session.

PCERT

During this baseline test Subject 1 would not give a value for the PCERT. During the 6 week exam, since the subject took no breaks he was only given the PCERT after riding and reported that he was at number 7 (hard).

2. ROM Testing

From the initial baseline measurement to the six week follow up measurement, Subject one increased length in all lower extremity measurements. In the hamstrings, there were gains of 7 degrees of motion in the right lower extremity, and 9 degrees of motion in the left lower extremity. In the Iliopsoas he gained 2 degrees in the right lower extremity and 4 degrees in the left lower extremity. In the adductor group 6 degrees of motion were gained in the right lower extremity and 8 degrees of motion were gained in

the left lower extremity. In the gastroc-soleus, Subject 1 gained 3 degrees of motion in the right extremity and 1 degree of motion in the left extremity.

Subject 2, a 12 year old male who rode the upper extremity tricycle. He attended 11 of the total number of twelve sessions, missing 1 session because of an undisclosed family vacation during the collection time.

1. Endurance Measures

Heart Rate

During the baseline testing, Subject 2's heart rate increased by 8 bpm after riding. After the six week program, his heart rate increased by 10 bpm after riding.

Respiratory Rate

During the initial session Subject 2's respiratory rate did not increase from beginning to end of ride time. At end of the six week sessions, his respiratory rate increased by four breathes per minute.

Number of Breaks

Subject 2, did not take any breaks during the initial baseline ride nor at the six week ride.

Continuous Ride Time

During the first baseline ride Subject 2 rode for only 24 minutes and 46 seconds. He did not ride for the full time because of a scheduling conflict with a physical therapy appointment that he had to attend. He also had requested to be done with riding for the day at that time. At the six week ride, he rode for 29 minutes and 19 seconds, very nearly the entire 30 minute period.

PCERT

At the initial ride, Subject 2 reported that he had ridden at a PCERT score of 5 (starting to get hard). At the six week ride, he reported riding at a level of 2 (very easy) by the end of the ride.

2. ROM Testing

Subject 2 maintained and/or improved range of motion in all of the lower extremity range of motion measurements. In the right hamstrings, right iliopsoas, left iliopsoas, and right gastroc-soleus, he maintained the same amounts of range of motion in the six week follow up as he had in the initial baseline evaluation. In the left hamstring muscles, he gained 1 degree of motion. In the adductor muscle group he gained 7 degrees of motion in the right extremity and 12 degrees of motion in the left extremity. In the left gastroc-soleus he gained 2 degrees of motion.

Subject 3, a nine year old male who rode the lower extremity tricycle. He attended 9 out of the twelve sessions, missing 2 sessions due to an illness and 1 session due to weather not permitting.

1. Endurance Measures

Heart Rate

At the initial baseline ride, Subject 3's heart rate actually decreased by 4 bpm during the exercise. His heart rate was 32 bpm higher on this day at rest than at the subsequent 6 week ride. After the six week ride, Subject 3's heart rate increased 24 bpm during exercise.

Respiratory Rate

During the initial baseline ride, Subject 3's respiratory rate increased by six breathes per minute. At the six week ride his respiraorty rate increased by 2 breathes per minute.

Number of Breaks

During the initial baseline ride, Subject 3 requested one break. During the six week ride, he requested no breaks during riding.

Continuous Ride Time

At the initial baseline ride, Subject 3 rode for 20 minutes and 21 seconds stopping because he was fatigued. At the six week ride he rode for the entire 30 minutes.

PCERT

During the initial baseline ride, Subject three reported that he was riding at a 5 (starting to get hard) at his first break. At the end of the ride, he reported that he was riding at an 8 (very hard). At the six week ride, Subject three reported that he was riding at a 7 (hard) at the end of the session.

2. ROM Testing

Subject 3 demonstrated gains in flexibility in all but one of the lower extremity range of motion measurements. In the right gastroc-soleus, he demonstrated an apparent "loss" of 12 degrees of range of motion. In the hamstrings he gained 2 degrees of motion in the right extremity and 12 degrees of motion in the left extremity. In the iliopsoas muscle group he gained 1 degree in the right extremity and 3 degrees in the left extremity. In the adductor group, he gained 3 degrees of motion in both the right and left extremity. In the left gastroc-soleus he gained 7 degrees of motion.

Range of Motion Measurements									
		Hamstrings		**Iliopsoas**		**Adductor**		**Gastroc-Soleus**	
		Right	Left	Right	Left	Right	Left	Right	Left
Subject 1	Baseline	-10	-20	-15	-17	10	9	-11	-5
	Post Intervention	-3	-11	-13	-13	16	17	-8	-6
Subject 2	Baseline	-2	-4	0	0	15	13	18	15
	Post Intervention	-2	-3	0	0	22	25	18	17
Subject 3	Baseline	-17	-25	-11	-12	21	20	0	-2
	Post Intervention	-15	-13	-10	-9	24	23	-12	-9

Endurance Measures at Initial Baseline and 6 Weeks Follow Up										
Subject	**Heart Rate Change (bpm)**		**Respiratory Rate Change (breathes per minute)**		**Number of breaks**		**PCERT Response (end of ride)**		**Continuous Ride Time (Total Ride Time - Breaks)**	
	Initial	6 Weeks	Initial	6 Weeks	Initial	6 Weeks	Initial	6 Weeks	Initial	6 Weeks
1	36	24	7	4	5	0	n/a	3	0:13:56	0:30:00

2	8	20	2	4	0	0	5	2	0:24:46	0:29:19
3	-4	24	6	2	1	0	8	7	0:20:21	0:30:00

Overall Results:

Overall the 3 subjects improved in endurance and flexibility, but there is no discernible difference to know if the upper extremity tricycle had more of a benefit then the lower extremity tricycle.

Two variable results were obtained during data collection for this study. The first was during the first exercise period, there was a decrease in heart rate. At the six week follow-up however, his resting heart rate was much lower. Therefore, the initial decrease may be contributed to anxiety associated with meeting new people and being asked to perform a new and challenging task.

The second was also in Subject 3 who, seemingly "lost" right ankle plantar flexion after the six week exercise program. In the initial evaluation of this subject, parent report was that the subject was dealing with increases in tone that was causing increased inflexibility. At this time, the subject was scheduled to be fitted for orthotics. With orthotics it would be expected that the subject would have maintained the ROM.

Study Limitations:

- Small number of subjects involved
- Scheduling conflicts
  - Weather
  - Illness
  - Vacations

One limitation to this study was the small number of subjects utilized. Such a small sampling was unable to resolve any outlier results, such as the two obtained with Subject 3. A larger population in this study may provide statistically significant changes in endurance and range of motion measures as well. Based on initial results, it is uncertain if statistically significant differences will be seen between the children who rode the upper and lower extremity tricycles, as both populations appeared to have improved. A larger sample size would allow for more global trends to be observed in conditioning.

A second limitation to the study was scheduling conflicts. The data for this study was collected in September through November of 2008, which caused a great many of our sessions to be rescheduled and a few to be cancelled due to weather (too cold, rainy or too dark). A few of our subjects had personal conflicts such as family vacation and illness, which caused missed sessions. It is general consensus of the researchers that these kinds of conflicts are typical to the pediatric client. Scheduling riding during spring and summer months would be more conducive to riding and would likely garner a larger subject population.

Research extension:

A second clinical trial of the experiment was repeated over the summer. The reason for continuing on clinical trials was to determine if a larger participant pool could show significant statistical changes. Four children between the ages of four and eleven rode AMBUCS adaptive tricycles for 5-7 riding sessions, following the same intervention protocol as stated before.

In the physical parameters measured – flexibility and endurance, no discernable patterns or statistical differences were noted for change. The examiners concluded that changes in HR and RR could be a result of increased cardiovascular activity (during PT session), anticipation of

riding, or resistance to being measured. There was an observed change seen in endurance as represented by increased continual riding times and decreased breaks was seen in Subjects 1, 3, and 4. Subject 2 was the only subject to display a significant decrease in total riding time throughout the entire collection period.

Subjectively, the researchers noted that positive emotional responses and increased social interaction as observed in the participants, suggest that tricycle riding was beneficial on more than just a physical level. The social benefit of increased interaction with peers provided a positive outlet for therapeutic recreation.

We determined that there was more of a social benefit than anything presented through the therapeutic riding program. It served as a great social outlet for the participants and their families.

The benefits of recreational therapy for children with cerebral palsy (CP) are documented in the literature on hippotherapy. These benefits include improvement in gross motor function, speech, self-esteem, and emotional well-being (). As access to equine riding programs is limited, we sought to evaluate the AMBUCS adaptive tricycle in a riding protocol. The rationale for the riding program is based on three primary premises.

- The postural demands and reciprocal movement patterns on the tricycle would be similar to the those of equine riding ()
- Inactivity/limited mobility in CP augments rigid movement patterns leading to decreased flexibility and endurance
- Activity-induced neuroplasticity is an underlying mechanism for altering motor behavior.

Therapeutic riding is an adjunct to traditional therapies providing children with special needs, a multi-dimensional activity that provides physical recreation and social interactions. The benefit of the therapeutic riding is that it allows for inclusion of children with disabilities and their same aged peers, while providing the increased exercise that children with disabilities require.

Therapeutic recreation is not a replacement to traditional therapies and interventions needed for children with special needs such as CP. Rather, it should be a supplement to current therapies. Therapeutic recreation will create for the child with special needs more multi-domain activity, including but not limited to, social interactions combined with physical activity. These kinds of activities could incorporate both children with their disabilities and their same aged peers, as well as provide the increased exercise that children with disabilities require.

There are clear potentials based on the results of initial investigation for children with disabilities to obtain a physical benefit from exercise based activities. Numerous studies have reported to benefits to all children regardless of disability status.

In the social context therapeutic recreation activities which can be done in groups with peers with and without disabilities are also a great benefit to children. Social development which frequently lags in this population could benefit from additional stimulation in a more relaxed setting.

<u>Parent Commentary:</u>

At the termination of the study, parents of the participants provided feedback though a written feedback form -

- The best part was “the exercise, the physical benefits and, the social confidence building.”
- He “enjoyed it a lot especially riding with other children.”

- He “loved it and was way more relaxed.”
- “It was fun to see him able to ride with his brother at the park”

Future areas of research:

- Effectiveness on other children populations
- Larger patient population
- How can community based programming benefit these children
    - Grants and community purchase of tricycles.

Future research is needed to determine the effectiveness of these types of activities for all children. To further determine the benefits of the six week riding protocol, a follow-up study with a larger patient population should be performed. Another area to research would be the effect of social interactions on child and parent perception of abilities before and after a initiating a therapeutic riding program. Subject population should also be considered in additional studies. This study was specifically narrowed to children with spastic diplegia. However, it is reasonable to say that children with many different types of disabilities could benefit from this type of exercise program. Isolating children with other more global disabilities may give a greater impression of overall effects to the child.

This study leads to the proposition that community based programming incorporating therapeutically recreational activities would be beneficial. Therapeutically based activities are not only beneficial to the child, but can nurture relationships with typically developing peers and within the family unit. Individually, the tricycles used in this study can be expensive for a family to purchase. However, it is of our opinion that if these tricycles could be purchased by local clinics, schools and/or the community via personal funds, fundraisers or grants, this would be a sound investment. The AMBUCS bikes are extremely adaptable, and can be adjusted to a variety of children (as was evident to this study). Therefore, bikes could be rented out for day or weekend slots or to simply be signed out for use. This would in turn benefit many families versus just one.

The hope for these studies is that it can provide an outline to create a community riding program for children in need of recreational therapy. Such a program would provide social benefits to children and parents to affect their social, physical, and cognitive level.