OUTPATIENT REHABILITATION FOR A PATIENT WITH HEMIPLEGIC
CEREBRAL PALSY

A Doctoral Project
A Comprehensive Case Analysis

Presented to the faculty of the Department of Physical Therapy
California State University, Sacramento

Submitted in partial satisfaction of
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DOCTOR OF PHYSICAL THERAPY

by

Molly Vetrone

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Department of Physical Therapy
Abstract

of

OUTPATIENT REHABILITATION FOR A PATIENT WITH HEMIPLEGIC CEREBRAL PALSY

by

Molly Vetrone

A patient with a medical history of perinatal arterial ischemic stroke which resulted in a diagnosis of hemiplegic cerebral palsy was seen for physical therapy treatment for 16 sessions from 3/10/15 to 5/5/15 at the pro-bono outpatient physical therapy clinic at California State University, Sacramento. Treatment was provided by a student physical therapist under the supervision of a licensed physical therapist.

The patient was evaluated at the initial encounter with the 6 Minute Walk Test to evaluate endurance, Peabody Developmental Motor Scale-Second Edition to evaluate gross and fine motor development, 10 Meter Walk Test to test walking speed, Gross Motor Function Measure-66 item to test gross motor function, Pediatric Evaluation of Disability Inventory to evaluate dependence on caregiver for assistance, observation for limitations in functional strength, and parent report on participation restrictions, and a plan of care was established. Main goals for the patient were to improve functional strength, static and dynamic standing balance, independent
ambulation, gait speed, usage of right upper extremity and functional independence. Main interventions used were gait training, task-specific training, constraint induced movement therapy, bimanual training and functional training.

The patient improved strength, balance, independent ambulation, gait speed, usage of the right upper extremity and functional independence. The patient was discharged to home with a home exercise program to be guided by his parents.

_____________________________, Committee Chair
Edward Barakatt, PT, PhD

Date
ACKNOWLEDGEMENTS

I acknowledge the STEPS program and Katrin Mattern-Baxter of California State University, Sacramento for allowing me the opportunity to learn about and treat pediatric patients with neurological disorders. I acknowledge my family and friends for all their support, especially my fiancé Hayden, who could not have been more supportive, loving and kind throughout my time as a doctoral student of physical therapy.
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Chapter 1

General Background

Although stroke is primarily thought to be a diagnosis of the elderly, it is not rare among infants and is a common cause of neurological disability. Similar to the adult presentation, strokes in infants can be either ischemic or hemorrhagic.¹ The more prevalent ischemic strokes occur 17 times more frequently in infants during the perinatal period, immediately before or within the first few weeks of life, as compared to throughout childhood.² Perinatal arterial ischemic stroke (PAIS) is defined as a focal disruption of cerebral blood flow secondary to an arterial blockage immediately before or within the first 28 days after birth.² The incidence of PAIS occurs in 20 per 100,000 live births in the United States. This disorder is financially taxing to the families of children who have experienced PAIS, costing the average American family over $43,000 within the first year post-stroke.²⁻⁴

Acute, clinical manifestations of PAIS typically occur in one of two ways; as a neonatal presentation or as a delayed presentation.³ Those who demonstrate signs and symptoms of PAIS immediately before or after birth are considered to have a neonatal presentation. Those who demonstrate signs and symptoms of PAIS after 1 month of life are considered to have a delayed presentation.³ Infants with the neonatal presentation typically exhibit symptoms such as apnea, behavioral changes, or seizures; with seizures being the most commonly occurring symptom, arising in 96% of cases.⁵ Those with delayed presentation typically display pathological hand
preferences or seizures. Other clinical signs and symptoms of PAIS include abnormal tone, hemiparesis, feeding difficulties and abnormal levels of consciousness.

Risk factors for PAIS can be categorized into three types: maternal, fetal and placental. Each type of risk factor can independently contribute to an infant's risk of suffering from a stroke. Therefore, it is important to monitor the physiological characteristics of the mother, fetus and placenta during the perinatal period. Maternal risk factors include thrombophilia, history of infertility, primiparity, prolonged rupture of membranes, preeclampsia or gestational diabetes, smoking, infection, maternal fever, emergency caesarian section delivery and intrauterine growth retardation. Fetal risk factors include thrombophilia, congenital heart disease, fetal heart rate abnormalities, arteriopathy, hypoglycemia, perinatal asphyxia, infection, need of resuscitation, decreased fetal movement and an Apgar score of <7 at five minutes postpartum. In addition to the fetal risk factors listed, PAIS has been shown to be more common in boys and individuals of African American descent. Lastly, placental risk factors for PAIS include chorioamnionitis and meconium-stained amniotic fluid. Although premature birth has been speculated to be a risk factor for stroke, 87% of neonates who suffered from symptomatic PAIS were delivered at term.

The effects of PAIS are vast but the main consequence of this diagnosis is its association with another condition called hemiplegic cerebral palsy. Similar to strokes in adulthood, impairments following a PAIS typically present unilaterally and on the side of the body contralateral to the lesion. For example, if a child suffers from a
stroke on the left (L) cerebral hemisphere, motor deficits will be displayed on the right (R) side of the child's body, with the upper extremity (UE) most commonly affected. Long term sequelae of PAIS include cognitive, behavioral and chronic motor deficits. These chronic motor deficits affect the child's ability to use his/her muscles and lead to a condition called cerebral palsy (CP). Cerebral palsy is the most common motor disability in childhood and perinatal arterial ischemic stroke is a main cause. In fact, following a PAIS, 68% of children developed CP. Of these cases, 87% were classified as hemiplegic CP.

Patients with hemiplegic CP typically show symptoms within the first year of life. These children are slow to reach developmental milestones such as crawling, sitting or walking. Despite the possible impairments attributed to hemiplegic CP, level of function varies widely, with many patients reaching high functional levels.

The prognosis for individuals with CP is highly variable and depends on the severity of deficits suffered. Those whose cerebral lesion was small or whose lesion quickly resolved, may experience better outcomes than those with a larger, more severe cerebral lesion. On average, patients with CP reach approximately 90% of their motor function by five years of age. Therefore, early interventions to increase motor function prior to the fifth year of life may be beneficial. Children with CP who are able to sit independently by age two have the best prognosis for future ambulation. Individual predictions of motor development can be made with patient-specific motor levels and usage of motor development curves. In general, children with more severe motor impairment levels are less likely to ambulate independently and less likely
achieve developmental motor milestones. Overall, the prognosis for patients with CP may be variable but with advancements in early diagnosis, intervention strategies, and use of adaptive equipment, those living with CP may experience improved functional outcomes and increased quality of life.
Chapter 2

Case Background Data

Examination-History

The patient was a 24 month-old boy who initially suffered from a PAIS two years prior to the treatment episode. The patient was born at full term with a birth weight of 9.4 pounds to a healthy, 28 year-old, primiparous mother who reported no complications during pregnancy. The patient’s mother demonstrated a slight fever during delivery at 100.6°F, and due to failure to progress, an emergency caesarean section was performed. At 36 hours postpartum the patient presented with apnea, cyanosis, abnormal posturing, and jittery movements. The patient was transferred to a neonatal intensive care unit where magnetic resonance imaging revealed the presence of a left-sided cerebral infarct, a result of a PAIS located in the middle cerebral artery. Following the stroke, the patient’s cerebral activity was closely monitored with repeated pediatric electroencephalograms. He was discharged from the hospital four weeks later. Since his stroke, the patient had received multiple episodes of physical and occupational therapy, and his parents wished to continue physical therapy interventions to gain further functional progress.

At evaluation the patient presented with hemiplegic CP with motor delays, decreased endurance, weakness, and incoordination of R upper and lower extremities. He tended to keep his R thumb adducted and R hand positioned in a fist despite the fact that he had full ROM in all joints. His parents’ chief complaint was that the patient had shown delayed progression of ambulation as well as a general lack of use
of his R arm and hand. The parents' goals for physical therapy included strengthening the weak UE and lower extremity (LE) musculature, improving ambulation, and increasing the use of his R UE and hand.

The patient resided in a single level apartment with very supportive parents that provided both social and physical support when needed. The patient was independent in rolling, sitting, and creeping but was dependent on parents for most activities of daily living (ADLs) and participation activities.

**Systems review**

The following systems were affected by his past history of ischemic stroke and current diagnosis of hemiplegic CP: musculoskeletal, cardiopulmonary, neurological, and language. Musculoskeletal, cardiopulmonary, and neurological impairments were observed and objectively measured throughout examination. Impairments of these systems can be seen in further detail in Table 2. Specific details on neurological impairments were reported by the patient's parent. Language delays were observed, and the patient was under the care of a speech therapist for improvement in language delays. The patient was also under the care of an occupational therapist for fine motor control of the R UE.
Examination- Medications

Table 1

Medication

<table>
<thead>
<tr>
<th>MEDICATION</th>
<th>DOSAGE</th>
<th>REASON</th>
<th>SIDE EFFECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Levetiracetam (Keppra)</td>
<td>100 milligram/milliliter- 2</td>
<td>Treatment of seizures. Anticonvulsant that decreases abnormal excitement in the brain.</td>
<td>Drowsiness, weakness, unsteady walking, coordination problems, headache, pain, forgetfulness, anxiety, agitation, dizziness, moodiness, nervousness, numbness, loss of appetite, vomiting, diarrhea, constipation, depression, fever, sore throat, seizures that are worse or different than one has experienced before.</td>
</tr>
<tr>
<td></td>
<td>milliliters two times per day</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Chapter 3

Examination- Tests and Measures

The patient's activity, body structure and function, and participation limitations and impairments were categorized and measured using the International Classifications of Functioning, Disability and Health (ICF) model.\textsuperscript{12} The 6 Minute Walk Test (6MWT) was used to assess aerobic capacity/endurance, a body structure and function impairment. The Peabody Developmental Motor Scale- Second Edition (PDMS-2) was used to identify limitations in balance, a body structure and function impairment. The PDMS-2 was also used to assess activity limitations such as object manipulation and locomotion impairments. Other activity impairments tested were: walking speed assessed by the 10 meter walk test (10MWT), and gross motor function assessed by the Gross Motor Function Measure-66 item (GMFM-66). The patient caregiver's report was used to identify limitations in attending community outings to assess participation changes. The caregiver also completed the assistance scale in the mobility domain of the Pediatric Evaluation of Disability Inventory (PEDI) to measure changes in patient participation. The PDMS-2 was utilized as a diagnostic measure and outcome measure, the GMFM-66 as a prognostic measure and outcome measure, and the 6MWT, 10MWT, and PEDI as outcome measures.

The PDMS-2 was used as a diagnostic measure to assess gross and fine motor function in comparison to age related norms. The PDMS-2 is a norm referenced, standardized measure that is used to assess a child's motor skills relative to his or her peers. The measure is also used to identify children who have developmental delays
and to translate those findings into individualized goals and objectives. The PDMS-2 is a 249 item measure that is divided into two scales; the Gross Motor Developmental Scale and the Fine Motor Developmental Scale. The Gross Motor Developmental Scale is further divided into four subscales titled Reflexes (only valid for those up to 11 months of age), Stationary (items testing balance), Locomotion (items testing the ability to move from place to place), and Object Manipulation (ability to manipulate objects). When scores from each of the subtests within the Gross Motor Developmental Scale are totaled, they are referred to as the gross motor composite.

The Fine Motor Developmental Scale is also made up of two subtests titled Grasping and Visuomotor Integration. Within all subscales, all items of the test are scored on a 3-point scale. A score of “2” indicates the child’s mastery of that motor skill; a score of “1” indicates a child has partially, but not fully met the criteria of mastery of that motor skill; and a score of “0” indicates the child could not or would not attempt the motor skill. Raw scores for each subscale are totaled and converted to age equivalents, percentiles, and standard scores from which comparisons can be made with age stratified normative data. These results allow the examiner to detect developmental delays as compared to children with typical development and assess change pre- and post-physical therapy intervention. Test-retest reliability of the composites of the PDMS-2 was deemed acceptable with a range of intraclass correlation coefficients (ICC) from 0.89-0.93. Inter-rater reliability was established and has a correlation coefficient of 0.98. Internal consistency was found to be high with Cronbach alpha levels ranging from 0.92 to 0.99. The effect size of the PDMS-2 assessing the change
in PDMS-2 scores following a rehabilitation program in children with intellectual disabilities was 0.74.\textsuperscript{14} An effect size of 0.74 demonstrates the PDMS-2 has moderate responsiveness for detecting change in fine and gross motor function for this population of children. The minimal detectable change at the 95\% confidence level (MDC\textsubscript{95}) for the total gross motor score was 7.76 points.\textsuperscript{14} The MDC\textsubscript{95} of 7.76 points means that with an increase in total gross motor score of 8 points or greater, one can be 95\% confident that there was an actual change in motor function rather than a change possibly due to measurement error. The standard error of the measure (SEM) for the Stationary subscale, Locomotion subscale, and Object Manipulation subscale all had a value of one.\textsuperscript{15} A manually calculated MDC\textsubscript{95} for each of these subscales was 2.77 points. The minimal clinically important difference (MCID) for the total gross motor score was 8.39 points.\textsuperscript{14} The MCID reflects that a score increase of greater than 8 points indicates an important clinical difference in the individual's condition has occurred.

The GMFM-66 was used as a prognostic measure and is considered the international standard to measure gross motor foundational skills, evaluate change, and determine developmental delay in children with CP.\textsuperscript{13} The GMFM-66 is a criterion-referenced measure and is validated for use across a spectrum of motor delay severities as delineated by a motor classification system known as the Gross Motor Function Classification System (GMFCS). The GMFCS is a five level classification system that describes the severity of gross motor function in children with CP.\textsuperscript{16} Those classified as level I are considered the least impaired and those classified as level V
are the most limited in their motor abilities.\textsuperscript{17} The GMFM-66 is divided into five dimensions of motor function: Dimension A: Lying and Rolling; Dimension B: Sitting; Dimension C: Crawling and Kneeling; Dimension D: Standing; and Dimension E: Walking, Running, Jumping. All items within a dimension are scored on a 4 point scale, summed, and converted into a percentage of the maximum score. Also provided is a SEM estimate which is used to provide a 95\% confidence interval for that child's score. These values are then placed on an item map and compared to percentiles of other children of the same age and GMFCS level.\textsuperscript{18} The internal consistency of the GMFM-66 is considered very high (alpha = 0.99).\textsuperscript{13} Overall, the GMFM-66 inter-rater reliability and test-retest reliability were good to excellent with ICC levels from 0.75 to 0.99, respectively.\textsuperscript{13} The MCID of the GMFM-66 for a patient with a GMFCS level I is 3.8 points in Dimension D: Standing; 6.5 points in Dimension E: Walking, Running, Jumping; and 2.7 points for the complete GMFM-66.\textsuperscript{13} Diagnostic validity values have not been established for this measure.

The 6MWT was used as an outcome measure to assess change in endurance or functional walking capacity. The test is performed by having the child walk his or her greatest distance over a six minute time period with rest breaks and use of assistive devices if necessary. After the six minute walking period has expired, the distance in meters that was covered is recorded. Test-retest reliability for children with CP is considered excellent with an ICC of 0.98.\textsuperscript{19} The SEM is 19.8 meters and the MDC\textsubscript{95} for all GMFCS levels is 54.9 meters.\textsuperscript{20} In addition, stratifying children with CP by their GMFCS level indicated that for children at level I, the MDC\textsubscript{95} of the 6MWT is
61.9 meters.\textsuperscript{20} For children with GMFCS levels of II and III the MDC\textsubscript{95} of the 6MWT is 64 meters and 47.4 meters, respectively.\textsuperscript{20}

The 10MWT was used as an outcome measure to assess walking speed over a distance of 10 meters. The test is performed by having a child walk 10 meters at a comfortable speed for three trials and the average speed of the three trials is determined. Shorter times are considered to represent better walking capacity.\textsuperscript{13} Psychometrics for this outcome measure are limited. The best available evidence for children with CP was based on a modified 10MWT where children were asked to complete the test at their “fastest speed”. The test-retest reliability for the modified version of this test is an ICC value of 0.81.\textsuperscript{20} The SEM is 4.4 seconds and the MDC\textsubscript{95} is 12.2 seconds.\textsuperscript{20} An MCID for this measure has not been established.

The mobility domain of the PEDI was used as an outcome measure to assess change in patient and caregiver participation pre- and post-physical therapy intervention. The PEDI is validated for use on children ages 6 months to 7 years and is separated into three individual sections including the Functional Skills Scale, the Caregiver Assistance Scale, and the Modifications Scale. Each section is separated into three domains: the Self Care domain, the Mobility domain, and the Social Function domain. The Mobility domain of the Caregiver Assistance Scale includes transfer skills and body transport activities. For this particular patient, the Mobility domain of the Caregiver Assistance Scale was used to quantify the level of assistance the child needed from his caregiver. The information gathered from this measure sheds light on the child's ability to participate in social and community outings. Internal
consistency for the six scales is high with Cronbach’s coefficient alpha of 0.95-0.99.\textsuperscript{13} Inter-rater reliability ICC levels ranged from 0.74 to 0.96.\textsuperscript{13} The MCID was determined to be an 11% score change post rehabilitation.\textsuperscript{21}

Table 2

Examination Data

<table>
<thead>
<tr>
<th>BODY FUNCTION OR STRUCTURE IMPAIRMENTS</th>
<th>Test Used</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spasticity</td>
<td>Modified Ashworth Scale</td>
<td>0, No increase in muscle tone</td>
</tr>
<tr>
<td>Endurance</td>
<td>6MWT with push toy</td>
<td>47.5 meters</td>
</tr>
<tr>
<td>Balance</td>
<td>PDMS-2: Stationary Subscale</td>
<td>Stationary Subscale: Raw score: 57, Percentile: 25%, Standard score: 8, Age equivalent: 14 months</td>
</tr>
<tr>
<td>LE strength</td>
<td>Observed in functional sit to stand</td>
<td>Patient was unable to go from sit to stand without use of arms &gt;1 repetition</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ACTIVITY LIMITATIONS</th>
<th>Test Used</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Locomotor skills and motor activities</td>
<td>PDMS-2: Locomotion subscale</td>
<td>Locomotion Subscale: Raw score: 75, Percentile: 1%, Standard score: 3, Age equivalent: 15 months</td>
</tr>
<tr>
<td>GMFM-66</td>
<td>A: Lying and Rolling</td>
<td>9/12 points, Developmental delay in R arm reaching while supine</td>
</tr>
<tr>
<td></td>
<td>B: Sitting</td>
<td>37/45 points, Developmental delay in sit to stand and R arm reaching during sitting</td>
</tr>
<tr>
<td></td>
<td>C: Crawling and kneeling</td>
<td>25/30 points, Developmental</td>
</tr>
<tr>
<td>Measurement Category</td>
<td>Test Used</td>
<td>Findings</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------</td>
<td>----------</td>
</tr>
<tr>
<td>Community outings</td>
<td>Patient’s parent report</td>
<td>Patient’s parents reported being full time caregivers and having reduced community outings due to increased difficulty and extra assistance from parent.</td>
</tr>
<tr>
<td>Need for assistance from parent</td>
<td>Pediatric Evaluation of Disability Inventory (PEDI)</td>
<td>Mobility domain: Total caregiver score: 18/35</td>
</tr>
</tbody>
</table>

Chapter 4

Evaluation

Evaluation Summary

The patient was a 24 month-old male who, at 36 hours postpartum, suffered a PAIS that affected the territory of the middle cerebral artery on the left hemisphere of his brain. The stroke led to developmental motor delays and a diagnosis of hemiplegic CP with his R UE and LE predominantly affected. The patient's parents were the primary caregivers and they reported that, although the patient had made functional improvements since his stroke, he had plateaued in progress and was dependent on assistance during transfers, ambulation, and general use of his R UE. The patient was found to have: impaired balance, decreased endurance, decreased strength, decreased locomotor skills, decreased ability to manipulate objects with his R hand, reduced walking speed, increased dependence on parents, and reduced participation in community outings and social gatherings.

Diagnostic Impression

The patient's presentation was consistent with the medical diagnosis of hemiplegic CP and a medical history of left-sided ischemic stroke. The patient presented with the inability to ambulate independently and a reduced ability to manipulate objects with his R UE. During ambulation, the patient presented with decreased strength as measured by observation, decreased speed as measured by the 10MWT, decreased endurance as measured by the 6MWT, and impaired balance as measured by the stationary subscale of PDMS-2 and GMFM-66 Dimension D.
Standing. The patient also demonstrated significant delays in locomotor skills and gross motor function as compared to other children his age as measured by overall scores on PDMS-2 and GMFM-66. Delays in motor function, lack of use of his R UE, and decreased ability to ambulate independently all contributed to increased patient dependence on his caregivers and decreased community participation.

Prognostic Statement

The patient presented with the negative prognostic indicators of a large initial cerebral lesion and severe motor impairments for hand function in his R UE.\textsuperscript{22} Despite the impaired use of his R UE and a large initial cerebral lesion, the patient's parents were motivated and determined to improve the patient's functional status.

The patient possessed multiple positive prognostic indicators for hemiplegic CP. His predictors for a good outcome included his young age, his ability to sit independently at two years of age, a less severe gross motor impairment level as delineated by his GMFCS level of I, intact cognitive function, few comorbidities, and strong family support.\textsuperscript{9,10} With interventions focused on task specificity, physical strengthening, and endurance training, the patient was expected to show increases in ambulation, usage of his R UE, gait speed, strength, endurance, balance, and independence in ADLs appropriate for his age. Due to multiple good prognostic indicators and support from parents, the patient had good rehabilitation potential to meet short- and long-term physical therapy goals.

Current G-code\textsuperscript{23}:

Mobility: G8978-CL based on PDMS-2.
Carrying, Moving & Handling Objects: G8984-CK based on PDMS-2.

Projected G-code:

- Mobility: G8980-CK based on PDMS-2.
- Carrying, Moving & Handling objects: G8986-CJ based on PDMS-2.

Discharge Plan

Due to good rehabilitation potential and expected completion of physical therapy goals, the patient was to be discharged from physical therapy after eight weeks. The continuation of a home exercise program (HEP) with parental assistance was to be put in place. Upon discharge from physical therapy, the patient would continue to live at home with supportive parents.
### Table 3
Evaluation and Plan of Care

<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>SHORT TERM GOALS (ANTICIPATED GOALS) (4 WEEKS)</th>
<th>LONG TERM GOALS (EXPECTED OUTCOMES) (8 WEEKS)</th>
<th>PLANNED INTERVENTIONS</th>
</tr>
</thead>
</table>
| Decreased Endurance    | Increase walking endurance/capacity by a distance of 30.95 meters as measured by 6MWT. | Increase walking endurance/capacity by a distance of 61.9 meters as measured by the 6MWT. | Gait training interventions to challenge endurance, strength, balance, coordination and locomotor skills:  
  - 10-20 minutes of treadmill (TM) walking each treatment. The patient was encouraged to walk by use of bubbles, toys, and 1-pad. Progression of walking included addition of 1 lb ankle weights and adding a small incline to TM (0.5% incline).  
  - The patient performed over ground (CG) walking for 10-15 minutes each treatment. Exercise progressed from walking with one hand held to two hands pushing lightweight baby stroller to walking independently without assistance indoors to walking independently on uneven surfaces outdoors. When holding father’s hand |
| Decreased LE strength | Increase repeated sit to stand on small bench without using arms to two times. | Increase repeated sit to stand on small bench without using arms to five times. | or pushing stroller, patient was only allowed to continue walking if his R hand was gripped or strapped to stroller or he used his R hand to hold his father's hand.  
- The patient participated in constraint induced movement therapy (CIMT) during TM walking and bimanual training in OG walking to facilitate increased function of his R UE in all activities.  
- The patient's parents were educated on the importance of having the patient walk independently at home, in the community, and on uneven surfaces such as grass in order to increase confidence, skill, and independence.  
- Above exercises to increase endurance as well as interventions listed below for balance also contributed to increases in LE strength.  
- The patient performed sit to stand exercises during treatment by placing patient on small bench and placing an object above his head out of grasp, encouraging him to stand up to get it. Exercise was progressed by increasing the repetitions of sit to stand to five repetitions in a row before child lost interest or became fussy. |

The patient presented with significant developmental delays in balance as measured by items in Dimension D: Standing of GMFM-66 and items in Stationary Subscale of PDMS-2. Improve Standing Dimension of GMFM-66 by 4points and Stationary Subscale of PDMS-2 by 3 points by reaching the following goals:
- Decreased balance in Improve arms free standing to Improve arms free standing to 20  
- Interventions going from supported
<table>
<thead>
<tr>
<th>Activity</th>
<th>Description</th>
<th>Patient Improvement</th>
<th>Patient Stability</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arms free standing</td>
<td>10 seconds.</td>
<td>seconds.</td>
<td>walking to unsupported walking as well as sit to stand exercises listed above contributed to increases in patient standing balance.</td>
<td></td>
</tr>
<tr>
<td>Decreased single leg stance on R LE.</td>
<td>Patient will improve single leg balance on R LE to 1-2 seconds.</td>
<td>Patient will balance on R LE for &gt;3 seconds.</td>
<td>• 10-15 minutes of stair climbing with assistance from PT for approximation to R knee during ascending stairs to help facilitate quadriceps contraction and approximation on R LE during descending stairs for stabilization while left leg stepped down. Exercise was progressed from PT holding two hands while ascending stairs to PT providing approximation only and child holding rail with one hand.</td>
<td></td>
</tr>
<tr>
<td>Decreased single leg stance on L LE.</td>
<td>Patient will improve single leg balance on L LE to 1-2 seconds.</td>
<td>Patient will balance on L LE for &gt;3 seconds.</td>
<td>• See above exercises in stair climbing for increases in single leg stance on left.</td>
<td></td>
</tr>
<tr>
<td>Reduced object manipulation (R&gt;L)</td>
<td>No improvements on Object Manipulation Subscale of PDMS-2 expected at this time.</td>
<td>Patient will increase Object Manipulation score on PDMS-2 by 3 points to total raw score of 5 points.</td>
<td>Bimanual Training to facilitate functional use and participation/coordination of both hands simultaneously. Exercises included: • See above for bimanual training during OG walking with stroller. • The patient was placed on the floor sitting at small bench where pudding was placed on a tray for patient to place both hands in and smear around, The patient was encouraged to use his R hand in an open and extended position (rather than its typical adducted and fisted position) while smearing pudding. Pudding was chosen to keep the patient interested in its texture for sensation purposes and</td>
<td></td>
</tr>
</tbody>
</table>
because it is non-toxic if he tried to put it in his mouth.

- The patient participated in bimanual training through bilateral hand play in rice. Small toys were hidden throughout a bucket of rice and the patient was encouraged to put both hands in rice and find the toys. Rice was also chosen for sensation purposes and the patient’s ability to move hand through full ROM within rice.

- The patient participated in bimanual training with toy car and small container with twist off lid. The patient was encouraged to “put the toy car in the garage” by holding onto the container with R hand and twisting off the lid with his left hand. The patient then placed car inside container and twisted back on the lid. Exercise was repeated up to 10 repetitions or until the patient lost interest.

CIMT was utilized by restricting use of the patient’s uninvolved hand (strapping a puppet onto the patient’s left hand) and encouraging use of his R hand.

Interventions of CIMT lasted for 10-30 minutes depending on the patient’s cooperation. Exercises included:

- CIMT with puppet on L hand and the patient’s R hand pushing buttons to open sesame street pop up toy. Once opened, the patient used R hand to push doors down on pop-up toy. This exercise was progressed by having the patient start by sitting on stable ground.
| Significant motor delays in locomotor/mobility skills as measured by items in Dimension E: Walking, Running, and Jumping of the GMFM-66 and by items in the Locomotion subscale of the PDMS-2. Improve Walking, Running, Jumping Dimension of GMFM-66 by 7 points and Locomotion Section of PDMS-2 by 3 points by achieving the following goals: |
|-------------------------------|---------------------------------------------------------------------------------|----------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| Inability to ambulate independently | The patient will ambulate 4-9 ft with narrow base of support, heel-toe gait, using reciprocal pattern for at least half the distance without arms held by parents. | The patient will ambulate 10 ft independently with narrow base of support, heel-toe gait, using reciprocal pattern for at least half the distance. | • Endurance exercises, LE strength exercises, and balance exercises above contributed to increases in independent ambulation. See above for details. |
| Reduced walking speed | No expected increase in the patient's walking speed at this time. | Patient will increase walking speed as measured by a decrease in time to walk distance of 10 meters by 12.2 (s) to 36.8 s. | • Endurance exercises, LE strength exercises, and balance exercises above contributed to increases in gait speed. See above for details. |

The patient worked on CIMT during TM walking and was encouraged to grip the TM with his R hand.

The patient worked on fine motor control with R UE during CIMT training by popping bubbles. The patient popped bubbles with R hand during supported standing and this exercise was progressed by having him pop bubbles during TM walking.

(E) The patient's parents were educated on the benefits of both bimanual training and CIMT to help increase functional use of patient. R UE. Parents were expected to have the patient perform 30 mins/day of CIMT with puppet on his L UE.
<table>
<thead>
<tr>
<th>PARTICIPATION RESTRICTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced community outings</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Increased dependence/assistance from parent</td>
</tr>
<tr>
<td></td>
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<tr>
<td></td>
</tr>
</tbody>
</table>

6MWT=6 minute walk test, TN= treadmill, lb= pound, OG= overground, CIMT= constraint induced movement therapy, R= right, UE= upper extremity. LE= lower extremity, PDMS-2= Peabody Developmental Motor Scale- Second Edition, GMFM-66= Gross Motor Function Measure- 66 item. PT= physical therapist, L= left, ROM= range of motion, mins= minutes, ft= feet, s= seconds, x= time.
Plan of Care – Interventions

See Table 3.

Overall Approach

The overall approach and guiding treatment philosophy for this episode of physical therapy was task-specific training. This approach to rehabilitation focused on expected achievement of neuroplastic reorganization through interventions that provided task specificity, high repetition, and augmented feedback.

Further implications of task specific training were applied through the constraint induced paradigm. This approach to rehabilitation focused on achievements in neuroplastic reorganization with efforts to reverse effects of learned non-use of the hemiplegic UE. Constraint of the uninvolved or dominant UE forces use of the affected UE in order to make improvements in overall function and coordination.²⁴

Increases in LE muscle strength and aerobic capacity/endurance were achieved through the application of the overload principle. Stair climbing and sit-to-stand exercises were performed until the patient was unable to continue to promote adaptations in muscles and cardiovascular fitness due to applied stress. At times, these activities were limited by the patient’s lack of cooperation or lack of proper performance. Application of the overload principle maximizes gains in muscular strength, endurance, and cardiovascular fitness.

Interventions throughout this episode of care were facilitated through a family-centered approach. This philosophy promoted treatment of the child within the context of the family to optimize developmental outcomes.²⁵ Goals, interventions, and the
home exercise program were conducted in collaboration with the parents in order to facilitate carry-over within the child's household and assist the family in managing the child's needs.25

PICO question

For a child with hemiplegic CP (P), is constraint induced movement therapy (CIMT) an effective intervention (I) compared to no CIMT (C) for increasing functional use of the affected/hemiplegic UE? (O)

Article1: In a systematic review (level of evidence: 1a), 23 evidence based studies were analyzed in order to determine whether CIMT was an effective intervention for children with hemiplegic CP.26 Studies were included in the systematic review if participants were children with hemiplegic CP, if treatments included were CIMT or forced-use therapy, and if outcome measures were used to assess effects of CIMT or forced-use therapy.26 Studies were excluded if they were not written in English. There were a multitude of constraint types used throughout the studies including casts, bivalve casts, fabric mitts, splints, slings and in one study manual restraint by parent. Constraint duration ranged from one to 24 hours per day and treatment sessions ranged from six weeks to 18 months. Outcome measures were available throughout the studies at both the body structure and function, and activity levels of the ICF model. Results of the review showed positive support for the use of CIMT to improve the frequency of use of the hemiparetic UE in patients with CP. Positive effects were consistent even in studies where intervention time was cut in half or required restraint time was a fourth of that used in comparable studies. Therefore,
rehabilitation programs with the goal to improve functional use of the UE in patients with hemiplegic CP should include some form of CIMT or forced-use therapy.

Article 2: A randomized control trial (level of evidence: Ib, PEDro level: 9/11) of 63 children with hemiplegia was used to determine whether CIMT was more effective than bimanual training in improving upper limb activity outcomes. Subjects were included in the study if they had congenital hemiplegia, were aged between five and 16 years old, were able to follow directions, and had spasticity grades one through three as measured by the Modified Ashworth Scale (MAS). Participants were excluded from the study if they had predominant dystonia and/or muscle contractures, past history of UE orthopedic surgery, or if they received spasticity injections or serial casting of the UE within the last six months. The 63 subjects were matched in pairs according to age, sex, hemiplegic side, and functional capability. Subjects were then randomly allocated to two treatment groups. The first treatment group participated in bimanual training for six hours per day for 10 days. The second treatment group participated in CIMT for six hours per day for 10 days. Both groups used the intensive day camp model. Subjects' UE function was assessed at baseline, three weeks, and 26 weeks following intervention. Results of the study showed that CIMT was superior to bimanual training for gains in unimanual capacity and bimanual therapy improved bimanual performance. Overall, differences between intervention groups were small. Regardless of treatment group, differences in UE function post-treatment remained present at the three week follow-up but were inconsistent at 26 weeks. Results of this study supported the physical therapy interventions of the patient of this case study by
including both CIMT and bimanual therapy as means to increase overall UE function. The patient’s characteristics were consistent with those of the study sample: the patient had a diagnosis of hemiplegia; did not exceed a grade of three on the MAS; did not present with predominant dystonia and/or muscle contractures; did not have a past history of UE orthopedic surgery, spasticity injections, or serial casting of the UE. The patient was slightly younger than the study’s minimum age of five years old.


Chapter 6

**Outcomes**

Table 4

**Outcomes**

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Initial</th>
<th>Follow-up</th>
<th>Change</th>
<th>Goal Met (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6MWT</td>
<td>47.5 meters ambulating with push toy</td>
<td>134.41 meters ambulating independently</td>
<td>+86.91 meters (MDC&lt;sub&gt;95&lt;/sub&gt; = 61.9 meters)</td>
<td>Y</td>
</tr>
<tr>
<td>PDMS-2: Stationary scale</td>
<td>Raw score: 37 Percentile: 25% Standard score: 8 Age equivalent: 14 months</td>
<td>Raw score: 39 Percentile: 37% Standard Score: 9 Age Equivalent: 21 months</td>
<td>Raw score: +2 points (MDC&lt;sub&gt;95&lt;/sub&gt; = 3 points)</td>
<td>N</td>
</tr>
<tr>
<td>GMFM-66: Dimension D: Standing</td>
<td>24/39 points</td>
<td>30/39 points</td>
<td>+6 points (MCID&lt;sub&gt;95&lt;/sub&gt; = 4 points)</td>
<td>Y</td>
</tr>
<tr>
<td>Repeated sit to stand</td>
<td>1 repetition with assistance</td>
<td>5 repetitions without assistance</td>
<td>+4 repetitions</td>
<td>Y</td>
</tr>
</tbody>
</table>

**Activity Limitations**

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Initial</th>
<th>Follow-up</th>
<th>Change</th>
<th>Goal Met (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PDMS-2: Object Manipulation</td>
<td>Raw score:2 Percentile: 1% Standard score:3 Age equivalent: 12 months</td>
<td>Raw score:11 points Percentile: 5 % Standard Score: 5 Age Equivalent: 17 months</td>
<td>+ 9 points (MDC&lt;sub&gt;95&lt;/sub&gt; = 3 points)</td>
<td>Y</td>
</tr>
<tr>
<td>PDMS-2: Locomotion</td>
<td>Raw score: 75 Percentile: 1% Standard score:3 Age equivalent: 15 months</td>
<td>Raw Score: 79 points Percentile:1% Standard score:3 Age equivalent: 15 months</td>
<td>+4 points (MDC&lt;sub&gt;95&lt;/sub&gt; = 3 points)</td>
<td>Y</td>
</tr>
<tr>
<td>10MWT</td>
<td>49 seconds Holding parents hand</td>
<td>19 seconds Ambulating Independently</td>
<td>-30 s (MDC&lt;sub&gt;95&lt;/sub&gt; = 12.2 s)</td>
<td>Y</td>
</tr>
<tr>
<td>GMFM-66: Dimension E: Walking, Running, Jumping</td>
<td>16/72 points</td>
<td>25/72 points</td>
<td>+9 points (MCID&lt;sub&gt;95&lt;/sub&gt; = 7 points)</td>
<td>Y</td>
</tr>
</tbody>
</table>
### Participation Restrictions

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Initial</th>
<th>Follow-up</th>
<th>Change</th>
<th>Goal Met (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community participation by parent report</td>
<td>1 outing/month</td>
<td>3 outings/month</td>
<td>+2 outings</td>
<td>Y</td>
</tr>
<tr>
<td>PEDPER Mobility domain on Caregiver Assistance Scale</td>
<td>18/35 points</td>
<td>20/35 points</td>
<td>+2 points (MCID&lt;sub&gt;95&lt;/sub&gt; = 11% point increase = 2 points)</td>
<td>Y</td>
</tr>
</tbody>
</table>

6MWT: 6 minute walk test, MDC<sub>95</sub> = Minimal Detectable Change at 95% confidence interval, Y = yes, N = no, PDMS-2 = Peabody Developmental Motor Scale- Second Edition, GMFM-66 = Gross Motor Function Measure-66 item, MCID<sub>95</sub> = minimal clinically important difference at 95% confidence interval, 10MWT = 10 meter walk test, s = seconds, PEDI: Pediatric Evaluation of Disability Inventory

**Discharge Statement**

The patient attended outpatient physical therapy for treatment of hemiplegic CP two times a week for eight weeks. The patient received gait training, strength training, endurance and balance exercises, CIMT, bimanual UE training, and a HEP. Over the course of therapy, the patient achieved goals related to ambulation, strength, endurance, balance, and increased use of his R UE. In addition, the patient’s parents reported that the child was more independent and relied less upon them for assistance as a result of physical therapy interventions. The patient’s parents were supportive of CIMT techniques and were independent in implementing the HEP. The patient was discharged to his home with continued support from his parents.

**DC G-Code with modifier<sup>23</sup>**

Mobility: Walking and moving around: G8980- CL

- Modifier: CL: 60-79% impaired
Carrying, Moving & Handling objects: G8986-CJ

- Modifier: CJ: 20-39% impaired
Chapter 7

Discussion

All of the patient’s goals were met except for one impairment level goal as measured by the Stationary Subscale of PDMS-2. Improvements in balance were made and scores on the Stationary Subscale did indicate an upward trend, but the score increase could not be determined as significant since it did not reach the MDC_{95}. It is important to note that the raw score for the patient’s stationary skills pre-intervention indicated his motor age-equivalent of 14 months to be significantly lower than his actual age of 22 months, an 8 month difference. His age-equivalent post-physical therapy intervention increased to 21 months compared to actual age of 24 months (a 3 month difference), which indicated that he was less delayed in stationary skills post physical-therapy intervention as compared to pre-physical therapy intervention. Improvements in other short- and long-term goals can be attributed to the patient’s participation and his parents’ continued motivation and support in the physical therapy plan of care.

LE strength was determined to be an impairment at the body structure and function level of the ICF model based on observation and clinical judgement. For a young child, the typical assessment of LE strength through manual muscle testing is not recommended. Instead, LE strength was measured through observation during the functional task of sit-to-stands. Sit-to-stands have various potential limiting factors such as spasticity, poor motor control, and decreased strength. Spasticity had previously been ruled out through application of the Modified Ashworth Scale and
motor control was ruled out due to the fact that the patient was able to perform one repetition of sit-to-stand effectively. Since the patient performed one repetition of sit-to-stand successfully but could not perform consecutive repetitions, the body structure and function impairment limiting this function was determined to be decreased LE strength.

The patient's improvements in ambulation and use of his R UE were some of the most significant changes. These improvements led to post-test scores significantly above expected MDC/MCIDs and increased the patient's overall independence, participation in ADLs, and function. Overall, this episode of physical therapy was successful for this patient due to his improvements in all areas previously limiting him including strength, balance, endurance, ambulation, R UE use, and dependence on caregivers.

When treating similar patients in the future, I will utilize similar interventions but be more persistent in providing treatment in a home environment. Current literature suggests that CIMT is an effective intervention for children with CP regardless of treatment environment, but those who received treatment at home as compared to those who received treatment in clinic showed significant continued improvement at follow-up.28 In addition, I will be more assertive in asking parents to step outside during physical therapy treatments. I found that if the parents were comfortable with it, leaving the room during therapy allowed the patient to be more focused and dependent on himself. During this patient case, there were times when the parents would coddle the child instead of letting him figure out difficult tasks on his
own. When the parents were asked to leave the room, the patient was less fussy and seemed to be more capable and assertive in problem solving. Lastly, in the future I will educate parents better on the importance of participating in the HEP. In this episode of care, I did explain the exercises within the HEP to the parents, but in the future I will focus more on the potential benefits and principles behind why the HEP really matters.
References


