OUTPATIENT REHABILITATION FOR A PEDIATRIC PATIENT WITH DEVELOPMENTAL DELAY

A Doctoral Project
A Comprehensive Case Analysis

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DOCTOR OF PHYSICAL THERAPY

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Todd Collins

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Abstract

of

OUTPATIENT REHABILITATION FOR A PEDIATRIC PATIENT WITH DEVELOPMENTAL DELAY

by

Todd Collins

A non-ambulatory 27-month-old girl with a history of failure to thrive, metabolic acidosis, and developmental delay was seen for 12 sessions over 7 weeks in a pediatric pro-bono outpatient clinic. Treatment was provided by a student physical therapist under the direct supervision of a licensed physical therapist.

The patient was examined using the two-minute walk test to examine ambulatory endurance, 10-meter walk test to determine gait speed, Peabody Developmental Motor Scale 2nd Edition to diagnose developmental delay, Gross Motor Function Measure-66 and Gross Motor Function Classification System – Expanded and Revised to track and predict gross motor function, and Pediatric Evaluation of Disability Inventory to assess the patient's participation needs at home and in the community. The main goals for this patient were to increase static and dynamic balance, increase ambulatory endurance and speed, increase gross motor function, and improve functional independence at home and in the community. The main interventions used in

this episode of care included: treadmill and overground gait training with and without body weight support, balance exercises, and task-specific training, all while utilizing a family-centered approach. The patient made significant improvements in her ambulatory speed and endurance, gross motor function, and functional independence at home and in the community. The patient was referred to neurologist for a second opinion on magnetic resonance imaging results and discharged to continue living at home with home exercise program under the supervision and care of her family after 7 weeks of treatment.

_____, Committee Chair
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_____
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Chapter 1

General Background

Cerebral palsy (CP) is the most common motor disability in children, affecting 3-4 of every 1,000 live births in the United States.[1] Cerebral palsy is a neurological disorder that can manifest through multiple physical impairments which include: aberrant movements of single or multiple limbs; impaired coordination, muscle tone, muscle weakness, balance, posture, fine motor skills, gross motor skills, and oral motor function. Cerebral Palsy is non-progressive, non-contagious, and is currently non-curable. It is caused by a malformation or damage to the developing brain, before birth, during birth, or after birth.[2] Individuals with CP may also have related conditions including autism, intellectual disability, seizures, scoliosis, contractures, and problems with vision, hearing, or speech.

Symptoms of CP can vary from case to case, presenting themselves on a continuum of impairments. Some children may be unable to walk and require life-long care, while others may have minimal ataxia and are able to live independently.[3] Cerebral Palsy can be classified into four types based on the primary type of movement disorder observed, spastic CP which makes up about 80% of all CP cases, dyskinetic CP (10%-15%), ataxic CP (5%), and mixed CP. Individuals with mixed CP can have multiple symptoms of each subgroup of CP. The most common combination is spastic-dyskinetic CP.[3]

Individuals with ataxic CP struggle most with balance and UE/LE coordination. These impairments typically lead to an unsteady gait pattern and will increase the

difficulty of fine motor skills.[3] Studies have shown that individuals with ataxic CP present with hypotonia, tremors on attention, and sensory impairments.[4]

Risk factors for congenital CP include sex (boys>girls), children of African descent,[5] low birthweight (< 5.5 lbs),[6] premature birth (<36 wks), multiple births (twin, triplet, etc), infections during pregnancy, jaundice and kernicterus, or other birth complications (detachment of the placenta, uterine rupture, or problems that disrupt oxygen supply to infant).[7] Months after a healthy birth, babies continue to be at risk of acquiring CP due to infection (meningitis or encephalitis),[7] physical injury (motor vehicle accident or physical abuse),[8] or problems that limit blood flow to the developing brain (stroke, brain bleed, heart defect, or sickle cell disease).[9] Other cerebellar neurological pathologies including spinocerebellar ataxia have been linked to diet, mainly vitamin E deficiency.[10]

The majority of individuals living with CP have a normal life expectancy.[11] However, those with an increased number of comorbidities, restricted level of mobility, the severity of feeding difficulty's, and presence of intellectual delay have an increased mortality rate.[12] Retrospective studies have shown that all individuals with CP who were able to sit independently by 2 years old (yo) were eventually able to ambulate without aid and those who were able to sit independently by the age of 4 yo were eventually able to ambulate with assistance.[11] Gross Motor Function Measure-66 (GMFM-66) and Gross Motor Function Classification System – Expanded and Revised (GMFCS–E&R) can be used together to create gross motor curves that are able to predict gross motor function up to age 12 years.[13]

Chapter 2

Case Background Data

Examination – History

The patient was born at 39 2/7 weeks via planned Cesarean section. After 4 days, she was discharged with her mother. The patient's mother reports that she was diagnosed with a bicornuate uterus, describing that the patient was gestated in the left uterine horn, the smaller side of the two. The mother reported that her pregnancy was uncomplicated besides gestational diabetes mellitus. Per medical review, the patient weighed 5 pounds (lbs) 15 ounces (oz) at birth and the delivery was reported to be without any complications.

Since birth, the patient refused to eat solid foods and would only drink breast milk. The patient said her first words at 6 months old and was creeping and pulling to stand at 10 months. She stopped meeting milestones after 10 months and ceased crawling around 14 months. At 14 months, she became ill and her weight dropped significantly. At the time, her mother was pregnant with another child and was unable to develop milk. At 15 months, the patient was admitted to the emergency department weighing 16 lbs. 8.6 oz. The patient presented with iron deficiency anemia, failure to thrive (FTT), constipation, decreased oral intake, decreased urine output, severe dehydration, and metabolic acidosis attributed to starvation. After 11 days, she was discharged home with a nasogastric (NG) tube. The patient had an NG tube from 15 months until about 24 months, which is when she began eating solid food for the first time. The mother reported that the older sister of the patient did not start walking until 17 months old. Brain

magnetic resonance imaging was done when the child was 27 months old with and without contrast, revealing mild nonspecific T2 hyperintensity in the posterior periventricular white matter, no evidence of acute or chronic cortical infarction, no hydrocephalus, intracranial hemorrhage or mass effect. There was no mention of the patient's cerebellum.

At the time of evaluation, the patient was 27 months old with history of FTT, metabolic acidosis, and developmental delay. She was able to maintain her balance for 5 seconds while rotating her head in a high kneeling position, cruise along a couch to her left and right, slowly lower herself from supported standing to sitting, take 4 steps forward with added support through her pelvis, receive a rolling ball and roll a ball away while in a seated position, and pull to stand and lift one foot at a time for 1 second while using hands for support. The patient was unable to maintain a standing position without assistance for any amount of time and used no balance strategy to maintain stability.

The patient lived in a single-story home with one step to enter the home. She had a large family support circle that invested time into her skill acquisition. A reverse walker had been donated to the family to increase her ability to ambulate throughout the house and in the community. The patient received physical therapy (PT), occupational therapy (OT), and speech therapy (SP) (1x/week) to work on balance, gait, fine motor skills, and feeding.

Systems Review

The patient's cardiopulmonary system was unimpaired: resting heart rate was 110 beats per minute, blood pressure was 100/60 millimeters mercury (mm Hg), and

respiratory rate was 25 breaths per minute. The neuromuscular system was impaired due to balance deficits and ataxic movements. The musculoskeletal system was impaired based on decreased gross strength, low muscle tone, and excessive range of motion. The integumentary system was unimpaired based on observation and parent report. Per parent report, her language communication was unimpaired, and she was able to speak over 50 words and stream two and three-word sentences in both English and Spanish. Cognition, affect, and learning needs were not impaired based on observation, interaction, and parent report.

Examination – Medications

The child was not taking medication at the time of treatment.

Chapter 3

Examination – Tests and Measures

The patient's deficits were categorized using the International Classification of Functioning, Disability, and Health for Children and Youth (ICF-CY) Model.[14] The patient was examined using the two-minute walk test (2MWT), 10-meter walk test (10MWT), Peabody Developmental Motor Scale 2nd Edition (PDMS-2), Gross Motor Function Measure – 66 (GMFM-66), Gross Motor Function Classification System – Extended & Revised (GMFCS–E&R), and Pediatric Evaluation of Disability Inventory (PEDI). The 2MWT was used to assess ambulatory endurance, a body structure and function measure. The 10MWT was used to identify preferred gait speed, an activity measure. The GMFM-66 was used as an activity level measure that assessed the patient's gross motor function and was used in conjunction with the GMFCS-E&R as a prognostic measure for the patients expected motor improvements. The PDMS-2 measures motor skills at the activity level and was used to diagnose the extent of developmental delay. The PEDI caregiver domain was used to assess the patient's participation needs at home and in the community.

The 2MWT is a body structure function measure that quantifies endurance by assessing distance walked over a two-minute time period. Individuals are allowed to use assistive devices but they should be consistent between test trials. The 2MWT is a modification of the 6-minute walk test (6MWT) and is typically used for patients who are unable to sustain ambulation for 6 minutes.[15] When comparing the 2MWT to the 6MWT, a study found excellent test-retest reliability for the distances covered over the first

2 minutes, with intraclass correlation coefficients (ICC) of 0.888 ranging from 0.814 - 0.933 for raw scores within a 95% confidence interval (CI_{95}) and the full 6 minutes (ICC) = 0.917 [0.862-0.951]) of the 6MWT for individuals between 3-85 yo.[15] Normative values within the pediatric population for the 2MWT have been reported to be 125.9 ± 24.9m for a healthy 3 yo girl.[16]

The 10MWT is an activity level outcome measure that quantifies one's preferred gait speed.[17] Individuals are allowed to use assistive devices but they should be consistent between test trials. During the test, the patient is given a 2-meter acceleration zone to obtain self-selected gait speed and is only timed during the following 10 meters. The test is performed three times, an average speed is collected, and is typically recorded in meters per second. The test-retest reliability of the 10 meter fast walk test (10MFWT) for children with CP between ages 4 -18 years old, was found to have a standard error of the measure (SEM) of 1.5 seconds, and therefore a minimal detectable change at the 95% confidence interval (CI) (MDC_{95}) of 4.3 seconds specifically for children in the GMFCS level II.[17] This means that the patient would need a change in their score of at least 4.3 seconds to be 95% confident that the improvement was not due to measurement error. The same study showed that the 10 MFWT had an ICC = 0.78 for raw scores within a 95% CI for children in the GMFCS level II. Children classified as GMFCS level II can walk independently and climb stairs holding a railing, but typically experience difficulty walking long distances, balancing on uneven terrain, inclines, in crowded areas or confined spaces.[17]

The PDMS-2 is a norm-based outcome measure that assesses a child's (1 – 72 months) motor skills and compares the scores to that of over 2000 children with typical development.[18] The PDMS-2 can be divided into two subscales; fine motor (FM) and gross motor (GM). The GM subscale is further divided into four subscales; reflexes, stationary, locomotion, and object manipulation. All tasks are scored from 0-2 points, with higher scores reflecting more accomplished skills. The maximum score on the subscales is as follows: reflexes (16 points), stationary (60 points), locomotion (178 points), and object manipulation (48 points). The scores found in the PDMS-2 are compared to a reference based norm to diagnose the level of developmental delay. For children between 27 – 64 months old, all subscales of the PDSM-2 were found to have excellent test-retest reliability, ICC = 0.993 - 0.995.[19] This means that if the test is administered multiple times, the outcomes will remain consistent. The same study found that the SEM for the GM subscale to be 3.0 points for raw scores within a 95% CI.[19] The MDC was calculated using the SEM, $MDC_{95\%} = SEM \times 1.96 \times \sqrt[2]{2} = 8.3$ points.[20] This means that the patient needed a change in their score of at least 8.3 points to be 95% confident that the improvement was not due to measurement error. A study investigating the diagnostic accuracy of the PDMS-2 found the best cut off point for determining "developmental delay" was a developmental quotient of 85, with a positive likelihood ratio of 81 and a negative likelihood ratio of 0.19.[21] This means that if a child has a developmental quotient of 85 or below, there would be a large shift in post-test probability that the child does truly have a developmental delay. Conversely, if the same

child had a developmental quotient of above 85, there would be a moderate shift in post-test probability that the child does not truly have a developmental delay.

The GMFM-66 is a standardized observational instrument designed and validated to measure change in gross motor function over time in children with CP.[22] The test has 66 items split into five dimensions: A, lying and rolling; B, sitting; C, crawling and kneeling; D, standing; and E, walking, running, and jumping. The scoring for each item is as follows: 0 points: patient does not initiate, 1 point: patient initiates motion, 2 points: patient partially completes movement/task, and 3 points: patient completes movement/task. Dimension A has 4 tasks (max score of 12 points), dimension B has 15 tasks (max score of 45 points), dimension C has 10 tasks (max score of 30 points), dimension D has 13 tasks (max score of 39 points), dimension E has 23 tasks (max score of 69 points).[23] Higher scores reflect greater motor capability. For children within the GMFCS level II, the dimension D has a minimal clinically important difference (MCID) of 5.3 points and dimension E has a MCID of 4.5 points.[24] This means that the patient needs a change of 4.5 points in dimension E to be considered a meaningful change. The same study found that the MCID for the total GMFM - 66 score is 1.5 points. This means that a child must have an increase of at least 1.5 points of their total GMFM-66 score to consider it a meaningful change. Another study examined the reliability and validity of the GMFM-66 in 0 to 3 yo children with CP. Test-retest reliability had an ICC of 0.966 (95% CI = 0.918–0.987), and interrater reliability was ICC = 0.978 (95% CI = 0.945–0.991), indicating a very high reliability.

The GMFCS - E&R is a 5-level classification system that describes the gross motor function of children and youth with cerebral palsy on the basis of their self-initiated movement with particular emphasis on sitting, walking, and wheeled mobility.[25] Children who are classified as level I can typically walk without restrictions but have difficulty with advanced motor skills. Children who are classified in level V are typically unable to ambulate and require maximum assist with bed mobility and transfers. The GMFCS – E&R was found to have an interrater reliability of 0.93 and test-retest reliability of 0.79.[26] A child whose function is classified at Levels I at age less than 2 years, will be able to walk, at least indoors without an assistive device, by age 6 to 12 years with a positive likelihood ratio (+LR) of 5.1.[26] Further, children in level II at age less than 2 years, will be able to walk, at least indoors without an assistive device, by age 6 to 12 years with a +LR of 9.[26] This indicates that children who are classified as GMFCS level I –II will have a moderate increase in probability that they will be able to walk without an assistive device between the ages 6-12. The GMFM-66 and GMFCS can be used together to create gross motor curves that are able to predict gross motor function up to age 12.[13]

The PEDI is a comprehensive clinical assessment that samples key functional capabilities and performance in children between the ages of 6 months to 7½ years.[27] The PEDI is designed to evaluate functional skills, caregiver assistance, and modifications needed. Each of those sections contains three domains: self-care, mobility, and social function. These domains are evaluated through parent interviews, direct observations, and testing of the functional abilities of the children.[28] The caregiver assistance scale ranges

from 0-5 points, 0 points representing total assistance; 5 points representing independence. The maximum score in the caregiver assistance section is 100 points; summed from self-care (40 points), mobility (35 points), and social function (25 points). For children between the ages of 1-19, with various diagnoses including congenital and developmental delay, the MCID of the caregiver assistance section was found to be 11.5% points.[29] Therefore, in order for a patient to feel a significant change in function, they would need a change of at least 11.5% points in their total caregiver assistance score. Caregiver assistance has been acknowledged as an important factor that contributes to a child's ability to participate in their community, especially at a young age.[28]

Table 2

Examination Data

<table>
<tr><th colspan="3">BODY FUNCTION OR STRUCTURE</th></tr>
<tr><td>Measurement Category</td><td>Test/Measure Used</td><td>Test/Measure Results</td></tr>
<tr><td>Gait endurance</td><td>2MWT</td><td>Distance: 92 feet
Conditions: reverse walker</td></tr>
<tr><td>Static standing balance</td><td>Item #56 GMFM – 66. Maintains standing, arms free, 20 seconds.</td><td>0/3: does not maintain standing, arms free</td></tr>
<tr><td>Gait Mechanics</td><td>Observational gait analysis</td><td>Bilateral overpronation, calcaneus valgus, and knee hyperextension during stance phase of gait; increased weight bearing through upper extremities; wide base of support with cocontracted muscles in lower extremities</td></tr>
<tr><td>Muscle Tone</td><td>Observation</td><td>Gross hypotonia throughout</td></tr>
<tr><th colspan="3">FUNCTIONAL ACTIVITY</th></tr>
<tr><td>Measurement Category</td><td>Test/Measure Used</td><td>Test/Measure Results</td></tr>
<tr><td>Gait speed</td><td>10MWT</td><td>Time: 43.5 seconds
Gait Speed: 0.23 meters/second
Conditions: two hand held assistance</td></tr>
<tr><td>Motor Skills</td><td>Peabody Developmental Motor Scale</td><td>
<table>
<tr><td>Subtest</td><td>Raw Score</td><td>Percentile</td><td>Age equivalent</td></tr>
<tr><td>Stationary</td><td>38/60 points</td><td>25</td><td>18 months</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><td></td><td></td><td>
<table>
<tr><td>Locomotion</td><td>56/178 points</td><td><1</td><td>10 months</td></tr>
<tr><td>Object Manipulation</td><td>4/48 points</td><td>1</td><td>12 months</td></tr>
</table>
Total Gross Motor percentile: 1%
Gross Motor Quotient: 66
</td></tr>
<tr><td>Gross Motor Function</td><td>Gross Motor Function Measure – 66</td><td>
<table>
<tr><td>Dimension</td><td>Raw Score</td></tr>
<tr><td>Lying & Rolling</td><td>12/12</td></tr>
<tr><td>Sitting</td><td>45/45</td></tr>
<tr><td>Crawling & Kneeling</td><td>27/30</td></tr>
<tr><td>Standing</td><td>8/39</td></tr>
<tr><td>Walking, Running, & Jumping</td><td>10/72</td></tr>
<tr><td>Total calculated from GMAE software</td><td>50.6%, SEM= 1.2
95% CI (48.3 – 52.0)</td></tr>
<tr><td>GMFCS E&R Level</td><td>II; 65th percentile</td></tr>
</table>
</td></tr>
<tr><td colspan="3">PARTICIPATION RESTRICTIONS</td></tr>
<tr><td>Measurement Category</td><td>Test/Measure Used</td><td>Test/Measure Results</td></tr>
<tr><td>Independence in home and community</td><td>Pediatric Evaluation of Disability Inventory – Caregiver section</td><td>
<table>
<tr><td>Domain</td><td>Raw Score</td><td>Standard Score</td><td>Standard Error</td></tr>
<tr><td>Self-Care</td><td>4/40</td><td>31.3</td><td>6.4</td></tr>
<tr><td>Mobility</td><td>5/35</td><td><10</td><td></td></tr>
<tr><td>Social Function</td><td>9/25</td><td>46.1</td><td>3.6</td></tr>
<tr><td>Total</td><td>18/100</td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Participation in play at the playground</td><td>Parent report</td><td>Patient has not been exposed to the playground at the park yet.</td></tr>
</table>

2MWT = two minute walk test, 10MWT = 10 meter walk test, GMAE = gross motor ability estimator, SEM = standard error of measurement, GMFCS E&R = gross motor function classification system expanded and revised

Chapter 4

Evaluation

Evaluation Summary

The patient was a 27-month-old female with a diagnosis of developmental delay and history of FTT and metabolic acidosis. The patient demonstrated decreased gait endurance and impaired stationary balance as shown by the 2MWT and stationary subscale of the PDMS – 2, respectively. Functional activities were found to be limited by decreased gross motor function and skills. The patient was able to pull to stand and maintain independent standing for no longer than 1 second. The patient was able to ambulate for distances beyond 50 feet with two hands held but could only take 2 steps with one hand held. The patient's participation was found to be restricted by relying on caregivers to assist with functional tasks, as shown by the PEDI. Furthermore, the child was unable to participate in play at a local playground.

Diagnostic Impression

The patient was typically developing until age 10 mo when she began to get sick. The child had no formal diagnosis other than developmental delay but showed the following signs indicating ataxia: dysmetria, lack of righting reactions, gross hypotonia, abnormal gait mechanics, and sensory impairments. The impairments found in the patient's body structure and function level included standing balance, gait mechanics, and gait endurance, which led to activity level limitations such as decreased gait speed and gross motor function delays. These impairments and limitations contributed to the

patients overall increased reliance on her caregivers to assist her while participating in the community setting.

Prognostic Statement

The patient's positive prognostic factors included: a supportive family and being able to sit independently by age 2.[11] The patient's negative prognostic factor was her history of (NG) tube feeding.[12]

The GMFM-66 and GMFCS were used to help determine the patient's ability to perform different gross motor activities later in life. Based on the information gathered at the initial evaluation, the patient was classified as GMFCS level II which predicted her ability to ambulate indoors without an assistive device between the ages of 4 to 6yo.[25] According to the GMFM-66 developmental growth curves, the patient scored just below the 65th percentile and would reach 90% of her gross motor function by age 5.[30,31] The patient's projected maximum GMFM-66 was 75 points.[30]

G-Codes

Current with modifier: G8978-CK (40-60% impaired) based on total GMFM-66

Goal with modifier: G8979-CJ (20-40% impaired) based on total GMFM-66

Discharge Plan

The patient was expected to be discharged to continue living at home with home exercise program under the supervision and care of her family after 7 weeks of treatment. The patient would be referred back to neurologist further evaluate the reason for the ataxic presentation. The patient would continue receiving her additional PT, OT, and SP services after discharge.

Chapter 5

Plan of Care-Goals and Interventions

Table 3

Evaluation and Plan of Care

	PLAN OF CARE		
PROBLEM	Short Term Goals (3 weeks)	Long Term Goals (7 weeks)	Planned Interventions Interventions are Direct or Procedural unless they are marked: (C) = Coordination of care intervention (E) = Educational intervention
BODY FUNCTION OR STRUCTURE IMPAIRMENTS			
Impaired gait endurance	The patient will increase gait endurance by showing a 10% increase in distance walked during the 2 MWT with a reverse walker, from 92 feet to 101.2 feet. (based on 10% increase)	The patient will increase gait endurance by showing a 10% increase in distance walked during the 2 MWT with a reverse walker, from 101.2 feet to 111.3 feet. (based on 10% increase)	**Gait training:** Initially, gait training focused on utilizing overground walking with the PBWS harness, standard overground walking, and a child-sized treadmill. The PBWS gait training helped challenge the postural support systems that the treadmill was unable to target. The patient began to express negative feelings toward the PBWS harness and its use was discontinued after 3 sessions (total of 88 minutes). The treadmill was utilized during 7 sessions (total of 188 minutes) with speeds progressed from 0.15 m/s to 0.30 m/s. 1 lb ankle weights were used to increase proprioception through ataxic lower extremities. Each session that included treadmill training was finished with unsupported overground walking (total of 60 minutes). (C) HEP: Parents were instructed to take the patient for walks around the neighborhood using reverse

			walker 30min 3x/week. (E) Told parents to only give single hand-held assist while walking indoors and outdoors.
Impaired standing static balance	The patient will maintain standing, arms free <3 seconds (GMFM – 66 Item #56) (score of 1/3). (based on 1 point increase)	The patient will maintain standing, arms free 3-19 seconds (GMFM-66 Item #56) (score of 2/3). (based on 1 point increase)	**Standing progression:** Patient began standing in front of a bench while reaching for objects with alternating hands to reduce external support. The patient was then progressed to standing with back against the wall for minimal support for increased amounts of time. The patient was encouraged to lean away from the wall while reaching for toys and bubbles (5-10min per session). (E) Parents were encouraged to let the child experience controlled partial falls to help improve righting reactions.
ACTIVITY LIMITATIONS			
Limited gait speed	The patient will increase gait speed by ambulating 10 meters in 39.2 seconds with a reverse walker. (MDC: 4.3 seconds)	The patient will increase gait speed by ambulating 10 meters in 34.9 seconds with a reverse walker. (MDC: 4.3 seconds)	**Gait training:** See above
Limited gross motor function	No change anticipated.	The patient will increase gross motor function as measured by an increase in total GMFM -66 score by 1.5%. Increasing the patients score from 50.6% to 52.1% (MCID: 1.5%)	**Sit to stand progression:** Patient was progressed from sit to stands from a large bench to a small bench. By the end of the episode of care, the patient was standing up from sitting on the floor and eccentrically controlling her decent during a squat to the ground. Repetitions were increased throughout the episode of care. (10min each session) (C) HEP: Parents were told to play games with the patient that involved her performing the sit to stand motion.

			Standing progression: See above **Gait training:** See above
	Patient will be able to initiate a squat (GMFM – 66 Item #63) (score 1/3) (based on 1 point increase)	Patient will be able to safely lower herself down to a squat, using her arms (GMFM – 66 Item #63) (score 2/3) (based on 1 point increase)	**Sit to stand progression:** See above **Stair training:** The patient would climb up steps with 2 hand held assist with a step to pattern. The number of total steps climbed increased and level of 2 hand held assist was decreased throughout the episode of care. (10-15min every other session) **Gait training:** See above
	Patient will initiate standing while sitting on a small bench (GMFM – 66 Item #59) (score 1/3) (based on 1 point increase)	Patient will be able to attain standing from sitting on a small bench, using arms on the bench (GMFM – 66 Item #59) (score 2/3) (based on 1 point increase)	
	Patient will be able to walk forward <3 steps independently (GMFM – 66 Item #69) (score 1/3) (based on 1 point increase)	Patient will be able to walk 3-9 steps independently (GMFM – 66 Item #69) (score 2/3) (based on 1 point increase)	**Gait training:** See above
PARTICIPATION RESTRICTIONS			
Restricted independence in home and community	No change anticipated.	The patient will increase independence within home and community by increasing total PEDI caregiver assistance score by 11.5% points. From 18% to 29.5% (MCID: 11.5%)	**Gait training:** See above **Standing progression:** See above **Parent Education** (E) Parents were encouraged to give patient extra time to allow her to perform more tasks without assistance. Discussed topics including self-dressing, eating, bathing, and toileting. (5min every session)
Restricted participation playing with kids at the playground	No change anticipated.	The patient will be able to maneuver around jungle gym and play on the slide with her sister with min assist from a caregiver, per parent report.	**Parent Education** (E) Parents were encouraged to take walks to the park in their neighborhood to allow patient to explore playground equipment and interact with other children. (5min every session)
2MWT: two-minute walk test, PBWS: partial body weight support, HEP: home exercise program, GMFM – 66: gross motor function measure – 66, MCD: minimal detectable change, MCID: minimal clinically importance difference, PEDI: pediatric evaluation of disability inventory			

Plan of Care – Interventions

See table 3.

Overall Approach

The patient was seen for 12 sessions over 7 weeks, including initial evaluation, home visit, treatment, and discharge. The plan of care was centered on task-specific training to create realistic and relevant context for the patient to learn functional skills.[32] The overload principle was utilized by increasing the speed during treadmill training and increasing sets and repetitions for stair climbing, sit to stands, and balance activities.[33] Choosing goal-directed activities was a fun and engaging way to encourage the child to stay focused during 60-minute treatment sessions. During the episode of care, the student physical therapist visited the child at her house to observe the patient in her natural environment which helped create meaningful goals for the child. Family-centered therapy has been shown to increase developmental outcome measures, therefore the parents were involved during every treatment.[34] The student physical therapist helped coach the parents by educating about which activities to focus on at home throughout the day to increase overall training time.

PICO question

For a child with CP (P), is treadmill training (I) more effective than overground walking (C) to improve gross motor function, walking speed, and walking endurance (O)?

A randomized controlled clinical trial (RCT) (level of evidence: II) compared the effects of treadmill training and training with overground walking on motor skills in children with cerebral palsy.[35] Thirty-six children with cerebral palsy (GMFCS levels I-III) were randomly divided into two intervention groups. The experimental group included 17 children who underwent treadmill training without partial weight support. The control group included 18 children who gait trained over ground. The training program was two times a week for 7 weeks with four subsequent weeks of follow-up. The inclusion criteria were ages 3-12 yo; GMFCS levels I-III; and functional ambulation for at least 12 months. Exclusion criteria were a cognitive or visual impairment that could compromise the performance of the tasks and children who underwent an orthopedic surgery in the last 12 months. The study utilized the 6 Minute Walk Test, timed up-and-go test (TUG), PEDI, GMFM-88, and the Berg Balance Scale (BBS) as outcome measures to track changes in motor function. Both groups demonstrated significant improvements on the TUG, mobility section of the PEDI, GMFM-88 subscales C and E, and BBS; however, only the treadmill group maintained these improvements during the follow-up evaluation. An inter-group analysis found that the treadmill group had better performance in the TUG, PEDI, GMFM-88, and Berg Balance Scale when compared to the overground group ($p = 0.001$).[35]

In 2010 a review, of systematic reviews, was performed to gather current evidence from systematic reviews (level of evidence: I) on the effectiveness of treadmill training (TT), including partial body-weight support (PBWS) TT (PBWSTT), TT only, robotic-assist PBWSTT, and mixed TT, in children with motor impairments.[36] The

inclusion criteria were either PBWS and/or TT as an intervention; children from birth to 21 years of age; and a diagnosis consistent with having a motor impairment. Of 1166 total citations available, only 5 articles met inclusion criteria. The authors used AMSTAR analysis to determine the quality of the five systematic reviews: two high quality, two medium quality, and one low quality. The systematic reviews included a high proportion of children with CP, followed by a smaller proportion of children with Down syndrome, spinal cord injury, and other neurological impairments. The authors all concluded that TT appears to be a safe intervention for children with motor impairments, although there is still an insufficient amount of high level evidence to conclude that that TT has positive effects on walking in children with CP.[36]

In conclusion, the studies included suggest that TT has positive effects on developing motor skills with children classified as GMFCS level I-III, although there is insufficient high level evidence to make a definitive conclusion. Both studies reviewed included subjects who were ambulatory at the beginning of treatment, which my patient was not. The largest barrier that limited my ability to draw conclusions from the articles was due to the child's unique medical presentation. I was able to justify using a combination of PBWS gait training, TT, and over ground gait training based on the articles recommendations because they included children classified as GMFCS level II.

Chapter 6

Outcomes

Table 4

Outcomes

<table>
<tr><td colspan="5">OUTCOMES</td></tr>
<tr><td colspan="5">BODY FUNCTION OR STRUCTURE IMPAIRMENTS</td></tr>
<tr><td>Outcome Measure</td><td>Initial</td><td>Follow-up (DC)</td><td>Change</td><td>Goal Met? (Y/N)</td></tr>
<tr><td>Gait endurance (2MWT)</td><td>92 feet, reverse walker</td><td>125.6 feet, reverse walker (change score 10%)</td><td>+33.6 feet (36.5% increase)</td><td>Y</td></tr>
<tr><td>Static standing balance (GMFM – 66 item #56)</td><td>0/3; does not maintain standing, arms free.</td><td>2/3; maintains standing, arms free for 3-19 seconds (change score 2 points)</td><td>+2 points</td><td>Y</td></tr>
<tr><td colspan="5">ACTIVITY LIMITATIONS</td></tr>
<tr><td>Outcome Measure</td><td>Initial</td><td>Follow-up (DC)</td><td>Change</td><td>Goal Met ? (Y/N)</td></tr>
<tr><td>Gait speed (10MWT)</td><td>Time: 43.5 seconds
Gait Speed: 0.23 m/s
Conditions: 2 HHA</td><td>Time: 23.9 seconds
Gait Speed: 0.42 m/s
Conditions: reverse walker
(MDC= 4.3 seconds)</td><td>-19.6 seconds</td><td>Y</td></tr>
<tr><td>Gross motor function (GMFM – 66 total score)</td><td><table><tr><td>Dimension</td><td>Raw Score</td></tr><tr><td>Lying & Rolling</td><td>12/12</td></tr><tr><td>Sitting</td><td>45/45</td></tr><tr><td>Crawling & Kneeling</td><td>27/30</td></tr><tr><td>Standing</td><td>8/39</td></tr><tr><td>Walking, Running, & Jumping</td><td>10/72</td></tr><tr><td>Total calculated from GMAE</td><td>50.6%</td></tr><tr><td>GMFCS E&R Level</td><td>II; 65th percentile</td></tr></table></td><td><table><tr><td>Dimension</td><td>Raw Score</td></tr><tr><td>Lying & Rolling</td><td>12/12</td></tr><tr><td>Sitting</td><td>45/45</td></tr><tr><td>Crawling & Kneeling</td><td>29/30</td></tr><tr><td>Standing</td><td>27/39</td></tr><tr><td>Walking, Running, & Jumping</td><td>14/72</td></tr><tr><td>Total calculated from GMAE</td><td>56.9%</td></tr><tr><td>GMFCS E&R Level</td><td>II; 85th percentile</td></tr></table></td><td>+ 6.3% points

MCID = 1.5% points</td><td>Y</td></tr>
</table>

	(Item #63 GMFM – 66) 0/3: The patient was unable to initiate squat	(Item #63 GMFM – 66) 2/3: The patient was able to safely lower herself down to a squat, using her arms	+2 points	Y
	(Item #59 GMFM – 66) 0/3: The patient did not initiate sit to stand from small bench	(Item #59 GMFM – 66) 3/3: The patient attained standing from small bench without using arms	+3 points	Y
	(Item #69 GMFM – 66) 0/3: The patient did not initiate step	(Item #69 GMFM – 66) 2/3: The patient took 3-9 independent steps	+2 points	Y
PARTICIPATION RESTRICTIONS				
Outcome Measure	Initial	Follow-up (DC)	Change	Goal Met? (Y/N)
Independence in home and community (PEDI caregiver assistance)	Caregiver assistance total score: 18%	Caregiver assistance total score: 37%	+ 19% points MCID = 11.5% points	Y
Participation in play at the playground (parent report)	The patient has not been exposed to the park yet.	The patient went to the park 2-3x a week and was able to maneuver around playground and play on the slide with her sister with min assist from caregiver, per parent report.		Y
2MWT: two minute walk test, 10MWT: 10 meter walk test, 2 HHA: two hand held assist, STD: standard, m/s: meters per second, GMFM-66: gross motor function measure, GMFCS: gross motor function classification system, GMAE: gross motor ability estimator, PEDI: Pediatric evaluation of disability inventory, MCID: minimal clinically important difference,				

Discharge Statement:

The patient was a 27-month-old girl with history of FTT, metabolic acidosis, and developmental delay. She was seen in an outpatient probono clinic for 12 sessions over 7 weeks by a student PT under the supervision of a licensed PT. The plan of care focused on task-specific training which included gait, balance, and stair training. Before treatment, the patient was unable to stand independently or take independent steps. By the end of the episode of care, the patient had achieved all of her goals, taking up to 5

independent steps and standing without assistance for 4 seconds. The patient was discharged to continue living at home under the supervision and care of her family. Throughout the plan of care, the parents were educated about the importance of their involvement in their child's life to continue working on home exercises to achieve new milestones. The patient would benefit from seeing a neurologist to determine a reason for her ataxic presentation and continued therapy from her additional PT, OT, and SP services after discharge.

DC G-Code with modifier:

Goal with modifier: G8979-CJ (20-40% impaired) based on total GMFM-66

Chapter 7

Discussion

After 7 weeks of therapy, the patient made significant improvements in her gross motor function, balance, gait endurance, gait speed, and overall ability to participate in her home and community. As the child examined had no confirmed medical diagnosis other than that of developmental delay, it was hard to determine the exact measures needed to track progress, diagnose delay, and predict improvements. The medical diagnosis of ataxic CP was used as a placeholder as it most accurately described her motor patterns. During the 7-week plan of care, the patient improved from the 65th percentile to the 85th percentile in the GMFCS level II. When working with similar patients in the future I will continue to utilize the same treatment philosophies as this patient. This includes task-specific training, overload principle, goal-directed activities, and the family-centered approach. When working with non-ambulatory children, I have observed that it is important to stress both balance using overground gait training and repetitive motions using treadmills to help achieve a higher level of motor function.

Reflecting on the overall episode of care there are some things that I wish I could have done differently. The pre-treatment 10MWT was performed with two hand held assistance when the post-treatment was performed with a reverse walker. At the time of the initial evaluation, the patient was uninterested in the assistive device and would only cooperate while holding her parent's hands. At times the outpatient clinic used for treatment was overwhelming for the child which could have led to distractions limiting performance.

As mentioned earlier, there is a lack of evidence supporting treadmill training for children with CP. Further, the majority of research done involves spastic CP with little mention of children with ataxic CP. The emergence of RCTs that involve non-ambulatory children with ataxic CP will improve my ability to treat this patient population in the future.

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