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Conceptual Framework of a Novel Intervention to Improve Mobility in Children with Cerebral Palsy: The Successes and Challenges of Implementing a Large Amplitude Movement Protocol

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CONCEPTUAL FRAMEWORK OF A NOVEL INTERVENTION TO IMPROVE
MOBILITY IN CHILDREN WITH CEREBRAL PALSY: THE SUCCESSES
AND CHALLENGES OF IMPLEMENTING A LARGE
AMPLITUDE MOVEMENT PROTOCOL

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A doctoral project submitted in partial fulfillment
of the requirements for the

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Department of Physical Therapy
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Tania Goodwill, Erin Jarrett, Beren Shah, and Alanna Stockford

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ABSTRACT

While cerebral palsy remains one of the most common childhood disabilities, clinicians continue to face significant challenges developing effective treatment strategies for the widely variable presentation of motor function impairments associated with cerebral palsy. A large gap exists between current research based evidence and feasible clinical practice. The purpose of this paper is to introduce a novel intervention protocol, explore the theoretical framework behind the protocol and provide insight to clinicians about the successes and challenges faced while pilot testing the intervention. The novel intervention was adapted and implemented by researchers combining a large amplitude movement protocol with the well-researched concepts of task specific, goal oriented and high intensity practice. A previous feasibility study conducted on the large amplitude movement protocol showed subjects demonstrating improvements in multiple gait characteristics and mobility. While data were collected during this study, it will be reported separately to allow this paper to focus on the theoretical framework of the intervention and the clinical implications of the intervention. The discussion of the successes and challenges faced by researchers during the implementation of the protocol give guidance for clinical adaptation of the protocol as well as direction for future studies.

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INTRODUCTION

Cerebral palsy (CP) is the most common physical disability originating in childhood, affecting approximately 2.11 children per 1000 live births annually.¹ A diagnosis of CP is based on permanent, activity limiting developmental impairments of motor function.² A rise in the prevalence of CP has been seen over the last several years and is thought to be linked to advancement in medical technology leading to decreased infant mortality (consequently resulting in an increase in the survival of infants with and without genetic/traumatic injuries).³

One frequently observed commonality in children with CP is dysfunction with postural control and movement patterns in daily activities, such as walking. These impairments restrict the ability for children with CP to participate in their roles at home, at school and in the community.² Gait patterns for children with CP have been shown to be less efficient and adaptable due to altered mechanics of the legs when moving the center of mass.^{4,5} The specific aspects of gait that are involved include restrictions in double limb support, stride length, step length, reduced gait velocity, shorter gait cycles and atypical postural sway compared to age-matched, typically developing peers.^{6,7,8} Numerous physical therapy interventions have been used to help improve functional mobility in children with CP, but empirical data supporting these interventions are limited and generally target the lowest level (body structure and function) and the level of activity of the International Classification of Function (ICF) model of enablement.⁹ These interventions include bimanual upper extremity therapy, strength training, hippotherapy, and reactive balance training.¹⁰ While past interventions have compartmentalized, and treated segmentally, different aspects of CP, new treatment

strategies should aim to address several inter-related dysfunctions with one multi-faceted intervention. An intervention that successfully accomplishes this would be ideal for healthcare professionals, individuals with CP and their families by providing the best care with reduced costs (with respect to time, money, and resources).^{11,12,13}

Over the lifespan, problems with mobility associated with CP often co-exist or lead to the development of secondary disabling conditions. These secondary conditions are just as varied as the presentation of CP and can include musculoskeletal, gastrointestinal, cardiovascular, neurological and psychological impairments.¹⁴ These secondary impairments include, but are not limited to, bony degeneration, contractures, cardiovascular disorders, depression, low self-esteem, overuse syndromes, pain, seizures, ulcers, reduced balance and coordination, incontinence and obesity.¹⁴

Obesity is one co-morbidity that has become more prevalent in the last 20 years, causing a large gap between past treatment approaches and current needs of the population.¹⁵ Obesity in ambulatory children with CP aged 6 to 19 has risen from 8.8% (1994-1997) to 17.2% (2003-2005), regardless of gender, functional level, or type of CP.¹⁵ These numbers are similar to the distribution seen in non-disabled children (10.9% in 1991, 16.0% in 2002).^{16,17} Negative health and psychosocial effects of obesity both in children with and without disabilities are far-reaching. Secondary issues from obesity include gastrointestinal, cardiovascular, respiratory, musculoskeletal, and metabolic complications, in addition to depression and stigma.¹⁸ Obese children with physical disabilities of CP and spina bifida showed a higher trend for secondary conditions than obese non-disabled children (asthma, high blood pressure, high blood cholesterol, diabetes, depression, fatigue, gastrointestinal problems, joint or bone pain, sleep apnea,

liver or gallbladder problems, low self-esteem, preoccupation with weight, early maturation, and pressure sores) with the rate of high blood pressure reaching significance.¹⁹ Obesity, along with the multitude of other primary and secondary conditions associated with CP, assure that no two children with CP are alike creating a large hurdle to conducting research on a standardized, multi-faceted intervention.

Despite the prevalence of CP, clinicians encounter important challenges in their efforts to effectively address the needs of individuals with CP and their families. One reason for this may be the complexity of the processes involved in translating research-based evidence into clinical practice.²⁰ Although clinicians believe the idea of evidence-based practice is sound, many barriers exist that prevent the integration of evidence into practice. These barriers include time constraints, lack of access to information, and a clinician's lack of confidence with interpreting research findings. Another challenge in delivering effective care is that research based evidence does not support the use of many intervention strategies currently used in clinical practice.²¹ In a recent systematic review of 64 interventions used to address movement disorders of children with CP, over 70% of strategies were categorized as "use with caution" or "do not use" because of their lack of effectiveness.²¹ The majority of research looks at the effectiveness of an intervention for specific outcomes but tends to leave the underlying mechanisms of action, or dosing, associated with the results unexplored. This leads to yet another challenge experienced by therapists in that dosing may not be adequate to drive changes in motor learning or critical body structures and functions affected by CP, such as muscle and bone. For this reason, determining appropriate dosing and strengthening knowledge of the mechanism of actions of therapeutic interventions has been identified as a national priority.²²

While commonalities exist, there is a great deal of heterogeneity in the timing of onset of the condition, from injuries as a fetus up to two years of age.¹¹ Further, there is wide variation in the clinical presentation of movement disorders, associated health conditions, and the development of secondary disabling conditions.¹¹ Due to this heterogeneity, best practice recommendations stress a highly individualized approach to intervention, which contradicts typical research practice in which interventions are standardized across individuals and adapted in the clinic to achieve individual goals.²²

A possible solution to the lack of multi-faceted interventions for CP is an investigative large amplitude movement protocol. A large amplitude movement protocol, based loosely on the Lee Silverman Voice Training (LSVT) BIGTM protocol, has recently been shown to be superior to other treatment options for adult patients with Parkinson's disease (PD).²³ As a result of the task-specific ambulation and reaching tasks in the intervention, significant improvements were seen in gait velocity and stride length during ambulation resulting in functional improvement and providing evidence for transfer of improvements to novel skills.²⁴ Although studies have only confirmed the functionality of this intervention on patients with PD, etiological similarities between PD and CP with respect to decreased control of voluntary movements stemming from basal ganglia involvement, make a similar intervention promising for children with CP.^{2,24,25}

A previous feasibility study, exploring the use of high intensity, large amplitude movements to address both gross motor and social skill limitations, was conducted using similar large amplitude movements in children with CP.²⁶ The study found that the children enjoyed the movements and that the movements led to immediate statistically significant improvement in gait characteristics and mobility.²⁶ It is believed that

increased mobility in children with CP will also lead to a reduction in obesity by increasing participation and activity tolerance throughout daily life promoting a healthier, active, lifestyle.

As a result of the gaps in literature and in clinical practice, the focus of this paper will be a novel, multi-faceted investigative intervention, the Large Amplitude Movement (LAM) protocol, its mechanism of action and the challenges it may face in clinical practice. LAM derived its strategy based on commonly practiced techniques in rehabilitation that are believed to drive neuroplasticity, including goal oriented, task specific, high intensity practice. These strategies are incorporated with large amplitude movements, driven by verbal cues structured to emphasize an external focus and the sustainability of improvements made.^{27,28,29,30} The conceptual framework for the use of the LAM protocol will be discussed. The details of the intervention will be described including suggested dosing for an abbreviated episode of care. The paper will also discuss the successes and challenges observed with implementation of this intervention when applied to a single subject with right-sided hemiplegic CP

THE LAM APPROACH

Conceptual Framework

Large amplitude training has become a new area of study in the treatment of low amplitude movements, reduced executive functioning and sensory-perceptual deficits commonly seen in neurologic patients such as PD,²³ stroke,³¹ Multiple sclerosis (MS),³² CP,^{26,32} and Down syndrome.³³ Current evidence demonstrates better outcomes as a result of task specific, repetitive, part to whole training with positive feedback for the acquisition (or reacquisition) of mobility, stability, controlled mobility and skill.³⁰ These

concepts provide the framework for the LAM protocol and its use in the treatment of CP.

The first of these concepts is that of task specificity. It has been shown that interventions that incorporate task specificity are capable of driving functional changes in those with a variety of brain lesions, including CP. Each aspect of the protocol allows the child to work toward success with various movements used in daily life, such as rising from sit to stand, retrieving items from the floor while seated and in standing, and reaching for items across the midline of the body. Given the pediatric population, the various movements have “fun” themes that encourage creativity and participation. For example, rising from sit to stand is portrayed as a super hero with a cape who is preparing to fly, and reaching across midline is portrayed as a monkey reaching for a vine. It would seem a child may be more inclined to participate and enjoy an activity in which they can pretend to be an animal, pirate, or superhero rather than simply practicing “sit to stands.”

Another concept engraved into the protocol is the use of an external focus of attention. The use of an external focus simply describes focusing one’s attention on something outside of the body when performing a task instead of focusing on the body parts performing the movement.²⁷ Studies have shown that by providing an emphasis on external focus of attention, improved movement performance is observed in a wide variety of age groups, conditions, and skill levels.²⁷ Although it was not tested (the accepted standard to test an external focus is an electroencephalogram [EEG]) whether the participant actually had an external focus when performing the movements, our cues were designed to have participants focus on an external object or entity. This concept is closely related to goal-oriented practice, especially in children. This means that exercises focus on tasks that are important to, and chosen by, the child. This may include reaching

for toys that are significant to the child or simply using their imagination to fashion amusing stories around the exercises (e.g. an elephant reaching for a bag of peanuts instead of simply reaching to the side). Research demonstrates that an external focus allows for improved outcomes with longer lasting effects of rehabilitation.²⁹

Additionally, the concept of high volume practice is heavily integrated into the LAM treatment approach. This intensive practice allows for improved outcome in gait, balance, and mobility in those with varying levels of neurological disorders.²⁸ The intervention is structured such that the exercises are performed daily with the therapist, and again on their own at home, producing a high volume of practice. Per typical strength training protocols, the goal is for each exercise to be performed 10 times each, 3 times a day. This goal is achieved by starting with a high volume of a few exercises and using the gradual progression theory of exercise over the course of treatment to incorporate all aspects of the intervention.

The final concept to be discussed is that of sustainability. Often, physical therapy lacks an element that allows for gains made to continue after discharge. The LAM protocol seeks to eliminate poor carryover of gains by motivating the child to practice on an ongoing basis with a themed approach that is fun for the child. Additionally, the intervention is designed to provide an illustrated booklet and a DVD (reminding the child of the correct movement patterns as well as of the colorful themes and reinforcing the external cues) to assist with retention of skills at home.

The combination of these theoretical concepts, a unique intervention scheme and a specific child-friendly home exercise plan provides the foundation for the implementation of the LAM protocol and continued at-home treatment. The LAM

protocol was structured in such a way to attempt to reduce healthcare costs by offering an evidence based intervention that could be taught appropriately in an abbreviated episode of care with a system to continue treatment at home to maximize and maintain gains. In addition, effectively targeting and treating primary motor impairments at a young age may provide a mechanism to slow down, and possibly prevent, the occurrence of some secondary disabling characteristics.

Training Protocol

One subject was recruited to participate in the intervention for an abbreviated episode of care. The subject was six years of age with a neurologist diagnosis of right hemiplegic CP and was functioning at a GMFCS Level I. The subject was also classified as a Level 6 with the 5, 50 and 500 meter categories of the Functional Mobility Scale (FMS) and a Level 9 according to the Gillette Functional Assessment Questionnaire (GFAQ). The subject's parent reported that the subject had an expressive language disorder, attention deficit hyperactivity disorder (ADHD), and epilepsy. The subject was asked to return for six visits (one pre-interventional testing, four intervention sessions, and one post-interventional testing). Written informed parental consent and written child assent were obtained prior to participation. The Biomedical Institutional Review Board (IRB)[†] at the University of Nevada, Las Vegas (UNLV) approved this study.

The first visit consisted of gathering baseline data. Table 1 shows the reliability and validity of each test and measure used during pre and post- intervention testing.

[†] IRB approval #1004-3445

The first assessment completed was a timed-up-and-go (TUG) test, using an instrumented chair to measure dynamic mobility and control.³⁴ Three distances were used (three, six, and nine meters). These tests were repeated three times at each distance.

Following the TUG, the subject's jump power was assessed with a vertical jump for maximum height. This was measured by placing a small amount of finger paint on the subject's index finger with instructions to jump as high as possible while touching a piece of paper on the wall with the paint. An external focus of attention was attempted with encouragement to "put the paint as high on the paper" as possible.

The Bertec Balance Platform Series Force Plate[‡] was then used to measure the subject's limits of stability (LOS). The subject was given standardized instructions to lean as far forward, backward, leftward, and rightward as possible without falling.

Finally, the subject was instrumented with external markers in order to monitor movement in three dimensions via a Vicon[§] motion capture system. Following instrumentation, the subject was asked to walk across the GAITRite^{**}, an instrumented 4.27-meter walkway, at the subject's preferred walking speed. Spatio-temporal parameters were measured for multiple steps across the walkway as well as three-dimensional motion tracking via infrared video cameras, with information being obtained for a single stride (due to calibration and space constraints). The subject walked a total of nine passes, three passes for each condition (self-selected speed, fast speed, and dual task). For the "fast speed" condition, the subject was given the instruction, "walk as fast as you can without running" and was asked to walk quickly across and back over the

[‡] Bertec Corporation, Columbus, Ohio

[§] Vicon Motion Systems LTD, Oxford, United Kingdom

^{**} CIR Systems, Inc., Sparta, New Jersey

walkway, through the camera calibration zone three times. For the “dual task” condition, the child was given a small, lightweight tray (8 x 10 inch canvas with inclinometer embedded) to carry while again walking across the walkway at preferred speed, following the same procedures as for the other two walking conditions. At the conclusion of the first visit the subject was fitted with an accelerometer that attached to the right ankle. The subject was instructed to wear it for the week between the first and second visit, removing it only to bathe and sleep. The accelerometer was returned to the research team on the subject’s second visit.

Visits two to five implemented a 25 to 30 minute physical therapy intervention using large amplitude movements. The subject was instructed to move as big and shout as loud as possible. The intervention was administered to the subject each of four days with each day escalating gradually in complexity of movements and the number of repetitions. Prior to the intervention, the subject performed a TUG test and maximum vertical jump test. Next, the subject completed the intervention led by five student researchers and supervised by a licensed Physical Therapist (PT). The subject then completed a hedonic (liking) scale, by marking on a piece of paper with a 10 cm line. The subject marked in response to activity enjoyment; left end of the line, corresponding to “did not enjoy at all” or the extreme right end of the line corresponding to “this was a blast, I really had fun!” On the last day of intervention period, the subject was again given the ankle accelerometer to wear until it was collected at the beginning of the sixth visit.

During the sixth and final visit, intervention follow-up measures were obtained. The procedures conducted and measures collected were identical to the first visit. Figure

1 is a visual representation of the methods used during testing and intervention implementation.

Intervention Protocol

The LAM intervention is a combination of large whole body movements that focuses on functional movements a patient will likely encounter in daily life. The protocol utilized for this study implemented a four day intervention period. Each day had a theme related to the new exercises to be introduced that day (i.e. animals, super athletes). Table 2 demonstrates the introduction of new exercises, as well as, the increased intensity of repetitions. Additionally, there was an illustrated booklet with depictions of each exercise and a DVD showing the movements while providing guidance with external cues and the number of repetitions for each exercise. Throughout each exercise, emphasis was placed on being as big and as loud as you can be. This was done by emphasizing movements and counting out loud for each repetition. Encouragement was also given throughout the intervention by asking if the movements were as big as they can be or if they could be bigger.

Successes Observed

While specific data on gait characteristics and mobility were collected, it will not be reported in this paper as the primary focus of this paper is to shed light on a novel intervention and its clinical implications. Instead, this section will discuss the subjective benefits observed lending evidence to the successful adaptation of a theoretical framework for a new intervention for children with CP.

The LAM intervention was fun and meaningful for the subject, and the daily themes (e.g. animals, pirates) spurred creativity. For example, with the “Blast Off” LAM

exercise, the subject ensured everyone wore their “helmet,” “buckled up,” and “fueled up” before initiating the movement. Due to the fun nature of the intervention, the subject was more willing to proceed through baseline measurements in anticipation of the LAM exercises, and was motivated to learn and be involved. Although shy at first, the subject grew socially comfortable and enjoyed participating in the LAM exercises with the group of five student researchers. This increase in participation and creativity suggest cognitive benefits in addition to any observed physical benefits.

The subject found the LAM exercises involving upper and lower extremity reciprocal movements the most challenging. However, the subject acquired the skill with a fun approach and “part to whole” practice. Although the subject did not “master” reciprocal movement of the extremities, the subject displayed the coordinated movement sequence once on a few occasions and increased to two consecutive repetitions, a marked improvement from baseline attempts. This observation suggests improvements in new movement pattern acquisition and retention along with increased coordination.

The cardiovascular and pulmonary benefits of endurance exercise are well documented, along with assisting in management of a healthy ratio of height to weight. By increasing the repetitions and amounts of LAM exercises throughout the intervention, the subject was encouraged to increase exercise tolerance. Functional movements were emphasized through incorporation of strengthening components (e.g., sit to stand), range of motion (e.g. reaching), balance (e.g. lunges with arms out), and coordination (e.g. reciprocal movements). The subject’s mother reported that the subject showed increased movement capabilities and energy throughout the day. This suggests the movements not only increased the activity level of the subject, but also may work to improve movement

patterns which potentially worked to conserve energy with everyday tasks resulting in improved energy levels throughout the day.

Another success to be noted was the subject's compliance, and according to the subject's mother, even enthusiasm, to participate in the home exercise program. With the aide of the illustrated booklet and narrated DVD, the subject was motivated to complete the exercise at home establishing the high volume practice intended to drive meaningful change in the subject's gait characteristics and mobility. In addition the subject's mother was able to participate in the exercise program with the subject and reported that together they were able to log each days exercise activity and set goals for improvement.

Challenges Encountered

Subjectively, the intervention resulted in improvement of the subject in multiple areas of gait and mobility as noticed by researchers and the subject's mother. However, much of the data collection was done with significant challenges presented by the subject's primary and secondary conditions. While the purpose of this paper is to discuss the novel intervention, a brief review of the issues encountered during data collection is presented followed by a more in depth look at the challenges that arose during the implementation of the intervention.

During data collection, researchers noted the subject had difficulty understanding directions, did not understand the concept of the hedonic scale, was distracted easily during TUG and GAITRite trials, unreliable responses to questions (always saying no), required external motivation from the subject's mother (confounding variable) and had difficulties with several tests/measures due to the secondary condition of obesity.

As discussed, obesity is on the rise in both typically developing children and children with CP. As defined by the Center for Disease Control (CDC), our subject's pediatric BMI was 33.0 (above the 95th percentile for age and gender). The subject had difficulty with body weight support during some of the testing and the intervention (difficulty standing from a low seated position) and demonstrated rapid fatigue abnormal for children of similar age. In addition, obese children are more likely than non-obese children to show asymmetries in gait.³⁵ Due to this fact it is unknown how much of the noted gait asymmetry demonstrated by the subject was attributable to the subject's CP verses the subject's childhood obesity.

The implementation of the treatment protocol faced many of the same challenges as the data collection. One of the biggest issues, likely caused by the subject's diagnosed ADHD, was that the subject was very easily distracted by the slightest changes in position of the researchers, the smallest change in verbal cues and most of all, the presence of new items or individuals in the treatment area. The subject's responses continued to be unreliable during the treatment sessions and continually required new methods of motivation to not only stay engaged but to also make each exercise was completed with the appropriate form and number of repetitions.

For future implementation of the protocol, clinicians could reduce, and possibly avoid, these challenges by conducting the treatment in a one on one session in a room with minimal distractions with consistent verbal cues. In addition when cueing the subject to choose an option rather than give them the option of "yes" or "no", have them choose between two options that you want to accomplish. This prevents the subject from picking an option that stalls or prevents the treatment session to continue, while also

giving them ownership of the treatment as they have the feeling of being in charge of the session.

CONCLUSION

The LAM protocol, when combined with a task-specific, goal-oriented, high-intensity approach, may be beneficial for children with CP in terms of gait characteristics, lower extremity power, and general exercise benefits. The LAM protocol is a fun, sustainable treatment that encourages family involvement. While no results are reported in this paper from the data collection, the paper discusses the theoretical framework for a novel treatment protocol and describes the successes and challenges faced with data collection and protocol implementation. Additionally, the results of a prior feasibility study on a large amplitude movement protocol demonstrated statistically significant improvements in bilateral stride length, stride velocity, step width (heel to heel base of support) and decreased double limb support.²⁶ While randomized controlled trials (RCTs) are the gold standard in research design, the RCT may have limitations in producing translatable findings for clinical rehabilitation, partly due to the lack of generalization of complex conditions.³⁶ This paper follows a more contemporary model of research which allows a protocol to explore dosing of an investigative intervention which crosses all ICF levels.²² In addition, a single-subject design may be better suited for a subject who has a specific combination of conditions, such as right hemiplegic cerebral palsy, cognitive limitations, and obesity. Possible directions for future research should include the protocol conducted with fewer confounding factors, in a comparison study between typically developing children and children with CP, in a comparison study

between obese children and obese children with CP and most importantly, in clinical practice, to discover if the changes seen in gait and mobility are clinically relevant.

Table 1. Tests and Measures used according to the ICF model

Eligibility			
Test/Measure	Reliability	Validity	Primary Purpose
Gross Motor Function Classification Scale (GMFCS)	Inter-rater $k = 0.81$ for children 12-18 ³⁶ Inter-rater $k = 0.84$ ³⁷ Inter-rater $k = 0.75$ for children 2-12 years of age ³⁸ Inter-rater reliability: 0.91 Intra-rater reliability: 0.83	Moderate correlation with age-equivalent scores at >2 years of age with Peabody Gross Motor Age Equivalent and Vineland Gross Motor Age Equivalent ($p < 0.0001$). Not significant for Bayley Mental Development Equivalent or Vineland Communication Age Equivalent and Vineland Adaptive Behavior Age Equivalent ³⁷	To classify the mobility and developmental status of children with CP up to 18 years of age and meet eligibility requirements
ICF Level: Participation			
StepWatch Accelerometer	The StepWatch Activity Monitor had an accuracy of 99.87% compared with the observer-counted steps and was shown to be valid and reliable when compared with heart rate monitoring. ³⁹	No data available	To measure and reflect a change in the participants' participation in society
Gillette Functional Assessment Questionnaire (GFAQ)	ICC .92, .92, .81 ⁴⁰	The validity of this tool was correlated with all other assessments to which it was compared (including WeeFIM Scale and the POSNA Transfers and Basic Mobility Scale. ⁴⁰	To measure and reflect a change in the participants' functional gait and level of participation in society.
ICF Level: Activity			
TUG	ICC 3, 1=0.991 for 3M, ICC 3, 1=0.996 for 6M, ICC 3, 1=0.998 for 9M, ICC 3, 1=0.998 for 12M	No data available	To measure and reflect functional gait and gait speed
Bertec Balance Platform Series Force Plate: (Bertec, BP5050; Columbus, OH)	No data available	No data available	To measure limits of stability
ICF Level: Body Structure/Function			
GAITrite: Walkway (CIR Systems, Inc., Model No. 0499, P803; Sparta, NJ) GAITrite: Inclinometer (CIR	Ages 4- 8: ICC>0.8 for cadence, step length, and stride length, while ICC <0.8 for other parameters in this age group. Ages 8- 11: ICC >0.8 for cadence and heel-to-heel BOS, while	No data available	To collect spatio-temporal measures relating to gait.

<p>Systems, Inc., Model No. IAG3015 P803; Sparta, NJ</p> <p>GAITRite: Software (Version 4.2; Sparta, NJ)</p>	<p>ICC <0.8 for other parameters.⁴¹</p>		
<p>Vicon: 12-camera motion capture system (Vicon Nexus Motion System 2.0, 120 Hz; Oxford, UK)</p> <p>Vicon: Hardware (Vicon, MX, T- series, 200Hz; Centennial, CO)</p> <p>Vicon: Software (Vicon, Nexus 1.8; Centennial, CO)</p>	<p>No data available</p>	<p>No data available</p>	<p>To measure patterns of functional gait.</p>

Figure 1. Methods

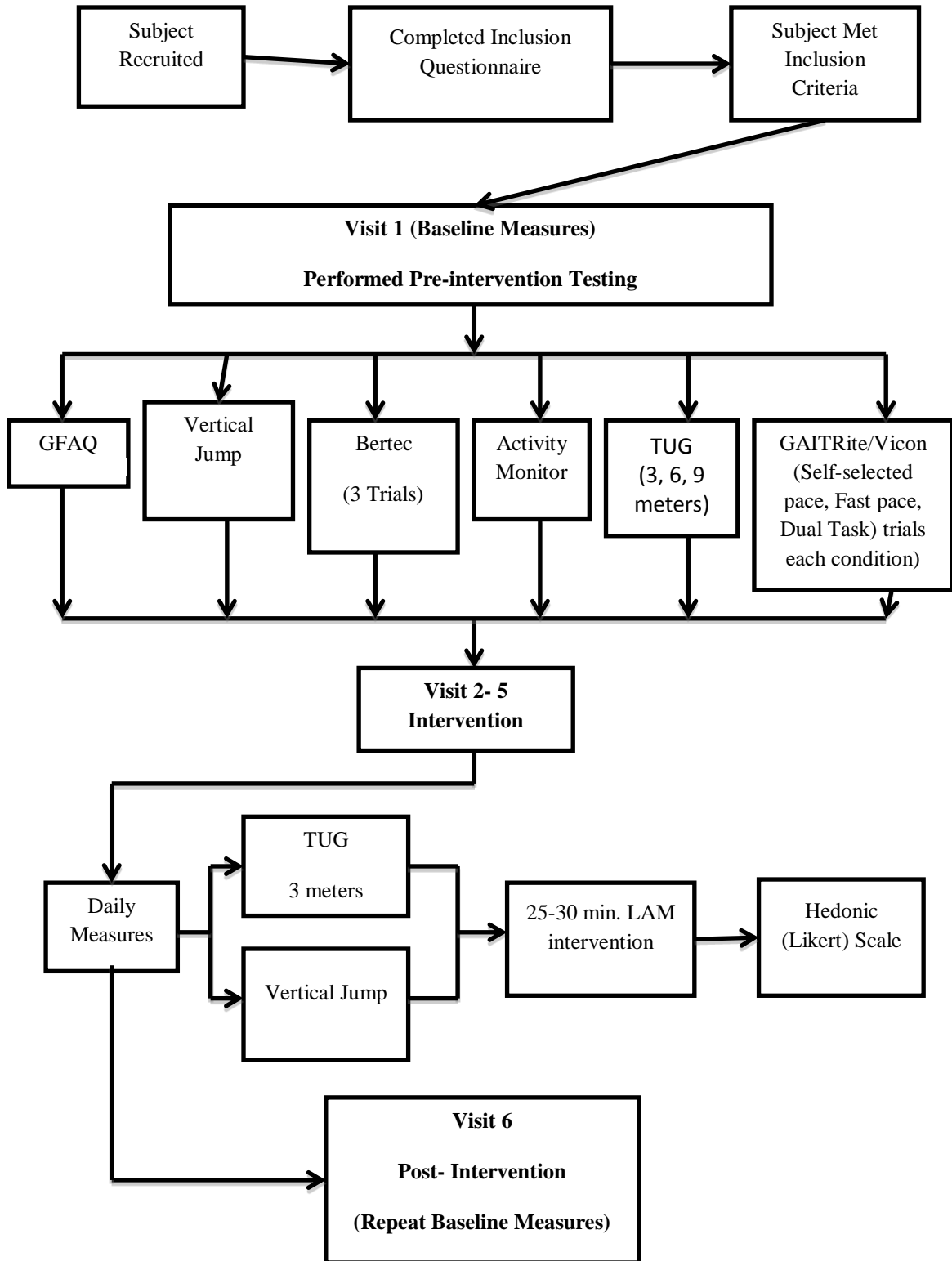


Table 2. LAM Themes and Progressions

Theme of the Day	Number of New Exercises	Number of Repetitions
Super Athletes (Day 1)	4	7
Pirates (Day 2)	4	8
Animals (Day 3)	3	9
10 Rep Challenge!	0	10

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Curriculum Vitae

Tania Goodwill

Education

- University of Nevada, Las Vegas
Doctor of Physical Therapy – Anticipated Graduation date May 2014
- University of Nevada, Las Vegas
Undergraduate Physical Therapy Prerequisite Classes - 2009 – 2010
- University of San Diego
Bachelor of Arts in Biology - 1999

Physical Therapy Clinical Education

- Select Physical Therapy – Coronado, Henderson, NV
Orthopedic Outpatient (June 2012- August 2012)
- St. Mary’s Regional Medical Center, Reno, NV
Acute Care, Inpatient (July 2013- September 2013)
- Renown Rehabilitation Hospital, Reno, NV
Rehab, Inpatient (October 2013 – December 2013)
- Advanced Pediatric Therapies, Sparks, NV
Pediatric Outpatient and Early Intervention (January 2014 – March 2014)

Continuing Education

- Understand and Explain Pain Seminar, Adriaan Louw, UNLV 2012
- Autism Research Institute Conference, Las Vegas, NV 2011

Professional Membership

- American Physical Therapy Association 2011 - 2014
 - Pediatrics Section Member
 - Neurology Section Member

Curriculum Vitae

Erin Harrison Jarrett

Education

University of Nevada, Las Vegas: Las Vegas, Nevada
Doctor of Physical Therapy, May 2014

Lenoir- Rhyne University; Hickory, North Carolina
B.S., Health and Exercise Science, May 2011.

Clinical Experience

- Sunrise Hospital and Medical Center, Las Vegas, NV January 2014-
March 2014
Inpatient/Outpatient Pediatric Clinical Affiliation
- Children's Therapy Center, Henderson, NV October 2013-
December 2013
Outpatient Pediatric Clinical Affiliation
- Life Care Center of America, Las Vegas, NV July 2013-
September 2013
Skilled Nursing Facility Clinical Affiliation
- Select Physical Therapy, Crestview, FL June 2012-August
2012
Outpatient Clinical Affiliation

Continuing/Supplemental Education

- a. Combined Sections Meeting of the American Physical Therapy Association (APTA);
2014 Las Vegas, Nevada
- b. Explain the Pain Seminar by Dr. Adrian Lowe, 2013; Las Vegas, Nevada
- c. UNLV Distinguished Lecture Series; 2012-2014

Professional Membership

- American Physical Therapy Association Member □□2011– 2014
- Nevada Physical Therapy Association Member, 2011- 2014

Curriculum Vitae

Beren M. Shah

Education

- **University of Nevada, Las Vegas (UNLV)**
Doctorate of Physical Therapy – May 2014
- **University of California, Los Angeles (UCLA)**
Bachelors of Science in Biology – December 2009

Clinical Experience

- **Clinical Affiliation – Select Physical Therapy – Sports/Outpatient Orthopedics**
Student Physical Therapist: January 2014 – March 2014
- **Clinical Affiliation – Summerlin Hospital – Inpatient Acute Care/Wound Care**
Student Physical Therapist: October 2013 – December 2013
- **Clinical Affiliation – Health South, Desert Canyon – Inpatient Rehabilitation**
Student Physical Therapist: July 2013 – September 2013
- **Clinical Affiliation – Integrity Physical Therapy – Outpatient Spine/Manual Therapy**
Student Physical Therapist: June 2012 – August 2012

Continuing/Supplemental Education

- **Interprofessional Seminar Series**
UNLV Students & Faculty of Physical Therapy, Nursing, Dentistry and Medicine
- **American Physical Therapy Association:**
--**Combined Sections Meeting, National Student Conclave, Federal Advocacy Forum**
Student Assembly, NPTA Student Representative, Nevada Delegation – 2012-2014
--**Section on Health Policy & Administration Leadership Conference**
“Lead Wherever You Are: Becoming a Personal Leader (C1)”
“Leading Others: Adaptive and Transformational Leadership in Physical Therapy (C2)”
- **Traumatic Brain Injury and Neuro-Developmental Treatment Approach**
Presented by Eric Siller, MPT, C/NDT, CBIS

- **Emergency Department PT Service: Enhanced Care thru an Emerging Area of Practice**
Presented by Dr. Michael T. Lebec PT, Ph.D.
- **Understand and Explain Pain**
Presented by Adriaan Louw, PT, M.App.Sc., Ph.D.(c)
- **Dry Needling Level 1 Proficiency**
Presented by KinetaCore Continuing Education

Professional Membership

- **Nevada Physical Therapy Association (NPTA)**
Member since 2011
- **American Physical Therapy Association (APTA)**
Research, Orthopedics and Health Policy & Administration Sections
Member since 2011

Curriculum Vitae

Alanna K. Stockford

Education

- University of Nevada, Las Vegas
 - Doctor of Physical Therapy-- expected May 2012
- University of North Carolina, Greensboro
 - Bachelor of Arts, Psychology-- 2008

Clinical Experience

- Select Physical Therapy, Tampa, FL
 - Outpatient Orthopedic (June 2012- August 2012)
- Sunrise Hospital, Las Vegas, NV
 - Inpatient Rehabilitation (July 2013- September 2013)
- St. Rose, San Martín Campus, Las Vegas, NV
 - Acute Care (October 2013- December 2013)
- Boulder City Hospital, Boulder City, NV
 - Outpatient Clinic (January 2014- March 2014)

Continuing/Supplemental Education

- “Explain Pain” Seminar, Dr. Adriaan Louw,
 - The University of Nevada at Las Vegas, 2012
- Advances in Neurological Therapeutics Medical Education Conference
 - Lou Ruvo Institute, Las Vegas, NV, 2012
- American Physical Therapy Association (APTA) Combined Sections Meeting
 - San Diego Convention Center, San Diego, CA, 2013
 - Sands Convention Center, Las Vegas, NV, 2014

Professional Memberships

- APTA (2011- present)
 - Neurology Section Member (2012- present)
 - Acute Care Section Member (2012-present)