Professional Assignment Project

"Therapeutic Horseback Riding for Cerebral Palsy Children"

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2. Introduction

Herewith we present the written paper for the professional assignment project, (PAP) module III.1.2. This end project gives us the opportunity to apply the knowledge and skills we acquired during the last two years in producing a project which is of significant relevance to the profession of physiotherapy. When this assignment is completed in a satisfactory manner, we would be able to refer to ourselves as starting physiotherapists. We hope that the end product of this assignment would be of a great service for physiotherapists and other health professionals.

The creators Tammy Levi and Michal Leibovitz are at the service of their client Dror Ben Shaul upon his request to review scientific literature and to present the results which supports the benefits of Therapeutic horseback riding for Cerebral Palsy (CP) children, looking at various aspects of disease related dysfunctions.

2.1 The Client

Dror Ben Shaul is the manager of "D.B.S Stables", Batzra, Israel. The riding centre serves competitive dressage and show jumping riders as well as rehabilitating patients who receive therapeutic horseback riding. The patient population consists of head injuries, spinal cord injuries, CP etc. "D.B.S stables" cooperates with the ministry of defense concerning patients who were injured during their army service or at any national security related activities.

2.2 The purpose of this project

Physiotherapists who treat CP children should correlate with other therapeutic approaches that their patients might be receiving. Our topic in hand, Therapeutic horseback riding, aims at similar goals physiotherapy treatment aims at concerning body functions. In Therapeutic horseback riding points of attentions are given to aspects such as postural control, muscle symmetry, muscle tone, gross motor function, coordination, trunk postural reactions and more. This paper will review the effects of Therapeutic horseback riding, in order to increase level of awareness and understanding among PT's, concerning the process in practice and the beneficial effect. A document as such would be of a meaningful service enhancing more cooperation between the different therapeutic approaches.

Now days, physiotherapists choose to specialize in this field and to execute physiotherapy treatments through horseback riding. There are programs which qualify therapeutic riding instructors but the additional value of physiotherapists who
choose to follow these programs, is enormous. Some authors would say that Therapeutic riding is a type of physiotherapy treatment which to be performed only by qualified physiotherapist in the field and with the assistance of trained horse people. The idea behind this strategy is to improve strength, balance and posture by utilize the movement of the horse. This aspect increases the value of this project.
3. Cerebral Palsy

3.1 Introduction

Cerebral Palsy (CP) is a non-progressive disorder of posture and movement caused by a defect or insult to the central nervous system. Basically, it is a static encephalopathy with a delayed developmental presentation. Although it may appear to worsen, changes are actually the result of the deficits becoming more obvious as the child grows and matures over time (Nelson & Ellenberg, 1982). The area of the brain affected or damaged is directly reflected by the resulting disabilities. Although it is a motor disorder, it also can be associated with additional developmental disabilities, such as cognitive impairment, depending on the degree of brain damage that has occurred. There is no cure for this lifetime condition, but therapy, education, and technology can maximize each child’s potential by improving functional abilities and quality of life. (Jones et al. 2007)

In attempt to classify the extent of impairments, professionals encountered many difficulties. Some includes the fact that the etiology of CP is unclear in many cases, and the mixed symptoms often presented by CP children (Scrutton 1984).

This chapter will be divided into seven parts:

- Historical perspective
- Pathophysiology
- Incidence and etiology
- The different types; spastic group, hypotonic group, athetoid group, ataxic group and mixed group
- Additional impairments to CP: visual problems, speech problems and mental deficiency.
- The nature of the motor impairment and reflexes inhibition
- Primitive reflexes: Abnormal reflexes and tonic reflexes.
- The sensory aspect of CP
- Summery

3.2 Historical Perspective

CP was originally diagnosed more than a century ago and has been the subject of books and papers by some of the most eminent medical minds of the past one hundred years. The first medical records of cerebral palsy were made by the English surgeon William John Little in 1843, and initially referred to as Little’s disease. CP described as a disorder that appeared to strike children in the first year of life, affected developmental skill progression, and did not improve over time. Little also
connected this disorder to a lack of oxygen during birth. Later in 1897, Sigmund Freud suggested that CP might be rooted in the brain development in the uterus and related aberrant development to factors influencing the developing fetus (Accardo 2004). Birth asphyxia (oxygen deficiency) alone was thought to be the cause of CP until the 1980s, when biomedical research found this etiology to be less likely and only one of many with potential to result in CP (Moster 2001, Nelson & Ellenberg 1986).

In 1992 (Mutch et al) modified the definition of CP as follows: ‘an umbrella term covering a group of non-progressive, but often changing, motor impairment syndromes secondary to lesions or anomalies of the brain arising in the early stages of development.’ This definition continued to emphasize the motor impairment and acknowledged its variability.

Reassessment of the definition of CP was prompted by a host of factors: changes in delivery of care to children with disabilities; recognition that children with slowly progressive inborn errors of metabolism can present with motor difficulties at times indistinguishable from those of children with non-progressive disease; increased availability of high-quality brain imaging to identify impairments in brain structure; acknowledgment that developmental motor impairment is almost invariably associated with a range of other disabilities; and increased understanding about associated antecedents and correlates of CP.

3.3 Pathophysiology

The clinical presentation of CP may result from an underlying structural abnormality of the brain; early prenatal, perinatal, or postnatal injury due to vascular insufficiency; toxins or infections; or the pathophysiologic risks of prematurity. Evidence suggests that prenatal factors result in 70-80% of cases of CP. In most cases, the exact cause is unknown but is most likely multifactorial (Jacobsson, 2004).

Major events in human brain development and their peak times of occurrence (Volpe, 1995) include the following:

- Primary neurulation - Weeks 3-4 of gestation
- Prosencephalic development - Months 2-3 of gestation
- Neuronal proliferation - Months 3-4 of gestation
- Neuronal migration - Months 3-5 of gestation
- Organization - Month 5 of gestation to years postnatal
- Myelination - Birth to years postnatal
Given the complexity of prenatal and neonatal brain development, injury or abnormal development may occur at any time, resulting in the varied clinical presentations of CP (whether due to a genetic abnormality, toxic or infectious etiology, or vascular insufficiency). For example, cerebral injury before the 20th week of pregnancy can result in a neuronal migration deficit; injury between the 26th and 34th weeks can result in periventricular leukomalacia; injury between the 34th and 40th weeks can result in focal or multifocal cerebral injury.

Brain injury due to vascular insufficiency depends on various factors at the time of injury, including the vascular distribution to the brain, the efficiency of cerebral blood flow and regulation of blood flow, and the biochemical response of brain tissue to decreased oxygenation.

The physical stress on premature infants and the immaturity of the brain and cerebral vasculature likely explain why prematurity is a significant risk factor for CP. Prior to term, the distribution of fetal circulation to the brain results in the tendency for hypoperfusion to the periventricular white matter. Hypoperfusion can result in germinal matrix hemorrhages or periventricular leukomalacia. Between weeks 26 and 34 of gestation, the periventricular white matter areas near the lateral ventricles are most susceptible to injury. Because these areas carry fibers responsible for the motor control and muscle tone of the legs, injury can result in spastic diplegia (i.e. predominant spasticity and weakness of the legs, with or without arm involvement of a lesser degree).

When larger lesions extend past the area of descending fibers from the motor cortex to involve the centrum semiovale and corona radiata, both the lower and upper extremities may be involved. Periventricular leukomalacia\(^1\) is generally symmetric and thought to be due to ischemic white matter injury in premature infants. Asymmetric injury to the periventricular white matter can result in one side of the body being more affected than the other. The result mimics a spastic hemiplegia but is best characterized as an asymmetric spastic diplegia. The germinal matrix capillaries in the periventricular region are particularly vulnerable to hypoxic-ischemic injury because of their location at a vascular border zone between the end zones of the striate and thalamic arteries. In addition, because they are brain capillaries, they have a high requirement for oxidative metabolism (Volpe 1995, Jacobsson 2004).

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1 **Periventricular leukomalacia** (PVL): The periventricular area is the area around the spaces in the brain called ventricles. PVL is the death of the white matter of the brain due to softening of the brain tissue, caused by a lack of oxygen or blood flow to the periventricular area of the brain, which results in the death or loss of brain tissue.
Many authorities grade the severity of periventricular hemorrhage-intraventricular hemorrhage using a classification system originally described by (Papile et al 1978)

Grade I - This is subependymal and/or germinal matrix hemorrhage

- Grade II - This is subependymal hemorrhage with extension into the lateral ventricles without ventricular enlargement.
- Grade III - This is subependymal hemorrhage with extension into the lateral ventricles with ventricular enlargement.
- Grade IV - A germinal matrix hemorrhage that dissects and extends into the adjacent brain parenchyma, irrespective of the presence or absence of intraventricular hemorrhage, is also referred to as an intraparenchymal hemorrhage when found elsewhere in the parenchyma. Hemorrhage extending into the periventricular white matter in association with an ipsilateral germinal matrix hemorrhage/intraventricular hemorrhage is termed a periventricular hemorrhagic venous infarction.

At term, when circulation to the brain most resembles adult cerebral circulation, vascular injuries at this time tend to occur most often in the distribution of the middle cerebral artery, resulting in a spastic hemiplegic CP. However, the term brain is also susceptible to hypoperfusion, which mostly targets watershed areas of the cortex (eg, end zones of the major cerebral arteries), resulting in spastic quadriplegic CP. The basal ganglia also can be affected, resulting in extrapyramidal or dyskinetic CP. Dyskinetic (extrapyramidal) CP is associated with several unique etiologies. Historically, kernicterus, or acute neonatal bilirubin encephalopathy, was a major cause. With improvement in early management of hyperbilirubinemia, the vast majority cases of dyskinetic CP are currently associated with presumed hypoxic ischemic injury rather than with hyperbilirubinemia (Capute 2001). In the absence of hypoxia, hyperbilirubinemia, or prematurity, the possibility of a metabolic or neurodegenerative disorder as a basis for this presentation must be considered.

In summary, no set rules exist as to where or when the brain injury can occur, and injury may occur at more than one stage of fetal brain development. Additionally, causes are multiple and potentially multifactorial, including vascular insufficiency, infection, maternal factors, or underlying genetic abnormalities. Regardless of the etiology, however, the underlying brain anomaly in CP is static, although the motor impairment and functional consequences may vary over time. By definition, cases associated with underlying disorders of a progressive or degenerative nature are excluded when diagnosing CP.
3.4 Etiology and Epidemiology

The etiology of CP is not well understood. Interpretation of the literature is limited by the lack of strict definitions in studies attempting to define a pathogenesis of CP and the relatively small size of certain studies. An increasing amount of literature suggests a link between various prenatal, perinatal, and postnatal factors and CP. Epidemiologic studies suggest that prenatal factors play a predominant role in the etiology of CP.

The following maternal and prenatal risk factors statistically correlate with CP:

- Long menstrual cycle
- Previous pregnancy loss
- Previous loss of newborn
- Maternal mental retardation
- Maternal thyroid disorder (especially iodine deficiency)
- Maternal seizure disorder
- History of delivering a child weighing less than 2000 g
- History of delivering a child with a motor deficit, mental retardation, or sensory deficit.

The following factors during pregnancy also correlate statistically with CP:

- Polyhydramnios (is the medical condition of too much amniotic fluid in the Amniotic sac. It is seen in 0.5 to 2% of pregnancies)
- Treatment of the mother with thyroid hormone, estrogen or progesterone
- Maternal seizure disorder
- Maternal severe proteinuria (from protein and urine - means the presence of an excess of serum proteins in the urine)
- Maternal high blood pressure
- Maternal methyl mercury exposure
- Congenital malformations in the fetus
- Male sex of fetus
- Bleeding in third trimester
- Intrauterine growth retardation
- Multiple gestations (The apparent overrepresentation of CP in multiple gestation pregnancies may relate more to the presence of prematurity or intrauterine growth retardation. Multiple gestations may not be an added risk
for CP. The exception is when one twin dies; the surviving twin has a higher chance than a singleton of developing CP).

The following prenatal factors are associated with an increased risk of CP:

- Prematurity
- Chorioamnionitis
- In approximately 10% cases of CP, birth asphyxia can be determined as the definitive cause.

Cases of CP attributed to birth asphyxia must document clear evidence of acidosis, moderate-to-severe neonatal encephalopathy, restriction to spastic quadriplegia, dyskinetic or mixed types of CP, and exclusion of other etiologist. Additionally, an intrapartum event must be suggested by a sentinel event, fetal heart rate changes, Apgar score less than 4 at 5 minutes, organ system damage related to tissue hypoxia, and early imaging abnormalities (Artal 2003).

The following postnatal factors may contribute to CP:

- Infections (e.g. meningitis, encephalitis)
- Intracranial hemorrhage (e.g. due to prematurity, vascular malformations, or trauma)
- Periventricular leukomalacia (in premature infants)
- Hypoxia-ischemia (e.g. from meconium aspiration)
- Persistent fetal circulation or persistent pulmonary hypertension of the newborn
- Kernicterus

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2 Chorioamnionitis is a inflammatory condition of pregnancy affecting the uterus
3 Apgar scale: a system of assessing the general physical condition of a newborn infant based on a rating of 0, 1, or 2 for five criteria: heart rate, respiration, muscle tone, skin colour, and response to stimuli. The five scores are added together, with a perfect score being 10.
4 Meconium is the first stool of an infant, composed of materials ingested during the time the infant spends in the uterus.
5 Kernicterus: is damage to the brain centers of infants caused by jaundice. Newborn babies are often polycythemic, meaning they have too many red blood cells. When they break down the cells, one of the by-products is bilirubin, which circulates in the blood, and causes jaundice).
3.4.1 Possible causes of CP by types include the following:

**Spastic hemiplegic**

- Of all cases, 70-90% is congenital and 10-30% is acquired (e.g. vascular, inflammatory, and traumatic).
- In unilateral lesions of the brain, the vascular territory most commonly affected is the middle cerebral artery; the left side is involved twice as commonly as the right.
- Other structural brain abnormalities include hemibrain atrophy and posthemorrhagic porencephaly.
- In premature infants, this may result from asymmetric periventricular leukomalacia.

**Spastic diplegic**

- In premature infants, spastic diplegia may result from parenchymal-intraventricular hemorrhage or periventricular leukomalacia.
- In term infants, no risk factors may be identifiable or the etiology might be multifactorial.

**Spastic quadriplegic**

- Approximately 50% of cases are prenatal, 30% are perinatal, and 20% are postnatal in origin.
- This type is associated with cavities that communicate with the lateral ventricles, multiple cystic lesions in the white matter, diffuse cortical atrophy, and hydrocephalus.
- The patient often has a history of a difficult delivery with evidence of perinatal asphyxia.
- Preterm infants may have periventricular leukomalacia.
- Full-term infants may have structural brain abnormalities or cerebral hypoperfusion in a watershed (ie, major cerebral artery end zone) distribution.

**Dyskinetic (extrapyramidal)**

- This type may be associated with hyperbilirubinemia in term infants or with prematurity without prominent hyperbilirubinemia (Stanley 2000; Jacobsson 2004).

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6 **Porencephaly**: is a type of cephalic disorder. This is an extremely rare disorder of the central nervous system involving a cyst or cavity in a cerebral hemisphere. The cysts or cavities are usually the remnants of destructive lesions, but are sometimes the result of abnormal development. The disorder can occur before or after birth.
3.4.2 Prevalence
In developed countries, the overall estimated prevalence of CP is 2-2.5 cases per 1000 live births (Majnermer 2004). The prevalence of CP among preterm and very preterm infants is substantially higher (Vincer 2006, Ancel 2006). In the developing world, the prevalence of CP is not well established but estimates are 1.5-5.6 cases per 1000 live births. These figures may represent an underestimation because of a paucity of data, the lack of health care access, an overrepresentation of severe cases, and inconsistent diagnostic criteria (Stanley 2000).

3.4.3 Age of onset
The brain lesions of CP occur from the fetal or neonatal period to up to age 3 years. Insults to the brain after age 3 years through adulthood may manifest clinically as similar or identical to CP, but, by definition, these lesions are not CP. Although the lesion to the developing brain occurs prior to age 3 years, the diagnosis of CP may not be made until after that time. Some authorities advocate not making a definitive diagnosis in some cases until age 5 years or later. This approach allows the clinical picture to be clear and potentially allows exclusion of progressive diseases (Shevell, 2004; Stanley, 2000). In addition, some children have been diagnosed with CP at an early age, only to have the symptoms resolve later (Jacobsson 2004).

3.5 Classification and types
CP is classified according to the lesion location: hemiplegia: lesion in one hemisphere, quadriplegic- lesion in 2 hemispheres and diplegic: lesion in the region of the ventricle. The widespread division is classified by the abnormal muscle tone, which is the most common for all CP children. There is a certain difficulty with this classification system due to the great variations and the ongoing alteration in clinical presentations (Eicher 1993).

3.5.1 The Spastic group
This group includes 60% of all CP children and related to pyramidal system disorder which is the motor system that controls all voluntary movements. A common phenomena in this group is a high tonus known as the Clasp Knife phenomena (tonus which characterized by resistance to passive movement which gradually decrease through the whole range of motion) (Bobath 1959).
Other clinical presentations include:

- Tendency to develop contractures, due to the high tonus. The most common areas are hip knee and ankle joints, and the lumbar fascia.
Pathological reflexes (e.g. Babinski sign\(^7\)), (Bobath 1959).

Persistence of primitive reflexes: Asymmetrical Tonic Neck Reflex, Tonic Labyrinthine Reflex; these reflexes persist beyond the normal time of a normal development (Bobath 1959).

Decrease or absence of superficial reflexes (e.g. abdominal reflexes) (Bobath 1959).

Problems with controlling fine voluntary movements (Bobath 1959).

Associative reactions: group of repetitive movements, manifested during a certain action (strenuous action or one that is involved with excitement). The manifestation is an increased tonus in additional impaired body structures that do not directly participate in the action performed. Therefore, for example, hemiplegic child who is writing with his healthy hand can demonstrate associative response in his impaired hand (Bobath 1959).

Increased deep tendons\(^8\) reflexes.

Clonus (muscular spasm involving repeated often rhythmic, contractions).

Defective development of the equilibrium reactions. (Bobath 1959).

**Movement characteristics of the spastic group:**

- Decreased movement. Use of typical repetitive movement patterns.
- Decreased range of motion (initially due to abnormal tonus and later due to tissue shortening).
- Absence of proximal stability may lead to absence of rotational movements and therefore only movements in the sagittal plane might be possible. (Bobath 1959).

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7 *Babinski sign* - extension upward of the toes when the sole of the foot is stroked firmly on the outer side from the heel to the front; normal in infants under the age of two years but a sign of brain or spinal cord injury/disorder in older persons.

8 *Tendon reflex* - is a feedback mechanism that controls increasing muscle tension by causing muscle relaxation before tension force becomes so great it may damage the muscle. The deep tendon reflexes provide information on the integrity of the central and peripheral nervous system. Generally, decreased reflexes indicate a peripheral problem and lively or exaggerated reflexes a central one.
The spastic group can be further divided into subgroups, according to the type and extent of extremities affected;

**Diplegia:**
The deformities most commonly associated with Spastic diplegia are contractures of the hip flexors and adductors, the hamstrings and hip internal rotators (Stokes 2004). Most spastic children belong to this group, where all four limbs are affected, however legs more than arms. The damage is usually symmetrical, head control is normal and the development of hands equilibrium reactions is delayed. Kyphosis may develop as a sequela to tight hamstrings or hyperlordosis as a compensatory balance mechanism (Stokes 2004).

The most common sitting position will include neck hyperextension and kyphotic back. Weight bearing is on the sacrum instead the ischium, along with slight bend knees, expressing the shortness of the hamstring muscles, which is common in this group. This sitting position is unstable and the child's balance is undermined easily. Therefore, the child prefers the “W” kneeling posture; this position includes increased internal rotation in the hips and flexion in the knees. For this group of children, this type of sitting position provides the widest and the most stable base of support (Bobath 1959).

In general, children in this group present rigid back and impaired rotational movements. These abnormalities are expressed in the crawling patterns of these children, as they progress in a sort of “rabbit jumps”; the child shifts his legs forward while using his hands for weight bearing, and bounces both legs forward (Bobath 1959).

Diplegic children are unable to seat down through the side. They roll as one unit and are lacks the capability of legs separation. In standing position one leg is carrying more weight than the other, the hip and knee are usually in hyperextension while the other leg, which carrying less weight is in flexion of the hip and knee with plantar flexion of the ankle. Hyperextension of the knee might develop in order to compensate for tight tendo-achilles.

Most of this group of children walks independently and these deformities develop as a result of the crouch gait adopted by many children with spastic diplegia due to spasticity in the hip adductors and flexors, hamstrings and calf muscles (Stokes 2004). During walking the hips and knees are flexed and the back is in a forward flexion position. The walking base is narrow due to spasm in the hip adductors. Due to the asymmetrical posture, a tendency to develop a secondary scoliosis is present (Bobath 1959).
Quadriplegia:
All four limbs are affected, however arms more than legs or may be equally affected. A severe deformity of upper extremities will accompany an impaired head control and impaired speech, problems in vision and mouth functioning. The body impairment is usually asymmetrical, because of increased ATNR reflex (which will be explained later), dominantly affecting one side of the body (Bobath 1959).

The equilibrium reactions and the righting reactions⁹ are mostly impaired. The quadriplegic child present balance difficulty in sitting position and therefore a special chair with extra support is required. Most of the children in this group can not walk; therefore, contracture and deformities are common problem which occur as a result of the constant sitting position, which consist of adduction and flexion of the hips, flexion of the knees, and planter flexion of the ankles. Many develop dislocation of their hip joint and spinal curvature. Hip subluxation or dislocation can cause significant morbidity in terms of pain and difficulty with postural control, causing limitations in sitting, standing and walking, and hygiene and personal care considerations (Stokes 2004).

In this group, a typical "scissoring position" of the legs may be presented due to hip adductors spasm. The arms characterized by flexion position which includes retraction of the shoulder blades, adduction and flexion of the shoulders, flexion of the elbows, pronation in the forearms, write ulna deviation and fist position of the fingers. The impairments are asymmetrical (one side is usually more severely affected) therefore; a secondary scoliosis may develop (Bobath 1959).

Hemiplegia:
In the hemiplegic group, one side of the body is affected and the muscle tone is typically spastic. Most of the children in this group walk independently but there is a wide variation in the function of the affected arm and hand. Children with hemiplegia often experience under development of the affected side, which result in smaller limbs on this side and leg shortening. Involvement of the non-affected side is present

⁹ Equilibrium and Righting reactions: Righting reactions can be broken into several different reflexes that serve to keep the head in a normal position, right the body to a normal position and adjust the body parts in relation to the head and vice versa. The majority of the righting responses should be built into the nervous system before three years of age. The Equilibrium reactions develop in childhood as well and are for the purpose of maintaining or regaining control over the body’s center of gravity.
(Stoke 2004). Most prominent characteristics of this group include; asymmetrical postures and reactions, side flexion of the back towards the affected side is commonly present, and while sitting most of the weight is carried on the non affected side, as well as in standing (the affected leg is in an abduction position). While walking the hip on the affected side is in abduction and extension, and the knee is in slight flexion. The ankle is in planter flexion and a step, which will be taken with this leg, will be performed on the tip of the toes (Bobath, 1959). The upper extremity is characterized by flexion patterns, which will be aggravated during walking and running.

Due to the asymmetry of impairments, also here a secondary scoliosis is common (Bobath 1959).

3.5.2 The Hypotonic group

Nearly all CP children are born hypotonic, and only later on when they are trying to move against gravity, they develop their abnormal tonus. This group is characterized by low muscle tone that does not enable movement against gravity. The prominent characteristics in this group are; increased passive range of motion, muscle "weakness", tendency for a "frog position" in the legs while lying supine (flexion, abduction and internal rotation in the hips, and flexion in the knees), delay in the development of equilibrium reactions (Bobath 1959).

3.5.3 The Athetoid Group

Originate in extrapyramidal 10 system impairment. All four limbs are affected; arms more than legs, and the impairments are usually asymmetrical. The prominent characteristics of this group are inability to preserve postural control against gravity, varies muscle tonus, impaired development of equilibrium reactions and the appearance of associative reactions (see explanation in chapter 3.8.1 (Bobath 1959).

The Athetoid group can be divided into four sub groups:

Pure Athetoid:

- Usually quadriplegics.
- Alternating muscle tone (low to normal).

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10 Extrapyramidal system: is a neural network located in the brain that is part of the motor system involved in the coordination of movement. Extrapyramidal neurons, like related gamma system neurons, excite or inhibit anterior horn cells. Reflex activities of a target muscle are affected by motor signals from the corticospinal tract and by the influence of extrapyramidal signals. Extrapyramidal tracts originate from different part of the brain as the red nuclear, reticular formation.
Choreoathetoid:
> Only quadriplegics.
> Alternating muscle tone (low to normal-high).

Athetosis Spastic:
> Usually quadriplegics. The head, back and arms are involved more than the lags.
> Moderate spasticity.

Athetosis tonic-spastic:
> Only quadriplegics.
> Alternating muscle tone (low to very high). The origin of the name tonic-spastic is in the rapid changes in muscle tonus.

Movement characteristics of the athetoid group:
> Basically low muscle tonus that is changing according to the sub groups.
> Uncontrolled movement reactions.
> Inaccurate movement in large ranges.
> Primitive reflexes presentation.

3.5.4 The Ataxic Group
The origin of the impairment that causes ataxia, is in the small brain (cerebellum), and is often genetic in nature. Most of the children are quadriplegics.

Prominent characteristics of this group include;
> The tonus varies from low to low-normal during fast oscillations that appear in distal body parts as intention tremor along with lack of proximal stability, which impairs the performance of distal movements against gravity.
> Impaired coordination
> Sever impairment of equilibrium and proprioception which lead to impairment in joint positional sense
> Decrease in deep tendons reflexes (Bobath 1959).

Movement characteristics of the ataxic group:
> Typical movements in mid positions. Absent of rotational movements in order to maintain balance.
> Typical walking with a broad base.
> The use of orthoses is performed to assist in stability.

\[\text{Intention tremor}\] - refers to an oscillating tremor that accelerates in pace on approaching the target
Psychological factor; the ataxic child experience fear to move due to the impaired movement control.

3.5.5  The Mixed Group
This group presents many differences regarding the extent of impairments and functional levels. The most common presentation is high muscle tonus in the extremities, in combination with low tonus in the back (Bobath 1959).

It is possible to classify CP children according to severity of the impairments and functional level:

- **Mild**: no restrictions in daily functioning that are demanding independency.
- **Moderate**: noticeable difficulties in daily functioning. Assistance devices may be required (rollator, orthoses etc.)
- **Severe**: more severe restrictions in daily functioning. Assistance devices are required (rollator, orthoses etc.)

3.6 Additional impairments in Cerebral Palsy
Additional impairments include vision problems, hearing and speech impairments, sensory disturbances, mental retardation and epilepsy;

**Motoric eyes impairment:**
The CP child frequently is unable to develop normal eye-hand coordination, which reduces his ability to experience sensory stimulations. Approximately 50% of the CP children suffer motoric eyes impairments of different types. Most prominent problems are focus inability, and constant or altered strabismus (crossed eyes). Many CP children are not able to move the pupils in an isolated manner from the head movement.

**Speech impairment:**
Motoric aphasia is actually very rare with CP children. Speech impairment will usually be present as a result of spastic agnosia\(^{12}\). The agnosia may affect different body parts or may affect the body as a whole. This may impair the child's body perception. Agnosia can be as a result of a cortical damage; however can also arise from the

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\(^{12}\) **Agnosia** - inability to interpret sensations and hence to recognize things, typically as a result of brain damage
child’s inability to use his hands to grasp and inspect objects, as well as the inability to inspect his own body and surroundings (Bobath 1959).

Mental retardation:
It is difficult to determine mental retardation in CP children, mostly because of the motoric (objects use) and communication impairments. Therefore, all the impaired abilities of the CP child should be taken under consideration before making a diagnosis concerning his mental state. It is estimated that:

- 50% of CP children have normal to high intellectual function.
- 25% of CP children have limited intellectual function and will benefit from special educational programs.
- 25% of CP children suffer from mental deficits of different levels and will generally not benefit from special educational programs (Bobath 1959).

3.7 Characteristics of the motoric impairments in CP
Despite the broad and varied clinical picture among CP children, abnormal muscle tonus and impaired muscle coordination are commonly found. These two factors lead to inability to maintain balance, and problems to execute and acquire practical motoric capabilities. Normal muscle tonus is necessary for executing normal, long lasting, smooth movements. Normal tonus enables a solid adaptation of the body in order to enable its movements.
Every change in position accompanies tonus change in the entire body. These changes occur automatically and unconsciously to maintain the child’s equilibrium. This group of automatic reactions that maintain the balance is called balance reactions. These reactions are influenced by sub-cortical centers, and provide the basis for all movements and normal motoric abilities. If they are not fully developed, various daily activities become impossible. Therefore, for example, it is not possible to reach for an object that is beyond the base of support in the absence of normal equilibrium reactions. In the absence of these reactions the hand that is reaching for the object is then essential for the balance maintenance.
The motoric impairment in CP children arises from impairment in postural reflexes mechanism. The result is abnormal postural reflexes and tonic reflexes. These reflexes are related to spasticity, affecting the development of normal balance reactions, which are Righting Reactions and equilibrium Reaction. These reactions are essential for the development of intentional movements (Bobath 1959).
3.7.1 Reflexes inhibition patterns in a healthy infant

When the child is progressing from primitive reflexes\textsuperscript{13} activity, to voluntary movements and acquires equilibrium, he is gradually starting to combine the use of visual, auditory, sensory and proprioceptive information, and learns to modify and to adjust to the existing movements patterns. He is learning to combine recognizable motoric patterns in various ways in the required timing and direction. The original patterns are not suitable for all possible activities and should therefore be modified and become partially inhibited. The child needs to learn how to use elements of these patterns and combine them with additional diverse patterns, in order to make them suitable for the varied functions required in daily living. Even in specific activity such as grasping, diverse possibilities exist that requires accuracy, fine movements and skillfulness. In pinch grip for example, it is necessary to bring the first two fingers together and to remove the rest of the fingers. This involves a gradual inhibition of specific partial movement patterns, which are not necessary and interfere with the execution of a specific function. Inhibition is therefore highly significant in coordinating movement and stability, especially in selective fine movements (Bobath 1959).

In the CP child, the brain deficit effects the motoric development. All CP children present primitive reflexes of movement and stability, and usually tonic reflexes activity. Spasticity appears to be the direct result of tonic reflex activity, or in another words; tonic reflexes and spasticity exist parallel to each other. The degree of spasticity is directly related to the power and frequency of the tonic reflexes activity (Bobath 1959).

3.8 The Abnormal Reflexes

Most commonly presented;

\textbf{Flexor Withdrawal Reflex:}
The entire lower limb is involved in flexion movements, usually together with abduction and external rotation. This reflex does not allow a selective bending of a single joint (Bobath 1959).

\textsuperscript{13} \textbf{Primitive reflexes} develop during uterine life. They should be fully present at birth and are gradually inhibited by higher centers in the brain during the first 6 to12 months of post-natal life. If they are activated by minor stimuli in the environment at a later age, they can interfere with the development of more complex skills
Extensor Thrust Reflex:
Present in many spastic CP children while lying supine: extension in all the joints in the leg including hip adduction and internal rotation, and ankle planter flexion (Bobath 1959).

Crossed Extension Reflex:
This reflex is a combination of the Flexor Withdrawal Reflex and the Extensor Thrust Reflex; while one leg is bended in a pattern of abduction and external rotation, the opposite leg is straightened in a pattern of adduction and internal rotation. This reflex enables a kick in every leg separately. In the spastic child this reflex is usually delayed, except than during walking. Then the extensor spasm increases in the standing leg, while the other leg is elevated and bended in order to execute the walking step (Bobath 1959).

3.8.1 The Tonic Reflexes

Primitive reflexes develop during life in the womb. They are present at birth in a baby born at full term (40 weeks), and are gradually inhibited by higher centers in the brain during the first 6 to 12 months of post-natal life. If they continue to be activated at a later age, they can interfere with the development of more complex skills;

Tonic Labyrinthine Reflex (TLR)
With this primitive reflex, tilting the head backwards when lying supine causes the back to stiffen and even arch backwards, causes the legs to straighten, stiffen, and push together, causes the toes to point, causes the arms to bend at the elbows and wrists, and causes the hands to become fisted or the fingers to curl. The presence of this reflex beyond the newborn stage is also referred to as abnormal extension pattern or extensor tone (Sieglinde 2006)

Asymmetrical Tonic Neck Reflex (ATNR)
This primitive reflex appears when the child turns his head; when the face is turned to one side, the arm and leg on the side to which the face is turned extend and the arm and leg on the opposite side bend (Sieglinde 2006) In sever cases this reaction will occur instantly and in milder cases the reaction may appear later. This reaction is more prominent in the hands than in the legs, and occasionally can be seen only in the hands. With some of the mild cases this reflex reaction exists only when the child attempt strenuous activity, or when he is excited (Bobath 1959).
The presence of the ATNR, as well as the TLR, beyond the first months of life may indicate that the child has developmental delays. In children with cerebral palsy, the reflexes may persist and even be more pronounced. As abnormal reflexes, both the ATNR and the TLR can cause problems for the growing child. The ATNR and TLR both hinder functional activities such as rolling, bringing the hands together, or even bringing the hands to the mouth. Over time, both the ATNR and TLR can cause serious damage to the growing child's joints and bones (Sieglinde 2006)

Symmetrical Tonic Neck Reflexes (STNR)
In this case extension of the cervical spine will lead to increased extensor spasm in the hands, and increased flexor spasm in the legs. Flexion of the cervical spine will lead to the opposite affect. When it is performed passively, the CP child can straighten his hands although his legs will remain in flexion (Bobath 1959). This reflex occurs most noticeably in sitting and does not have the same potential for deformity, but can affect the functional abilities of the child. A child who has poor head control will, therefore, experience sudden movements in the arms or legs over which they have no control.

Associative Reactions:
Tonic postural reactions may appear when movement that occurs in one part of the body will lead to increased tone in other parts, which are not related directly to the movement:
- In quadriplegics, the effort of moving one hand will increase the spasticity in the rest of the body.
- In hemiplegics, the same effort will increase the spasticity on the hemiplegic side and will emphasis the hemiplegic posture.

When treating a CP child it is essential to consider these associative reactions and not demand from the child a great deal of effort. For example, in hemiplegic child, in an attempt to achieve extension in the spastic arm, extensor spasm may appear in the hemiplegic leg. Associative movements as opposed to associative reactions can be seen also in healthy children during a strenuous exercise, such as lifting a heavy object, or when performing an action which demands a particular concentration (Bobath 1959).
**Positive Supporting Reaction:**
This reaction appears as a result of a stimulus that arises when the heel touches the ground and further stimulated by the pressure leading to a stretch of the intrinsic muscles of the foot. As a result, the muscle tonus of the flexor and extensor muscle groups will increase (Co-Contraction) in the stance leg, especially in the Anti-Gravity muscles. With this reaction the leg "stiffens" and becomes a type of a supporting "pole". The reaction continues as long as the two stimuli are present. The gait of a spastic child includes planter flexion. Due to the positive supporting reaction, the tonus will increase every time the child will place his foot on the ground. Due to that the child tends to lean backwards, what makes it more difficult to transfer weight in order to walk properly.

In summery: recognizing these reflexes helps in analyzing the motoric behavior of the CP child, and in understanding their influence on the coordination of balance and movement. The motoric patterns that are expected are the result of combination of reflexes that usually works simultaneously. It is not always possible to isolate them based on observation alone, and they are more prominent in sever cases of CP (Bobath 1959).

### 3.9 Summery
Cerebral Palsy is a senso-motoric disorder due to non progressive damage in the immature brain. There are mixed presentations of symptoms, but common for all CP children is damage to muscle tonus, which is accompanied by various additional impairments such as in cognition, vision and speech. The pathophysiology is ischemic hypoxia in the central nerve system, which develops mostly before birth. The aetiology in most cases is unclear, and the classification to groups is indistinct. However four main groups may be seen: spastic, hypotonic, ataxic and athtoid. Each group has unique characteristics, though many children belong to a mixed group and present various conditions with different disability levels.

The brain disorder causes impairment in the postural reactions due to damage in the existing postural reflexes and impaired inhibition of primitive reflexes. Recognizing these reflexes assist in understanding their affect on postural control, coordination and movement. CP children lack the experience of normal sensory stimulations such as vision, propricception and touch. Treatment should be directed to the motoric aspect through the sensory aspect, while utilizing the largest variety of sensory stimulations; many of these can be found in Therapeutic horseback riding.
4. Therapeutic Horseback Riding

The following chapter will provide information about Therapeutic riding including historical review, description of the different methods, patient population and introduction into the beneficial effects.

4.1 Clarifications of basic terms

Equestrian: a broad term to describe horseback riding or horsemanship. In ancient Rome this term was used to describe a member of one of the two upper social classes in the Roman Republic and early Roman Empire.

Equine: used to describe a horse, or characteristic of a horse, of or belonging to the family of horses, donkeys, zebras etc’.

Hippotherapy: treatment with the help of horses. Originates from the Greek word "hippos", means horse.

4.2 Introduction

Horses have always been appreciated by humans for their strength, beauty, and gentle manner. Children, especially, have gravitated toward them and many experience their first horseback riding lesson at a young age. However, horses can play a very different role in the lives of children and adults with disabilities. Therapeutic horseback riding is a physical and occupational therapy that uses the movement of the horse as a treatment tool. (Apel 2007)

Therapeutic riding addresses impairments, functional limitations, and disabilities in clients with neuromusculoskeletal dysfunction, such as cerebral palsy. It is used as part of an integrated treatment program to achieve functional outcomes, and engages the client in activities on the horse that are enjoyable and challenging. The therapist modifies the horse's movement and carefully grade sensory input, establishing a foundation for improved neurological function and sensory processing. This foundation can be generalized to a wide range of daily activities, making the horse a valuable therapeutic tool for rehabilitation (Meregillano 2004).

During riding the horse serves as dynamic base of support on which clients must control and coordinate their movement. The horse constitutes a driving force for change, affording the client abundance of divers practice conditions. The movement of the horse provides a rhythmic sense which is a fundamental property of the human motor system (Haehl at al 1999). Not only physical, but also psychological benefits are attributed to horse riding. Testimonies of parents, therapists and patients bear witness to psychosocial benefits that include increased motivation, higher self-esteem, and better concentration and academic performance (von Arbin 1994,
Increased motivation plays an important role in cases where patients have become tired of clinically based therapy.

Impairments that are addressed by Therapeutic riding include the following:

- Abnormal muscle tone
- Impaired balance responses
- Impaired coordination
- Impaired communication
- Impaired sensory and motor functions
- Postural asymmetry
- Poor postural control
- Decreased mobility
- Limbic system dysfunction related to arousal and attention skills

4.3 Historical perceptive

Therapeutic riding, in the literal sense, has existed for many years. In 1952, Madam Liz Hartel of Denmark, who had poliomyelitis, brought recognition to the field by winning the silver medal for Grand Prix Dressage at the Helsinki Olympics after she had rehabilitated herself by riding. After this event, international attention began focusing on the therapeutic use of horse riding (Pauw 2000). One of the first organizations was the Pony Riding for the Disabled Trust and was formed in England in 1958. Therapeutic riding began to spread across Europe, special riding facilities were developed in Germany and Switzerland, and experienced riders who were injured or underwent a disease which caused physical limitations dared and returned to their hobby. The interest has increased and therapeutic riding rehabilitation centers initiated in America as well. The North American Riding for the Handicapped Association (NARHA) was formed in the 1960's (Potter at al 1994).

The NARHA national organization is one of the biggest organizations up to now. Its mission is to promote equestrian activities for people with disabilities. Currently in the United States and Canada, more than 700 NARHA program centers serve some 42,000 individuals with disabilities. These programs have been successful through an integrated team approach, using the expertise of professionals, such as physicians, physical therapist, psychologist, therapeutic riding instructors, equine scientists, veterinarians and others (NARHA 2007).
4.4 Patient population and medical conditions

Individuals of all ages, with a wide range of physical, cognitive and/or emotional disabilities benefit from Therapeutic horseback riding and other equine activities. The sense of independence and acceptance found through these activities with the horse benefits all (NARHA 2007). Individuals with the following disabilities commonly participate and benefit from Therapeutic riding and related equine activities:

- Muscular Dystrophy
- Cerebral Palsy
- Visual Impairment
- Down Syndrome
- Mental Retardation
- Autism
- Multiple Sclerosis
- Spina Bifida
- Emotional Disabilities
- Brain Injuries
- Spinal Cord Injuries
- Amputations
- Learning Disabilities
- Attention Deficit Disorder
- Deafness
- Cardiovascular accident/Stroke

4.5 The different methods in Therapeutic riding

Any riding program using horses’ related activities for clients with physical, mental, cognitive, social or behavioral problems is a therapeutic riding program. (Heine 1997). However, Therapeutic riding is a broad term used to describe several methods of providing treatment to people with disabilities (Potter at al 1994).

Hippotherapy is a specialized physiotherapy treatment that makes use of the horses’ unique three-dimensional movement impulses at a walk to facilitate movement responses in patients positioned on the horse (Straut, 2000). During Hippotherapy the patient does nothing to actively influence the movement of the horse; on the contrary, the patient is moved by the horse and responds to the horse’s movement. The physiotherapist directs a specially trained horse handler to vary the horse’s movement as required, through changes in cadence, stride length, and direction.
Hippotherapy is a distinct area within Therapeutic riding, which also includes vaulting in special education and riding as a sport for people with a disability, and for the last ten years or so, particularly in Germany, the use of horses in psychology and psychiatry. Practitioners in the different specialties within Therapeutic riding agree that there may well be some degree of overlap in activities among these areas; each area has objectives and specially trained professionals unique to that setting.

“Hippotherapy” is not a uniformly used term across the globe. Therefore, we can not be sure that the “Hippotherapy” practiced in one part of the world would be the same as the “Hippotherapy” practiced and written about in another (Debuse et al 2004). Among the different approaches described in literature, we could find developmental vaulting and riding as a sport for the disabled.

Developmental vaulting which is used to improve cognitive, perceptual, and motor skills, allows the rider to explore various types of movement on the horse's back. It is a type of gymnastic exercise on top of the horse's back when it is moving in a 10 m' circle and responding to a trainer which is standing in the middle of the circle. This method requires a strong trust relationship between horse and rider, and known as a method which is highly develop self-esteem and motivation level. This method is known to be effective in cases of behavioral and/or emotional problems.

Sports riding are used to develop social skills and to provide recreational therapy for people with disabilities, and include activities such as trail riding and Special Olympics. The Dressage sport provides many special events and competitions for disabled riders.

* the terms Hippotherapy and Therapeutic riding will both be used in conjunction in this paper and will be used to describe the same concept despite the fact that Therapeutic riding is the broad description and Hippotherapy is more of a distinguish area within it. Most of the articles used for this paper refer to these two terms as to one and same concept. The methods overlap greatly, depending on the level of impairments. CP children present a variation in conditions and severity. The therapeutic riding program will be tailored and adjusted to the specific capabilities and needs of the specific patient. This paper will explain the differences in perception and practice when using one approach or the other, though the research results are collectively presented.
4.6 Therapeutic riding sessions in practice

Sterba et al (2007) describe how the instructors of Therapeutic riding selects target objectives based on the child’s individual physical needs, encouraging the development of sensorimotor and perceptual-motor skills. The rider undergoing the treatment is directed by the instructor and aided by the side-walker(s) who offer as much assistance as necessary, while still being least-restrictive to the rider. The rider performs activities such as touching various parts of the horse’s body (e.g. the mane, neck, flank, back) or reaching for an object (e.g. ball or ring), which involves crossing the midline while maintaining appropriate balance and posture. The horse may initially remain still for these activities then begin a slow and steady walk with the rider comfortably lying prone, supine, or sitting upright on a warm horse blanket using a vaulting surcingle as a handhold. When using a saddle, the rider may either sit or stand up using specially designed stirrups, attempting proper postural alignment. The rider imitates movements demonstrated by the nearby instructor (e.g. arms abducted or placed overhead; bilateral arm circles, forward then backward; raising and lowering a stick held with both hands). While the horse is being guided safely by the lead-walker using a lead-line attached to the horse’s halter, the rider is encouraged to toss beanbags into bins, place large rings on top of cones, or simulate steering the horse using reins attached to the halter or horse’s bit. As the therapy progresses less support is provided by the side-walker(s). Exercises are focused on progressively challenging the rider’s ability to stretch and move while maintaining balance and posture in all body positions during the horse’s slow, steady gait.

Hippotherapy by Sterba et al (2007) is treatment performed on the horse under the direction of a licensed health professional (e.g. physical therapists, occupational therapists) The Hippotherapy method does not teach specific techniques and skills associated with riding a horse. The therapeutic effects are achieved by responding and interacting passively to the horse’s movement. The rhythmic and repetitive movement of the horse's gait induces a constant need for the rider to adjust to the horse's movement. This natural physiological response elicited in the rider is used by the therapist to improve muscular strength, neuromotor function and sensory processing. The therapist may use the "Backriding" strategy, where both therapist and client are sitting on the horse’s back, while the therapist is sitting behind the child. This is often used to develop posture in the front rider. To a limited basis, an instructor may backride a child until the child feels secure.
5. Beneficial effects on impairments presented by CP children; explanations and literature survey

The following chapter will focus on the benefits of Therapeutic riding for a list of impairments presented in the various conditions of CP children, based on and presenting the research results of studies that were carried out in the particular field involved. The topics which will be presented are; postural control, coordination, balance and postural reactions, regulation of muscle tonus, increased joints range of motion, muscle symmetry, weight bearing and weight shifting capabilities, walking abilities, sensory input (including vestibular stimulation and proprioception stimulation), muscle strengthening and psychological benefits.

The topics will be addressed separately; however, most of the studies looked at several impairments in conjunction. Certain topics are tightly close to each other and some overlap may be present in the following pages.

5.1 Improved postural control

Postural control and coordination are dynamic processes that provide foundation for function. Shumway-Cook (2001) defined postural control as one’s ability to control the position of the body in space so as to maintain stability and an appropriate orientation of the body with respect to the task.

Posture is the position in which you hold your body upright against gravity while standing, sitting or lying down. Good posture involves training your body to stand, walk, sit and lie in positions where the least strain is placed on supporting muscles and ligaments during movement or weight-bearing activities. Problems in postural control could be explained by:

- Balance problems (Bertoti 1988).
- Coordination problems (Riede, 1982).
- Deficient in normal vestibular stimulations damage the proper development of postural reflexes and may lead to dysfunction of postural control (Blery & Kauffman, 1996).
- Congenital or acquired impairments which of neurological or orthopedic origin, may also lead to postural problems (Blery & Kauffman, 1996).

One of the most significant studies was performed by Bertoti (1988). Using a repeated-measured design, Bertoti assessed postural changes in 11 children (4 girls and 7 boys, aged 28 to 114 months) with spastic CP after participation in a 10-week hippotherapy program (1-hour session, 2 times per week). Evaluation of posture was
carried out 3 times by three pediatric physical therapists; pretest-1 followed by a 10-week period of no riding, pretest-2 followed by a 10-week therapeutic riding program, and post-test. A composite score for each test period was computed for each patient, and a median score was calculated for the entire group at each test period. A statistical difference was observed among the 3 test periods with significant improvement occurring during the period of hippotherapy. Subjective clinical improvements such as reduced hypertonicity, as well as improved weight-bearing and functional balance skills were reported by parents and referring physical therapists. These findings represented the first objective report that hippotherapy may have beneficial effect on the posture of children with spastic CP. However, the author concluded that further investigation is needed to isolate additional variables such as range of motion, balance, weight shift and strength, and to evaluate the effects of hippotherapy on different disabilities.

Riede (1986) reported that development of normal postural mechanism enable better performance of movements. Improved proximal postural control will enable a better performance of distal movements. Riede stated that Horses, as living apparatus, constantly demand from their riders’ adaptive responses to a variety of movements. As a result, riders improve their coordination and balance and develop a better posture.


In a research that explored German and British physiotherapists’ views on the effects of hippotherapy, Debuse et al (2005) reported that both German and British respondents rate trunk and postural control as the second most important effects of hippotherapy on people with cerebral palsy.

An investigation by Haehl et al (1999) is of limited external validity due to a small number of subjects involved. However, its methodology is sound and it is of interest because it is the first study to analyze in detail, the movement of both non-disabled children and children with cerebral palsy during the equine walk. Understanding the influence of the horse's movement on the child may clarify mechanisms, which influence posture during hippotherapy. This study was conducted in two phases. First measures of the kinematic relationship between the rider and the horse were developed. A kinematic analysis of the rider's trunk and the horse's back was used to describe postural orientation, postural stability, and temporal phase relations of a novice and an experienced rider. Both riders exhibited biphasic movement patterns in response to the horse's movement. The experienced rider had a more vertical orientation of the trunk and delayed postural response to the movement of the horse.
Next they examined the influence of 12 weekly hippotherapy sessions on the postural control, coordination, and function of two children with cerebral palsy. Both children with cerebral palsy approximated the biphasic movement patterns exhibited by the two children developing typically. Both also demonstrated improved coordination between the upper and lower trunk, and between the lower trunk and the back of the horse. One child's functional mobility improved. These findings suggest that improvements in trunk stability and postural control were evident following hippotherapy. In one of the children also an improvement in functional ability (investigated with the Pediatric Evaluation of Disability, PEDI) was demonstrated.

5.2 Improved balance and postural reactions
As part of the postural control mechanism which develops during riding, the balance develops as well. This can be attributed to the three dimensional movement of the horse which moves its center of gravity in three directions; forward – backward, upward – downwards and to the sides (left – right). This movement transfers to the rider's body and causes balance disturbance with every single step the horse performs. In order to remain in balance while riding, equilibrium reactions are developing. These reactions are generated through every step of the horse. These reactions can be described as minor contra-lateral movements which may be performed in an unconscious manner. This enables an upright position of the rider's back onto the pelvis, which moves in relation to the horse's motion; in response to the forward – backward motion of the horse's back, the rider's moves in counter rotation (the right shoulder and the left pelvis bone are moving forward at the same time, followed by the same movement of the left shoulder and right pelvis when the horse takes another step). In response to the upward - downward motion of the horse's back, the rider's back moves in flexion – extension, and in response to the side motion of the horse's back, the rider's back moves in a side-flexion motion (Would 1996).

The changes in the horse's pace as it progress from walk trot and canter, or the lengthening of the horse's strides (e.g. by placing poles on the ground) assist in improving the rider's balance. The use of stirrups assists in the development of balance as the sensory intake of weight bearing increases.

The continuous pressure which transfers from the legs, while the feet are placed in the stirrups, contributes to the development and/or preservation of sensory intake, especially with patients who are unable to walk due to their disability (Rosin 1980). Would (2003) was able to demonstrate statistically significant improvements in weight-shift and balance in eight children following an intense hippotherapy program.
According to Fox et al (1994) Therapeutic riding improved balance, coordination, strength, and sitting posture in developmentally delayed children. The subjects were 19 developmentally delayed children (including an unspecified number of children with CP).

5.3 Improved Coordination
Shumway-Cook (2001) defined coordination as the organization or timing of the system’s multiple components. Variable used to describe coordination is the temporal phase relation between body segments. Horseback riding improves coordination and hastens reflexes. These develop subsequently to the improvement of postural control mechanism and equilibrium reactions (Rosin 1980).

The rider must learn how to coordinate his various body parts in order to influence the horse in the required method. The repetitive movement pattern of the horse assists the rider in the development of coordination and speeding up reflexes. When the rider provides the correct sign of commend, he will receive the desirable reaction from his horse.

5.4 Regulation of muscle tone
During riding, the rider’s body follows the rhythm of the horse. The rider alternately contracts and releases different muscle groups; these actions relax both body and mind (Blery & Kauffman 1996). According to Bobath, in order to reduce spasm in neurological patients, a long lasting treatment of slow rhythmic movements is required. This treatment can be executed by moving the patient’s body and the surface on which he is seated, just as during riding. This approach can reduce spasm (Rosin 1980).

Apart from the mobility benefit, the rider’s sitting position alone assists in breaking up the pathological patterns; Instead of using static positions, movements that detain pathological patterns are required. These movements not only detain abnormal posture but also assist in the performance of autonomic involuntary movements. By changing the constituents of the pathological pattern in the key points of control, spasticity may be reduced (Rosin 1980).

These key points of control could be:
- Proximal points: Neck, spine, shoulder girdles and pelvis. Spasticity in the limbs may be influenced and reduced by treating these key points.
Distal points: great toes, ankles, thumbs, fingers and wrist joints. Proximal spasticity may be influenced and reduced by treating these key points.

Children with CP tend to exhibit one of the following: (Moberg-Wolff 2005)

- Diplegic pattern of spasticity (scissoring, crouching, and toe-walking)
- Quadriplegic pattern (diplegic patterning in addition to flexion of the elbow; internal rotation, pronation, or adduction of the arms; flexion of the wrist and finger; and adduction of the thumb)
- Hemiplegic pattern (plantar flexion of the ankle; flexion of the knee; adduction of the hip; flexion, internal rotation, pronation, and adduction of the arm; flexion of the wrist and finger; and adduction of the thumb)

Equinovarus positioning of the foot is a common posture in the lower extremity, and it can be a major limitation to functional transfers or gait as a child grows older. While some muscles may maintain underlying volitional strength, others may not. Muscles crossing 2 joints are involved most commonly in contracture development. Spasticity often is worse when the patient awakens or at the end of a tiring day (Moberg-Wolff 2005).

Spasticity usually affects the flexors muscles of the spine and upper extremities, and the extensors muscles of the lower extremities.

The position required while sitting on the horse and holding the reins assists in eliminating components of pathological patterns;

Arms and Thoracic spine:

- The position of the joints in the arms and thoracic spine alters from the flexion pattern (shoulder blades retraction, shoulder extension, elbow pronation, wrist palmar flexion and thumb adduction) and changing during riding into extension pattern (shoulder protraction, elbow mid-position in regards to supination/pronation, slight dorsiflexion in the wrist and thumbs abduction). * bringing the thumb into abduction is a significant therapeutic tool used by physiotherapists, and aims at spasm reduction (Rosin 1980).
- The movement of the horse’s neck and head in forward-backward motion leads to flexion-extension motions in the rider’s shoulders and elbows. This assists in decreasing the flexion element and modifies it into more extension.

Lower extremities:

- The position of the joints in the legs alters from the extension pattern (which includes adduction internal rotation of the hip, plantar flexion and inversion of the ankle) and changing during riding as while sitting on the horse the hip is in abduction, external rotation and slight flexion, and the ankles position modify
into dorsiflexion and eversion, in case the use of stirrups is executed. This position allows reduction of extensor spasm in the legs.

**Additional points of attention:**

- The slow rhythmical movement of the horse encourages relaxation and in this way contributes to spasm reduction. However, it is important to point out that if the rider will resist the movement and will not let the horse move him, the tension in his body will increase and spasm may increase as well.
- The horse's body temperature appears to have influence as well. The warmth of the horse's body along with its slow rhythmical movement may lead to spasm reduction.
- When spasticity is reduced, e.g. in the hip adductors, basic movements such as sitting, standing and walking may improve. This makes the influence of the horse a great contributor to the every day functioning of the CP child. These normal movement senses could help in achieving co-contractions, joint stability, equilibrium reactions and postural reactions. For an optimal receptiveness of the horse's movement and body warmth, riding is performed with the rider sitting on a soft blanket which contains stirrups, and usually not on a saddle. A blanket with stirrups enables to sustain flexion positions in the hip and knee and dorsiflexion in the ankles. Without the use of stirrups, it is difficult to eliminate the pathological pattern of extension in the hip and knee, and plantar flexion in the ankle (Bertoti 1988).

To reduce spasticity and abnormal movement patterns with subsequent facilitation of "normal" movement skill was often stressed as a goal in Therapeutic riding programs (Bertoti, 1988; Benjamin, 1997). They claimed that the astride sitting posture on horseback resembled a reflex inhibition pattern (RIP) of neurodevelopment techniques for reducing the adduction/extension spasticity of lower extremities in children with spastic CP (Bobath, 1980). The astride sitting posture on horse back may also provide prolong stretching for the spastic hip adductors. The prolonged stretch can cause spasticity reduction for up to 35 minutes after stretching (Tremblay at al 1990). Therefore, the reported benefits of Therapeutic riding included decreasing spasticity of hip adductors (Bertoti 1988).

Despite these supportive researches further research is necessary and other researches showed different results, such as Cherng at al (2005), where improvement was noted in gross muscle functions in children with spastic CP, but no significant results were found in reduction of spasticity in the hip adductors muscles.
Debuse et al (2005) studied the differences between German and British physiotherapist's views on the effects of Therapeutic riding. The study revealed agreement among respondents on the overall perceived effects of hippotherapy on individuals with cerebral palsy, namely, the regulation of muscle tone, improvement of postural control and psychological benefits.

5.5 Increased joints range of motion
When spasticity is reduced, range of motion (ROM) increases. Limited ROM is occasionally the resultant of reduced mobility. Riding and its accompanied activities enhances mobility. As a result, joints range of motion may increase; stepping on the horse, the actual sitting position on the horse's back and stepping down from the horse's back encourage extension in the thoracic spine and flexion in the lower back. In this way these actions enhance increased ROM. Patting and hugging the horse encourage increased ROM in the upper limbs and assist in the reduction of spasm due to the protraction position in the scapula and the extension position of the elbow and wrist (Rosin 1980). The sitting position on the horse's back enables passive long lasting stretch of the hip adductors. If the child is unable to spread his legs wide enough to sit properly, he could be placed with his legs resting in front of him on the horse's shoulders and neck. It is expected that due to the horse's high body temperature and the movement it provides, the child will relax his muscles and proper sitting position could be gradually achieved.

5.6 Improved muscle symmetry
Benda et al (2003) evaluated the effect of hippotherapy on muscle activity in children with spastic cerebral palsy, using study design of pretest/post-test control group. Fifteen (15) children ranging from 4 to 12 years of age diagnosed with spastic cerebral palsy were randomized to either 8 minutes of hippotherapy or 8 minutes astride a stationary barrel. Outcome measures: Remote surface electromyography (EMG) was used to measure muscle activity of the trunk and upper legs during sitting, standing, and walking tasks before and after each intervention. The objectives were (1) to determine if there are any changes in muscle activity after a short hippotherapy session and (2) to compare the effects of symmetrical sitting practice on a stationary barrel to symmetrical sitting practice on a rhythmically moving horse. Results: after hippotherapy, significant improvement in symmetry of muscle activity was noted in those muscle groups displaying the highest asymmetry prior to hippotherapy. No significant change was noted after sitting astride a barrel. They
concluded that eight minutes of hippotherapy, but not stationary sitting astride a barrel, resulted in improved symmetry in muscle activity in children with spastic cerebral palsy. These results suggest that the movement of the horse rather than passive stretching accounts for the measured improvements. This improvement in symmetry was typically achieved through a reduction in activity of the overactive muscle group and a corresponding increase in muscle activity on the contralateral side adjusting to maintain balance.

5.7 Improved weight bearing & weight shifting capabilities

The horse's movement may improve weight bearing and shifting. When the rider is sitting properly and places an equal pressure on the stirrups in dorsi flexion position at the ankle, he gains feeling of weight bearing and weight shifting in each leg alternately, which occur in response to the movements of the horse's legs. This feeling closely resembles the feeling established during normal walking. Some of the disabled riders present a dominant leg, as in hemiparesis CP patients. Riding may induce placing more weight on the weaker leg if done properly and supervised closely by the instructor. If this weight shifting is preserved while keeping an upright posture, the rider will gain sensory input that is similar to the one gained from normal walking. Practicing weight bearing and weight shifting can be performed also with the rider leaning on his hands, which will be placed on various body parts of the horse (Would 1996). According to Bobath weight bearing positions assist in spasm reduction when those perform away from pathological pattern and during movement. Improvement of weight bearing and shifting enhances symmetrical posture in kneeling, sitting and standing, and assist in the prevention of structural deformities which may develop in the lack of symmetry (Bertoti 1988).

Bertoti (1991) measured weight bearing of arms and legs in one, 21/2-year-old child with hemiplegic CP. Weight bearing improved in both sides, arms and legs, but more so on the hemiplegic side; no statistics were reported for weight-bearing data. The author concluded that hippotherapy could be recommended to promote symmetry, equalize weight bearing, and facilitate weight shift in children with hemiplegia. Would (2003) was able to demonstrate statistically significant improvements in weight-shift and balance in eight children following an intense hippotherapy programme.

Liao et al (1997) reported that the ability to perform quicker rhythmic weight shifting has been noted to be correlated with walking performance in children with CP. Therefore, the ability of rhythmic weight shifting gained during Therapeutic riding may transfer to walking performance.
5.8 Improved walking abilities

As mentioned earlier in this paper, the three-dimensional, reciprocal movement of the walking horse produces normalized pelvic movement in the rider, closely resembling pelvic movement during ambulation in individuals without disability (Sterba et al 2007). The movement of the horse at walk does facilitate pelvic movement, which may be the result of a distinct similarity in pelvic displacements found between the horse and the human (Young, 2005). The movement angle of the horses’ pelvis at walk is very similar to that of a human pelvis during walking. The horse’s pelvis moves an average of 3.9 degrees in the sagittal plane, 6.98 in the frontal plane and 9.1 degrees in the transverse plane. Similarly, children’s gait involved about 2-3 degrees of pelvic motion in the sagittal plane, 10 degrees in the frontal plane and approximately 10 in the transverse plane (Cherng, 2004).

Understanding the separated components of walking is the key for understanding how the horse’s movement influences the rider’s back. The components are anterior-posterior pelvic tilt combined with back flexion-extension, side flexion and rotation.

1. The horse's movement influences the anterior-posterior pelvic tilt of the rider.
   When the horse’s front leg is lifted from the ground and going into the swing phase, the rider’s pelvic will move into posterior tilt and the back will move in flexion direction. When the horse’s front leg touches the ground and going into the stance phase, the rider’s pelvic will move into anterior tilt and the back will move in extension direction.

2. The rider’s pelvic is positioned in 90 degrees in relation to the horse’s pelvic.
   When the horse lifts his front leg, rotation in its pelvic occurs, which lead to side flexion movement of the rider’s back.

3. When the front leg of the horse is lifted from the ground and is in the swing phase, side flexion of its back occurs, which lead to rotation movement of the rider’s back (Rosenzweig 1992).

In a more general description, Kuhnel (2003) stated in her horse and rider movement analysis that while walking the rider will lean forward as one of the horse’s front legs is lifted and set on the ground in front of him. As each leg is lifted and placed in front of him a repetitive rolling motion of the rider is created.

Would (1998, 2000), found evidence that the walking ability of the subjects she investigated had improved after a period of hippotherapy as compared with an equal length control period. The aspects of walking ability she investigated were subject-specific and included parameters such as weight transfer from one leg to the other,
ability to stand without support, ability to walk without using a walking aid, and ability to stop and turn successfully. Furthermore, the functional improvement gained during hippotherapy was maintained when the subjects were examined several months later. In a subsequent study, Would (2003) was able to demonstrate statistically significant improvements in weight-shift and balance in eight children following an intense hippotherapy programme.

McGibbon et al (1998) evaluated the effects of an eight-week program of hippotherapy on performance on the Gross Motor Function Measure (GMFM)\textsuperscript{14}, energy expenditure during walking, and gait parameters in five children with spastic cerebral palsy. All five children demonstrated a significant decrease in energy expenditure during walking and a significant increase in GMFM walk/run/jump subtest after hippotherapy. A trend towards increased stride length and decreased cadence during walking was noted.

5.9 Increased sensory input
The senses are the center of existence. The sensory stimulation transfers from the horse to the receptors in the human body. In this way we can utilize the sensory integration created by the moving horse, in order to help people to improve body equilibration, balance, coordination, speech, bodily awareness, memory, self esteem and more. Touch stimulation, vestibular stimulations and orientation stimulation are dominant factors in the motorical development of a child. Riding horses is an easy method to create these stimulations. During riding the rider feels the mobile surface under his body; the muscles and joints receive these sensory inputs through the many proprioceptors and adjust the reactions accordingly.

When sitting on the horse, the rider has higher viewpoint. For some children this is the first time in a long while that they are able to look at the world around them from a high and entirely different point of view; this amplifies the visual and vestibular systems. The quick movements the riders is feeling lead to arousal of the information processing mechanisms in his body. The new perceived information allows the rider to rediscover his own body capabilities and reveal the degree of control one has on his own body (Shakedi 1998).

\textsuperscript{14} The Gross Motor Function Measure will be discussed in chapter 6
5.10 Vestibular stimulation
These stimulations occur in the vestibular system, which is located in the inner ear. The vestibular system is the sensory system that provides the dominant input about movement and equilibrioception (sense of balance). The vestibular system sends signals primarily to the neural structures that control our eye movements, and to the muscles that keep us upright. This system enables the body to maintain a stable posture and to execute movements against gravity. Individuals with limited mobility lack vestibular stimulations so that the disorder not only persists but deteriorates with time. During horseback riding, the child may comprehend and perceive the three dimensional rhythmical movements, which serve as a unique and efficient method for vestibular stimulation for patients with impaired and limited mobility (Shakedi 1998).

5.11 Propreceptive stimulation
Proprioception is a distinct sensory modality that provides feedback solely on the status of the body internally. It is the sense that indicates whether the body is moving with required effort, as well as where the various parts of the body are located in relation to each other. The proprioceptive sense is believed to be composed of information from sensory neurons located in the inner ear (motion and orientation) and in the stretch receptors located in the muscles and the joint-supporting ligaments. There are specific nerve receptors for this form of perception, just as there are specific receptors for pressure, light, temperature, sound, and other sensory experiences. During horseback riding, the rider receives a lot of information from his muscles and joints, and needs to process the continuous information throughout the quick movements and rhythm changes. Rhythm changes contribute to increase senses activity. The rider gradually learns to move in harmony with the horse's movement and to be aware of his body centre position in relation to the horse (Shakedi 1998).

5.12 Muscle strengthening
O'Neil et al (2006) presented a special report of recommendations for the clinical management of children with cerebral palsy, spastic diplegia when increased functional mobility is the identified outcome. His recommendations provide a framework that allows physical therapists to increase their accountability and promote effective interventions for improved patient outcomes. The recommendations are suggestions for clinical management, not an all-inclusive document on physical therapy for children with cerebral palsy. O'Neil's report
included the recommendation of Therapeutic riding as a therapeutic intervention for strengthening exercises, muscle symmetry, balance and coordination. Some examples are presented bellow;

- **Specific Considerations for Children (Six to 12 Years):**
  Effective strengthening strategies include electrical stimulation, bike riding, aquatics and hippotherapy. Hippotherapy has also recently been shown to improve muscle symmetry. Exercise to increase balance and coordination for function, such as hippotherapy.

- **Strengthening interventions for infants and preschoolers (birth to five years):**
  Strategies are introduced during play. Consider using therapy balls, aquatic therapy and Hippotherapy.

### 5.13 Psychological benefits

Not only physical, but also psychological benefits are attributed to horse riding. Testimonies of parents, therapists and patients bear witness to psychosocial benefits that include increased motivation, higher self-esteem, better concentration and academic performance (von Arbin 1994, Freeman 1984). Increased motivation plays an important role in cases where patients have become tired of clinically based therapy. Although the physical effects of hippotherapy tend to be of most interest to physiotherapists and doctors, there is a substantial and growing body of evidence of the psychological and emotional benefits of horse-human interaction in therapeutic riding in general (Debuse 2004).
6. Commonly used measurements tools

6.1 Gross Muscle Function Measure (GMFM)

Many of the articles used for this project, presented the Gross Muscle Function Measure (GMFM; Russell et al 1989) as their measurement tool. This section will provide explanation of this clinical measurement system, followed by research results of Therapeutic riding on GMFM scores as measured by the different authors. A sample of a GMFM score sheet is presented in Appendix no’1.

The GMFM was developed for use with children with CP to evaluate the effect of treatment over time on gross motor function without regard to the quality of the performance (Russell et al., 1993). GMFM is composed of 88 test items and is categorized into 5 developmental dimensions by test position: Dimension A (lie/roll), Dimension B (sit), Dimension C (crawl/kneel), Dimension D (stand), and Dimension E (walk/run/jump). Each dimension can be used independently. A 5-year-old child with normal gross motor ability usually could accomplish all items. Dimension C (crawl/kneel) consists of 14 items, such as creep, 4-point, and high kneel. Dimension D (stand) consists of 12 items, such as stand still, one leg stand, squat, and pick up object from floor. Dimension E (walk/run/jump) consists of 24 items, such as cruises, walk 1 hand held, walk alone, run, jump distance, and hop. Each item is scored on a 4-point rating scale. Values of 0, 1, 2, and 3 are assigned as follows: 0 = cannot do; 1 = initiates (completes < 10 % of the task); 2 = partially completes (completes 10 to < 100 % of the task); and 3 = task completion. We take the walking forward 10-step item in Dimension E to explain the scoring method: 0 = no initiation of walking, 1 = walking forward less than 3 steps, 2 = walking forward 3-9 steps, 3 = walking forward 10 steps. Item scores for each dimension are summed together and converted to yield a percentage score for that dimension. The total score is derived by averaging the percentage scores for all five dimensions (Russell et al., 1993). Since its development, GMFM has been widely accepted and applied by pediatric clinicians to evaluate the gross motor function in children with CP for both clinical and research purposes.

Therapeutic riding research;

McGibbon at al (1998) reported a significant increase in gross motor function as measured by the Gross Motor Function Measure were reported in 5 children with spastic CP after an 8-week, twice weekly program of hippotherapy.

Sterba at al (2002) investigated the effectiveness of a 1-hour per week horseback riding program for 18 weeks on 17 children with spastic cerebral palsy. They found that the GMFM total score and GMFM Dimension E score were significantly
increased.
Cherng et al (2004) concluded that some children with spastic CP in his study showed improved gross motor function after a period of 16 weeks in duration, 2 sessions per week, for 40 minutes per session Therapeutic riding. The improvement of gross motor function was significant in total scores and Dimension E (walk/run/jump) of GMFM, which basically involved upright movement functions. In addition, the effect appeared to sustain for at least 16 weeks.
Winchester at al (2002) examined the effects of a seven-week therapeutic riding program and looked at whether the changes were retained after the program was discontinued. The GMFM and a timed 10-meter walk were used with seven children with developmental delay. Significant improvements in gross motor function were found and were maintained seven weeks after the program ended.

6.2 Pediatric Evaluation of Disability Inventory (PEDI)
Several articles present the PEDI as their measurement tool. This section will provide a short explanation of this clinical measurement system.
A PEDI evaluation sheet is presented in Appendix no’ 2.
The Pediatric Evaluation of Disability Inventory (PEDI) is an adaptive assessment instrument that provides clear links between assessed functional capabilities and defined goals. The PEDI incorporates parent observation and is sensitive to small increments of change.
The PEDI may be used for the clinical evaluation of functional capabilities, performance and changes in functional skills in children with disabilities 6 months to 7.5 years of age. Completion of the PEDI yields information in the domains of self-care, mobility, and social functions with more specific information on the subdomains.
Therapeutic riding research;
Casady and Nichols-Larsen (2004) studied 11 children with cerebral palsy, aged 2.3-6.8 years. The Pediatric Evaluation of Disability Inventory (PEDI) was used in addition to the GMFM. The improvements in PEDI total score, PEDI social score, GMFM total score and GMFM crawling/kneeling subtest demonstrate a significant treatment effect after the hippotherapy phase and no change in function during the no-treatment phase of the study.
An investigation by Haehl et al (1999) analyzed the movement of both non-disabled children and children with cerebral palsy during the equine walk. As part of her results it is reported that in one of the children an improvement in functional ability (investigated with the Pediatric Evaluation of Disability, PEDI) was demonstrated.
7. Conclusions

In conclusion, research evidence suggests that clinicians and therapists can recommend both Therapeutic riding and Hippotherapy as efficacious, medically indicated therapy for gross motor rehabilitation of children with CP. Both uncontrolled and controlled trials of Therapeutic riding have shown beneficial effects on body structures and functioning.

Nearly all researchers mentioned in this paper recommend that future research be conducted that looks more specifically at explicit areas of function most affected. Future research that compares the effect of Therapeutic riding with other treatment procedures that do not involve a horse is also needed. Further studies with larger samples, blinded assessment, and non-riding controls are needed to conclusively evaluate and compare the different methods within Therapeutic horseback riding.

What complicates the evidence base for this topic is the fact that some authors seem to blur the boundaries between Hippotherapy and the other areas within therapeutic riding, both in their intervention and in their measurements. There is a variety not only in the methods used to process the data, but also in the duration and nature of the therapeutic riding program. Therapeutic riding methods are described and performed differently in various parts of the world. Perhaps uniform global definitions of the different methods are required. Another problem is the great variation in conditions presented in Cerebral Palsy disorder. Many of the patients present mixed symptoms that also frequently alters with time. The creators feel that research in general focused on spastic CP children and that further study is necessary to investigate the effects of Therapeutic riding in other groups of CP.

It is important to note that before recommending Therapeutic riding or Hippotherapy to parents of children with CP, clinicians should have up-to-date information about the facilities available in their locality. This should include the names and telephone numbers of the Therapeutic riding centers, their proximity to their patients, costs, and type and quality of service, as well as knowledge on safety issues, such as levels of staffing and training of instructors and side-walkers.

From a personal perspective, the creators believe that animal do have healing influence, and horses in particular. This paper did not focus on the psychological effects and their contribution to the overall condition. Further research is required in this field in order to understand whether improved mood and motivation level can assist in improvement of physical limitations. From the little experience the creators had while observing Therapeutic riding sessions, it is strongly believed that the smile on the children's faces when they are on the horse, should never be considered as
irrelevant or not important. Few happy moments on the horse's back might mean the whole world for a child suffering from CP. After writing this thesis project, both creators found this topic to be fascinating. They intent to increase their knowledge in this field and feel extremely glad to come across such a unique therapeutic approach, that encounter animals and nature in the world of the disabled, which is usually consist of indoors activities and therapy methods that are applied in the same closed doors.
8. References

Cerebral Palsy literature list:


**Therapeutic riding literature list:**


• NARHA 2006 Statistical NARHA Center Information. Retrieved 15 October, 2007 from URL: http://www.narha.org


• Shumway-Cook, A. & Woollacott M.H. (2001), Motor Control: Translating Research into Clinical Practice, Lippincott Williams & Wilkins

Articles in Hebrew:

• Rosenzweig, M. (1992). Horseback Riding as a Therapeutic Tool, Horse world magazine 5-8:6