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# **THE PLACE OF THE HYPERBARIC OXYGENATION (HBO) IN THE TREATMENT STRATEGY OF CHILDREN WITH CEREBRAL PALSY AND RELATED DISORDERS**

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The high incidence of cerebral palsy (CP) and the difficulties in the corrections of the motor, speech and/or mental deficit determines the importance for investigation of new therapeutic approaches enlarging the treatment strategy for these children.

CP is "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 its development" (*Mutch et al. 1992*). Recognized associated impairments include sensory defects, cognitive and learning disability, behavioral disorders, and the presence of seizures of different types as well as very rare visual and hearing disability. The likelihood and severity of associated disabilities increases with increasing extent and severity of motor impairment (*Stanley et al 2000*).

CP has to be considered as a diagnosis of children aged at least 2 years old (*Stanley et al 2000*), as diagnosis before the age of 1 year 6 months is known to be unreliable. The presence of neurological and motor signs of developmental delay before the age of 1 year 6 months is defined with different terms as: "CP-risk infants"; "Central Motor Disturbance"; "Transitory Dystonic Syndrome" ; "Central Koordination Storung" or "Durchgang Syndrome". All these terms indicate the transitional identity of that status, which could be normalized 100% or the opposite - to develop a CP picture.

The child with "central motor disturbance" or "CP-risk child" has the chance to reach full normalizing of its motor development before the age 1 year 6 months – 2 years (*Vojta 1984*), because after that age the primitive and pathological reflexes and stereotypes destroy the normal locomotion and coordination and we find the coming up picture of the CP.

The treatment of the "CP-risk child" (or the child with central motor disturbance) should be directed to organization of the brain functions, i.e. toward creation of cerebral connections. The destroyed brain cells can not be restored and these, which are damaged, can not be repaired. Trough stimulating the creation of new bonds between the healthy cells becomes possible the healthy parts of the brain to take the functions of the damaged or destroyed cerebral cells. The more bonds there are between the neurons the better is the working ability of the system, which in its turn means better functional level.

## **Treatment strategy – what is that?**

Although the CP is "untreatable", in the common sense of the word, the therapy, the training, the interventions and the education can help for the improving the brain functions of the injured child, which improvement is more significant when these activities had started earlier(*Vojta 1984*).

The neurological organization of infants brain is a developing process, which could be influenced positively by different mechanisms.

The combination of the different methods for the determinate term and according to the calendar, motor and mental age and the severity of the symptoms for every single child, define the treatment strategy (TS), including medical and educational activities.

The medical part of TS is directed toward the stimulating of motor development. After the birth by the "CP-risk infants" TS is directed toward the improvement of brain metabolism, activating of brain blood-circulation, stimulating of muscular coordination and strength, building the body-scheme and the orientation in the space. After the age of 3-4 year by the "fixed CP" it is good too, to correct the muscular tone, to assure elasticity of injured muscular groups as well as the passive and active range of motion in the joints.

The spectrum of medical TS consist from different therapy methods as well as physiotherapy, low-frequency impulsive magnetic field, TENS, thermotherapy, underwater jet-massage, hyperbaric oxygenation, laser acupuncture, medication – per os (psycho-stimulants, myorelaxants, anticonvulsants) or local injected BtA, splints, surgical operations and others according to hospital management. A very important problem all over the time is prevention and therapy of the seizures.

### **What is the best therapy combination for the TS ?**

Its depend on a lot of factors: economical, cultural; but mainly on the hospital management, the doctors` point of view and the new research achievements.

A very short overview (Сарафова и съавт. 1987) of some more frequently used therapy approaches for the CP, could give us an idea how and why we could combine them, according our point of view.

*PHYSIOTHERAPY* is the main method in the TS of children with CP of all ages. It has best effect when it is started in the first tri-menon after the birth. Then is recommended to stimulate the muscle co-ordination of the movements by the Vojta and/or Bobath's (NDT) methods. After the child grow up at 2 years calendar age or motor age more than 9 months (independent creeping) the methods of Bobath and Sensory - Integration Therapy are more used. By the children after 5th years age are included also physical exercises directed to the relatively weak muscles.

*MAGNETIC-FIELD THERAPY* – we are applying low-frequent impulsive magnetic field – trans-cranially, preferably in the age till 12-16 months. Magnetic field improves brain metabolism by the oxygen utilization, activation of oxidative process and acceleration of cerebral blood flow in the magnetized tissue region.

*TENS* are applied by local and/or distal manner preferably after 24-th month. The local type is applied by relatively weaken muscles, antagonists of the spastic ones. The distal type is applied in the area of the cervical and/or lumbar thickening of the spinal cord, depending from the type of CP, gross motor abilities and the level of the muscular hyper-tonus. By TENS we could reach a strengthening of weak muscles, some short-lasting myorelaxation of spastic ones, an assertion of muscle elasticity, a prevention of muscle hypotrophia as well as sensory-integrated brain stimulation for any cases in an earlier age.

*THERMO-THERAPY* includes heat application by paraffin, gel or cold applications with gel, ice or cold air. The procedures have well expressed myorelaxing effect as well as a trophic such. They are applied to children after 24 – 36 months old with spastically increased muscle tone. The myorelaxation after cryo-therapy has rapid and short-lasting effect while after the heat-therapy has slow and long-lasting such.

*HYDRO-THERAPY* and specially the under-water jet-massage has well expressed myorelaxing effect over the spastic muscles and good trophic effect for the weakened muscles in dependence of its dosage for the children bigger than 36 months old. It could be applied too for children from 12 to 36 months old as a tool for creation of body-scheme and space orientation.

*LAZER ACU-PUNCTURE* - with very low power Helium-Neon or Infrared rays, is a painless and adjunctive method for reflex stimulation of the brain function toward motor, speech and mental activities. Its application is used, always after EEG examination after the age of 48 months.

**MEDICATION** according to the protocols of Specialized Hospital for Residential Treatment of Prolonged Therapy and Rehabilitation of Children with Cerebral Palsy "Santa Sofia" includes the use of few types of drugs: myo-relaxants, psycho-stimulants and anticonvulsants.

*Myo-relaxants* are applied according to the type of CP, its severity and achieved motor age, per os between 18 – 36 months old and local by BtA-injection between 24 months and 7-8 years old.

*Psycho-stimulants* (nootropics, amino-acids and others) are applied specially for kids with slow or limited ideomotor activity or mental retardation in the age after 24 months, when they are in status of pre-self-dependent walking.

*Anticonvulsant* are the necessary part of TS for the CP with associated seizures.

### **The new approaches:**

**HYPERBARIC OXYGENATION** (HBO) is the administration of 100% pure oxygen at greater pressures than that at sea level. Thus under hyperbaric conditions there will be an increase in oxygen in the following body tissues and fluids: bone, urine, plasma, lymph and cerebrospinal fluid. Some effects of pressurized oxygen in chronic brain insult, as one of the reasons for CP, are (*Neubauer 2003*):

- Reactivates idling neurons
- Enhances plasticity
- Efficiently elevates diffusional driving force for O<sub>2</sub> thereby increasing tissue oxygen availability
- Promotes phagocytosis (internal debridement)
- Ameliorates multiple biochemical changes
- Restores the integrity of the blood brain barrier and cell membranes
- Improves cell respiration, reduces cell byproducts – cytokines
- Promotes neovascularization
- Promotes epithelization
- Acts as scavenger of free radicals

- Bacteriostatic effects and neutralized certain toxins

### **Where is the place of HBO in the TS of CP ?**

Current data about the application of HBO for CP-treatment do not demonstrate one-way answers.

An our retrospective investigation (*Chavdarov et al 2001*) of 2522 infants treated by different way in Specialized Hospital for Residential Treatment of Prolonged Therapy and Rehabilitation of Children with Cerebral Palsy "Santa Sofia" in the period between 1993 and 2000 years, was done. The treatment has been started latest in third month after the birth and medical checking has been monthly. 41% of the infants are been treated just with physiotherapy (ad style Vojta or Bobath-NDT) and 59% of the them are been treated combined – physiotherapy and low-frequent impulsive magnetic field or hyperbaric oxygenation. The CP-risk infants are been with different level of motor disturbance according Vojta`s Neuro-Kinesiologikal Diagnosis (*Vojta 1984*).

The obtained results indicated that:

1. The "CP-risk infants" with combined treatment had 32% better outcome by the level of motor disturbance than these treated just with physiotherapy.
2. From all infants who did not fixed CP, these carried out combined treatment (Physio + LIMP or HBO) were 21% more than these with one-way Physiotherapy.

This study gives us the vision of abilities for building-up a TS with wider spectrum of therapy approaches with different mechanisms of action. TS has to include physiotherapy as a basic and classical method with proved influence over brain mature and forming of new brain connections for CP-risk infants and it could be better if physiotherapy is supported from the low-frequent impulsive magnetic field or hyperbaric oxygenation, which supplement its mechanisms.

Especially to observe the effects of hyperbaric oxygenation over the developmental out-come of CP-risk infants, succeeding investigations (*Chavdarov 2003*) in the same hospital were done. 96 CP-risk infants with central motor disturbance 3-level and spastic manace, treated with neuro-developmental physiotherapy or combine (neuro-developmental physiotherapy and HBO) and checked for spontaneous motor abilities and provoked motor activities before and after treatment, were investigated.

The obtained results indicated that:

1. spontaneous motor abilities and provoked motor activities increased significantly according statistical analyses in the 12<sup>th</sup> month and in the 18<sup>th</sup> month with the use of combined-treatment (neuro-developmental physiotherapy and HBO) versus mono-treatment with physiotherapy.
2. Development out-come of CP-risk infants is much more better, when in their early life, a combination of neuro-developmental physiotherapy and HBO, was used.

This study statistically prove the positive influence of HBO over the maturity and rebuilding processes of the structures and connections in the injured brain as well as the necessity of including of hyperbaric oxygenation in early periods of TS for CP-risk infants.

An investigation for the effects of hyperbaric oxygenation on psycho-motor functions by children with a "fixed" CP, was done too (*Chavdarov 2001*).

50 children with wide age range from 1 year 7 month to 19 years with different types of CP (spastic, ataxic/hypotonic and mixed as well as hemi-, di- and quadriplegia) was checked for their motor-, mental- and speech-abilities with different tests before and after the treatment with HBO. During the HBO-treatment, with the parents permission, no other therapy was done. The heterogeneous composition of investigated group and checked activities defined the way of change-registrations: without improvement (no new test-points), mild improvement (one/two new test-points) and moderate improvement (three and more new test-points).

All CP children ended the HBO-procedures were with motor delay or difficulties, 34 of them were with mental deviations and 41 of them were with speech deviations.

The obtained results indicated:

1. Four CP children (4/50) could not finished the HBO-treatment therefore unwanted side effects – activated seizures, activated oral movements, extreme pulse-rate, face hyperesthesia.
2. The motor improvement was mild by 28,2% (13/46) and moderate by 13,1% (6/46) or any improvement was registered by 41,3% of cases
3. The mental improvement was mild by 29,4% (10/34) and moderate by 5,9% (2/34) or any improvement was registered by 35,3% of cases
4. The speech improvement was mild (15/41) by 36,5% and moderate (3/41) by 7q4% or any improvement was registered by 43,9% of cases
5. Any improvement (single or combine) of psycho-motor functions of tested participants was reached by (28/46) 60,9% of them.

This study declare the HBO-treatment as a type of therapy by CP, resulted in improvement of motor, speech and mental activities. HBO was successful for bigger part of the treated children in different aspects of their disabilities.

**The HBO protocol we used, was:**

1. 20-30 procedures were carried out into a mono place chamber.
2. The air-pressure was 1,5-1,7 ATA
3. HBO-procedure lasted 50-60 minutes including: 10+10 min. compression/decompression and 30-40 min. iso-compression.
4. During the iso-compression the patients were breathing pure damp oxygen trough a hoot.

**What we suggest according our experience with HBO for CP?**

In the very early stages of the brain injure in the term after the delivery, when a diagnosis of central motor disturbance is done, especially for that newborns with

perinatal hypoxic-ishaemic events which risk for CP is many ones more (between 2-10%) than in a normal population (*Stanley et al 2000*), HBO has to be used as a basic method of therapy together with the physiotherapy.

TS for CP has a very poor spectrum in the period of the first two years after the delivery. The healing mechanisms of HBO are a perfect way to support the brain restoration in the injured newborn. Further more that the mechanisms of HBO and physiotherapy are with good one another coexistence and the HBO potentiated the efficacy of the physiotherapy.

By CP-risk infants, as is mentioned above, the HBO resulted in an improvement, which returned bigger part of these children to a normal functioning.

The other part of the obtained results indicate, that HBO can be an effective adjunctive treatment for the children with fixed CP, where the brain functions are separated yet in different areas – motor and cognitive.

In the motor area was noted an stimulation of ideo-motor activity which lead some time to gain a new motor milestones, to move more quickly or on longer distances or to increase the strength or range of motion. We noted an increased of manipulative actions by some of the fixed CP too.

In the cognitive area was noted different positive changes:

An increasing of “active” speech by some of the HBO-treated “fixed CP” children, was reached. For the children over 36 months, the speech production and articulation were augmented and a lot of new sounds was appeared especially for the children under 36 months, where an prattle-activation was reached;

An improvement in the field of the attention and its components as concentration, volume, steadiness and distribution, was noted by some of HBO-treated CP-children as well as an improvement of the memory and especially its ability for fixation.

It is necessary to be noted that while HBO resulted in an improvement, it did not return these children to normal functioning, although some of them made impressive gains which had a major impact on their life quality.

As we know there are few unwanted effects by the therapy with HBO, but most important of them, according our experience, is the activation of seizures.

There are different points of views about seizures and its treatment with HBO. The use of our HBO-protocol lead to an clinical manifestation of seizures by some patients (*Chavdarov 2001*) and especially by these CP-children with EEG and clinical characteristics of seizures. Therefore CP-children with clinical or EEG characteristics of seizures are not suitable for HBO-treatment and before to include such a patient for HBO its necessary to do a careful anamnesis for seizures and EEG-investigation.

### **Conclusion:**

According our investigations and experience in the HBO-treatment of children with CP, we suggest the necessity HBO to be included in treatment strategy of CP and related disorders, as a basic one by “CP-risk” infants and as an adjunctive such by “fixed” CP, whereas an EEG-examination to be carry out before the beginning of HBO.

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