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THE USE OF PERFORMANCE ENHANCING SWIMWEAR DURING AQUA THERAPY FOR CEREBRAL PALSY – A CASE STUDY

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The purpose of the thesis was to study the effects of the use of performance enhancing swimwear on a client with Cerebral Palsy (CP). This was done by interviewing a client with Spastic Diplegic CP who uses performance enhancing swimwear during aqua therapy sessions with her physiotherapist. For additional insight about the use of the swimwear the physiotherapist was also interviewed.

CP is the most common motor disability in childhood, primarily affecting motor control and movement coordination. The severity of disabilities vary from mild to moderate and severe, meaning the mildest cases can be ambulant and the most severe in a wheelchair unable to maneuver themselves. The more severe and moderate cases often possess movement restrictions when functioning on land. Even the milder cases can have movement impairments, but perhaps only affecting one limb. Regardless of severity, these impairments have the ability to significantly impact quality of life. Most often individuals with CP require some form of assistive aids, whether they are for movement, functionality, or activities of daily living (ADL). The movement restrictions affect the overall development and quality of life of the child.

When moving in water many of the restrictions that are present on land are removed. The ability to function without assistive aids in water creates freedom of movement and the possibility of moving in three dimensions. This can create physical, social and mental improvements in the child's life. These improvements can affect the child's quality of life by improving functionality, cognition, fitness, strength, posture and decrease pain. It can also improve mental wellbeing and self-esteem, by giving the child a feeling of accomplishment from learning new skills and the ability to compete on the same level as same aged peers.

Performance enhancing swimwear often uses compression fabrics and other beneficial properties to improve the overall functionality and efficiency of swimmers. Improved functionality in the water could further increase the possible positive effects of swimming and feelings of accomplishment. According to the client and physiotherapist interviewed, performance enhancing swimwear offers postural support and muscle activation. The physiotherapist noted a decrease in the effect of spasticity, possibly due to improved body positioning, thus creating an increase in voluntary muscle control in her clients. Despite the predominant use of performance enhancing swimwear with professional athletes, this swimwear could prove to be beneficial for the CP population in the aqua therapy setting.

CONTENTS

"We have a moral duty to remove the barriers to participation for people with disabilities, and to invest sufficient funding and expertise to unlock their vast potential… It is my hope this century will mark a turning point for inclusion of people with disabilities in the lives of their societies."

- Stephen Hawking

1 INTRODUCTION

Cerebral Palsy (CP) is a neurodevelopmental disorder that results from injury in the developing brain. The disorder primarily affects movement and muscle coordination but it can be accompanied by other associated conditions. These can include conditions such as epilepsy and problems with cognition and communication. (Cerebral Palsy Alliance 2015.)

CP is the most common motor disability in childhood. It can develop during pregnancy, childbirth, or after birth (up to approximately 2 years). Most commonly, damage to the brain happens prenatally, resulting in about 75-80% of cases. Causes can be either congenital, genetic, inflammatory, infectious, anoxic, traumatic or metabolic. (Wolting 2016.)

The effect of CP on an individual varies significantly and there's huge alteration between mild and severe conditions. An individual might be in a wheelchair with severe cognitive, motor and speech impairments, with other associated conditions. Alternatively they might have mild motor impairment with no other impairments. (Dodd, Imms et al. 2010, 8.) Because of this huge variability and the many possible secondary, associative and co-mitigating conditions, paediatric rehabilitation requires a multidisciplinary (MDT) approach. Physiotherapy is an integral part of the MDT approach. The key roles of physiotherapy is to support the child to achieve their maximal potential for physical independence and fitness. (Wolting 2016) Other types of treatment can include various types of therapy, assistive aids, drug therapy, orthopedic braces, botulinum-toxin injections, surgery and different alternative interventions. (Cerebral Palsy Alliance 2015.)

Children who might have difficulties moving on land can often be more functional in water. The experience of movement without assistive aids and the ability to perform movements that wouldn't normally be possible on land can help improve the child's overall development. (Campion 1991, 5-6.)

The development of performance enhancing swimwear originated through improving the performance of professional swimmers. When considering the motor challenges associated with CP, the possible performance enhancing qualities offered by this swimwear could be beneficial during aqua therapy.

2 PURPOSE OF THE THESIS

The purpose of this thesis was to study an individual CP client's perspective on the effect of performance enhancing swimwear during aqua therapy. This study was conducted by interviewing a client using performance enhancing swimwear during her aqua therapy sessions with a physiotherapist. For additional insight about the benefits of the swimwear the physiotherapist was also interviewed. There is currently no data available about the use of performance enhancing swimwear in aqua therapy with CP clients. For this reason, the aim was to get user experience on the topic, to determine whether there are any benefits from using the swimwear with CP clients.

3 CEREBRAL PALSY

Cerebral Palsy (CP) is a neurodevelopmental disorder that results from brain injury or malformation while the brain is still developing. The disorder is permanent (but not unchanging) and primarily affects movement and muscle coordination. Additionally, this disorder also affects muscle tone, reflexes, posture, gross & fine motor skills and balance. The motor disturbances are often accompanied by disorders of sensation, communication, cognition, behaviour, perception and possibly a seizure disorder. (Cerebral Palsy Alliance 2015.)

Because of the large variety of symptoms, the effect of CP on an individual varies significantly. An individual might be in a wheelchair with severe cognitive, motor and speech impairments. Alternatively they might have mild motor impairment leading to one foot dragging when the individual is somehow unwell, but has no other impairments. This variability leads to huge changes in the role and focus of physiotherapy for different individuals with CP. (Dodd, Imms et al. 2010, 8.)

CP is the most common motor disability in childhood. Its prevalence varies among different countries by 1-5 in every 1000 babies that are born. It affects boys more commonly than girls. CP can develop during pregnancy, childbirth or immediately after birth. The causes are either congenital, genetic, inflammatory, infectious, anoxic, traumatic or metabolic. CP is most commonly caused by prenatal injury, resulting in approximately 75-80% of cases. Contrary to previous beliefs, significant birth trauma or asphyxia causes less than 10% of cases. (Wolting 2016.)

The risk factors that might lead to a child developing CP can be divided into three categories: prenatal, perinatal and postnatal (0-2 years following birth). The prenatal risk factors include being born prematurely, birth weight less than 2500g, trauma, infections, hyperthyroidism, maternal epilepsy, severe toxaemia, drug abuse, multiple pregnancies and/or placental insufficiency. Risk factors during birth (perinatal) are premature rupture of membranes, prolonged and difficult labour, vaginal bleeding at the time of admission for labour and/or bradycardia. Directly after birth or during the first few years of life, risk factors include central nervous system infection, hypoxia,

seizures, coagulopathies, neonatal hyperbilirubinemia and/or head trauma. (Wolting 2016.)

In Finland, studies were conducted into the incidence of cerebral palsy per 100 000 births by the age of 7 years (gestational age), for birth years 1991–2008. This study indicated a prevalence of 2242 CP cases. The study also found that the most serious risk factors for developing CP include asphyxia (oxygen deficit), brain damage and intracranial haemorrhage. The incidence of CP was 0.22%, decreasing nonlinearly with increasing gestational age, and with time (Figure 1). (Hirvonen, Ojala et al. 2014, 1-8.)

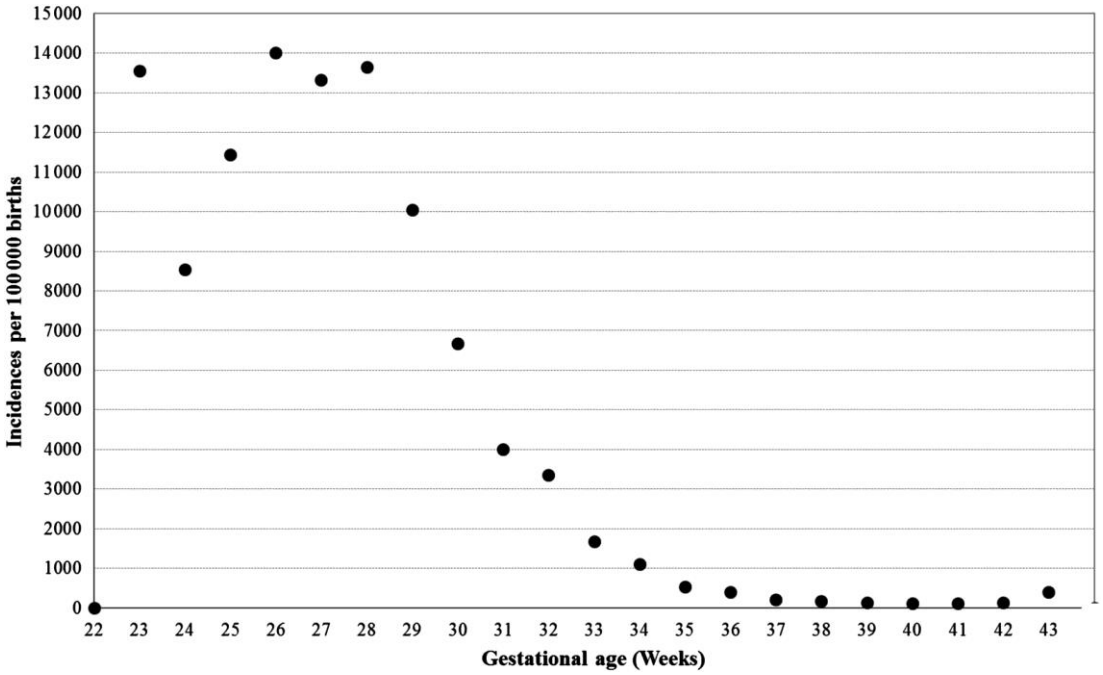

Figure 1 – Incidences of cerebral palsy (Hirvonen, Ojala et al. 2014, 1-8).

3.1 Diagnosis

Diagnosing a child with Cerebral Palsy takes time and careful observation. The diagnosis is not made until between the ages 2-5, when the brain has fully developed. There are some exceptions, such as with really severe cases when the child can be diagnosed soon after birth. There are no tests for CP, the diagnosing is done by monitoring the child's growth and looking for signs of impairment. Most often it's the parents who notice the child hasn't reached certain age appropriate mile stones such as sitting,

walking, crawling or rolling. If a milestone is late or muscle tone is impaired, it can be an indication for monitoring growth. Diagnosis can take months or even years to confirm. Diagnosis is made by using various examination tools such as computed tomography (CT) scan and magnetic resonance imaging (MRI) scans to see the possible brain damage. Different professionals will test hearing, vision and perception, in addition to cognitive, behavioural and physical development. Abnormal postural reactions, dislocated hips and presence of primitive reflexes will be tested by orthopaedic surgeon. Primitive reflexes are stereotypical responses that happen in reaction to various sensory stimuli. In the early months of life almost all motor behaviour is controlled by these reflexes. The child will develop motor skills when advanced postural reactions are present and primitive reflexes are lost. If the primitive reflexes are still present after the age of 6 months, it can be a sign of pathology. Although a child with CP doesn't develop as other children, the stages of normal development are used as a guideline for assessment and evaluation. Development charts are useful tool to outline the specific ages for different developmental milestones. Disabled Village Children have created a detailed chart to help assessing child's physical, mental and social development (Appendix 1). (Wolting 2016.)

3.2 Classification of Cerebral Palsy

There are several classification systems used to facilitate diagnosis classification of CP. The most commonly used systems are: classification based on severity, topographical distribution and muscle function. Classification based on severity level categorizes CP to be either mild, moderate, severe or no CP (Table 1). (Cerebral Palsy Alliance 2015.)

Table 1 – Classification based on severity (Cerebral Palsy Alliance 2015).

Category	Description
Mild	Child can move without assistance. Activities of daily living (ADLs) are not limited.
Moderate	Child needs braces, medications and/or adaptive technology to perform ADLs.
Severe	Child is in a wheelchair and will have considerable challenges in performing ADLs.
No CP	Child has cerebral palsy signs, however the impairment happened after completion of brain development and is classified under the incident that caused the CP i.e. traumatic brain injury or encephalopathy.

Classification based on topographical distribution describes which body parts are affected and whether they are weakened (plegic) or paralyzed (paresis) (Table 2). (Cerebral Palsy Alliance 2015.)

Table 2 – Classification based on topographical distribution (Cerebral Palsy Alliance 2015).

Category	Description
Monoplegia / monoparesis	Only one limb is affected.
Diplegia / diparesis	Both legs are typically affected. Affects lower extremities (LE) more than the upper extremities (UE).
Hemiplegia / hemiparesis	One side of the body is affected (one arm, one leg).
Paraplegia / paraparesis	Lower parts of the body are affected (trunk, pelvis and both legs).
Triplegia / triparesis	Three limbs affected. Can mean either both legs and one arm, or one leg and both arms. It can also mean one leg, one arm and the face.
Double hemiplegia / double hemiparesis	All four limbs are affected with one side more severely than the other.
Tetraplegia / tetraparesis	All four limbs are affected, three limbs more so than the fourth.
Quadriplegia / quadriparesis	All four limbs are affected.
Pentaplegia / pentaparesis	All four limbs, neck and the head are affected. Often accompanied by eating and breathing difficulties.

Classification based on muscle function has two main groups which are spastic and non-spastic. Spastic CP is often described as increased muscle tone (hypertonia) and non-spastic means decreased muscle tone (hypotonic), often leading to loose and floppy limbs. Non-spastic CP is then further divided into two categories dyskinetic and ataxic (Table 3). (Cerebral Palsy Alliance 2015.)

Table 3 – Classification based on muscle function (Cerebral Palsy Alliance 2015).

Category	Description
Spastic **(70-80%)**	Increased muscle tone. Muscles continuously contracted leading to stiff limbs. Movements are often jerky and reflexes can be exaggerated. Most likely both the arms and legs are affected. The tongue, mouth, and pharynx can be affected leading to speech, eating, breathing, and swallowing complications.
Dyskinetic **(15%)**	**Athetoid**: involuntary movement, mostly in the arms, legs, and hands. **Dystonia/Dystonic**: trunk muscles more affected than the limbs which causes fixed, twisted posture.
Ataxic **(5%)**	Affects coordinated movements, balance, posture and gait. Gait is often very wide and steps can be irregular. Fine motor skills, such as writing, are difficult.

It should be noted, often the type of CP is referred to by using a combination of the topographical method and the muscle function classification (i.e. spastic hemiplegia) (Figure 2). (Wolting 2016.)

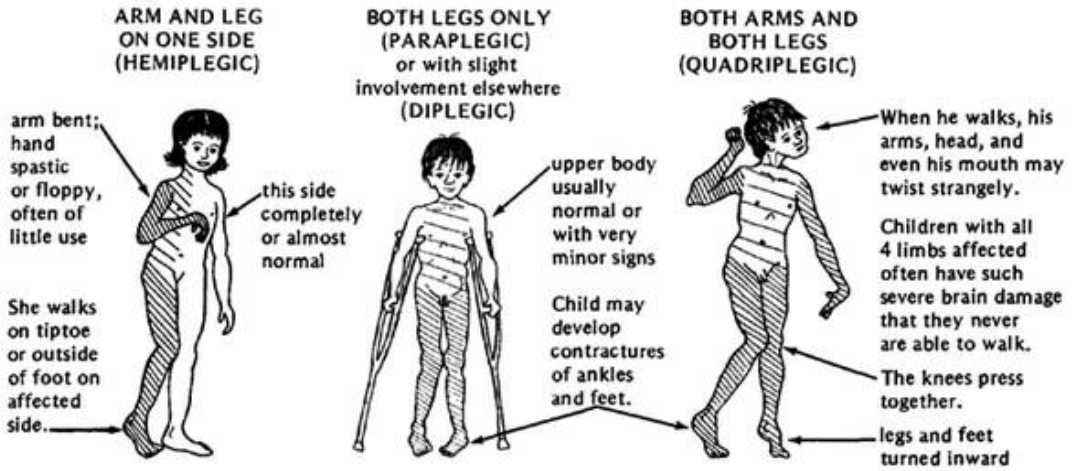

Figure 2 – Example types of CP: Hemiplegia, paraplegia and quadriplegia (Wolting 2016).

To further facilitate classification of muscle function subtypes, the Surveillance of Cerebral Palsy in Europe (SCPE) collaborative group has created a classification tree. The tree helps classify the appropriate muscle function type through asking generalized questions about muscle tone. These come in the form of yes or no questions. (Figure 3). (Wolting 2016.)

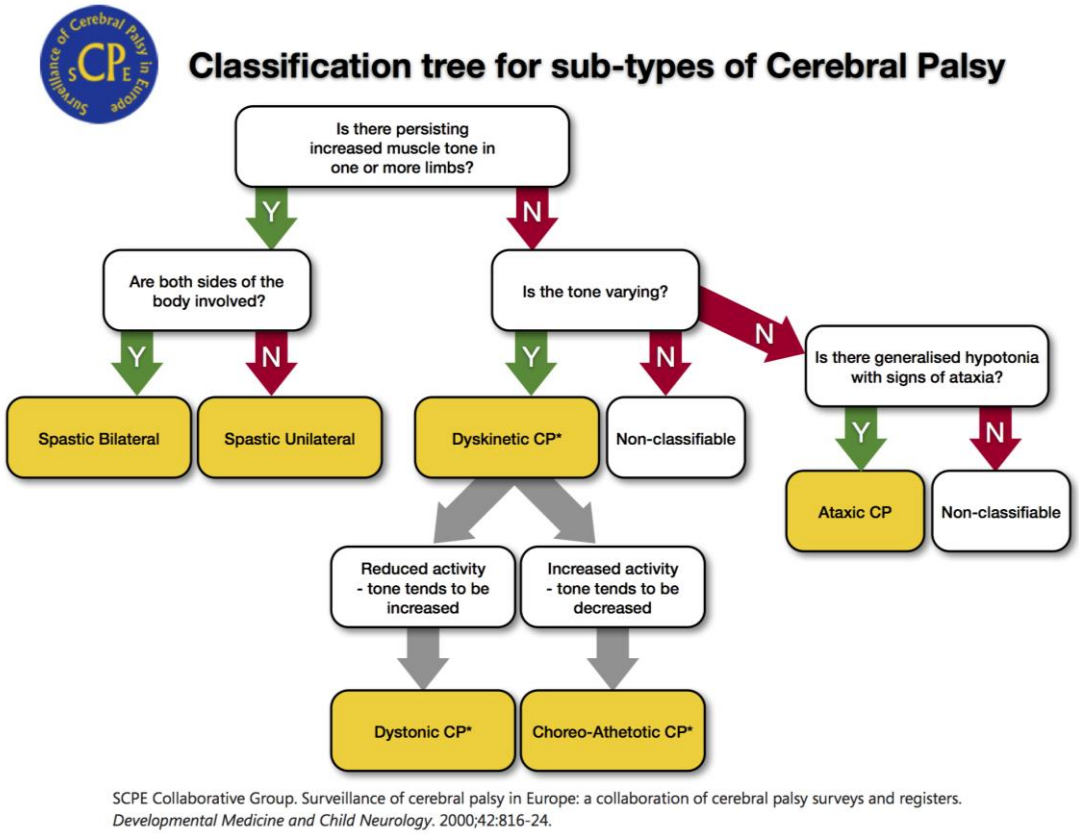

Figure 3 – SCPE classification tree for muscle function subtypes of CP (Wolting 2016).

The most universally used classification system relating to functionality is the Gross Motor Function Classification System (GMFCS). GMFCS is a five level system that correlates to the abilities and limitations of the individual with CP. Using this classification system helps determine types of surgery, physiotherapy, assistive aids and other forms of treatment or therapy needed (Table 4). (Cerebral Palsy Alliance 2015.)

Table 4 - Gross Motor Function Classification System (GMFCS) (Cerebral Palsy Alliance 2015).

Category	Description
GMFCS Level I	Walks without limitations.
GMFCS Level II	Walks with limitations. Limitations include walking long distances and balancing, but not as able as Level I to run or jump; may require use of mobility devices when first learning to walk, usually prior to age 4; and may rely on wheeled mobility equipment when outside of home for traveling long distances.
GMFCS Level III	Walks with adaptive equipment assistance. Requires hand-held mobility assistance to walk indoors, while utilizing wheeled mobility outdoors, in the community and at school; can sit on own or with limited external support; and has some independence in standing transfers.
GMFCS Level IV	Self-mobility with use of powered mobility assistance. Usually supported when sitting; self-mobility is limited; and likely to be transported in manual wheelchair or powered mobility.
GMFCS Level V	Severe head and trunk control limitations. Requires extensive use of assisted technology and physical assistance; and transported in a manual wheelchair, unless self-mobility can be achieved by learning to operate a powered wheelchair.

3.3 Subtypes of Cerebral Palsy

There are three main muscle function subtypes of CP: Spastic, ataxic and dyskinetic. Many children have a mixed form of CP with symptoms from more than one of these main subtypes. Spasticity and ataxia often occur together. (Wolting 2016.)

Children with spastic CP will have at least two of the three following characterizations: abnormal posture and/or movement pattern, increased muscle tone (possibly not constantly) and pathological reflexes. Spasticity is described as increased involuntary resistance in the muscle to passive motion. It implies increased muscle tone, which

causes limbs to be stiff and contracted continuously, and resistant to relaxing and flexing. Muscle reflexes are hyper sensitive (hyperreflexia) and the movements often tend to be jerky and awkward. In addition body parts such as the tongue, mouth, and pharynx can be affected. These factor into complicating everyday tasks such as eating, speaking and breathing. Spastic CP is caused by damage to the upper motor neurons in the motor cortex and it is the most common form of CP, accounting for approximately 70-80% of the cases. (Cerebral Palsy Alliance 2015.)

Hemiplegia is unilateral which means that one arm and one leg on the same side of the body are affected. Usually the upper body is more affected compared to the lower body. Individuals with spastic hemiplegic CP will commonly also have seizure disorders, visual field deficits, astereognosis and proprioceptive loss. Hemiplegia accounts for 20% of spastic CP cases. (Wolting 2016.)

Diplegia is bilateral which means it affects both sides of the body. With diplegia the legs are more affected than the arms. Often intelligence is normal and seizures are less likely. Children with spastic CP will most often have diplegia, which occurs in 50% of cases. Low birth weight and prematurity have been linked with diplegia. (Wolting 2016.)

Quadriplegia (bilateral) affects all four limbs, trunk and muscles of the mouth, tongue and pharynx. Premature babies are known to have more severe symptoms in the lower body. 30% of all individuals with spastic CP have quadriplegia. (Wolting 2016.)

Children with dyskinetic CP will have movement problems called dyskinesias, meaning abnormal movements that happen when the child initiates movement. The movement problems are accompanied by dysarthria (motor speech disorder), dysphagia (difficulty of swallowing) and drooling. Dysarthria complicates communication which is often falsely thought to be linked to an intellectual disability, but most likely the intellectual development is normal. Communication is further complicated by sensorineural dysfunction (hearing loss). Dyskinetic CP is often caused by either hyperbilirubinemia (high level of bilirubin in the blood) or severe anoxia (total depletion of oxygen e.g. during child birth). From all children with CP, approx. 10-15% have dyskinetic CP. Normal symptoms include abnormal posture

and/or movement patterns and involuntary and uncontrolled movements of the body parts that are affected. Dyskinetic CP is further categorized into to two subcategories: Dystonic CP and Choreo-athetotic CP. Dystonic CP is dominated by hypokinesia (decreased body movement) and hypertonia (increased muscle tone). The main aspects in Choreo-athetotic CP are hyperkinesia (increased body movements) and hypotonia (decreased muscle tone). (Wolting 2016.)

Children with ataxic CP have problems coordinating their movements. This includes loss of balance, fine motor control and coordination. Ataxia can be seen in early childhood as hypotonic muscle tone, or floppy limbs, for the first two years of life. Muscle tone becomes normal at 2-3 years of age, at which stage ataxia can be detected if present. It can be seen as wide-based gait and mild intention tremor. Also both dexterity and fine motor control are poor. Ataxia can often be combined with spastic diplegia. Most ataxic children can ambulate independently but some require walkers. Characteristic symptoms include abnormal posture and/or movement pattern and loss of movement coordination so that movements are often performed with abnormal force, rhythm and accuracy. (Wolting 2016.)

3.4 Associated conditions of Cerebral Palsy

Children with CP typically present with other associated health conditions. These might be related to CP or just associated with them, but they will most likely affect the child's quality of life. For example, difficulties in speech and controlling the muscles in the mouth and throat are conditions that hugely impact quality of life. Oral motor impairment can lead to problems with feeding and swallowing because of the lack of control in the muscles of mouth and throat. This affects ADLs such as feeding, swallowing and talking. Speech is also affected by motor speech disorders affecting the muscles of the mouth. In addition, children with CP may have problems with communication and speech production. Difficulties swallowing, blocked airways and the inability to cough are some examples why someone with CP may have respiratory issues. Respiratory conditions can seriously impact a child's quality of life. These respiratory issues can include asthma, bronchitis, pneumonia, bronchopulmonary dysplasia and respiratory distress syndrome (RDS). Epilepsy is also common among children with CP and approximately 35% of them have seizures. Children with CP

might also have intellectual difficulties resulting from CP. Intellectual difficulties can be rated as mild, moderate or severe. Learning difficulties may present due to varying reasons. These learning difficulties might impact higher-level functions such as organizational skills, or interfere with basic learning skills such as reading or writing. Hearing impairment, vision impairment, perceptual difficulties and digestive issues are also some of the associated conditions with CP. (Wolting 2016.)

Studies have gathered information on the rates of co-occurring impairments, diseases and functional limitations in children and adults with CP. The results indicate that the four most prominent problems are: pain which impacts 3 in 4 of the CP population, intellectual disability affecting 1 in 2, 1 in 3 are non-ambulant and 1 in 3 have problems with hip displacement (Figure 4). (Novak, Hines et al. 2012.)

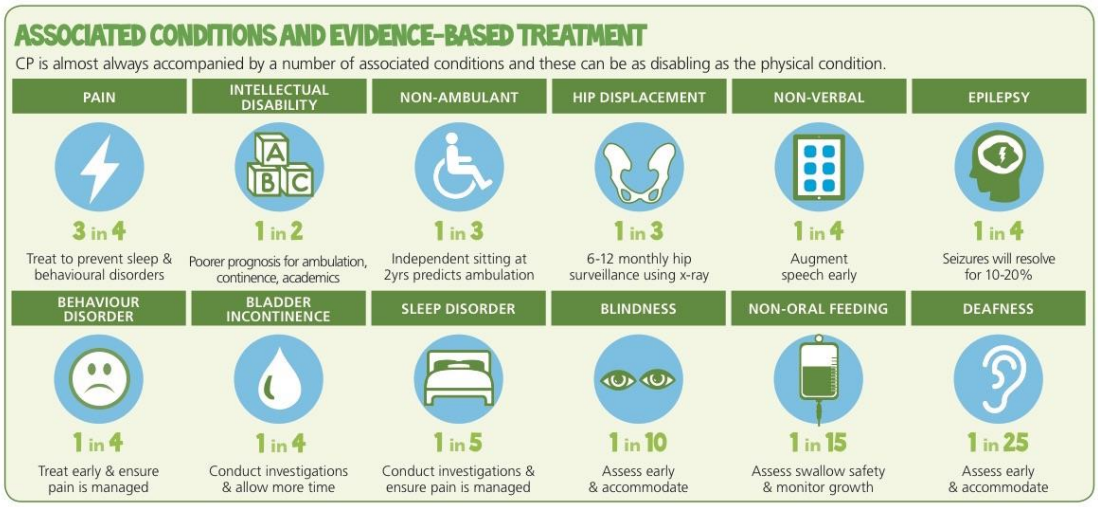

Figure 4 - Co-occurring impairments, diseases and functional limitations in children and adults with Cerebral Palsy (Novak, Hines et al. 2012).

4 TREATMENT OF CEREBRAL PALSY

The primary treatment mechanisms for children with CP are often different types of therapy and assistive aids, but depending on the individual they may require additional interventions such as drug therapy, orthopedic braces, botulinum-toxin injections and/or surgery. In addition, there are various types of alternative interventions that may be beneficial, for example aqua therapy, hippo therapy, music therapy, acupuncture and sensory integration. The child's primary physician, who is usually the pediatrician, will create a comprehensive health care plan for the child. Because of the many primary, secondary, associative and co-mitigating conditions associated with CP, the plan will most likely include many other healthcare professionals to ensure all different conditions are treated accordingly. Although each medical professional might have their own goals regarding treatment, there are typically some overriding treatment goals (Figure 5). (Cerebral Palsy Alliance 2015.)

Figure 5 - Overriding treatment goals for Cerebral Palsy (modified Cerebral Palsy Alliance 2015).

4.1 Early intervention

Neural pathways deliver messages to and from the Central Nervous System (CNS=brain and spinal cord) to different areas of the body. Neural pathways consist of neurons or nerve cells and communicate with each other via synapses. Specialized neurons respond to different areas, such as motor neurons create motor pathways and connect to the muscles to create movement. (Walker 2009.)

The importance of early intervention has been highlighted for reasons concerning the development of the young brain. During youth up to twice as many synapses are produced, and then may be preserved into adulthood. The highest amount of synapse formation (synaptogenesis) is during the first year of life and it will continue even after three years of age. During the peak time of synaptogenesis, synaptic pruning will occur. This meaning that the most active synapses are kept and the unused synapses eliminated. The synaptic pruning will get stronger around the age of 24 months. For the normally developing child this will allow them to learn new motor skills and guide the pruning of unnecessary motor patterns. For children with CP the learning of basic skills is often not possible without external input. Additionally if the synapses for basic skills are unused they might be pruned. Learning new skills in later life is not impossible but more difficult and requires increased intensity in stimuli. Secondary conditions such as contractures and deformities can also create a challenge for later interventions. (Wolting 2016.)

Neurons in the CNS are myelinated (process that allows the impulses to move faster in the CNS) from early age to adulthood. However the most rapid changes in myelination happen during the first two years of life. Neurons that are myelinated move hundreds of times faster in the CNS than the unmyelinated neurons. Practicing activities (such as playing a piano) causes nerve impulses to fire more frequently, which in turn increases myelination. This indicates that neural pathways with activities that are practiced get stronger and faster, when the ones that are not practiced stay weak. (Wolting 2016.)

These two processes account for neural plasticity in the young brain. This neural plasticity implies that specific interventions can be especially beneficial when administered from early age onwards. Neural plasticity creates possibility for changes in the damaged brain at a neuronal level, which can be especially seen in the young brain. With all this in mind, an important time for intervention is in the first few years of life. (Wolting 2016.)

4.2 Neural plasticity and activity

Increases in motor activity have proven to result in better physical and mental health. It has also been shown to improve other aspects of functioning such as cognitive performance, in addition to neural and physical recovery. In other words, not moving enough, or using inappropriate movement patterns, can have negative physiological consequences. Secondary physiological changes in muscles, bones and the respiratory system can lead to a worsening level of disability. With CP clients, muscles should be stretched regularly to maintain length. In addition, muscles require adequate and frequent loading to maintain strength. Bones also require loading to maintain strength. These factors should be included in treatment, especially for those who are not ambulatory. Heart and lungs require exercise at an adequate level and frequently to maintain endurance and fitness. Appropriate and regular exercise are particularly important for people with CP since the muscles, bones and cardiorespiratory system are not fully developed when the brain damage occurs. These factors result in reduced ability to achieve adequate levels of physical functioning, and slower progress in achieving these functionalities. (Damiano 2006.)

Randomized control trials focusing on traditional methods and postural strengthening techniques for children with CP resulted in great positive effects on trunk motor control in the treatment group. General consensus agrees that children should be as mobile as possible, even if only with the help of powered mobility. A recent review offering children with severe motor disabilities increased mobility options resulted in possibilities of independence, social interaction and aided socio-psychological development. It also stated that it doesn’t limit future self-mobility but might even encourage it. (Damiano 2006.)

Encouraging an active lifestyle is vital for maintaining and strengthening neural pathways. It's vital to prevent compensatory movement patterns, since the more frequently used motor pathways, are reinforced. In addition to prevention of damage, reinforcing functional motor pathways (with appropriate movement patterns and activity) is the key. It's more beneficial to prevent neural or physical damage, rather than to repair it afterwards. Thus therapeutic intervention aims to use plasticity of the brain to change neural structures to produce improved functioning. Successful methods for increasing neural plasticity include: using greater intensity through number of repetitions or levels of muscle activation, bigger challenges (problem solving) and electrical stimulation. Strength training has also been studied to be effective, however ensuring sufficient training intensity has been a common problem within various studies. In addition, strengthening is only one aspect of physical functioning. For more comprehensive treatment, activity based programs should be incorporated. Activity is most beneficial when done more frequently, with different levels of intensity and using varying programs. (Damiano 2006.)

When designing activities for children, emphasis should be placed on the quality of activity. Play is an important part in a child's development - it's an activity that will make the child happy. Enjoyable activities will ensure the child's willingness to repeat the activity. During play children will develop mentally, physically and socially. Children learn to walk, balance, coordinate and move through play. They learn to handle different objects, using hand-eye coordination and creativity. When playing with others, children learn social skills like sharing, expressing own ideas and communicating. They can also use play to work through emotional issues, such as things that frighten them, e.g. by playing doctor (Figure 6). (Wolting 2016.)

Figure 6 – Joy of learning, effects of play in child's development (Wolting 2016).

4.3 Physiotherapy for Cerebral Palsy

Pediatric rehabilitation with CP requires a multidisciplinary (MDT) approach, of which physiotherapy is an integral part. They key roles of physiotherapy is to support the child to achieve their maximal potential for physical independence and fitness. This can be achieved through minimizing the effect of physical impairment and thus improving quality of life of the child. Additionally the family should be a vital part of the rehabilitation process. Physiotherapy utilizes physical approaches to maintain, promote and restore physical, psychological and social well-being. This relates to all environments the child is in, such as school, home and recreation. Physiotherapists use a wide range of therapeutic approaches and methods to influence the functional ability of the child, such as positioning, sitting, transfers from sitting to standing, walking with or without assistive aids and orthoses, wheelchair use and transfers. There's a huge variety of different physiotherapeutic and physiotherapy-related approaches available, with variable levels of evidence to support the effectiveness. Bobath or Neurodevelopmental therapy (NDT) is one of the most commonly used approaches, with varying evidence both for and against it. Physiotherapy approaches such as fitness training and goal oriented training have a high level proof of effectiveness. (Figure 7). (Wolting 2016.)

TABLE 1.7 Therapeutic approaches to the management of CP.

Bobath/Neurodevelopmental therapy (NDT)
Conductive education
Sensory integration
Adeli suit
Aim-oriented management
Advance neuromotor rehabilitation
Biofeedback
Dohsa-Hou (a Japanese psychorehabilitation technique)
Electrical stimulation
Early intervention (e.g. Portage project)
Functional physical therapy
Movement Opportunities via Education (MOVE)
Patterning (Doman-Delacato, i.e. IAHP/BIBIC/Brainwave)
Pelvic positioning
Physical activity training
Strength training
Targeted training
Vojta
Training program (15 modalities) by Phelps
Recreational therapies (e.g. hippotherapy/saddle riding, hydrotherapy/swimming programmes)
Alternative therapies (e.g. hyperbaric oxygen therapy, acupuncture, and osteocraniosacral therapy)

Figure 7 – Therapeutic approaches to the management of CP (Wolting 2016).

Due to the huge variability in the possible effects of CP in an individual, it is difficult to define specific physiotherapeutic guidelines regarding suitable forms of intervention. For effective treatment it is common and necessary to use different intervention approaches that the therapist determines, based upon each individual client's abilities, limitations and goals. Additionally, children commonly possess impairments from two or more types of CP, further complicating decisions concerning intervention types. For example, a child may have spastic quadriplegia with dyskinetic components that involve the upper extremities (UE) more than the lower extremities (LE). Appendix 2 demonstrates the most common impairments in four categories: Hypertonic (Spastic), Hypotonic (decreased muscle tone), Athetoid (dyskinetic) and Ataxic. These are used as guidelines only and each client should be assessed as an individual. (Tecklin 2008, 207.)

Passive stretching can be used for spastic muscles to relieve soft tissue tightness. Increased tone can lead to contractures and soft tissue shortening. By stretching, the therapist can help normalize tone and maintain the length of soft tissues. In addition, passive stretching can also improve ROM and walking efficiency. When muscle is immobilized in a shortened position, it can lead to loss of sarcomeres (basic unit of muscle tissue). With stretching, the loss of sarcomeres can be reduced and by holding muscle in lengthened position it can increase the formation of sarcomeres. Passive stretching can be achieved by manual stretching, weight bearing, splinting or serial casting. (Wolting 2016.)

Splinting and serial casting can be used to alter and prevent the shape of body tissue. Splinting can be used to create low force, long duration stretching, reduce swelling, resting posture and active and passive ROM. Serial casting is used mostly for spasticity related contractures to increase ROM. The process includes a series of casts, applied to one or multiple joints. Each new cast is applied and old one removed once an increase in ROM is achieved. (Wolting 2016.)

Weight bearing with the use of a Tilt-Table offers a prolonged stretch and prevent contractures in the lower limbs. Tilt-table, Standing Frame and other weight bearing exercises also provide stimulation of antigravity muscle strength, prevention of hip

dislocation, decreased spasticity, increased bone mineral density, increased self-confidence and improved motor function. (Wolting 2016.) Periods of rapid growth are extremely crucial times to include stretching into the therapy plan, to avoid contractures. (Tecklin 2008, 208.)

Muscle weakness in CP can be caused by deficits in motor unit activation, decreased muscle volume or muscle length, poor co-activation of antagonist muscles and altered muscle physiology. Strength training can increase muscle strength, improve cardiovascular health, endurance, maintenance of bone mass, weight management, self-perception, muscle performance and gait. (Tecklin 2008, 208.) Functional exercises that incorporate aerobic, anaerobic and strengthening components have been noted to improve overall fitness, intensity of activities and quality of life in ambulatory children. Stationary bikes and treadmill training programs can be beneficial for gait and gross motor development. Treadmill training (with body weight supported) allows the development of stepping patterns, which can improve gait patterns and lower extremity movements in individuals with CP. (Wolting 2016.)

Altered postural tone whether it be hyper, hypo or fluctuating tone, affects the ability to organize and control voluntary movements to produce functional movement patterns. To gain more functional movement patterns and avoid secondary complications, children with CP require external postural support in different positions (positioning). (Wolting 2016.)

Electrical stimulation is aimed at increasing muscle strength and motor function by stimulating the muscles with a Transcutaneous Electrical Nerve Stimulation (TENS) unit, Neuromuscular Electrical Stimulation (NMES) or Functional Electrical Stimulation (FES). At the moment, there are limited studies to prove their effectiveness in individuals with CP. (Wolting 2016.)

Due to the vast array of therapy related interventions, systematic review was performed on the subject to identify the best, evidence based treatment interventions for children with CP. As high as 30-40 % of interventions are not supported by evidence and shockingly 20 % of available interventions are ineffectual, harmful or unnecessary. The study included 166 systematic reviews (or the next best available). They

were conducted by medical/allied health professionals and at least 25% of the participants have CP. According to the review, the following interventions have the most reliable evidence base to support them: botulinum toxin (BoNT) injections for spastic muscles, diazepam, and selective dorsal rhizotomy (SDR) surgery for spasticity, casting for improving and maintaining ankle ROM, hip surveillance for maintaining hip joint integrity, constraint-induced movement (CIM) therapy, bimanual training, context-focused therapy, goal-directed/functional training, occupational therapy following BoNT, home programmes for improving motor activity performance and/or self-care, fitness training for improving fitness, bisphosphonates for improving bone density, pressure care for reducing the risk of pressure ulcers, and anticonvulsants for managing seizures. 70% of the interventions had a lover level, or inconclusive evidence base, such as acupuncture, alcohol (muscle injections for spasticity), Animal-assisted therapy, assistive technology, baclofen (oral), behavioural therapy and coaching, cognitive behaviour therapy, communication training, conductive education, counselling, oral dantrolene, dysphagia management, early intervention (for motor outcomes), electrical stimulation, fundoplication; gastrostomy, hand surgery, hip surgery, hippo therapy, hydrotherapy, intrathecal baclofen, massage, orthoses, oral–motor therapy, orthopaedic surgery, parent training, phenol (muscle injections), play therapy, respite, seating and positioning, sensory processing, single-event multilevel surgery, social stories, solution-focused brief therapy, strength training, stretching, Thera suits, oral tizanidine, treadmill training, oral vitamin D, Vojta therapy, and whole-body vibration. It should be noted that early intervention, cognitive-behavioural therapy, parent training and solution-focused brief therapy had good-quality evidence supporting them in non-CP populations. Interventions that proved to be ineffective were craniosacral therapy, hip bracing, hyperbaric oxygen, NDT, and sensory integration. (Figure 8 and Figure 9). (Novak, Mcintyre et al. 2013, 885-900.)

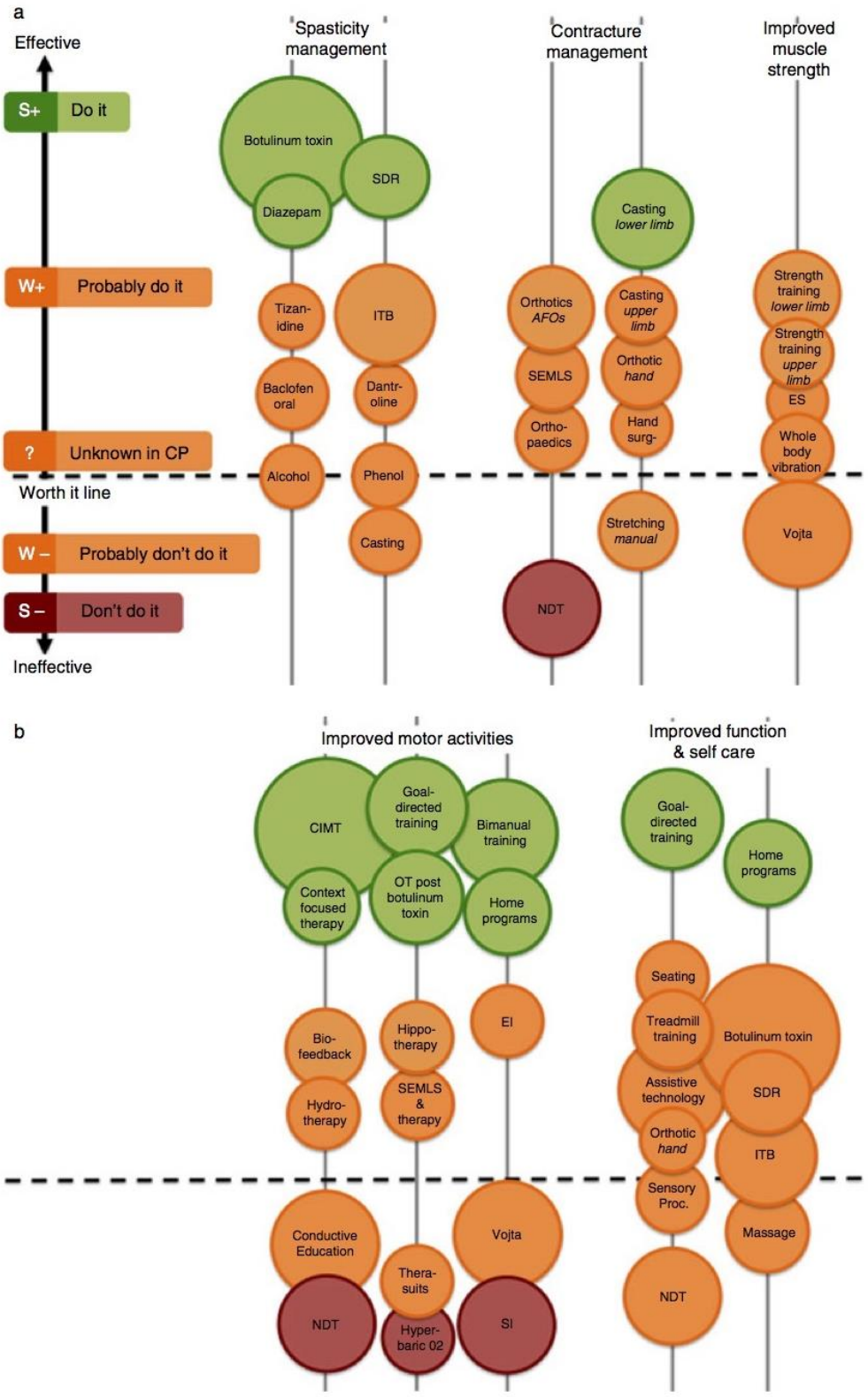

Figure 8 – State of the evidence for Cerebral Palsy intervention by outcomes (Novak, Mcintyre et al. 2013, 901-902).

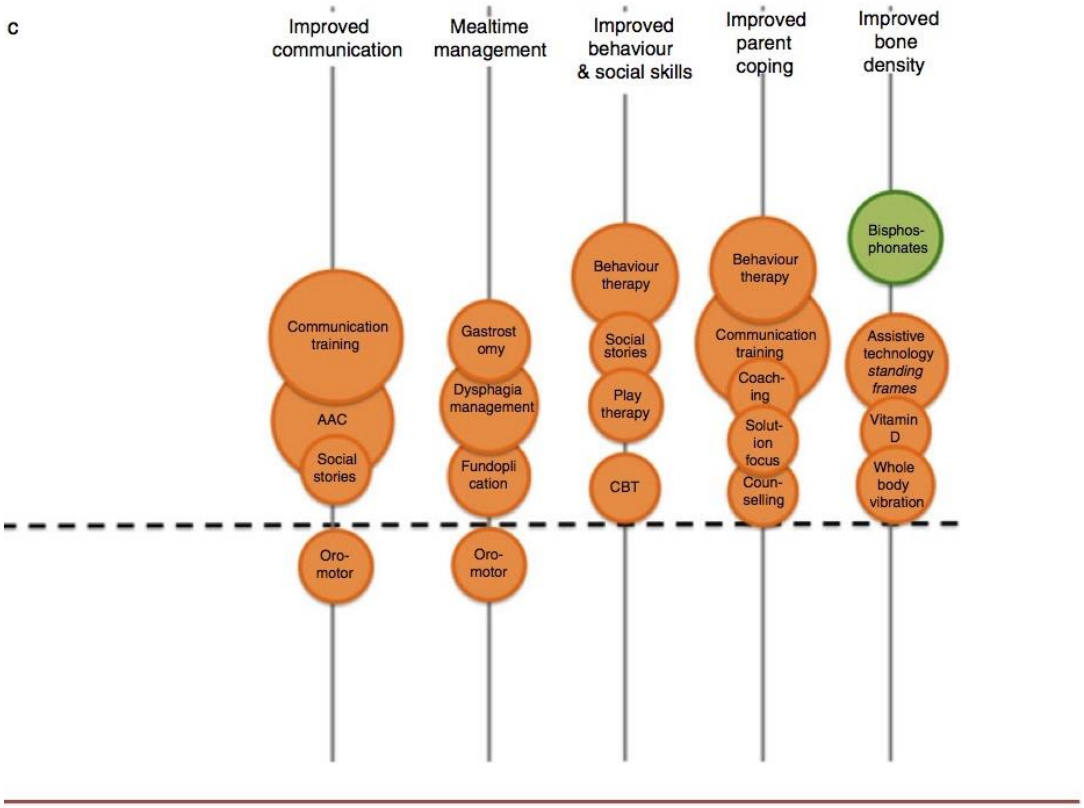

Figure 9 – State of the evidence for Cerebral Palsy intervention by outcomes continued (Novak, Mcintyre et al. 2013, 901-902).

When choosing the appropriate approach, the goals, abilities and challenges of the client should be addressed. In addition, further quality research is needed to prove the efficacy of some possibly beneficial interventions. (Novak, Mcintyre et al. 2013, 902-905.)

4.4 Aqua Therapy

Swimming is an important skill to learn as part of any child's physical education. It provides great value for survival, fitness and fun. On contrary to land, water offers the potential for activity in three dimensions. In addition, submersion in water can provide perceptual stimulation visually, aurally, via skin proprioceptors and by heat. Because of the many unique properties of water, children and adults are able to gain multiple therapeutic effects while submerged in water (Figure 10). (Campion 1991, 5-30.)

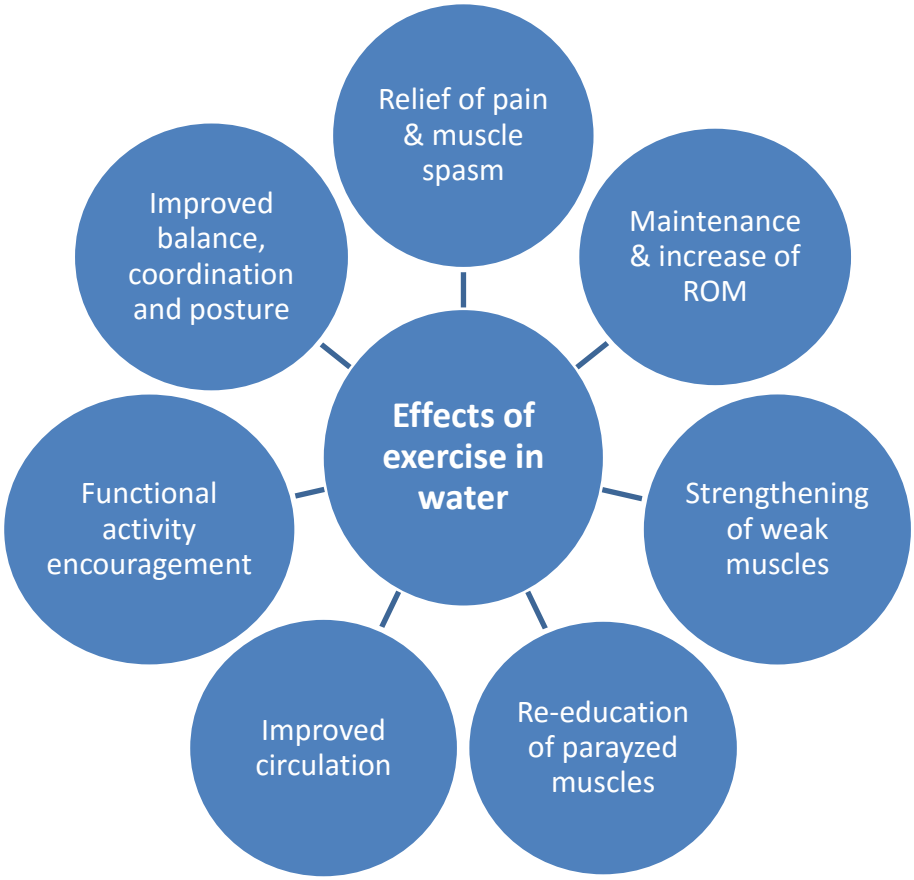

Figure 10 – Therapeutic effects of exercise in water (modified Campion 1991, 29.).

On land, forces such as bodyweight and gravity will place stress on the musculoskeletal system, affecting the way the body moves. Water reduces bodyweight by 90%, which allows children to ambulate freely without the extra pressure exerted by gravity. Weightlessness experienced in water provides the possibility of increased ROM and repetition, in addition to facilitating stretching and balancing. (Cerebral Palsy Alliance 2015.)

Hydrostatic pressure in water increases blood circulation, by making the heart pump more vigorously when it's under water. The pressure felt on the body improves proprioception, joint position and body awareness. Furthermore it reduces swelling and blood pressure. When the water is warm it also offers a massaging effect on the muscles and joints that are often overstressed. (Cerebral Palsy Alliance 2015.) Buoyancy, weightlessness and the warmth of water will help the child achieve feelings of relaxation when in the water. When relaxation is achieved, greater freedom of movement and activity in the water is possible. (Campion 1991, 8.)

5 AQUA THERAPY FOR CEREBRAL PALSY

Children with movement disorders can have impaired body image and spatial awareness. Often these difficulties are caused by lack of experience of active movement in the normal environment. Studies show that limitations of active movement, from any cause, are to likely decrease perceptual development including body image and spatial awareness. Children who might have difficulties moving on land can find moving in water easier. That experience may help to improve the child's awareness and understanding. The ability to see the body as a whole unit has a significant role in the child's overall development. The elements of water enable a child with disability to move with freedom and execute movements that wouldn't be possible on land. (Campion 1991, 5-6.)

5.1 The effects of aqua therapy on Cerebral Palsy

Children with CP get enjoyment from exercise in the water. Buoyancy offers postural support, in addition to reducing joint loading and impact. The reduction is important for children with CP, since there is typically constant and abnormal loading with unstable joints. This enables children to perform a large variety of aerobic and strengthening exercises that are easily modified to suit their varying motor abilities. Different modality options can be especially beneficial for children with significant movement limitations that affect their ability to perform land-based activities. (Kelly, Darrah 2005, 839-840.)

Studies conducted, researching the benefits of aqua therapy for CP, report positive effects in muscle strength, respiratory function, flexibility, gait and gross motor function. (Kelly, Darrah 2005, 839-840.) Another study review consisting of eight studies, with a total of 115 participants, studied the effect of aqua therapy as intervention for children and adolescents with CP. All studies stated that aqua therapy is a beneficial therapeutic intervention, either as a major component or as a stand-alone treatment. The studies revealed positive results in improved gross motor skills (four studies), gross motor function (two studies) and improved swimming skills (three studies). Overall functioning improved in walking efficiency (three studies), LE

strength (two studies), balance (two studies), respiratory function (one study), reduced spasticity (one study) and increased ROM (two studies). Seven of the studies reported positive impacts on participation such as performance, satisfaction, social functioning and self-perception. (Blohm 2011.) In addition to these results, exercise in water can aid in achieving more efficient gait, help normalize muscle tone and reduces rate of contractures (Figure 11) (Berker, Yalçin et al. 2010, 45-46).

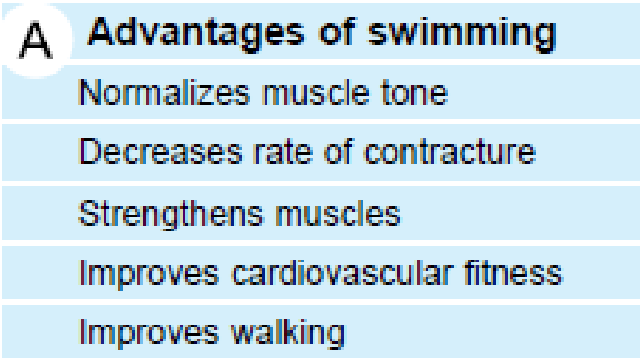

Figure 11 - Advantages of swimming for child with Cerebral Palsy (Berker, Yalçin et al. 2010, 46).

Aqua therapy can be offered in an individual and group setting. In an individual setting it is possible to ensure proper technique and intensity for the individual, however the group setting has possible social benefits to offer. Socialization amongst peers can create a motivating and socially stimulating therapy setting for children with CP. Competition and group modeling can also prove to be beneficial for the overall participation of children in exercises. (Kelly, Darrah 2005, 840-841.)

The ability to learn how to swim can boost a disabled child's confidence and mental health by offering independence, sense of achievement from learning new skills and the ability to compete in a similar level to their friends. This independence is further increased by the child's ability to move in water without assistive aids. Freedom of movement brings physiological and psychological wellbeing to the child's life. (Campion 1991, 5-31.)

5.2 Halliwick Concept

The Halliwick Concept is a worldwide, recognized approach for teaching people to swim and enjoy activities in water. This technique is applicable to people with or without disabilities. Accordingly, it can be used in therapy sessions for clients with CP. The Halliwick Concept utilizes an approach known as the Ten Point Programme. The initial focus in this programme is mental and physical adjustment to water. In the second component, focus aims to build confidence in performing rotations, considering the instability in water. The last component focuses on combining skills to build mobility through a swimming stroke. (Maes, Gresswell 2010.)

This approach provides therapists with a means of evaluating the clients' possible competences and challenges in water. There are varying types of difficulties for clients with CP, and so the supports (starting positions, support and instructions) offered by the therapist depends on their individual's needs. The level of difficulty of the activities in water can be slowly increased and the amount of assistance decreased, leading to swimming without assistance. (Maes, Gresswell 2010.)

5.3 Precautions

Uncontrolled epilepsy, incontinence, skin infections, urinary tract infections and recent surgery are some of the contraindications to do aqua therapy. (Hellinckx, Areia et al. 2016.) There are however, a number of different incontinence swimwear available, but they need further product developing. Special focus should be placed on improving the efficiency in concealing the liquids in order to prevent the leakage into the pool and investing in the aesthetic appeal of the incontinence swimwear to prevent stigmatizing people with this problem. (Falcone, Broega 2014.) Special needs children and children with epilepsy, or poorly controlled fits are at increased risk for submersion accidents in the water. Taking part in aquatic activities should be safe however, when these children are properly supervised at all times. (Kemp, Sibert 1993, 684-685.)

In general, when supervised by a trained and professional therapist, aqua therapy is considered to be safe for clients with CP (Cerebral Palsy Alliance 2015). Regardless, some key issues should be considered when planning aqua therapy for children with CP. First, the therapist needs to consider what is an appropriate frequency, duration and intensity to promote beneficial intervention. Secondly, deciding whether the client would benefit more from an individual or group setting is important. Finally, the therapist must ensure the pool setting is safe and suitable for therapy. For safety reasons it is advised that children are able to touch the bottom of the pool with their feet and that there are ledges to hold on to when needed. (Kelly, Darrah 2005, 840–841.)

6 PERFORMANCE ENHANCING SWIMWEAR

How efficiently a person moves in water is dependent upon the interaction of propulsive and resistive forces. This efficiency can potentially be improved though increasing the propulsive forces, or decreasing the resisting ones. One of the key factors in creating a faster, more efficient swimmer is having less resistance, more commonly known as resistive drag, created by the swimmer. There are number of forces affecting upon a swimmer's body when going through the water. These include form, wave and surface drag. Form drag is created when speed increases and the swimmer's body (specifically the front region) moves against the water. Wave drag is also created by increased speed, where different water velocities surrounding the swimmer's body increase waves and create more resistance. Surface drag (or frictional drag) is referring to interaction between the swimmer's body and the water, which can slow the swimmer down. Additional factors such as skin roughness, hair, body contouring and swimsuit fabric can create this type of friction. Having shaved hair and wearing a latex swimming cap produces less friction than hairy surfaces, which equates to less drag. Tight swimsuits that have surface drag reducing qualities, which can be beneficial, such as sheer fabric, minimal seams and edges. For example, the bodysuits worn in the 2000 Sydney Olympics possessed fabric aimed to produce less friction than naturally shaved skin, therefore generating better results. (Sanders, Rushall et al. 2001, 1-4.)

6.1 The development of performance enhancing swimwear

Initial swimsuits were mostly made from wool. These were heavy and not tight enough to reduce drag in water created by the swimmer. Before 1928 there were no specific swimsuits made for competitive swimmers, until Speedo introduced the Racerback suit. This was the beginning of performance enhancing swimwear, and in 1969 the Olympic, gold medal winning, skintight swimsuit was designed by German Dr. Conrad Dottinger. This opened the eyes of swimsuit manufacturers, regarding the importance of form fitting suits to reduce drag. In 1996 the first major, modern technology swimsuit was introduced by Speedo (the Aqua-Blade suit). This suit utilized water repellant material to improve performance, in what was considered

highly improved technology at the time. Speedo continued developing, and in 1999 they created the Fastskin, which at the time was the most technically advanced swimsuit created. They replicated the features of sharkskin into their fabric, in order to create minimal drag and maximum swimming efficiency. The Fastskin fabric wasn't however as effective as initially hoped, but the benefits were created by its tight, streamline fit. 28 of the 33 Sydney Olympic gold medals in 2000 were won with the assistance of Speedo's Fastskin, thus altering the direction of competitive swimwear design. After this, other companies such as Adidas and TYR Sport Inc. took major leaps in development of performance enhancing swimwear. In 2008 Speedo introduced the LZR Racer, which utilized highly developed technology, created in cooperation with NASA. The LZR's tight fit created better oxygen flow to the muscles and the fabric ensured a more hydrodynamic body position. The low drag LZR panels in the suit improved swimmer's body shape, which led to more buoyancy in the water. The results appeared significant, and in the 2008 Beijing Olympics 25 world records were broken, 23 when wearing the LZR suit. 94% of gold medals and 89% of all medals were won when wearing the LZR suit. Inspired by the suit, other manufacturers such as Arena and Jaked, created suits with similar qualities, using only polyurethane fabric to create even more buoyancy. This made a significant difference and lead to 43 new world records being set at the 2009 World Aquatics Championships in Rome. After this competition FINA (Fédération Internationale de Natation) decided to ban the use of all full body length suits with high-technology fabrics. In 2010 FINA retracted the original ban and changed it to concerning all non-textile fabrics and allowing men to have suits from the knees to navel long and women from knees to shoulder straps. (Meyer 2015, 5-15.)

6.2 Research concerning performance enhancing swimwear

Researching the bodysuits is challenging due to a number of factors. Considerations should be made to the fit of the suits, conditions of testing and placebo effect. Quite few objective scientific studies have been done on the effectiveness of bodysuits. A practical test on the effects of Speedo Fastskin suit on swimming performance was done by swimming coach in 2001. He compared the results of two groups swimming 25-meter sprint, other group with body suits and the other with conventional suits. The bodysuit had significant advantages for certain type of swimming styles such as

butterfly and crawl stroke but no effect or negative effects on breaststroke and back stroke. The test was done with unshaved swimmers. (Sanders, Rushall et al. 2001, 5-6.)

Another study done in 2007 with 14 competitive swimmers wearing two different types of fastskin suits, full body (FB) and leg suit (L) and normal racing suit (N). They swam six different distances (25, 50, 100, 200, 400 and 800 meters) over the course of two weeks. Speedo Fastkin, Arena Powerskin, Tyr Aquashift, ASCI and Nike Lift suits were used in the study. The studies found that there was on average 3,2 +/- 2,4% performance benefit when wearing FB and a 1,8 +/- 2,5% benefit when wearing L when compared to N. Benefits were seen in reduced drag, reduced energy cost of swimming, reduced swimming time in freestyle and increased distance per stroke. The studies also found the benefits of wearing FB to be slightly more significant than wearing L. (Chatard, Wilson 2008.)

6.3 Performance Enhancing Swimwear and Cerebral Palsy

Individuals with CP often have tight and weak muscles. Muscle weakness can often be found in the extremities and trunk. Study comparing children with Spastic diplegic CP and children without CP noted that Children with CP were significantly weaker, had lower voluntary agonist muscle activation, and increased antagonist co-activation. The study concluded that since there are large deficits in voluntary muscle activation with CP children, voluntary contraction exercises in strength training might not produce muscle hypertrophy. They suggested that enhanced feedback or neuromuscular electrical stimulation could be beneficial to aid muscles that can't voluntarily contract sufficiently. (Stackhouse, Binder- Macleod et al. 2005.)

The sequence of muscle activation during whole body movements was studied in normal population, and it found that some of the core stabilizers such as transversus abdominis, multifidus, rectus abdominis and oblique abdominals, were activated before any of the other muscles included in the movement. This suggests that movement control and stability are developed in a core to extremity and head to toe progression. Children with CP have poor trunk stability caused by weakness in dorsal and frontal trunk muscles. There is positive correlation between the strength of trunk

muscles and the functional abilities of children with spastic CP. (Sediek, El-Tohamy et al. 2016.)

6.3.1 Psychosocial and Psychological Benefits

Children with disabilities have higher risk of suffering from psychological problems. Feelings of frustration, depression and low self-esteem can be caused by the fact that they have to rely on others to do basic ADL's. Being unable to control your own body can create a feeling of helplessness in the child, this can further increase the negative feelings. Furthermore, when the children become older the physical self becomes more important and it influences their self-concept and feelings or self-worth. People's understanding of themselves, their self-perception, comes in part from their physical abilities and in part from the views of people in their social circle. Self-esteem levels have been found to correlate with the individual's quality of life. People with disabilities have been found to have increased challenges with self-esteem and self-perception. Self-perception again, correlates directly to one's body image. Body image has a great effect on individuals cognitive functioning and mental health. (Chau 2012, 5-19.)

Individuals with CP might have irregular body shape such as protruded rib cage or medical devices like central venous line. Compression fabrics such as power mesh fabric can help compress these irregularities to result in body shapes resembling of those of their peers without disabilities. Clothing can have a big effect on your self-perception and it can help you feel at ease in your body. For someone with a disability it can enhance the psychological, physical and social wellbeing. Physical needs can be fulfilled by clothing that is comfortable and promotes safety, whereas social and psychological needs are met by wearing clothes that are aesthetically pleasing. In the design of clothes for special needs population, looking good and fitting in with peer group expectations play an important role. Looking good promotes positive self-esteem and can generate positive responses from others, which further reinforces this increase in self-esteem. (Chau 2012, 5-19.)

6.3.2 Physiological Benefits

One example, from a large selection of performance enhancing swimwear's, is Speedo Fit. Speedo Fit range offers swimwear that are suitable for everyone from professional athletes to fitness and recreational swimmers. Their specially designed swimsuit have specific qualities to enhance the performance of the swimmer that wears them. The swimsuits are designed to support the swimmers body position and activate the key muscles to ensure better swimming technique. It offers core support whilst simultaneously activating the core muscles to improve performance. However is not just technically enhancing, but it's also aesthetically innovative with modern and functional colors and graphics. (Speedo 2014.) Speedo Fit Kickback swimsuit features internal compression panels that activate the core to help maintain better body position in water and swim more efficiently. Power mesh fabric around upper body provides compression to improve comfort and confidence. (Speedo 2016.)

There is limited research relating to hydrotherapy and CP. Additionally, the majority of this research is restricted to predominantly spastic CP. Currently there's no clinical information or research on the effects of performance enhancing swimwear on the special needs population. Based upon the benefits of performance swimwear, correlated with the activity and participation limitations associated with CP there's potential for it being a valuable tool in aqua therapy for clients with CP (Table 5).

Table 5 - The effect of performance enhancing swimwear on Cerebral Palsy.

Swimwear properties	Application to Cerebral Palsy
Core compression	Activates core muscles and gives enhanced feedback to muscles that are not naturally strong enough to produce sufficient enough contraction. Increased muscle activation will ensure better swimming position.
LZR panels	LZR panels in the suits improve the swimmers body shape which leads to more buoyancy in the water.
Tight fit	Better oxygen flow to the muscles.
Mesh fabric	Mesh fabric or other compressing fabrics can help compress the body to hide some possible differences. Individuals with CP might have protruding stomach or ribs that they are conscious of, by compressing these structures the swimmer will feel less self-conscious which will improve self-esteem and so can correlate positively to cognitive functioning and mental health.
Waterproof fabric	Waterproof or water repellant fabrics create more buoyancy in the water which will reduce the amount of drag and help swimmer to get a more functional swimming position.
Functionality/ Enhanced swimming position	Being able to be more functional in the water due to more sufficient muscle activation and enhanced swimming position, brings more functional movement in the water. More sufficient, more independent movements in the water will increase the self-esteem of the individual and therefore lead to increased quality of life.
Reduced energy cost	Less energy required from the muscles to produce quality movement, which means you can do more exercises, more efficiently.
Brand, color, design	Speedo as many other performance swimwear brands are very well known and well branded. Wearing a popular brand brings social acceptance and admiration. Colors and designs are modern and attractive. Looking good and being socially acceptable will promote positive self-esteem.

7 THESIS PROCESS & METHOD

The thesis process started in January 2016, after meeting the physiotherapist interviewed, to agree on the topic for the thesis. After the topic was decided and the plan presented, the next step was to choose the method, size and type of study. For the purposes of this thesis, it was decided to use a case study, by interviewing one client and one physiotherapist. The interview was done by using natural conversation style, with several open-ended questions. A case study was decided for the ability to have a practical implementation in the thesis. Then it was considered to do either a practical test of some skills in the water (with and without the swimmers), or an interview. An interview was chosen, so that there could be discussion of possible practical benefits on a wider spectrum, instead of performing only one specific task. The aim with the interviews was to include the practical view of a client and physiotherapist on the topic. The open-ended questions where chosen so that there was an opportunity for the client and physiotherapist to discuss their practical experiences. The questions are provided in Appendix 3 for additional information.

The next step was to choose how large a study group was appropriate for the purposes of the study. The decision to use only one client and one therapist for the interviews was based upon few contributing factors. There wasn't any previous data available on the use of performance enhancing swimwear in aqua therapy with CP clients. This could be because the topic is somewhat new and there hasn't been lot of research about it. This was the first indicator that it could be best to use only a small study group to start with, to determine whether a larger scale investigation on the topic was beneficial. Another factor affecting the size of the study group was the amount of possible candidates for the interviews. The physiotherapist interviewed works with CP clients, three of which are using the performance enhancing swimwear. From these three it was decided to use the client with best cognitive abilities to express their own views in the interview.

The thesis was initiated in January 2016. The overall goal was to finalize the material and present in Fall 2016 (Table 6).

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Table 6 – Thesis Schedule

Topic	Period
Topic decided	January 2016
Presentation of plan for the thesis	February 2016
Interviews	February 2016
Research and review of data	Summer 2016
Writing thesis	Fall 2016
Presentation	Fall 2016

Case can be defined as either a single person, a group, institution or community. Case study therefore means investigating one of the case options, to answer a research question. The research question seeks a range of evidence, which can be found in the case setting. Some characteristics of a case study are the use of multiple sources of evidence and not starting with prior theoretical notions. A case study consists primarily of qualitative data (what people tell you, what people do) but can include some quantitative data (statistics, counting and measuring). Qualitative data can enable you to see the case from the point of view of those involved. It can also help you carry out research, when other methods are not valid, or the subject is too little known – so more formal research might follow later. A case study can be done by using different data collection methods, some of which are: interview, document, work sample and observation. Some of the important steps for getting started with case study is to get to know relevant literature. Because you cannot know what the result of your study is, all the literature might not be relevant to your results. It's good to do this in parallel with getting to know your case in context. The next steps are getting to know your case in their setting, deciding on broad aims and the research question. (Gillham 2010, 1-27.)

In large scale case studies, interviews can be a time consuming process. When doing individual case studies however, interviewing can even be essential. Face-to-face interview will create more in depth answers than a questionnaire, because people will disclose more things in person. There are structured and un-structured types of interviews depending on the case used and the wanted outcome. The most structured type

of interviews are questionnaires, where you can you use simple and specific, closed questions. Semi-structured interviewing is the most important style of interviewing in case studies. The main point in this type of interviewing is that you are aware of the most important issues you want answered in your investigation. It is done with the key points in mind, but the questions are asked fluently and naturally, so it seems like there's no technique to it. With this style of interviewing, both open-ended and closed questions are used. Unstructured types of interviews are styles such as using natural conversation to ask research questions and verbal observation (listening to people's conversations). (Gillham 2010,59-79.)

8 CLIENT OBSERVATION

The client is a 14 year old girl with spastic diplegic Cerebral Palsy. Her gait is challenged by the spasticity in her LE, creating stiffness of movements and the lack of hip and knee flexion on the left side during the swing phase of her gait. She swings her leg from the side without using hip and knee flexion to bring the leg forward. There isn't much rotation in her body during movement. She has challenges walking the stairs and with pelvic control. The client started physiotherapy since she was 10 months old and she has been working with the same physiotherapist ever since. She has previously been going long distances with a wheelchair but has since been able to give it up. She has also used a "Dallari" before which is like a rollator except you drag it behind you. Her present assistive aids include a tricycle, foot stopper on the tricycle, knee brace, special shoes and dynamic ankle-foot orthosis (dafo's). She has had surgery in her adductor and gastrocnemius muscles. She has been injected with Botox in her muscles to reduce spasticity.

8.1 Physiotherapy for the client

In the land based physiotherapy, the physiotherapist has worked on improving the client's pelvic control, weight sifting, transfers, rotations and reciprocal movements during walking. They have also been working on stair walking and it was a special area of focus before the client started 7th grade and her new school only had stairs and no elevators. They've also practiced cycling and the client can now use a tricycle. In winter they have practiced skiing to improve rotations and reciprocal movement. One of their goals for now is for her to gain more independence and confidence in strange environments. The client has been going to aqua therapy with the physiotherapist for 11 years. In her aqua therapy sessions she has been using the Speedo Fit Kickback swimsuit for one month. Client has also been going to riding therapy for approximately 8 years and wheelchair basketball for 2 years.

8.2 Clients perspective on the swimwear

Client stated in the interview that she enjoys using the Speedo kickback swimsuit because they feel nice and she likes to swim in them. She has noticed that her swimming position is better in the water because she can get to a more horizontal position than before using the swimwear. She said she has also noticed an increase in her body control. She says that before using the swimwear she had been struggling with "seahorse" movement, when you sit with a floating pool noodle between your legs and try to stay in balance. Before she would fall forwards on the noodle and try to stop falling by using neck to tilt her head backwards. Now she says she can activate her core muscles to balance on top of the pool noodle. She also states that when she grows out of the swimwear she will want to use the same ones in the future as well.

8.3 Physiotherapist perspective

The physiotherapist working with the client specializes in pediatric physiotherapy and offers aqua therapy sessions along with land based physiotherapy for children. She currently has three clients (including the interviewed client) that are using the performance enhancing swimwear in their aqua therapy sessions. All of the tree clients have spastic diplegic CP. All clients have different challenges in their swimming due to CP and they've all benefitted from using the swimwear. The most visible changes has been seen with the client that has the most challenges with her motor skills. The physiotherapist states that with her clients the swimwear has improved the control and movements of the hip, kicking, body awareness, swimming position, effectiveness of swimming and reduced extension spasticity of the back. The therapist explains that one of her client's swimming position with regular swimwear was heavily extended back and the legs position very low, leading to no hip movements and small kicks. After using the swimwear for the first time the client was able to get into a more vertical position in the water, involve hip movements and improve the kicks by doing more relaxed, wider range kicks. The client was also now able to learn to move in the different planes of motion in the water. The therapist says that with all three of her client's the neck is often extended back when swimming and this the swimwear hasn't been able to improve.

The physiotherapist explains that when her client (that was interviewed) first used the swimwear she didn't explain beforehand what the client should expect from the swimwear so that she wouldn't have any expectations. The client had problems with lack of movement in the hip, leg position was low, back was extended and knees stiff. The swimwear has helped her in improving the swimming position to more vertical, relaxing the hip to allow movement, the extension in the back is not present and relax the legs to allow smoother, more effective movement. It has also allowed her to improve on the effectiveness of her swimming style, allowing her to last longer without exhaustion and swim faster. The therapist says that during a timed swimming test where the client had to swim 200 meters, of which 50 meters was by swimming backstroke, her result without the swimmers was 21 minutes and with the swimmers 18 minutes and 20 seconds.

One of the most visible changes in skills during the aqua therapy sessions has been the client's performance with the pool noodle. The therapist states that without the swimmers the client wasn't able to sit with the noodle between the legs without falling forwards. The client would use her back and neck to compensate but it wouldn't prevent her from falling. From the first time of using the swimwear it was visible that there was an improvement with the pool noodle exercise. Now the client was able to sit on the noodle and use her hands to paddle water to enable her to go forward in the water. She was also then able to talk and focus on other things while performing the exercise. Her ability to now learn new skills and being able to have more endurance in the pool has led to getting more enjoyment out of swimming. The client has stated to the physiotherapist feeling more equal to her peers and can get more feelings of success from swimming. The therapist describes that when the client got out of the pool at her swimming test after improving her time by over 2 and half minutes, the client had looked and felt like a winner.

The physiotherapist says the swimsuit is meant to be really tight for it to the most effective. It supports the pelvic area and tightens the core to gain the most ideal swimming position and efficiency. The tightness, however, can affect the client's ability to independently put on the swimsuit, such as problems with balance and hand functions could make this difficult for the client. For the purpose of the client becoming more

independent, the physiotherapist and the client have chosen a slightly looser fit of the swimwear than would be recommended. One of their future goals for the client is for her to be able to function more independently and so the swimwear should able her to survive in the dressing room without assistance. Their next goals also include improving the ability to move along different planes of motions, specially moving along the axis of the sagittal plane is still challenging, and the head position while swimming.

The physiotherapist says that it's advised with regular swimmers that you don't use the performance enhancing swimwear all the time but change back to normal swimmers every now and then so that the muscles don't get used to them. She says that with her client's she wouldn't start changing back to regular swimwear because she feels that it's not necessary in this case at least until the swimming would improve to stronger level when it might be of benefit. With her clients the spasticity reduces the voluntary muscle control and the qualities of the swimwear are able to reduce the effect that spasticity has on the muscles to improve voluntary control. Going back to normal could be challenging emotionally and wouldn't benefit them physically. Emotionally it could possibly give the image to the client that all the improvement is because of the swimwear, when in reality the client is still doing all the work.

9 CONCLUSION

Based on the potential benefits associated with performance enhancing swimwear and the possible gross motor challenges related to CP, this swimwear could be a beneficial assistive tool in aqua therapy. Children with CP might have weakened core muscles, poor body awareness and weakened muscle control. The ability to activate core muscles with the swimwear can lead to better swimming position and improved efficiency in the water. The client's own experiences and the physiotherapist's observations seem to conclude that performance enhancing swimwear can have positive physical and psychological results. According to their experiences, core muscle activation improved swimming position by reducing the back extension and offering a more vertical position in the water. This could reduce the effects of spasticity on the voluntary muscle control, by allowing more voluntary muscle activation. Increased voluntary muscle activation can enable the swimmer to be more functional in the water and develop their swimming style to be more efficient. The interviews revealed that the client was able to increase the range of her kicks and involve hip movement into her swimming. The client was also able to gain positive experiences of success, by developing her skills and improving her swimming efficiency. This can have huge positive effect on self-esteem and self-image. Improvement in self-esteem correlates positively with quality of life.

Concluding from the research and associated interviews, at worst the swimwear could provide no change in the physical abilities, however still offer potential psychosocial benefits due to the modern look and increased confidence when wearing the swimwear. At its best, performance enhancing swimwear can help the child gain new skills and increase functionality in the pool.

10 DISCUSSION

From the very beginning of starting the thesis, I was very excited about my topic. I was somewhat familiar with CP and aqua therapy already and was happy to add a new perspective on the approach. Considering the fact that CP is the most common motor disability in childhood, it is interesting that conservative care for it hasn't changed much in a long time. There are considerable amounts of alternative therapy approaches for CP, but they haven't been able to create an evidence base for the effectiveness of many of these approaches. Aqua therapy is considered to be an alternative approach and the evidence base for it isn't as strong as, for example, with Botox or lower limb casting. This is possibly due to the complexity in clinically analyzing the effectiveness of this therapy. For this reason, one of the biggest difficulties with the thesis process was to find quality evidence based information on aqua therapy, but even more so on performance enhancing swimwear. Regardless, anecdotal evidence identifies many potential benefits. I was already previously aware of some of the physical benefits of aqua therapy but was interested in finding knowledge on some of the mental health benefits. In addition to this, I was excited with the results I was able to gather from the research and interviews concerning my topic. The most eye-opening news for me was the possible psychological effects of the swimwear, and how this can impact positively on quality of life.

The self-image of someone with motor disability can be affected by the restrictions of their abilities. The creation of new treatment approaches and assistive devices should focus on uncovering the potential of the individual, to offer a maximal amount of independent function. The ability to be as independent as possible will help the individual achieve increased quality of life physically, psychologically and socially. If there is a possibility to achieve this, whether it's on land or in water, I think it should be offered. The performance enhancing swimwear could have the ability to help discover the full potential of individuals in the aqua therapy setting.

For future studies, it could be beneficial to include more subjects into the case study, to investigate the topic with a larger case sample. It could be interesting to test if the swimwear is found to be beneficial with other specific types of CP such as dystonic or

ataxic. Concluding from all the research and interviews, it suggests that the results could be applicable on a larger scale. The effects might not only be physical but more multidimensional, affecting the social and psychological dimensions as well. This could indicate that the results of this study are also relevant for other groups in the special needs population. It might also be beneficial to include a practical test into the data collection.

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THE DISABLED VILLAGE CHILDREN – EVALUATION OF A CHILD'S LEVEL OF PHYSICAL DEVELOPMENT (Wolting 2016).

Name: _____

Birth date: _____

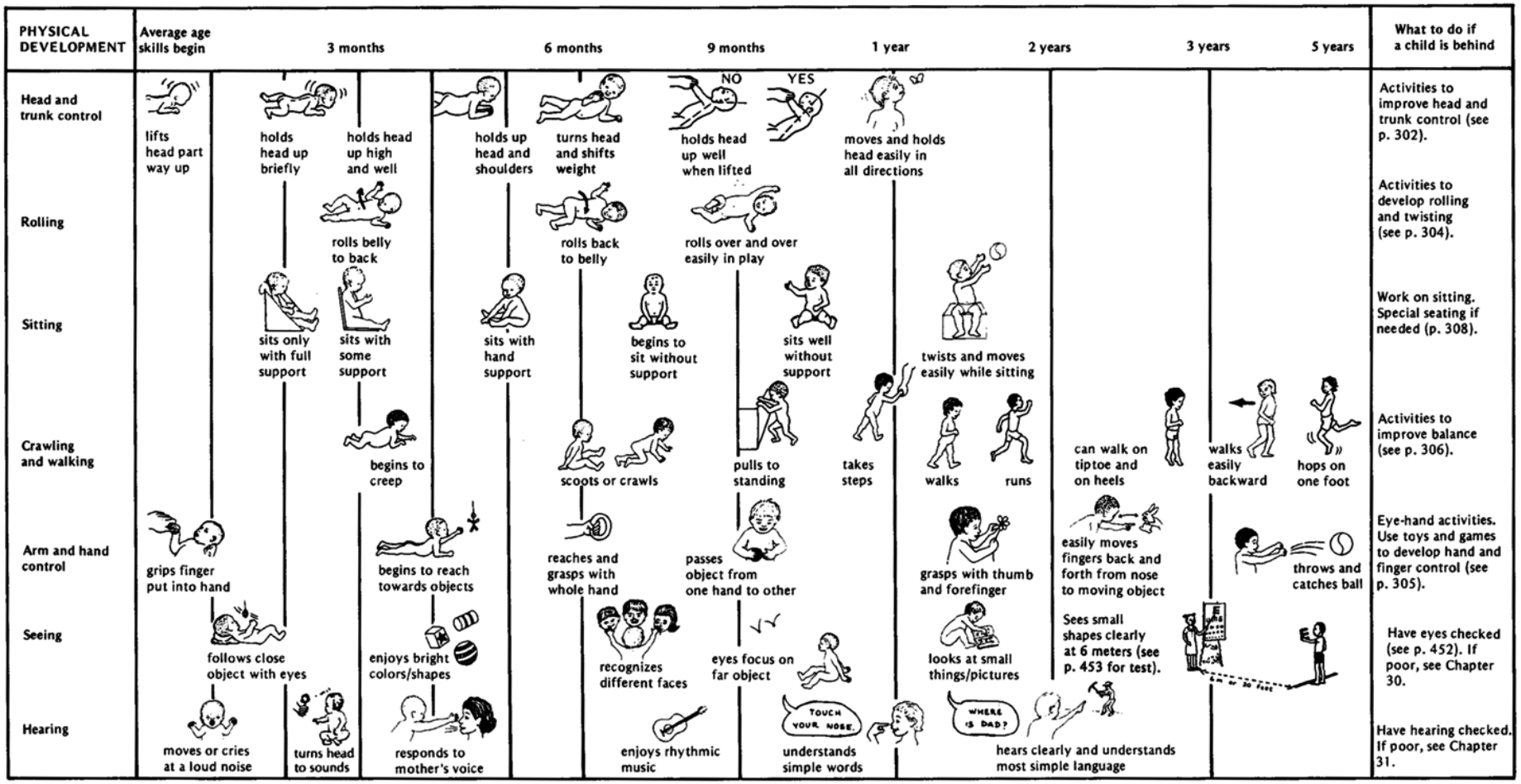
Date: _____

EVALUATION OF A CHILD'S LEVEL OF *PHYSICAL* DEVELOPMENT

RECORD SHEET 6 (page 1)

Note: Although on these guides physical and mental skills are separated, the two are often closely interrelated.

These charts show roughly the average age that a normal child develops different skills. But there is great variation within what is normal.



THE DISABLED VILLAGE CHILDREN – EVALUATION OF A CHILD'S LEVEL OF MENTAL AND SOCIAL DEVELOPMENT (Wolting 2016).

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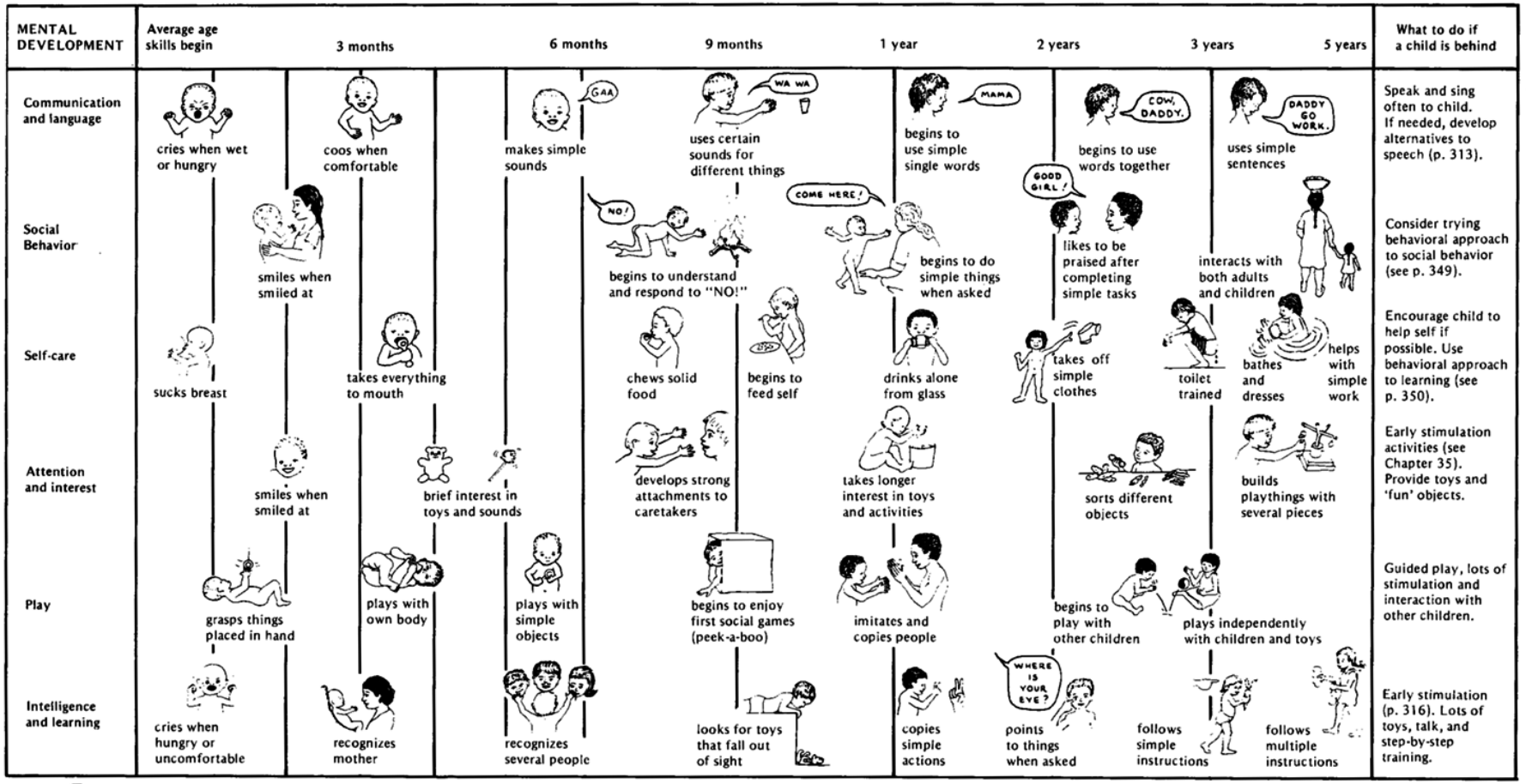
Birth date: _____

Date: _____

EVALUATION OF A CHILD'S LEVEL OF *MENTAL AND SOCIAL* DEVELOPMENT



Put a (circle) around the level of development that the child is now at in each area.

Put a [square] around the skill to the right of the one you circled, and focus training on that skill.

If the child has reached an age and has not mastered the corresponding level of skill, special training may be needed.

RECORD SHEET 6 (page 2)

COMMON IMPAIRMENTS IN CHILDREN WITH CEREBRAL PALSY (Tecklin 2008,207-210.)

DISPLAY 5.14 "Typical" Impairments of the Infant and Child with Hypertonia (*continued*)

Sensory/Perceptual System
- Decreased tactile and proprioceptive awareness
- Difficulty discriminating different kinds of touch
- Decreased kinesthesia throughout the body
- Decreased vestibular registration
- Decreased body awareness
- Vision used more in an upward gaze, sometimes asymmetrically

Cardiovascular and Respiratory Systems
- Poor cardiovascular fitness due to decreased mobility
- Reduced breath support with flared ribs and tight rectus abdominus

Gross Motor Impairments
- Limited independent mobility on the floor or in vertical
- May use assistive device for mobility
- Poor sitting balance with spastic quadriplegia
- Poor higher-level balance skills

Fine Motor Impairments
- Decreased use of hands due to use for stability and for assistive device for mobility
- Poor grasp and release and decreased in-hand manipulation with spastic quadriplegia

Oral Motor Impairments
- Usually noted more with spastic quadriplegia
- May have drooling, poor articulation
- May have difficulty feeding

DISPLAY 5.14

"Typical" Impairments of the Infant and Child with Hypertonia

Neuromotor System

- Decreased stiffness in neck and trunk
- Increased stiffness in extremities, distal > proximal; varies with type, extent, and location of the lesion
- Difficulty grading between coactivation (CA) and reciprocal inhibition (RI), times with excessive amounts of either CA or RI
- Difficulty initiating certain muscle groups (i.e., hip extensors and triceps)
- Difficulty sustaining certain muscle groups (i.e., thoracic extensors and abdominals)
- Difficulty terminating certain muscle groups (i.e., hip flexors, adductors, and internal rotators)
- Activation of muscles tends to be in small ranges
- Difficulty with eccentric control (i.e., quadriceps)

Musculoskeletal System

- Limited range of motion of certain muscles (soft tissue shortening)
- Other muscles are overlengthened (the antagonists)
- Decreased ability to generate force in certain muscles, also in spastic muscles
- Strength of poor grade
- High risk for scoliosis
- At risk for hip subluxation and/or dislocation

DISPLAY 5.15 "Typical" Impairments of the Infant and Child with Hypotonia

Neuromotor System
- Decreased stiffness throughout the trunk and extremities
- Inability to grade the level of stiffness necessary for functional activities
- Extension favored over flexion for function
- Difficulty coactivating for stability in trunk and in the extremities in horizontal and vertical positions
- Muscle activity is initiated in phasic bursts for functional activity
- Great difficulty sustaining most muscle groups, especially abdominals and gluteals for proximal stability
- Muscles tend to terminate passively
- Poor eccentric control of certain muscles (i.e., quadriceps)

Musculoskeletal System
- Joints tend to be hypermobile, so the child relies on ligaments for stability
- Stability gained through end-range positioning
- Contractures develop secondary to positioning of the arms and legs (i.e., pectorals, tensor fascia latae, flexors of the hips and elbows)
- Ribcage at risk for becoming flat/ovoid owing to gravity in supine and prone positions
- Difficulty generating force throughout the body

Sensory/Perceptual System
- Difficulty with tactile and proprioceptive awareness (requires greater input for the sensory information to register)
- Decreased kinesthesia and body awareness
- May seek increased sensory input, sometimes in unsafe situations
- Decreased ability to use both sides together as a wide base is used for stability

Cardiovascular and Respiratory Systems
- Decreased breath support and shallow breathing with weak abdominals and diaphragm
- Poor cough
- Decreased cardiovascular fitness

Gross Motor Impairments
- Developmental milestones achieved later
- May skip creeping on hands and knees
- Uses "W" sitting for stability
- Lacks higher-level balance skills
- Uses end-range stability without midrange control

Fine Motor Impairments
- Lacks shoulder girdle stability and therefore distal strength
- Hands without arches
- Decreased bimanual skill and in-hand manipulation
- Decreased success with independent activities of daily living

Oral Motor Impairments
- Decreased strength of oral motor muscles
- Breathy voice and short utterances
- Decreased rotary chew ability with inability to handle variety of textures
- Stuffs mouth due to decreased proprioception

DISPLAY 5.16 "Typical" Impairments of the Infant and Child with Athetosis

Neuromotor System
- Profound global decrease in stiffness, proximal > distal
- Poor damping, see high-amplitude and low-frequency oscillations
- Difficulty with coactivation, reciprocal inhibition noted much more frequently
- Inability to grade initiation or sustaining of muscle activation
- Muscle termination tends to be passive
- Difficulty with eccentric control of muscles

Musculoskeletal System
- Significant asymmetry of the spine and hips
- Joints may be hypermobile owing to excessive reciprocal inhibition
- Significant hypermobility at C1 and C6–C7 with increasing age, resulting in possible spinal subluxation
- Frequent temporomandibular joint problems
- Poor ability to generate force

Sensory/Perceptual System
- Vision used in upward gaze
- Decreased proprioception, tends to be worse in the upper extremities than the lower extremities
- Poor body awareness
- Poor kinesthesia

Cardiovascular and Respiratory Systems
- Respiration fluctuates in rate and rhythm
- Poor breath support

Gross Motor Impairments
- Developmental milestones achieved later
- Limited floor mobility with great difficulty sitting on the floor
- Delayed acquisition of ambulation skills
- Use of "W" sitting for stability

Fine Motor Impairments
- Difficulty using hands for tasks as they are used for stability in vertical and on the floor
- Decreased bimanual skill and in-hand manipulation
- Decreased success with independent activities of daily living

Oral Motor Impairments
- Poor articulation
- Breathy voice and short utterances
- Prone to temporomandibular joint impairments because of asymmetric use of the facial muscles
- Frequent drooling with poor lip closure

DISPLAY 5.17 "Typical" Impairments of the Infant and Child with Ataxia

Neuromotor System
- Tends to have slight decrease in stiffness in trunk, sometimes in the limbs as well
- Poor grading of stiffness
- Poor damping, oscillations are of high frequency and low amplitude
- Difficulty timing and sequencing initiating, sustaining, and terminating muscle activation
- Decreased ability to grade coactivation and reciprocal inhibition
- Poor coactivation of trunk, hips, and shoulder girdles

Musculoskeletal System
- Difficulty generating force
- Tends to rest in end range and rely on ligaments for stability

Sensory/Perceptual System (very significant sensory deficits, which are as restricting as the motor deficits)
- Relies on vision for balance and postural alignment; therefore, not free to scan the environment
- Visual system with severe nystagmus
- Decreased visual perception
- Decreased proprioception throughout the body
- Increased latency in processing sensory information
- Severe postural insecurity; very fearful of movement
- Poor vestibular system
- Tends to be tactilely defensive with poor discrimination; never gets sustained input
- Difficulty generalizing sensory and motor information to perform novel tasks

Cardiovascular and Respiratory Systems
- Often fluctuating with poor proximal stability
- Limited mobility impacts ribcage development, especially in thoracic expansion
- Poor cardiovascular fitness
- Shallow and rapid breathing

Gross Motor Impairments
- Uses a very wide base to move on the floor independently
- Keeps legs flexed in vertical to lower the center of gravity
- Pace of development tends to be slower owing to poor balance in upright

Fine Motor Impairments
- Poor skills due to an inability to grade precise movements
- Difficulty with activities requiring dissociation of the arms

Oral Motor Impairments
- Wide range of movement
- Difficulty with a variety of textures and tastes

THE CLIENT AND PHYSIOTHERAPIST INTERVIEW QUESTIONS

The interview questions for the client:

1. Which swimmers do you use during your aqua therapy sessions?
2. How long have you used them?
3. How long have you been going to Aqua therapy?
4. What do you think about the swimmers that you are using?
5. Have you noticed any difference to what swimming is like with and without those swimmers?
6. Was there something that was difficult to do in the water before using this swimwear?
7. What would you still like to improve on in the water?

THE CLIENT AND PHYSIOTHERAPIST INTERVIEW QUESTIONS

The interview questions for physiotherapist:

1. How many of your clients use the swimwear and what kind of clients are they?
2. What have been the biggest challenges in swimming with you clients before using the performance enhancing swimwear?
3. Has there been some changes in your clients swimming after using the swimwear?
4. What kind of physiotherapy you do with the client X (that was interviewed)?
5. What kind of swimming style/position the client had before using the swimwear and has now?
6. Has her swimming skills improved somehow after using the swimwear?
7. What are your goals for her aqua therapy, what would you still want to work on?