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Interventions and Management

1. *Front Hum Neurosci.* 2016 Jul 15;10:354. doi: 10.3389/fnhum.2016.00354. eCollection 2016.

Restricted Arm Swing Affects Gait Stability and Increased Walking Speed Alters Trunk Movements in Children with Cerebral Palsy.

Delabastita T, Desloovere K, Meyns P.

Observational research suggests that in children with cerebral palsy, the altered arm swing is linked to instability during walking. Therefore, the current study investigates whether children with cerebral palsy use their arms more than typically developing children, to enhance gait stability. Evidence also suggests an influence of walking speed on gait stability. Moreover, previous research highlighted a link between walking speed and arm swing. Hence, the experiment aimed to explore differences between typically developing children and children with cerebral palsy taking into account the combined influence of restricting arm swing and increasing walking speed on gait stability. Spatiotemporal gait characteristics, trunk movement parameters and margins of stability were obtained using three dimensional gait analysis to assess gait stability of 26 children with cerebral palsy and 24 typically developing children. Four walking conditions were evaluated: (i) free arm swing and preferred walking speed; (ii) restricted arm swing and preferred walking speed; (iii) free arm swing and high walking speed; and (iv) restricted arm swing and high walking speed. Double support time and trunk acceleration variability increased more when arm swing was restricted in children with bilateral cerebral palsy compared to typically developing children and children with unilateral cerebral palsy. Trunk sway velocity increased more when walking speed was increased in children with unilateral cerebral palsy compared to children with bilateral cerebral palsy and typically developing children and in children with bilateral cerebral palsy compared to typically developing children. Trunk sway velocity increased more when both arm swing was restricted and walking speed was increased in children with bilateral cerebral palsy compared to typically developing children. It is proposed that facilitating arm swing during gait rehabilitation can improve gait stability and decrease trunk movements in children with cerebral palsy. The current results thereby partly support the suggestion that facilitating arm swing in specific situations possibly enhances safety and reduces the risk of falling in children with cerebral palsy.

[PMID: 27471457](#)

2. *Hum Mov Sci.* 2016 Jul 13;49:178-185. doi: 10.1016/j.humov.2016.07.001. [Epub ahead of print]

Biomechanical analysis of gait termination in 11-17year old youth at preferred and fast walking speeds.

Ridge ST, Henley J, Manal K, Miller F, Richards JG.

In populations where walking and/or stopping can be difficult, such as in children with cerebral palsy, the ability to quickly stop walking may be beyond the child's capabilities. Gait termination may be improved with physical therapy. However, without a greater understanding of the mechanical requirements of this skill, treatment planning is difficult. The purpose of this study was to understand how healthy children successfully terminate gait in one step when walking quickly, which can be

challenging even for healthy children. Lower extremity kinematic and kinetic data were collected from 15 youth as they performed walking, planned, and unplanned stopping tasks. Each stopping task was performed as the subject walked at his/her preferred speed and a fast speed. The most significant changes in mechanics between speed conditions (preferred and fast) of the same stopping task were greater knee flexion angles (unplanned: $+16.49 \pm 0.54^\circ$, $p=0.00$; planned: $+15.75 \pm 1.1^\circ$, $p=0.00$) and knee extension moments (unplanned: $+0.67 \pm 0.02 \text{N/kgm}$, $p=0.00$; planned: $+0.57 \pm 0.23 \text{N/kgm}$, $p=0.00$) at faster speeds. The extra range of motion in the joints and extra muscle strength required to maintain the stopping position suggests that stretching and strengthening the muscles surrounding the joints of the lower extremity, particularly the knee, may be a useful intervention.

[PMID: 27423033](#)

3. Rehabil Nurs. 2016 Jul 22. doi: 10.1002/rnj.293. [Epub ahead of print]

Evaluation of Functional Status Associated with Overweight in Adults with Cerebral Palsy.

de la Torre-Olivares R, Moreno-Lorenzo C, Pérez-Mármol JM, Cabrera-Martos I, Villaverde-Gutierrez C, Castro Sánchez AM, Aguilar-Ferrándiz ME.

PURPOSE: To describe the motor disability level of ambulatory adults with overweight and cerebral palsy (CP) and to investigate the functional factors associated with weight gain in this population. **DESIGN:** Cross-sectional study. **METHODS:** Thirty adults with CP were classified according to their body mass index (BMI). Mobility, physical disability, functional independence, gait and balance, gross motor function, and maximum walking speed were assessed to evaluate their physical status. The influence of demographic and functional factors on BMI was analyzed, using bivariate and multivariate regression analyses. **FINDINGS:** Multiple regression analyses showed that age ($p = .012$) and lower cardiorespiratory function/lower walking distance ($p = .048$) were significantly associated with higher BMI. Other functional outcomes were not associated with BMI. **CONCLUSIONS:** Greater age and reduced walking distance related to cardiorespiratory function seem to be the main factors associated with BMI. **CLINICAL RELEVANCE:** Cardiorespiratory rehabilitation is recommended in conjunction with nutritional nursing interventions.

[PMID: 27443819](#)

4. Dev Med Child Neurol. 2016 Jul 27. doi: 10.1111/dmcn.13192. [Epub ahead of print]

Using diffusion tensor imaging to identify corticospinal tract projection patterns in children with unilateral spastic cerebral palsy.

Kuo HC, Ferre CL, Carmel JB, Gowatsky JL, Stanford AD, Rowny SB, Lisanby SH, Gordon AM, Friel KM.

AIM: To determine whether diffusion tensor imaging (DTI) can be an independent assessment for identifying the corticospinal tract (CST) projecting from the more-affected motor cortex in children with unilateral spastic cerebral palsy (CP). **METHOD:** Twenty children with unilateral spastic CP participated in this study (16 males, four females; mean age 9y 2mo [standard deviation (SD) 3y 2mo], Manual Ability Classification System [MACS] level I-III). We used DTI tractography to reconstruct the CST projecting from the more-affected motor cortex. We mapped the motor representation of the more-affected hand by stimulating the more- and the less-affected motor cortex measured with single-pulse transcranial magnetic stimulation (TMS). We then verified the presence or absence of the contralateral CST by comparing the TMS map and DTI tractography. Fisher's exact test was used to determine the association between findings of TMS and DTI. **RESULTS:** DTI tractography successfully identified the CST controlling the more-affected hand (sensitivity=82%, specificity=78%). **INTERPRETATION:** Contralateral CST projecting from the lesioned motor cortex assessed by DTI is consistent with findings of TMS mapping. Since CST connectivity may be predictive of response to certain upper extremity treatments, DTI-identified CST connectivity may potentially be valuable for determining such connectivity where TMS is unavailable or inadvisable for children with seizures.

[PMID: 27465858](#)

5. Dev Med Child Neurol. 2016 Jul 28. doi: 10.1111/dmcn.13209. [Epub ahead of print]

Mapping corticospinal tract projection patterns in unilateral cerebral palsy.

Basu AP.

[No abstract available]

[PMID: 27471192](#)

6. Dev Med Child Neurol. 2016 Jul 16. doi: 10.1111/dmcn.13199. [Epub ahead of print]

Cerebral palsy is associated with an elevated risk of stroke throughout life: evidence from Taiwan.

Day SM.

[No abstract available]

[PMID: 27422853](#)

7. Eur J Paediatr Neurol. 2016 Jul 12. pii: S1090-3798(16)30094-0. doi: 10.1016/j.ejpn.2016.07.005. [Epub ahead of print]

Status dystonicus in children: Early recognition and treatment prevent serious complications.

Combe L, Abu-Arafeh I.

This is a retrospective study of all patients presenting to our paediatric unit with status dystonicus (SD) over a period of five years. Anonymous information was collected and a descriptive analysis is made. There were four episodes of SD in three children between 11 and 15 years of age. All children are known to have severe dyskinetic cerebral palsy and presented with an acute or sub-acute deterioration in their symptoms. Symptoms were triggered by infections in three of the four episodes. Early features included frequent and repetitive generalized muscle spasms, poor swallowing, poor sleep, distress and pain. Patients responded to supportive treatment, rehydration, benzodiazepines, baclofen and l-dopa. Intensive care was not necessary in any of the patients and patients made full recovery within 5-14 days. This report shows the value of early recognition and treatment of SD can be successful in preventing serious complications.

[PMID: 27444503](#)

8. Front Hum Neurosci. 2016 Jun 24;10:284. doi: 10.3389/fnhum.2016.00284. eCollection 2016.

Does a Combination of Virtual Reality, Neuromodulation and Neuroimaging Provide a Comprehensive Platform for Neurorehabilitation? - A Narrative Review of the Literature.

Teo WP, Muthalib M, Yamin S, Hendy AM, Bramstedt K, Kotsopoulos E, Perrey S, Ayaz H.

In the last decade, virtual reality (VR) training has been used extensively in video games and military training to provide a sense of realism and environmental interaction to its users. More recently, VR training has been explored as a possible adjunct therapy for people with motor and mental health dysfunctions. The concept underlying VR therapy as a treatment for motor and cognitive dysfunction is to improve neuroplasticity of the brain by engaging users in multisensory training. In this review, we discuss the theoretical framework underlying the use of VR as a therapeutic intervention for neurorehabilitation and provide evidence for its use in treating motor and mental disorders such as cerebral palsy, Parkinson's disease, stroke, schizophrenia, anxiety disorders, and other related clinical areas. While this review provides some insights into the efficacy of VR in clinical rehabilitation and its complimentary use with neuroimaging (e.g., fNIRS and EEG) and neuromodulation (e.g., tDCS and rTMS), more research is needed to understand how different clinical conditions are affected by VR therapies (e.g., stimulus presentation, interactivity, control and types of VR). Future studies should consider large, longitudinal randomized controlled trials to determine the true potential of VR therapies in various clinical populations.

[PMID: 27445739](#)

9. J Pediatr Urol. 2016 Jun 11. pii: S1477-5131(16)30116-4. doi: 10.1016/j.jpuro.2016.05.027. [Epub ahead of print]

Bladder and bowel continence in bilateral cerebral palsy: A population study.

Wright AJ, Fletcher O, Scrutton D, Baird G.

INTRODUCTION: The attainment of continence is an important milestone in all children, including those with disability. **OBJECTIVE:** To describe the age of bladder and bowel continence in children with bilateral cerebral palsy (BCP), and the association with intellectual impairment (II) and severity of motor disability. **PATIENTS AND METHODS:** The parents of 346 children with BCP were interviewed as part of a population-based prospective study of the children at 3, 7, and 17 years of age. The age of bladder and bowel continence by day and night was ascertained and compared with controls from the Avon Longitudinal Study of Parents and Children (ALSPAC). **RESULTS:** The median age for daytime bladder and bowel continence in BCP children was 5.4 years compared with 2.4 years in the controls. At 13.8 years of age, 59.4% of BCP children and 99% of controls were continent by day. In BCP children, there was no difference between the attainment of daytime bladder and bowel control. Night-time bladder and bowel control was slower and less completely attained, with 50% of BCP children continent by the age of 11.8 years compared with 3 years in control children. At 13.8 years of age, 51.9% of BCP children compared with 99.4% of controls were continent for bowel and bladder at night. Gross Motor Functional Classification Score (GMFCS) and intellectual ability (IA) (II) were strongly associated with continence attainment ($P < 0.0001$), but gender was not. **DISCUSSION:** Delayed and less complete continence attainment was noted in other clinic series of children with cerebral palsy (including hemiplegics) and children with II. Severity of motor disability (GMFCS), and II impacted on other aspects of toilet training, such as: motivation, understanding, communication, and independence skills. The presence of neurogenic bladder and bowel dysfunction can occur in all levels of GMFCS. Thus, there are many reasons that can prevent continence attainment. **CONCLUSIONS:** Children with BCP achieved day and night-time bladder and bowel continence more slowly and less completely than controls, with 60.8% being continent by day and 54.6% by night at the age of 17 years. The majority of BCP children who were continent by day had achieved this by the age of 5.5 years (86%). At least 88% of BCP children with GMFCS I/II and normal, specific or mild learning impairment were continent for bladder and bowel by day and night. Expectations should be shared with parents, and failure to attain expected continence should be actively investigated.

[PMID: 27448847](#)

10. Zh Nevrol Psikhiatr Im S S Korsakova. 2016;116(4. Vyp 2. Children's neurology and psychiatry):68-75.

[The evaluation of the clinical efficacy of complex treatment and preventive orthodontic and rehabilitation measures in children with spastic cerebral paralysis]. [Article in Russian]

Bronnikov VA, Danilova MA, Zalazaeva EA.

Based on the results of the comprehensive examination of 120 patients, the necessity of development and introduction of rehabilitation complex of therapeutic and preventive measures with regard to the type and severity of cerebral paralysis and patient's age in practice was shown. The main purpose of treatment and preventive measures was a complete social adaptation of children with spastic forms of cerebral paralysis, which was dependent on the integrity of speech functions. Rehabilitation measures were implemented by single multidisciplinary team with clear functional responsibilities of each member. The study determined the efficacy of treatment, preventive and rehabilitation measures in children with spastic forms of cerebral paralysis. It has been shown that the complex of treatment-and-preventive and rehabilitation measures for children with spastic forms of cerebral paralysis is positive and should be carried out continuously, from the early age to the maximum achievable level of correction of lost functions.

[PMID: 27456724](#)

11. Res Dev Disabil. 2016 Jul 13;57:125-135. doi: 10.1016/j.ridd.2016.03.015. [Epub ahead of print]

Factors contributing to the longitudinal development of social participation in individuals with cerebral palsy.

Tan SS, van der Slot WM, Ketelaar M, Becher JG, Dallmeijer AJ, Smits DW, Roebroek ME; PERRIN+ study group.

AIMS: We aimed to determine factors associated with the longitudinal development of social participation in a Dutch population of individuals with Cerebral Palsy (CP) aged 1-24 years. **METHODS AND PROCEDURES:** For this multicentre prospective longitudinal study, 424 individuals with CP aged 1-24 years were recruited from various rehabilitation centers in The Netherlands. Social participation was measured with the Vineland Adaptive Behavior Scales. We assessed associations

with age, intellectual impairment, level of gross motor function, gender, type of CP, manual ability, epilepsy, hearing-, visual-, speech impairment and pain, internalizing- and externalizing behavioral problems, type of education and parental level of education. Each individual was measured 3 or 4 times. The time between measurements was 1 or 2 years. **OUTCOMES AND RESULTS:** Epilepsy and speech impairment were each independently associated with the longitudinal development of social participation. The effects were rather small and did not change with age. Also, a trend was found that children attending special education develop less favorably in social participation. **CONCLUSIONS AND IMPLICATIONS:** Our results might provide parents and caregivers with starting points to further develop tailored support for individuals with epilepsy, with speech impairment and/or attending special education at risk for suboptimal social participation.

[PMID: 27423104](#)

12. Acta Paediatr. 2016 Jul 28. doi: 10.1111/apa.13532. [Epub ahead of print]

Slow pupillary light responses in infants at high risk of cerebral palsy were associated with periventricular leukomalacia and neurological outcome.

Hamer EG, Vermeulen JR, Dijkstra LJ, Hielkema T, Kos C, Bos AF, Hadders-Algra M.

AIM: Having observed slow pupillary light responses (PLR) in infants at high risk of cerebral palsy, we retrospectively evaluated whether these were associated with specific brain lesions or unfavourable outcomes. **METHODS:** We carried out neurological examinations on 30 infants at very high risk of cerebral palsy five times until the corrected age of 21 months, classifying each PLR assessment as normal or slow. The predominant reaction during development was determined for each infant. Neonatal brain scans were classified based on the type of brain lesion. Developmental outcome was evaluated at 21 months of corrected age with a neurological examination, the Bayley Scales of Infant Development Second Edition and the Infant Motor Profile. **RESULTS:** Of the 30 infants, 16 developed cerebral palsy. Predominantly slow PLR were observed in eight infants and were associated with periventricular leukomalacia ($p=0.007$), cerebral palsy ($p=0.039$), bilateral cerebral palsy ($p=0.001$), poorer quality of motor behaviour ($p<0.0005$) and poorer cognitive outcome ($p=0.045$). **CONCLUSION:** This explorative study suggested that predominantly slow PLR in infants at high risk of cerebral palsy were associated with periventricular leukomalacia and poorer developmental outcome. Slow PLR might be an expression of white matter damage, resulting in dysfunction of the complex cortico-subcortical circuitries. This article is protected by copyright. All rights reserved.

[PMID: 27468114](#)

Prevention and Cure

13. Brain Pathol. 2016 Jul 28. doi: 10.1111/bpa.12421. [Epub ahead of print]

Upregulation of cystathione β -synthase and p70S6K/S6 in neonatal hypoxic ischemic brain injury.

Lechpammer M, Tran YP, Wintermark P, Martínez-Cerdeño V, Krishnan VV, Ahmed W, Berman RF, Jensen FE, Nudler E, Zagzag D.

Encephalopathy of prematurity (EOP) is a complex form of cerebral injury that occurs in the setting of hypoxia-ischemia (HI) in premature infants. Using a rat model of EOP, we investigated whether neonatal HI of the brain may alter the expression of cystathionine β -synthase (CBS) and the components of the mammalian target of rapamycin (mTOR) signaling. We performed unilateral carotid ligation and induced HI (UCL/HI) in Long-Evans rats at P6 and found increased CBS expression in white matter (i.e., corpus callosum, cingulum bundle and external capsule) as early as 24 hours (P7) post-procedure. CBS remained elevated through P21, and, to a lesser extent, at P40. The mTOR downstream target 70 kDa ribosomal protein S6 kinase (p70S6K and phospho-p70S6K) and 40S ribosomal protein S6 (S6 and phospho-S6) were also overexpressed at the same time points in the UCL/HI rats compared to healthy controls. Overexpression of mTOR components was not observed in rats treated with the mTOR inhibitor everolimus. Behavioral assays performed on young rats (postnatal day 35-37) following UCL/HI at P6 indicated impaired preference for social novelty, a behavior relevant to autism spectrum disorder, and hyperactivity. Everolimus restored behavioral patterns to those observed in healthy controls. A gait analysis has shown that motor deficits in the hind paws of UCL/HI rats were also significantly reduced by everolimus. Our results suggest that neonatal HI brain injury may inflict long-term damage by upregulation of CBS and mTOR signaling. We propose this cascade as a possible new molecular target for EOP - a still untreatable cause of autism, hyperactivity and cerebral palsy.

[PMID: 27465493](#)

14. Eur J Paediatr Neurol. 2016 Jul 9. pii: S1090-3798(16)30091-5. doi: 10.1016/j.ejpn.2016.07.002. [Epub ahead of print]

Advancing non-invasive neuromodulation clinical trials in children: Lessons from perinatal stroke.

Kirton A.

Applications of non-invasive brain stimulation including therapeutic neuromodulation are expanding at an alarming rate. Increasingly established scientific principles, including directional modulation of well-informed cortical targets, are advancing clinical trial development. However, high levels of disease burden coupled with zealous enthusiasm may be getting ahead of rational research and evidence. Experience is limited in the developing brain where additional issues must be considered. Properly designed and meticulously executed clinical trials are essential and required to advance and optimize the potential of non-invasive neuromodulation without risking the well-being of children and families. Perinatal stroke causes most hemiplegic cerebral palsy and, as a focal injury of defined timing in an otherwise healthy brain, is an ideal human model of developmental plasticity. Advanced models of how the motor systems of young brains develop following early stroke are affording novel windows of opportunity for neuromodulation clinical trials, possibly directing neuroplasticity toward better outcomes. Reviewing the principles of clinical trial design relevant to neuromodulation and using perinatal stroke as a model, this article reviews the current and future issues of advancing such trials in children.

[PMID: 27470654](#)

15. J Med Life. 2016 Apr-Jun;9(2):170-6.

Correlations between risk factors and functional evolution in patients with spastic quadriplegia.

Rogoveanu OC, Tuțescu NC, Kamal D, Alexandru DO, Kamal C, Streba L, Trăistaru MR.

Cerebral palsy is the most common cause of developing neuro-motor disability in children, in many cases, the triggering cause remaining unknown. Quadriplegia is the most severe spastic cerebral palsy, characterized by severe mental retardation and bi-pyramidal syndrome. The purpose of this paper was to demonstrate the importance of knowing the risk factors and the psychosomatic ones, determining to what extent they influence the functional evolution in patients diagnosed with spastic quadriplegia. 23 children diagnosed with spastic quadriplegia were included in the study, being aged between 1 year and half and 12 years. Patients were assessed at baseline (T1), at one year (T2) and after two years at the end of the study (T3). Patients received a comprehensive rehabilitation program for the motor and sensory deficits throughout the study. Initially, a comprehensive evaluation (etiopathogenic, clinical and functional) that started from a thorough medical history of children (the older ones), was conducted but chose parents to identify the risk factors, and a complete physical exam. At each assessment, joint and muscle balance was conducted. To assess functionality, the gross motor function classification systems (GMFCS) and manual ability (MACS) were used. Many risk factors that were classified according to the timeline in prenatal factors, perinatal and postnatal, were identified from a thorough history. A direct correlation was noticed between the decrease of coarse functionality and manual ability, both initially and in dynamic and low APGAR scores, low gestational age, low birth weight and a higher body mass index of the mother. A direct link was observed between the gross motor function and the manual ability. A significant improvement in the MACS score was noticed in patients with a better GMFCS score.

[PMID: 27453749](#)

16. Pediatrics. 2016 Jul 21. pii: e20160269. [Epub ahead of print]

Neurodevelopmental Disorders or Early Death in Siblings of Children With Cerebral Palsy.

Tollånes MC, Wilcox AJ, Stoltenberg C, Lie RT, Moster D.

OBJECTIVES: To explore the presence of shared underlying causes of cerebral palsy (CP) and other neurodevelopmental disorders, by examining risks of other disorders in siblings of children with CP. **METHODS:** We used Norwegian national registries to identify 1.4 million pairs of full siblings (singletons) and 28 000 sets of twins born from 1967 to 2006, identify stillbirths and neonatal deaths, and find individuals with CP, epilepsy, intellectual disability, autism spectrum disorders, attention-deficit/hyperactivity disorder, blindness, deafness, schizophrenia, and bipolar disorder. Associations between CP in 1

sibling and neurodevelopmental disorders or early death in other siblings were estimated using logistic regression models. RESULTS: here were 5707 neonatal survivors (beyond 28 days) with CP (2.5/1000). These children had substantial comorbidity (eg, 29% had epilepsy). Singleton siblings of (singleton) children with CP had increased risks of neurodevelopmental problems, including epilepsy (odds ratio [OR], 1.8 [95% confidence interval (CI), 1.5-2.5]), intellectual disability (OR, 2.3 [95% CI, 1.8-2.9]), autism spectrum disorders (OR, 1.6 [95% CI, 1.1-2.2]), attention-deficit/hyperactivity disorder (OR 1.3 [95% CI, 1.1-1.6]), blindness (OR 2.4 [95% CI, 1.1-5.4]), and schizophrenia (OR 2.0 [95% CI, 1.2-3.2]). There was no increase in risk of bipolar disorder (OR 1.0 [95% CI, 0.6-1.6]). Families with children with CP also had increased risk of losing another child in the perinatal period (stillbirth OR, 1.8 [95% CI, 1.5- 2.3]; neonatal death OR, 1.7 [95% CI, 1.3- 2.2]). Associations were stronger within sets of twins. CONCLUSIONS: Siblings of a child with CP were at increased risk for a variety of other neurodevelopmental morbidities, as well as early death, indicating the presence of shared underlying causes.

[PMID: 27443356](#)