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Hydrotherapy for Spastic Diplegic Cerebral Palsy in Children: A Detailed Case Study

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ABSTRACT :

The following fictional case study will include an assessment, treatment and evidence that supports aquatic therapy for a four year old child diagnosed with spastic diplegia cerebral palsy (CP). CP is the most common childhood physical disability[1] and as such it can have significant impacts on a child's function, participation and inclusion in activity. It is also common for children with CP to present with additional comorbidities that impact overall health and make learning new tasks difficult. Aquatic therapy has been found to improve strength and function for children diagnosed with CP. Therefore, the purpose of this case is to discuss the positive effects of a 10 week aquatic therapy intervention for a four year old child diagnosed with CP. It will also highlight outcome measures that were used to determine a baseline and monitor treatment progress for a child participating in hydrotherapy.

Introduction :

Cerebral Palsy (CP) is a movement and postural disorder that appears in early childhood or infancy as a result of brain damage[2]. Though there are several definitions in the literature, CP can generally be classified as any non-progressive central nervous system injury occurring during the first two (some literature says five) years of life[2]. After the age of five, brain damage is classified as an acquired brain injury[2]. In 2011, Statistics India found that 0.1% of the Indian population - or just over 42,000 people - were diagnosed with CP[3]. Globally, population-based studies indicate that the prevalence of CP is said to range from 1.5 to more than 4 per 1,000 live births or children of a determined age range[4]. There is no one test used to diagnose CP, and the presentation of the condition will look very different from one person to another. According to the CP India Network[5], general categories include hemiplegia (affecting the ipsilateral arm and leg); diplegia (affecting both legs or both arms); and quadriplegia (affecting both arms and legs, muscles of the trunk, mouth and face). Symptoms that can present with CP depend on which area(s) of the brain are injured. For example, possible symptoms include muscle tightness or spasm, involuntary movements, difficulty with gross motor skills and abnormal perception and sensation[6].

Although there is no cure for CP, the condition can be managed, allowing some people who have CP to go to school, work, get married and participate in society[5]. In fact, over half of the children diagnosed with CP (58%) can walk independently and another 3% can walk using a mobility device[2]. Early intervention with supports such as physiotherapy (PT) can help individuals to achieve this independence. Specifically, PT aims to help people with CP achieve their physical mobility by promoting exercises that emphasize independence[6].

The purpose of this case study is to discuss the effects of a hydrotherapy intervention strategy for a four year old child with spastic diplegic CP. It should be noted that while the primary focus will be on hydrotherapy, the authors will also be prescribing exercises for the parents to work on at home with the patient. Difficulties managing this case predominantly encompassed initial communication and rapport-building between the therapist and patient, as well as the patient's low confidence when starting to walk without her gait aid. All of these difficulties resolved themselves as the patient became more familiar with the therapist, and confidence in her prescribed exercises improved.

The following cases provide a description of why aquatic therapy was determined to be an appropriate and evidence-based intervention for a child with CP. The buoyancy of aquatic therapy makes it easier for children who have mild to moderate limitations to move compared to exercises out of water. Performing exercises such as walking in water has the potential for better joint alignment in addition to allowing the opportunity to perform movements such as jumping and running that can have a harder impact on joints[7]. In addition, walking in water provides a better opportunity for muscle strengthening due to the increased resistance to movement[7]. However, it is also important to engage the patient and encourage their active participation. Kelly and Darrah[8], noted that the properties of water not only make it easier for children with CP to move but also make exercises more interesting and motivating. According to a literature review by Roostaei et al.[7], three of the 11 studies they found specifically targeted participants who were younger (approximately 2-9 years old), two of which demonstrated significant changes as measured by the Gross Motor Function Classification System (GMFCS). One of the studies (a control trial design) by Lai, Liu, Yang, Chen, Wu & Chan[1], found that the pediatric hydrotherapy group had a greater GMFCS average than the control group, and showed higher scores on the Physical Activity Enjoyment Scale than the control group after treatment. The delivery method of these studies varied from individual sessions to group therapy, however the majority used a 1:1 instructor to child ratio[7]. As such, the current case study will follow a 1:1 ratio of therapist to child. Roostaei et al.[7] also found that the length of sessions may impact improvement as measured by the GMFCS, regardless of intensity of treatment. For example, the authors recommend sessions of 45 minutes or longer, since sessions lasting 30 minutes or less did not show improvement in total GMFCS score. This remained true even when higher intensity exercises were conducted. Therefore, the current case study

will also focus on therapy sessions lasting a minimum of 45 minutes. It should be noted that this case study is a fictitious profile created by the authors for educational purposes only.

Patient Characteristics

Patient is a four year old female who was diagnosed with spastic diplegia cerebral palsy at birth. She was born prematurely. Patient presents with an abnormal gait pattern and poor trunk control, and has previously had interventions for balance, trunk control and gait aid training. She is currently using a four-wheeled walker with forearm support, and has outgrown her orthotics. In addition to a gait assessment, the authors' intervention objectives will be to update the patient's current home exercise program and assess appropriateness for hydrotherapy.
The patient has epilepsy (controlled with medication), mild Attention Deficit Hyperactivity Disorder, and wears prescription glasses. She has regular follow-up care with medical staff to monitor her CP and epilepsy.

Examination Findings

Subjective

The patient has had difficulty navigating less accessible environments outside of the home with her walker. Her parents' current concern is that she is starting kindergarten in the fall. Although she will attend a fully integrated, accessible public school, she would still navigate much more easily without her walker. She will also have assistance from an Education Assistant, as well as an Individualized Education Plan outlining modifications & accommodations in physical education and fine motor control. It is important to the patient that she has better mobility independence in order to play with her classmates; in addition, she has outgrown her current orthotics, and requires new ones. The patient's parents report she has low walking endurance (must use gait aid for longer distances), trouble toileting (functional incontinence due to limited strength and balance while holding seated position), and mild reflux.

Objective :

Observation

Upon observation in quiet standing the patient presented with knee valgus, abnormal trunk and knee flexion, and internally rotated lower limbs. Her gait analysis found a toe-stepping gait, bilateral hip flexion, adduction, internal rotation, and a bilateral decrease in stride length. She had excessive knee flexion and ankle plantar flexion due to hamstring and plantar flexor spasticity and/or contractures, and an overall reduced gait velocity. In the upper extremity, her arm swing was reduced (more notably on the right side), and she held her arms at 90-90 during the full gait cycle. Her trunk also demonstrated excessive bilateral sway towards the stance leg throughout the full gait cycle.

Neurological Testing

The patient's neurological and vascular assessment found hyper reflexivity in her upper and lower limbs, with clonus presenting in the lower. No other significant findings were noted.

Range of Motion

Goniometry was used to measure the patient's active (AROM) and passive range of motion (PROM). The patient's upper limbs were within functional limits, however her lower limb values were all significantly decreased:

- Knee extension: limited by rigidity in 15° of knee flexion
- Ankle dorsiflexion: limited by rigidity in 30° of ankle plantar flexion for AROM; achieved 0° in PROM
- Hip extension: limited by rigidity in 5° of hip flexion

Condition-Specific Classifications

The Gross Motor Function Classification System (GMFCS) was used to describe the motor function of the patient and to distinguish her functional abilities, quality of movement and needs for assistive technology. The patient could walk in most settings and climb stairs holding onto a railing. She experienced difficulty walking long distances without a gait aid and balancing on uneven terrain and inclines. She had minimal ability to perform gross motor skills such as running and jumping, mostly due to poor AROM and balance impairments. Her parents noted that she has difficulty walking in crowded areas or confined spaces. Due to all of these factors, the patient was classified as a GMFCS Level II.[9]
The Manual Ability Classification System (MACS) was used to observe the patient's fine motor skills, to see how she can handle objects in every day activities and to determine her need for assistance or adaptation to perform manual activities in everyday life. The patient was observed completing the following tasks: opening a puzzle box, emptying the contents of the box onto the table, handling the pieces of a puzzle and placing the pieces back in the box, closing and opening a zipper, buttoning and unbuttoning a jacket, drinking from a cup, using a spoon

to scoop up food, pounding pegs using a toy hammer and putting marbles into a jar. Besides buttoning up her shirt, the patient was able to handle objects and complete the tasks, albeit with reduced speed, coordination and precision. These results lead the authors to conclude that the patient is at a MACS level II.

The Communication Function Classification System (CFCS) was used to classify the effectiveness of the patient's everyday communication skills. The patient's parents stated that their daughter communicates effectively with familiar people like friends and family, but struggles to communicate and interact with acquaintances or unfamiliar people in most environments. This was evident during the beginning of the assessment as the patient was very shy and unwilling to speak or participate without prompts from her parents. Nevertheless, towards the end of the assessment the patient opened up and communication skills were better. These observations lead the authors to conclude that the patient is a CFCA level III.

Functional Outcome Measures

Clinical Impression

Outcome Measure	Patient Values/Scores	Notes
Timed Up and Go (TUG)[10]	21.4 seconds	With current gait aid, but without orthotics
The Trunk Control Measurement Scale (TCMS)	Total score: 32/57 • Static sitting balance: 14/20 • Dynamic sitting balance/selective movement control: 12/27 • Dynamic reaching: 6/10	Higher score indicates better control
6 Minute Walk Test (6MWT)	356m	With current gait aid
Modified Ashworth Scale for hypertonia (MAS)	• Hamstrings: 4 • Quadriceps: 3 • Soleus: 3 • Gastrocnemius: 4 • Hip flexors: 4 • Hip adductors: 2 • Hip internal rotators: 2	Score of 0: no resistance Score of 5: significant rigidity
Paediatric Balance Scale (PBS)	Total score: 42/56 The patient had the most difficulty with: • Placing alternate foot on stool • Standing on one foot • Standing in tandem • Standing with eyes closed • Turning and looking behind	Higher score indicates better balance and more independence

4 year old female diagnosed with spastic diplegic cerebral palsy. She is GMFCS level II. Currently she is using a 4WW to ambulate for longer distances. She is MACS level II. Her upper extremities are only affected during fine motor skills. She would benefit from PT to address her gait, balance and trunk control so she is able to attend full-time kindergarten independently. Prognosis is good and patient is expected to improve physiotherapy problem list with hydrotherapy, treadmill training, and an updated HEP.

Problem list to be addressed with physiotherapy intervention:

- Atypical postural
- Toe-stepping gait with significant lack of trunk control
- Lower extremity weakness
- Increased tone and spasticity in:
  - Plantar flexors
  - Hamstrings

- Hip adductors & internal rotators

Balance issues

- Decreased tolerance to external perturbations
- Decreased balance on one foot and in narrow stances

Physiotherapy Interventions

Intervention[11][12][13][14]	**FITT**	**Goals**	**Outcome Measure(s)**
Goal-directed training & home programs[11]	F: 2-3x/week I: challenging by end of set T: 10 reps, 3 sets T: strengthening (squats, leg extensions, bridging etc.)	• Improve function and self-care • Improve gait by increasing L/E strength	6MWT
	F: every day I: challenging balance while staying safe T: 5-10 minutes T: balance (seated, reaching, standing with wide/narrow BOS, add throwing ball against wall while sitting/standing if able)	• Improve function and self-care • Improve gait by increasing balance	• PBS • TCMS
	F: every day I: to point of slight discomfort but no sharp pain T: 30 sec each stretch, 3x T: stretching (all major muscle groups especially those with increased tone or tightness)	• Improve function and self-care • Increase ROM	Goniometry
Strength Training Lower Limb - Treadmill Training[15][16]	F: 3x/week I: 4-6 /10 BORG T: 30 minutes T: Gait training, endurance	• Improve gait speed • Improve endurance	• 6MWT • TUG
Hydrotherapy[1][7][8][12][17][18]	F: 2x/week I: 4-6 /10 BORG T: 45 minutes T: resistance exercises, ROM, cardiovascular - focused games, trunk/balance - focused tasks	• Improve motor activities • Increase strength by using water resistance • Increase ROM • Reduce tension in muscles • Improve cardiovascular conditioning (heart pumps more blood per beat when body is submerged in water) • Improve balance by increasing trunk control	• MAS • PBS • TCMS

Hydrotherapy Intervention Details[1][7][8][12][17][18]**:** standing in the shallow end of the pool, using water belt flotation device as needed; note that most of the intervention activities are play-based[19]

Warm-Up (10 min):

- "Simon Says": AROM exercises including cervical, shoulder and lower limb AROM, then graduating to full body movements
- "Mirror Game": child and physiotherapist (PT) take turns being the mirror and the person, mimicking each other's slow movements
- "Follow the Leader": child is the leader and takes PT through motions of her choice

Strength, Cardio & Balance (20 min):

- "Freeze Game" with music: compound (multi-joint) movements for cardio/strength
- Push-ups from side of pool, flutter kicks while holding edge of pool, jumping jacks, dancing, etc.
- Freeze when the music stops; every few freezes change the movement
- PT performing Inside Leg Rotation (Watsu technique) with 4 year old client with cerebral palsy[18]

Manipulatives for reaching and trunk control:

- Play with water toys (watering cans, boats, balls, floating shapes) to practice reaching, walking, trunk control; encourage movement in the water with the toys
- "Fun Balance"
- Try to lie prone, sit and/or stand on a floating board, floating noodle, and ball

Stretch & Cool-Down (15 min):

- "Watsu" with music: for relaxation and ROM

Outcome :

Patient saw a change in 13 points on the PBS (Pre-intervention: 42/56, Post-intervention: 55/56) which substantially reduces her probability of falling. With a minimal clinically important difference (MCID) of 2 points on the MAS,[20] her spasticity was also significantly reduced bilaterally over the 10 week period:

- Hamstrings (MAS pre: 4, post: 2)
- Quadriceps: (MAS pre: 3, post: 1)
- Hip flexors (MAS pre: 4, post: 1)
- Plantar flexors (MAS pre: 4, post: 2)

At the 6 week mark onward, the patient also had a noticeably larger stride length and increased gait velocity. This likely contributed to the reduction in 5.1 seconds in her TUG test and reduction of 60.9m in the 6MWT using her newly fitted gait aid. Although there is no MCID established for GMFCS level II for CP, there is a minimal detectable change of 47.4m for children with CP at a GMFCS level III[21]. Therefore, it can be hypothesized that reduced spasticity and increased ROM in her lower limbs had a positive functional outcome effect on the patient's gait pattern, which resulted in an increase in her capacity for mobility and ambulation.

Correspondingly, the patient also saw improvements by 11 points (MCID 6)[22] in TCMS, specifically in dynamic sitting balance and dynamic reaching. These changes were observed in the reduction in patient trunk away during ambulation. There was also noticeably less trunk sway during ambulation as weight distribution appeared equal upon foot contact, and the patient's shoulders remained stacked over the hips.

In addition, some referrals to other health care professionals are necessary to address aspects of the patient's function that PT intervention cannot directly address:

- Referral to occupational therapist for decreased fine motor skills and toileting
- Referral to orthotist for new AFOs as she has outgrown her current pair
- Referral to speech language pathologist to improve communication with unfamiliar persons

Discussion

A four year old patient diagnosed with spastic diplegic cerebral palsy was referred for physiotherapy services in order to be fitted for a new gait aid and to prepare the patient for kindergarten in the fall. The patient presented with poor balance, limited ROM and moderate to severe hypertonicity in the plantar flexors, hip flexors, adductors and hamstrings. These findings put the patient at an increased risk of falling and appeared to limit her gross motor functioning, ambulation and gait function. Rehabilitation goals included: increasing balance to reduce the risk of falls, reducing spasticity and tone, and improving AROM and ambulation endurance in order to walk to school and play with other children.

Hydrotherapy was selected as an appropriate intervention to improve the patient's symptoms, and reduce her limitations in functional activity and participation. Evidence shows that performing exercises such as walking in water can: improve joint alignment, reduce impact to allow for more rigorous exercise like running and jumping, increase strength, and increase ease of movement[7]. Although there is stronger evidence to support treadmill training, the patient has a more meaningful connection with swimming, finding it fun and motivating. The authors' hypothesis was that two 45 minute sessions of hydrotherapy a week for 10 weeks would make a clinical difference on the patient's spasticity, balance and functional mobility. Following the intervention, the patient's ambulation distance increased, and her balance improvements significantly reduced her fall risk.

Broader implications of hydrotherapy intervention can extend to other conditions that present with spasticity, including multiple sclerosis[23], spinal cord injury[24], and stroke patients[25]. Management will vary depending on the presentation of each individual and their disease specific functional classification.

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