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Review of Cerebral Palsy: The Various Intervention Techniques

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REVIEW OF CEREBRAL PALSY:
THE VARIOUS INTERVENTION TECHNIQUES

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ABSTRACT

Review of Cerebral Palsy: The Various Treatment Techniques

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Cerebral palsy (CP) is a neurodevelopmental disorder that results from a disruption in the development in the infantile or fetal brain. It affects over 17 million people worldwide. The goal of this review paper is to provide an in-depth literature review behind the causes, diagnosis, associated disorders of CP as well as the treatment interventions that would lead to a comprehensive treatment plan for CP patients. There are many possible causes of CP, contrary to the popular belief that CP is only caused by hypoxia or ischemia at birth. Diagnosis requires determining the motor function, part(s) of the body affected, and the severity; diagnosis techniques have been recently improving. Identification of the associated disorders is also important for treatment. The treatment interventions comprehensively reviewed include physical therapy, occupational therapy, and the combination of physical therapy and occupational therapy. Additional treatment interventions examined are exercise interventions, speech and language pathology, medications, and surgical procedures. It can be concluded that the best treatment plan for a CP patient will be individualized for each specific patient and may include different amounts of the treatment interventions.

Keywords: Cerebral Palsy, Treatment Intervention

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CHAPTER I

Introduction

Cerebral palsy (CP) is a neurodevelopmental disorder that affects over 17 million people worldwide and is the most common physical disability in childhood (Cerebral Palsy Alliance Research Foundation, 2018). When broken down, the word cerebral means 'pertaining to the brain' and palsy is defined as 'lack of muscle control,' which is very appropriate when classifying the disorder and the associated impairments. The International Consensus selected the official definition of CP in 2005 as, 'A group of permanent disorders of the development of movement and posture, causing activity limitation, that are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain' (Gulati & Sondhi, 2017). The term 'cerebral palsy' encompasses a wide range of various types of CP that are all slightly different in presentation, associated symptoms, and the rate of occurrence within the population. Other associated symptoms of CP can include disturbances of sensation, perception, cognition, communication, and behavior, by epilepsy and by secondary musculoskeletal problems (Gulati & Sondhi, 2017).

Causes of CP

It was historically thought that the only cause of CP was hypoxia or ischemia at birth (Cerebral Palsy Alliance Research Foundation, 2018). This false belief resulted in a lack of further research into the cause of CP for many years. Although hypoxia or ischemia at birth are still possible causes of CP, there have been many advancements in recent times that demonstrate many other possible causes and risk factors could lead to an infant being born with or developing

CP. Cerebral palsy occurs when a problem or combination of problems leads to an injury affecting the development of a fetal or infantile brain (Cerebral Palsy Alliance Research Foundation, 2018). This problem could take place during the pregnancy or during birth, known as congenital CP, or after the child has been born, which is known as acquired CP (Cerebral Palsy Foundation, 2018). It is believed now that CP typically occurs if there is a summation of events causing or accelerating the progression of the disorder; this phenomenon is called casual pathways (Cerebral Palsy Alliance Research Foundation, 2018).

A study suggests that there is more of a genetic determinant behind the development of CP than what was previously believed (MacLennan et al., 2015). A new-generation exome sequencing has shown that 14% of CP cases have single-gene mutations that are likely the cause of CP and up to 31% have clinically relevant copy number variations (MacLennan et al., 2015). Further testing such as full genome sequencing, gene expression testing, and fine scale copy number variant investigations may result in an increased number of CP cases resulting from genetic origins. These changes in the genetic code of the fetus would result in abnormal development of the brain. Another study echoed the findings that more CP causes have a genetic beginning than what was previously thought, but also noted that there is a gap in knowledge in the understanding of the genes that lead to CP (Fahey et al., 2017).

Other possible causes of CP include different problems during the development of the infant's brain. One specific condition that results from a brain development problem is *periventricular leukomalacia* (PVL). PVL is a brain injury that results in death to small areas in the ventricles of the brain; these areas of dead tissue create small holes in the white matter of the brain (Volpe, 2001). The holes interrupt connection in the brain tissue

that hinders transmission of brain signals (Cerebral Palsy Foundation, 2018). The hindered brain signals result in problems with motor function—mostly generating spasticity, cognitive impairment, and vision problems (Poinsett & Cerebral Palsy Guidance, 2020). Although it is known that PVL is caused by a lack of oxygen or blood flow to the periventricular area of the brain, the exact reasoning behind why there is a lack of oxygen is still unknown; this lack of oxygen can occur during the birth of an infant, if the infant is born prematurely, and many other events or infections during pregnancy and birth (Poinsett & Cerebral Palsy Guidance, 2020).

Many problems that can occur after the first 28-days of the infant's life may result in the development of acquired CP. Some of these problems include complications with blood flow to the brain that can cause blood clotting and fetal stroke, neonatal infections, or head injuries that lead to brain damage (Jansheski & Cerebral Palsy Guidance, 2020). All of these factors put the infant at a higher risk of developing CP even after birth.

Although there is not always an exact known cause of CP, there are many known risk factors that may increase the risk of a patient developing CP. The presence/occurrence of more than one risk factor can result in the casual pathways, as defined previously, which increases the possibility of the presence of CP in a patient due to the addition of causes and risk factors. Potential risk factors of CP that would affect the development of the brain, just as a genetic mutation or copy number variations, include maternal infections, fevers, or traumas (Cerebral Palsy Foundation, 2018). Another maternal risk factor includes placental abnormalities; these abnormalities can cause restricted amount of nutrients and oxygen to the fetus during the development (Cerebral Palsy Alliance Research Foundation, 2018). Other problems that can lead to under or

inappropriate development of the fetal brain and result in CP include uterine trauma or rupture, chorioamnionitis (inflammation of the amniotic membranes), carrying multiple fetuses, prematurity or low birth weight, and medical negligence or mistake among others (Jansheski & Cerebral Palsy Guidance, 2020; Cerebral Palsy Foundation, 2018). Most of the time, despite all this knowledge, the true cause of CP in most patients remains unknown.

Diagnosis of CP

Cerebral palsy is typically diagnosed in children since this is when the symptoms begin to emerge. Previously, a child would only be examined for CP if they had missed several developmental milestones. However, the diagnosis of CP has recently become more accurate and now occurs much sooner than ever before. Historically, the average age of diagnosis was between 12 and 24 months; now, with improved technology and techniques, it is possible to diagnose CP as young as 6 months (Novak et al., 2017). The optimal diagnostic approach includes a combination of various medical techniques and tools including term-age magnetic resonance imaging (86%-89% sensitivity), the Prechtl Qualitative Assessment of General Movements (98% sensitivity), the Hammersmith Infant Neurological Examination (90% sensitivity), and the Developmental Assessment of Young Children (83% C index) (Novak et al., 2017). Other important information for diagnosis can come from the patient's medical history. The specific tests needed for the diagnosis of individuals will vary based on the patient's age, suspected type of CP, and other outside factors such as the availability of medical resources. All of these tests and tools should be administered by a handful of medical professionals and discussed

comprehensively before further actions should take place. Those comprehensive steps are currently the most accurate way to diagnose CP at the earliest time possible.

There are many research studies that are now being conducted with a goal of improving the diagnosis process as well as further decreasing the age of diagnosis. For example, a research study was conducted that was interested in the change of diagnosis age of individuals with CP when a recently published early diagnosis and intervention plan was put into action in an American clinical setting (Byrne et al., 2017). This plan implemented early diagnosis and intervention guidelines created from evidence by a group of international interdisciplinary experts. The authors translated the international guidelines of CP diagnosis into an algorithm that can be applied in a clinical practice which explained what tests should be used for certain age groups of the patient in question. The tests will vary based on the age of the patient as well as the symptoms demonstrated (Byrne et al., 2017). This new algorithm detailed steps that cultivated beneficial improvements to infrastructure, assessments, scheduling algorithms, documentation, and supports in diagnosis or counseling (Byrne et al., 2017). These improvements in the diagnosis process resulted in an increase in clinic team awareness of early diagnosis and interventions, an increase of number of three- to four-month screening visits, and a significant decrease in the mean age of diagnosis (Byrne et al., 2017). This study demonstrates just how successful new diagnosis techniques are in the clinical setting and shows the need to expand this new knowledge and techniques to all settings for the benefit of all patients.

Diagnosis of CP goes beyond just determining if the patient has CP or not, but also what type of CP. The types of CP can be described and categorized based on three

different factors including motor function, part(s) of the body affected, and how severe the symptoms are (Cerebral Palsy Alliance Research Foundation, 2018). Each of these types are unique and the patient can display vastly different characteristics based on what type of CP they have. The four different types of CP based on motor function include spastic, dyskinetic, ataxic, and mixed type. Spastic CP is the most common type of CP at over 70% of cases and is triggered by damage to the corticospinal tracts and corticobulbar tracts located in motor cortex of the brain and spinal cord (Cerebral Palsy Group, 2016 and Cerebral Palsy Alliance Research Foundation, 2018). Spastic CP causes increased muscle tone in those affected—which then generates very stiff and jerky movements; the patient may feel as if they cannot relax their muscles. The increased spasticity in the muscles will lead to difficulty for the patient when performing both fine and motor movements such as walking, talking, trying to eat, or dress oneself. Spasticity of muscles is a characteristic that is not limited to CP, but can also be seen as a result of damage to the motor cortex due to a traumatic brain injury, spinal cord injury, stroke, and multiple sclerosis (Cerebral Palsy Alliance Research Foundation, 2018). The second motor function type is dyskinetic CP, which also includes athetoid or extrapyramidal CP, and occurs when there is damage to the basal ganglia (Cerebral Palsy Group, 2016). This type is less common than the first and only occurs in around 10-20% of cases. It is identified by "slow and uncontrollable writhing or jerky movements of the hands, feet, arms, or legs" (Cerebral Palsy Foundation, 2018). Dyskinetic CP can also affect the tongue and face and cause challenges when eating, speaking, etc. The third motor function type is called ataxic CP and results from damage to the cerebellum. It is described by having a tremor, shaky and unsteady movements, and problems maintaining balance (Cerebral

Palsy Alliance Research Foundation, 2018). This unsteadiness can occur in the muscles of all the limbs, hands, eyes, tongue, or throat. Due to such a global effect on the body, both gross and fine motor skills are difficult. Finally, the last type is mixed CP. A patient with a mixed CP has damage in more than one part of the brain and will display characteristics of more than one of the other types of CP.

The categorization of the various body parts that can be affected are quadriplegic, diplegic, and hemiplegic. A quadriplegic patient would indicate that all four limbs are affected. Along with the limbs, the face, mouth, and trunk are also commonly affected in a quadriplegic patient. A patient with both legs affected would signify the diplegic category. Finally, a hemiplegic patient would be affected on one side of their body—so either both the right arm and leg or both the left arm and leg.

The final classification based on the severity includes gross motor skills, fine motor skills, and communication. The Gross Motor Function Classification Scale (GMFCS), Manual Ability Classification System (MACS), and Communication Function Classification System (CFCS) are classification systems for health care professionals to categorize patients with CP into one of five different levels based on their level of function (Palisano, et al., 2018). The GMFCS classifies the patient based on the child's self-initiated movements with emphasis on sitting and walking. The MACS classifies a patient based on their self-initiated ability to handle objects during daily activities. Lastly, the CFCS scale classifies a patient based on their everyday performance of different means of communication including speech, gestures, eye gaze, facial expressions, and augmentative and alternative communication. These scales enable health care

professionals to communication and select the most effective, individualized plan of care and goals for the patient.

Each of these different types and classifications are important to find the most effective treatment interventions for the patient. Just as important as identifying the correct type of CP, the earlier detection of CP also plays a critical role in the available approaches of interventions of CP and the associated symptoms. The brain has the greatest plasticity in childhood, meaning the brain has the ability to modify its structure and function to adapt to changes. The earliest interventions also create the opportunities for maximal benefits for the patient into adulthood (Byrne, et al., 2017).

Associated Disorders

Due to the nature of CP as a disorder, most patients with CP also suffer from at least one other associated disorder. There is a wide range of associated disorders as well as varying levels of severity of the associated disorders. A research study found that the rate of occurrence and severity of comorbidities are unevenly distributed throughout those suffering from CP based on neurologic subtype (spastic quadriplegic, dyskinetic, ataxic-hypotonic) or non-ambulatory motor status (Gross Motor Function Classification System levels IV and V) (Shevell, et al., 2009).

Patients with moderate to severe CP tend to suffer from delayed growth and development of their bodies (Cerebral Palsy Foundation, 2018). The limbs and muscles that are affected by CP do not grow as fast or as long as those that are unaffected. A CP patient that suffers from spasticity of their muscles proceeds to have a lack of stretching of muscles and tendons as the limb grows. As a result of the spastic muscles not growing

as fast as the bones, contractures may also occur and cause problems with both gross and fine motor skills (Krigger, 2006). A contracture occurs when a muscle become 'stuck' in an abnormal, and usually painful, position. Such gross motor function problems may result in patients being unable to walk without an assistive devise or be non-ambulatory. Patients that are non-ambulatory tend to have markedly reduced bone mass which can lead to osteopenia, osteoporosis, fracture, scoliosis, or pain (Krigger, 2006).

Seizures are another common associated disorder for CP patients with about one half of pediatric CP patients experiencing at least one kind of seizure (Krigger, 2006). There are many different types and levels of severity of seizures; these types affect CP patients differently and require individualized treatment. Due to the rate of seizures in some patients, the diagnosis of epilepsy is common in patients with CP, occurring in one in four pediatric CP patients (Cerebral Palsy Foundation, 2018). Some patients with CP may suffer from abnormal sensations and perceptions. This may cause them to lack the sensation of pain resulting in risk for self-harm or injury such as biting on their own fingers and hands too much when teething (Krigger, 2006). Patients may also lack the sensations such as a simple touch (Krigger, 2006). Conversely, some CP patients may suffer from pain on a regular basis, with as many as three in four patients experiencing chronic pain (Allergan Foundation & World Cerebral Palsy Day, 2016).

Impaired oral-motor functions are a common associated disorder of CP that can lead to various other problems. These include dysphagia (i.e., difficulty swallowing), hypoxemia, temporomandibular joint contractures, vomiting, and aspiration pneumonia associated with gastroesophageal reflux, poor nutrition, failure to thrive, drooling, and communication difficulties (Krigger, 2006; Poinsett & Cerebral Palsy Guidance, 2019).

Malnutrition can also result from oral-motor dysfunction if a health care professional is not addressing this issue. Oral-motor problems tend to be common in patients with CP. For example, one in five pediatric patients have saliva control problems and one in four is unable to talk due to oral-motor difficulties (Allergan Foundation & World Cerebral Palsy Day, 2016). Other speech and language problems may also be the consequence of diminished oral-motor function (Cerebral Palsy Foundation, 2018).

Cognitive impairment and behavioral issues tend to be commonly associated with the diagnosis of CP (Poinsett & Cerebral Palsy Guidance, 2019). To be clear, the lack of cognitive functioning is not the same as being determined to have a cognitive impairment; patients with a cognitive impairment will still have full cognitive functioning. Confusing "cognitive impairment" with a "lack of cognitive functioning" can be very frustrating for the patient due to how different the treatment approaches are. It is crucial to identify if a cognitive impairment is present as soon as possible in order to quickly implement an intervention process. There are also times when an oral-motor problem may be interpreted as a cognitive impairment, but these two associated disorders are very distinct and require very specific intervention actions. Common cognitive impairments that affect patients with CP include attention deficit hyperactivity disorder (ADHD), challenges with behavior, emotional problems (i.e., inability to connect with others emotionally), psychological issues, depression, anxiety, and mood swings, and problems with comprehension and decision-making skills (Poinsett & Cerebral Palsy Guidance, 2019).

Hearing and vision abnormalities are other commonly associated disorder of CP (Cerebral Palsy Foundation, 2018). Both will have a wide range of severities and

conditions based on the individual patient. Individuals with CP may also have other associated disorder not listed here. As mentioned, CP is a very individualized disorder that will affect each of its patients differently; associated disorders and severity vary from individual to individual.

CHAPTER II

Interventions of Cerebral Palsy

Unfortunately, there is no cure for CP, so those affected will have this disorder for the entirety of their lives. However, those with CP typically have a team of health care professionals working together to create a plan of care that allows the patient to have the most functional and enjoyable life. This health care team will ensure that all possible symptoms are being addressed in all areas required for the individual with CP. The team ensures that both the symptoms directly related to CP and the symptoms from associated conditions are being addressed. A healthcare team can be made up of one or more of the following professionals: a primary care physician, a physical therapist, an occupational therapist, a speech and language pathologist, a psychologist, an orthopedic surgeon, an ophthalmologist, an audiologist, and/or a special educator (Cerebral Palsy Alliance Research Foundation, 2018). Ideally, an intervention plan will begin as soon as possible as there are many negative consequences for the individual both physically and mentally if CP goes untreated.

Physical Therapy

One of the first interventions recommended for a CP patient is physical therapy. Physical therapists (PT) are health care professionals specializing in movement that aims to optimize quality of life through prescribed exercises, hands-on care, and education (American Physical Therapy Association, 2019). Physical therapists will begin by doing an initial assessment of the patient to evaluate what skills will need to be addressed for each patient and come up with a plan of care. Physical therapists prescribe individualized

plans of care for patients with a goal of managing pain, promoting movement, increasing function, and decreasing chances of future complications (Cerebral Palsy Group, 2016). Because PT is so individualized, the plan of care for a hemiplegic CP patient will look very different than the plan of care for a diplegic CP patient which will also look very distinct from a plan of care for a quadriplegic CP patient. This will enable the therapist to address the unique needs of the patient.

Even with the use unique plan of care, there are some common areas of focus for all CP patients. These areas include coordination, balance, strength, posture, gait, flexibility, endurance, pain management, and overall health (Cerebral Palsy Guide, 2020). There are many different techniques and approaches to address these areas of need; however, some are more commonly used by PTs. One of these techniques that a PT can administer both during the initial assessment and regularly during treatment sessions is gait analysis (Krigger, 2006). Watching the patient walk enables the physical therapist to watch the patient's coordination, balance, strength, posture, flexibility (or lack thereof), and endurance all at once. After the PT has assessed the gait, they can then write or alter the plan of care to address the abnormalities. For example, if the patient is physically unable to get their feet flat due to very tight heel cords, the PT can have the patient do active stretches, in which the patient initiates or maintains the stretch, or utilize a hands-on approach and passive stretching, in which the therapist will do the stretching for the patient (Wiart et al., 2008). Stretching exercises for flexibility can be used on most muscle groups and can be done during PT sessions; however, CP patients will only do a select amount of stretches per therapy session due to the uncomfortable nature of this

stretching unless the stretching methods are worked into other activities such as an obstacle course (Wiart et al., 2008).

Based on the gait analysis, the PT might also focus on improving strength, endurance, and coordination, which typically go hand-in-hand. If the patient is having trouble stabilizing their upper body and core, a PT may have them do various stabilization and strengthening exercises and activities. These exercises and activities can include the typical core exercises like crunches, planks, and push-ups, but the PT will need to make them fun in order to keep the patient, who is typically younger, engaged. The PT could also do strengthening exercises for the lower extremities. A study was completed with a group of patients with spastic CP that demonstrated an improvement in lower extremity strength following a 5-week strengthening program (Lee et al., 2008). These strength gains resulted in improvement in the Gross Motor Function Measure (GMFM) score as well as increase in gait speed and stride length (Lee et al., 2008). The therapist could turn the exercises into a game or reward the patient with a treat or free time for every repetition they complete or for completing all of the prescribed exercises.

Another option would be to complete activities to address strength, endurance, posture, and coordination, such as the progressions of riding a bicycle. The patient will need the strength and endurance in their legs to pedal the bike as well as core strength to maintain good posture while riding the bike. An improvement in strength was demonstrated in a study with pediatric CP patients completing a cycling training (Chen et al., 2012). Coordination is needed to stay balanced as well as cadence in both legs to steer and pedal (Toovey et al., 2019). For all CP patients to participate in activities like biking, specific adapted equipment pieces have been made for various levels. A balance bike is

one example in which there are no pedals, so the patient can still sit on the seat and work on core stabilization but can work on walking with the bike instead of pedaling (Bergeron Peglow, 2020). These bikes also typically have a handle for the therapist to help the patient balance if needed. Another bike may have a full seat with a back instead of a normal bike seat for patients that may struggle with core stability (Bergeron Peglow, 2020). The last option includes an adapted static bike. An adapted static bike was used in a study with CP patients during a 6-week biking program (Williams & Pountney, 2007). After 6 weeks, the participants demonstrated a clinically significant improvement in the 66-item Gross Motor Function Measure (GMFM-66) score as well as standing, walking, running, and jumping dimensions of the 88-item Gross Motor Function Measure (Williams & Pountney, 2007). Along with improvements in strength, endurance, posture, and coordination, the ability for CP patients and others with disabilities to participate in biking makes therapy fun and allows them to participate in an activity with other friends and family (Pickering et al., 2013).

Lastly, gait analysis will expose the specific aspects of gait that need to be improved by physical therapy. Cerebral palsy patients will regularly practice walking through various gait training techniques. One type of gait training involves walking on a treadmill with an assistive device that wraps around the patient's legs and core to decrease the amount of load on the patient's lower extremities. This approach utilizes a body weight support gait training treadmill and enables the therapist to manually move the patient's lower extremities to where they should be and what biomechanical path they should be following without the entire body weight of the patient (Mao et al., 2015). Another type of treadmill gait training involves a device like the body weight support

previously mentioned, but the training is completed via robot-assisted gait therapy (driven gait-orthosis) (Sarhan et al., 2014). This device has mechanical parts that moves the patient's lower extremities in the correct biomechanical pattern instead of having the PT do this (Sarhan et al., 2014). Studies have shown that this new type of therapy is successful in improving patients' gross motor function and gait variables after ambulation training (Sarhan et al., 2014). Finally, the last type of treadmill gait training involves walking with an anti-gravity treadmill. Again, this allows the patient to practice their gait patterns with less of a load on their lower extremities. However, with antigravity treadmills, the PT will not be able to manually adjust the lower limbs of the patients due to the seal for the antigravity effects.

A study was conducted to investigate this last training approach in which an experimental group of CP patients participated in antigravity treadmill gait training for 45-minute training sessions, 3 times a week for 8 weeks (Lotfian et al., 2019). After comparing the gait analysis between the experimental group before and after the training as well as compared to the control group, the results showed improvements in many aspects of gait including dynamic balance, walking speed, endurance, and mobility (Lotfian et al., 2019). This confirms the viability of an antigravity treadmill gait training program. Additional gait training without a treadmill may also need to be incorporated if the patient has an assistive device such as a wheelchair, walker, or orthotics. Orthotics are removable external devices designed to support weak or ineffective joints or muscles and have a wide range of different kinds that address different gait or structural problems (Novak et al., 2013).

In addition to gait analysis, the PT conducts various tests, determined by the patient's age, to establish the need for upper body strengthening, posture, and coordination therapy. Along with the upper body strengthening exercises mentioned above, pediatric CP patients can continue to improve upper body and core strength through fun activities such as assisted rock climbing, laying prone on a flat scooter and using their arms to propel themselves forward, and swinging. Upper extremity and hand-eye coordination can be enhanced through different bouncing, throwing, and catching activities.

Based on the various goals and benefits of physical therapy, there is a recognizable need for CP patients to participate in physical therapy throughout their lifetime. Unfortunately, there have been studies that indicate that most CP patients do not regularly attend physical therapy upon completion of secondary school—only 33.7% of the 35,000 youth CP patients examined participated in PT after secondary school (Liljenquist et al., 2018). There are many adult CP patients that are missing out on the continued benefits of PT including promotion of self-care, ambulation, and functional mobility which translate into improved participation in activities such as independent living and employment (Liljenquist et al., 2018). Health-care professionals should be an advocate for this intervention even after the patient completes school—for the overall welfare of the patient. There is a need for improvement in lifelong participation in PT.

Occupational Therapy

One common intervention used for patients with CP is occupational therapy. An occupational therapist (OT) works with patients to develop the skills needed for activities of daily living (Rezaie & Kendi, 2020). Activities of daily living typically include self-

care (grooming, dressing, feeding, etc.), play, and fine motor skills (writing, etc.) (Rezaie & Kendi, 2020). Due to the importance of these tasks, therapy in these areas of life result in higher quality of life and social participation. Occupational therapists emphasize the opportunity of independence for the patient. Occupational therapy is also typically prescribed by a physician at a young age and continued for many years.

Occupational therapy techniques can focus on two main areas, motor limitations due to the nature of CP and the sensory and cognitive abilities of patients (Cerebral Palsy Guide, 2020). The first goal for an OT is to work on motor planning with the patient to help carry out daily activities despite certain motor limitations. An OT will spend more time on smaller, fine motor skills such as the movement of the fingers as opposed to a physical therapist who tends to work on bigger, gross motor skills such as walking. However, this does not mean that there will never be any overlap between these two—an occupational and physical therapist can both be working on the same skills with the patient (Cerebral Palsy Guide, 2020). Engaging in techniques to help develop and sharpen the skills of the patient for sensation, perception, cognition, communication, and behavior is the second half of the goal of OT (Rezaie & Kendi, 2020).

The specific tasks for the patient will vary based on the individual needs found in an evaluation by the OT, but there are some common tasks for an OT to work on with a patient. Upper extremity rehabilitation, specifically strengthening and stabilization of the upper body, is one task that an OT typically focuses on with a patient (Cerebral Palsy Guide, 2020). Researchers presented a study done in search of the perfect design of an upper extremity rehabilitation game that kept CP patients engaged and entertained while also requiring enough of a challenge in the strengthening and stabilization aspect (Dunne

et al., 2010). The game was created utilizing a multitouch display that had many different scenarios to keep the patients focused while requiring them to complete different desired stretches as well as strengthening and coordination exercises (Dunne et al., 2010). Technology like this and activities such as crawling, laying prone on a scooter and having the patient use their upper extremities to propel themselves forward, and sitting on an exercise ball while trying to complete a puzzle game are all ways to strengthen the patients' upper extremity. Occupational therapists also spend time working on crossing the midline of the body in activities such as throwing a ball or reaching from one side to another (Cerebral Palsy Guide, 2020).

If a CP patient is diagnosed with any type of hemipelagic CP, an OT typically prescribes tasks to address the goal of improving function on the affected side. A few different techniques to approach this include bilateral and bimanual training as well as modified constraint-induced movement therapy (CIMT). Bilateral and bimanual training are two approaches that challenge the patient to complete exercises or movements with both hands (Cerebral Palsy Guide, 2020; Novak et al., 2013). This can be anything from buttoning a shirt to playing with Legos. In contrast, modified constraint-induced movement therapy has the patient practice many different tasks only using their affected limb due to their unaffected limb being in a restraint, such as a weighted glove (Hoare et al., 2010; Novak et al., 2013). This method requires the affected limb to complete many repetitions in a short amount of time. Research has been conducted that compares the effectiveness of these two approaches following an injection of Botulinum toxin-A. An experimental group of participants received constraint-induced movement therapy while a control group received bimanual training following the Botulinum toxin-A injection

and were tested using the Assisting Hand Assessment before the injection as well as 1, 3, and 6 months after the injection (Hoare et al., 2010). Both approaches resulted in improved use of the affected upper limb in the post testing, so the ideal methodology used will vary based on the unique needs of the patient.

Occupational therapists may work on daily routines, such as a morning or nighttime routine, by creating a social story. A social story is an individualized book describing a situation, skill, or concept and the relevant social cues, perspectives, and common responses to prepare a child for a social situation (Novak et al., 2013). A common social story for a morning routine may include a picture of the child getting out of bed and dressed for the day. The next image may show the child brushing their hair and teeth. The specific steps of brushing their teeth could also be included based on the needs of the patient. Finally, the social story could include the patient eating breakfast and grabbing their backpack to head to school. The story can utilize the common cues that the therapist uses in order to help the patient follow along and align the process with what they are working on in therapy. These can really help both the patient as well as the patient's family or caretakers.

Despite the importance of OT, not many patients with CP adhere to their therapy treatment. A study was conducted to investigate why there was a lack of adherence and found many different factors that can affect adherence including child and family-related factors, the severity of the child's problems, child's behavioral status, socioeconomic class and education status, family structure, therapist-related factors, and the family's previous experiences (Rezaie & Kendi, 2020). Hopefully with the problems behind the

lack of adherence identified, new solutions can be made to improve upon these factors and increase adherence.

Combination of Physical Therapy and Occupational Therapy

There are many circumstances in which an occupational therapist and a physical therapist will work synergestically during therapy. The physical and occupational therapists can have the patient complete different exercises at the same time or work at different times while working toward the same goal. For example, a physical and occupational therapist may be working with the patient at the same time but on different goals by having the patient sit on an exercise ball, to target trunk strength and stability, while having the patient try to complete a puzzle or write their name, to work on the fine motor skills of the hands. Another example of a therapy session in which this type of collaboration occurs could include an obstacle course in which the patient must jump on shapes on the ground, saying the shape as they land on it, throw a ball using their affected hand, and running over to a whiteboard to write the numbers 1 through 10 in chronological order. This obstacle course would address the gross motor skill goals of jumping, throwing, and running for a physical therapist goals while also working on the cognitive function of shapes and numbers as well as writing for an occupational therapist's goals. This would enable the therapists to decrease the total amount of time a patient must spend in therapy each week. This can be especially important because therapy is hard for patients, as it continuously challenges the patient to do activities that may be difficult and frustrating. Therefore, being efficient with time in therapy is essential. It can also be important if the patient is a child with a short attention span. Conversely, both PTs and OTs may be working at different times toward the same goal

with different therapy techniques. A physical therapist may have the patient work on upper extremity and core strength by doing various stretches and yoga poses, while an occupational therapist may work on upper extremity and core strength by having the patient brush their teeth, comb their hair, and use the restroom.

A physical and occupational therapist may also utilize the same type of therapy for reaching different goals. The use of hydrotherapy is one example of this. Hydrotherapy challenges patients to complete exercises while submerged in water, typically above 99 degrees Fahrenheit, to decrease pain, loosens tight muscles, stimulates blood flow, and allows a feeling of weightlessness (McCann, 2018). Many studies have been conducted to confirm the benefits of hydrotherapy including a study done examining the motor function and enjoyment effects of hydrotherapy for pediatric CP patients of varying severities (Lai et al., 2014). The study found that the CP patients that were in the aquatic therapy group had greater average scores on the 66-item Gross Motor Function Measure as well as the Physical Activity Enjoyment Scale compared to the control group that did not receive hydrotherapy; these results even stood true in patients that had a high level on the Gross Motor Function Classification System (e.g., level IV) (Lai et al., 2014).

An example of therapists utilizing hydrotherapy for different goals would include a PT using hydrotherapy to work on gross motor skills such as gait training whereas an OT can use this technique to practice fine motor skills such as grasping. Researchers analyzed how effective hydrotherapeutic gait training is for CP patients in a 10-week study. The CP patients participated in two, 45-minute group aquatic training sessions each week (total of 20 treatment sessions) lead by three physical therapists and a sports

teacher (Ballaz et al., 2011). The primary goal was to increase the gait efficiency of the patient as measured by the gait energy expenditure index (EEI). After the duration of the study, it was found that the EEI had increased for the CP patients resulting in a better gait for those patients and proving the effectiveness of a group aquatic training program (Ballaz et al., 2011).

Physical therapists and occupational therapists may also utilize the same type of therapy for overlapping goals, both reaching towards a similar goal but also for different goals at the same time. For example, both PTs and OTs may use bimanual training and/or constraint-induced movement therapy with the goal of getting the patient to use both the affected and unaffected limb the same amount and with the same mechanical patterns and strategies. Both therapists want the patient to use their affected limb the same amount as the unaffected limb in order for them to move and participate in activities in a safe, efficient way. The PT and OT can both use the bimanual training and/or constraint-induced movement therapy (CIMT) to have the patient pick up different objects off the ground to practice use of both limbs. But an OT may also use these two approaches to have the patient zip a zipper or other daily activities while the PT may also use the two approaches to have the patient pedal a bike with both legs or chest pass a ball with both hands. A systematic review was done over the various studies done utilizing constraint-induced movement therapy in children with hemiplegic CP and demonstrated that this type of therapy is beneficial for an increased frequency of use of the upper extremity following CIMT (Huang et al., 2009). This review included studies that had both CIMT in physical therapy sessions and occupational therapy sessions demonstrating how PTs and OTs can utilize the same type of therapy for overlapping goals as well as separate

goals (Huang et al., 2009). Overall, the practices of a physical therapist and an occupational therapist working with a patient with CP can overlap in many different ways.

Additional Treatments

Patients with CP may also have many other treatment interventions in addition to physical therapy and occupational therapy. These additional treatments may include exercise, speech and language pathology, medications, and surgical procedures. The patient's health care team will discuss and determine if there is a need for these additional interventions for the individual patient.

Exercise has been shown to benefit most people—this includes patients diagnosed with CP. There have been research studies that demonstrated improvement in both anaerobic and aerobic capacity and fitness of CP patients when participating in a targeted exercise program (Butler et al., 2010). Although these gains have been demonstrated during the follow-up testing, there is not a very high recorded amount of transfer between the benefits and new growth from the exercise program to the activities of daily life (Verschuren et al., 2008; Butler et al., 2010). More research should be done in order to investigate how to increase this carryover between the exercise program and the patient's daily life.

Another type of intervention commonly utilized by patients is speech and language pathology, or speech therapy. Speech therapy has a goal of improving the patient's capacity for communication, saliva control, and eating, drinking, and swallowing (Krigger, 2006; Cerebral Palsy Alliance Research Foundation, 2018). There

are many different techniques that will strengthen the muscles of the mouth and face in order help all those goals (Cerebral Palsy Group, 2016; Sigan et al., 2013). In addition to strengthening the oral-motor muscles needed to communicate, there are devices known as augmentative and alternative communication (AAC) devices that help the patient express their thoughts via a picture board, keyboard and touchscreen, speech-generating device, or computer with eye-gaze technology (National Institute of Deafness and Other Communication Disorders, 2019; Hemmingsson & Borgestig, 2020). All these techniques and technologies help the patient interact with their environment and communicate with those around them.

Medications may be chosen by a physician as an option for CP patients that need additional therapy. Some of the most common oral medications prescribed for CP patients are: centrally acting drugs such as Baclofen and Tizanidine; peripherally acting drugs such as dantrolene sodium; and anticonvulsants such as Benzodiazepines and Diazepam (Chung et al., 2011; Chang et al., 2013). Medications may also be administered through injections or pumps, which include botulinum toxin injection, intrathecal baclofen pump, and alcohol or phenol injections—that all have chemodenervation effects (Chung et al., 2011; Chang et al., 2013). There are also many different types of medications that may be picked to address the symptoms of associated disorders that a patient has. Choosing the appropriate medication(s) for a patient can be difficult.

Though this is typically not the first intervention chosen, surgical procedures are still an option for some CP patients. Surgery is discussed with the patient's health care team and caregiver(s) when the other treatment interventions are no longer helping the

patient. The common operations include muscle lengthening, tendon lengthening, tendon transfer, tenotomy/myotomy, osteotomy, arthrodesis, selective dorsal rhizotomy, and operations to address comorbidities of CP such as cochlear implants and gastrostomy (Cerebral Palsy Guide, 2020). Patients that need surgery tend to be very satisfied with the decision and outcome of surgery.

CHAPTER III

Discussion

With all of the available treatment options, the best care plan for a CP patient needs to be unique and fit the specific needs of that patient. There are many possible combinations of treatment that could be the answer for CP patients, but it will require trial and error to truly determine which of these treatments help the patient. Within specific treatment interventions, it is possible that a patient will work best with one certain health care professional or approach. For example, patient A may really enjoy structured physical therapy that clinic 1 offers while patient B works better with clinic 2 because of the laid back, fun type of therapy. Patients could even work better or worse with specific therapists within the same clinic. Again, this will vary among individual patients. Communicating with the patient is important in order to learn if they have a preference as to the type of treatment or the therapist with whom they prefer to work with.

Some treatment types may cause more trouble for the patient or pose new challenges for patients and therapists. For example, a medication may help with spasticity of the larger muscles in the legs but cause the side effect of tremors in the hands and smaller muscles. This would make activities such as writing and completing daily tasks much harder, which would require the OT to be even more creative with their treatment techniques. Another example would be if the patient has back to back appointments for two different interventions. The patient may be tired or not need to work on an overlapping goal in both appointments if that is not efficient. So, the health care professionals must communicate the best plan of action for the patient for each treatment

session. The health care provider will then need to be flexible with the plan of care and be willing to think outside of the box when coming up with a new or adjusted plan.

In general, pediatric patients tend to need treatment approaches that make the work seem like play. Treatment is typically not enjoyable and hard work for the patient, so the more that the health care professional can make it seem like a game, typically the better the pediatric patient will respond. It is also important to remember that if the patient is a child, that some days may be better than others, just like working with adults. There are times in which the pediatric patient experiences an episode such as a seizure or a bad night of sleep resulting in a less productive therapy session. They will not do much at a treatment session but might try with lots of persuasion and treats after. This is something that health care workers need to keep in mind when working with pediatric patients. Another aspect that must be kept in the mind of the health care professional when working with pediatrics, the caregiver(s) must be kept in the loop and be involved in the treatment since the patient is a minor. It is also important because certain treatment interventions require exercises or things to practice while outside of the clinic. For example, an occupational therapist may send home a social story for getting ready in the mornings. However, the patient may need help from their caretaker(s) to complete the new home task. Open communication between the health-care professionals and the caregiver(s) is critical.

The treatment plan will also need to evolve and change as the patient gets older or if the condition of the patient changes, such as symptoms changing severities or associated disorders varying with time. The treatment plan may also need to change based on the patient's progress, whether it is improving or plateauing. All of the

treatment options aim for continual improvement of the CP patient's health and quality of life.

CHAPTER IV

Conclusion

Since it is the most common physical disability in children, interest in CP and possible treatments has been on the rise. Knowing the possible causes and risk factors for CP can help to diagnose this disorder, as well as possible associated disorders, at an earlier age. Cerebral palsy can develop as a result of a problem or problems that leads to an injury affecting the formation of a fetal or infantile brain. With the new diagnosis tools, the patient can not only be diagnosed with CP, but can also distinguish which type of CP is present based on the categorization of motor function, part(s) of the body affected, and how severe the symptoms are. Along with the diagnosis of CP, patients can also be diagnosed with a variety of other associated disorders that may be commonly found within CP patients.

Despite not having a cure for CP, there are many different interventions that help the patient have the most functional and pleasant life. Treatment interventions common for CP patients include physical therapy, occupational therapy, exercise programs, speech therapy, medications, and surgical procedures. The different interventions and techniques that will be used for the patient will be determined by the patient's health care team in order to find the most optimal approach for treatment. Some patients will need more of one type of intervention and less of another, which is why there is not a "one size fits all" treatment plan. It may take time and trial and error to determine which treatment interventions help the patient. The patient, caregiver(s), and health care team will need to discuss the best options for each patient. There is always a demand for continuous advancements in research and intervention techniques in order to ensure the most up to

date techniques and methods. Researchers are constantly examining new treatment options to give the patients the most enjoyable and functional life possible.

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