

# Science Infos

## Paralysie Cérébrale

N°34 MARS 2017



FONDATION  
PARALYSIE CÉRÉBRALE  
LA FONDATION MOTRICE

### Focus



*Les besoins non satisfaits en matière de réadaptation sont substantiels et toujours croissants à travers le monde et sont particulièrement aigus dans les pays à revenus faibles ou intermédiaires. L'accroissement de la prévalence des maladies non transmissibles, le vieillissement de la population et l'amélioration de l'accès aux soins d'urgence, aux traumatismes et aux soins médicaux correspondent à une demande croissante de services de réadaptation.*

*Le plan d'action mondial de l'OMS relatif au handicap 2014- 2021 propose des actions qui ont pour objectif de renforcer et de développer la réadaptation.*

*Une réunion s'est tenue au siège de l'OMS à Genève les 6 et 7 février 2017 rassemblant des représentants des gouvernements, l'OMS et d'autres organismes des Nations Unies, des représentants des groupes d'utilisateurs se service de réadaptatio et des prestataires de services de réadaptation, des organismes de financement, les principales organisations professionnelles, des instituts de rcherche et les organisations internationales et non gouvernementales concernées avec pour objectifs*

- *d'attirer l'attention sur les besoins en réadaptation,*
- *de mettre en évidence le rôle de la réadapttion dans la réalisation des objectifs de développement durable*
- *d'appeler à une ation mondiale coordonnée et concertée en vue de renforcer la réadaptation dans les systèmes de santé.*

*Le compte rendu de la réunion est disponible sur le site de l'OMS*

<http://www.who.int/disabilities/care/rehab-2030/en/>

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# Manifestations et congrès

## Mai 2017

### Formation rééducation intensive: fondements, évidences scientifiques et principes clés

L'Institut Motricité Cérébrale a le plaisir de vous proposer une journée exceptionnelle à Paris en compagnie des auteurs et promoteurs de la recherche faite sur la rééducation intensive HABIT et HABIT-ILE

17 mai 2017

Paris, France

[http://www.fondationparalysiecerebrale.org/sites/default/files/reeducation\\_intensive.pdf](http://www.fondationparalysiecerebrale.org/sites/default/files/reeducation_intensive.pdf)

### 29th Annual EACD Meeting,

17-20 mai 2017

Amsterdam, Pays bas

<http://www.eacd2017.org/>

## Juin 2017

### Congrès Réseau Breizh - Sferhe – CDI

#### "La paralysie cérébrale au fil du temps »

26-27 juin 2017

Saint Malo, France

<http://www.tmsevents.fr/congres/2017/sferhe/>

## Octobre 2017

### 32e congrès de la SOFMER

05-07 octobre 2017

Nancy, France

<http://nancy.sofmer2017.com/index.php?pageID=09eb828f52123930a2186e7b5a4db890>

### European Congress of NeuroRehabilitation (ECNR)

24-27 octobre 2017

Lausanne, Suisse

<http://www.ecnr-congress.org/>

## Juillet 2018

### 12 th International Society of Physical and Rehabilitation Medicine ( ISPRM) World Congress

08-12 juillet 2018

Paris, France

<http://www.isprm2018.com/>



# Publications scientifiques

## Méthodologie de la recherche

Le profil de veille a été mis en place sur Pubmed avec le mot clé "Cerebral Palsy" pour des publications majoritairement en français ou en anglais, avec abstract ou full text

**Free article** indique le lien vers les articles dont le texte intégral est librement disponible

## Epidémiologie

### Cerebral Palsy-Trends in Epidemiology and Recent Development in Prenatal Mechanisms of Disease, Treatment, and Prevention.

Stavsky M, Mor O, Mastrolia SA, Greenbaum S, Than NG, Erez O.

*Front Pediatr.* 2017 Feb 13;5:21. doi: 10.3389/fped.2017.00021. eCollection 2017.

Cerebral palsy (CP) is the most common motor disability in childhood. This syndrome is the manifestation of intrauterine pathologies, intrapartum complications, and the postnatal sequel, especially among preterm neonates. A double hit model theory is proposed suggesting that an intrauterine condition along with intrapartum or postnatal insult lead to the development of CP. Recent reports demonstrated that treatment during the process of preterm birth such as magnesium sulfate and postnatal modalities such as cooling may prevent or reduce the prevalence of this syndrome. Moreover, animal models demonstrated that postnatal treatment with anti-inflammatory drugs coupled with nanoparticles may affect the course of the disease in pups with neuroinflammation. This review will describe the changes in the epidemiology of this disease, the underlying prenatal mechanisms, and possible treatments that may reduce the prevalence of CP and alter the course of the disease.

**Free PMC Article**

DOI: 10.3389/fped.2017.00021

PMCID: PMC5304407

PMID: 28243583

## ✚ Prévalence- Incidence

### Prevalence Estimate of Cerebral Palsy in Northern Alberta: Births, 2008-2010.

Robertson CM, Ricci MF, O'Grady K, Oskoui M, Goetz H, Yager JY, Andersen JC

*Can J Neurol Sci.* 2017 Mar 21;1-9. doi: 10.1017/cjn.2017.33. [Epub ahead of print]

**OBJECTIVES:** The objectives of this study were to determine prevalence estimates of cerebral palsy (CP) among 5-year-old children in northern Alberta; to provide congenital, gestational age- and birth weight-specific, and postneonatal CP rates; and to describe motor subtypes and function.

**METHODS:** This population-based prevalence estimate study, part of the Canadian Cerebral Palsy Registry, reports confirmed CP diagnoses at age 5 years made by pediatric rehabilitation and child neurology specialists. Prevalence rates with 95% confidence intervals (CIs) used Alberta government denominators of same-age children and live births.

**RESULTS:** The Northern Alberta CP rate (birth years, 2008-2010) for 173 5-year-old children is 2.22 (95% CI 2.12, 2.32) per 1000 5-year-old children. The congenital CP rate is 1.99 (95% CI, 1.89-2.09) per 1000 live births; unilateral congenital CP, 1.0 (95% CI, 0.64-1.36) per 1000 live births; and postneonatal CP, 0.12 (95% CI, 0.1-0.14) per 1000 live births. Gestational age-specific rates are similar: age <28 weeks, 27.2 (95% CI, 23.05-31.35) and 28 to 31 weeks, 29.5 (95% CI, 25.78-33.22). Motor subtypes for 169 children (data missing, 4; male, 97; postnatal, 9) are: spastic, 148 (87.6%) including 31 (20.9%) with diplegia, 10 (6.8%) triplegia, 33 (22.2%) quadriplegia, 74 (50%) hemiplegia/monoplegia; and dyskinetic, 18 (10.6%) and ataxic, 3 (1.8%). A total of 107 (63.3%) ambulate without assistive devices and 111(65.7%) handle most objects with their hands independently.

CONCLUSIONS: This is the fourth Canadian CP prevalence study; one from Quebec used a similar case ascertainment approach and two 1980s studies from Alberta and British Columbia used administrative databases. Northern Alberta CP rates are comparable with other developed countries. The hemiplegic subtype is the most common. Rates among preterm children have declined but are similar for the <28 and 28 to 31 gestation-week groups.

DOI: 10.1017/cjn.2017.33

PMID: 28322177

### **Prevalence of Cerebral Palsy among 8-Year-Old Children in 2010 and Preliminary Evidence of Trends in Its Relationship to Low Birthweight.**

Durkin MS, Benedict RE, Christensen D, Dubois LA, Fitzgerald RT, Kirby RS, Maenner MJ, Van Naarden Braun K, Wingate MS, Yeargin-Allsopp M

*Paediatr Perinat Epidemiol.* 2016 Sep;30(5):496-510. doi: 10.1111/ppe.12299. Epub 2016 May 23.

BACKGROUND: The public health objective for cerebral palsy (CP) in the United States is to reduce the percentage of children with CP who were born low birthweight (LBW, <2500 g) by 10% between 2006 and 2020. This study reports the prevalence of CP in a constant surveillance area for the years 2006, 2008, and 2010 and describes initial progress towards the CP public health objective.

METHODS: Data on children with CP at age 8 years were ascertained by the Autism and Developmental Disabilities Monitoring (ADDM) Network, a population-based surveillance system that monitored CP in four areas of the United States.

RESULTS: CP prevalence in 2010 was 2.9 per 1000 [95% confidence interval (CI) 2.6, 3.2], down from 3.5 (95% CI 3.2, 3.9) in the same surveillance area in 2006. Among CP cases with no documented postneonatal aetiology, 49.1% (95% CI 42.9, 55.2) were born LBW in 2010 compared with 54.3% (95% CI 48.4, 60.1) in 2006. In 2010, 28.1% (95% CI 22.9, 30.4) were born very low birthweight (VLBW, <1500 g) compared with 35.4% (95% CI 30.0, 41.2) in 2006. The relative risks for associations between CP and both LBW and VLBW also declined, though not significantly, during the study period.

CONCLUSIONS: Declines in the associations between CP and LBW categories may have contributed to declines during the study period in both the prevalence of CP and the percentage of children with CP who were born LBW or VLBW. Ongoing monitoring of these trends is warranted.

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DOI: 10.1111/ppe.12299

PMCID: PMC5351288

PMID: 27215680 [Indexed for MEDLINE]

## **Facteurs de risque – Causes**

### **Antecedents and neuroimaging patterns in cerebral palsy with epilepsy and cognitive impairment: a population-based study in children born at term.**

Ahlin K, Jacobsson B, Nilsson S, Himmelmann K

*Acta Obstet Gynecol Scand.* 2017 Mar 12. doi: 10.1111/aogs.13128. [Epub ahead of print]

INTRODUCTION: Antecedents of accompanying impairments in cerebral palsy (CP) and their relation to neuroimaging patterns need to be explored.

MATERIAL AND METHODS: A population-based study of 309 children with CP born at term in 1983-1994. Pre-, intra- and postpartum variables previously studied as antecedents of CP type and motor severity were analysed in children with CP and cognitive impairment and/or epilepsy, and in children with CP without these accompanying impairments. Neuroimaging patterns and their relation to identified antecedents were analysed. Data were retrieved from the CP register of western Sweden, obstetric and neonatal records.

RESULTS: Children with CP and accompanying impairments more often had low birth weight (kg) (OR 0.5 95% CI; 0.3-0.8), brain maldevelopment known at birth ( $p=0.007$ , OR  $\infty$ ) and neonatal infection (OR 5.4 (1.04-28.4)). Moreover, neuroimaging patterns of maldevelopment (OR 7.2 95% CI; 2.9-17.2), cortical/subcortical lesions (OR 5.3 95% CI; 2.3-12.2) and basal ganglia lesions (OR 7.6 95% CI; 1.4-41.3) were more common, whereas white matter injury was found significantly less often (OR 0.2 95% CI; 0.1-0.5). In most children with maldevelopment, the intra- and postpartum period was uneventful ( $p<0.05$ ). Cerebral maldevelopment was associated with prepartum antecedents, while subcortical/cortical and basal ganglia lesions were associated with intra- and postpartum antecedents.

CONCLUSION: No additional factor other than those related to motor impairment was associated with epilepsy and cognitive impairment in CP. Timing of antecedents deemed important for the development of CP with accompanying impairments were supported by neuroimaging patterns.

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DOI: 10.1111/aogs.13128

PMID: 28295155

### **Association Between Maternal Body Mass Index in Early Pregnancy and Incidence of Cerebral Palsy.**

Villamor E, Tedroff K, Peterson M, Johansson S, Neovius M, Petersson G, Cnattingius S.

*JAMA*. 2017 Mar 7;317(9):925-936. doi: 10.1001/jama.2017.0945.

Importance: Maternal overweight and obesity are associated with increased risks of preterm delivery, asphyxia-related neonatal complications, and congenital malformations, which in turn are associated with increased risks of cerebral palsy. It is uncertain whether risk of cerebral palsy in offspring increases with maternal overweight and obesity severity and what could be possible mechanisms.

Objective: To study the associations between early pregnancy body mass index (BMI) and rates of cerebral palsy by gestational age and to identify potential mediators of these associations.

Design, Setting, and Participants: Population-based retrospective cohort study of women with singleton children born in Sweden from 1997 through 2011. Using national registries, children were followed for a cerebral palsy diagnosis through 2012.

Exposures: Early pregnancy BMI.

Main Outcomes and Measures: Incidence rates of cerebral palsy and hazard ratios (HRs) with 95% CIs, adjusted for maternal age, country of origin, education level, cohabitation with a partner, height, smoking during pregnancy, and year of delivery.

Results: Of 1 423 929 children included (mean gestational age, 39.8 weeks [SD, 1.8]; 51.4% male), 3029 were diagnosed with cerebral palsy over a median 7.8 years of follow-up (risk, 2.13 per 1000 live births; rate, 2.63/10 000 child-years). The percentages of mothers in BMI categories were 2.4% at BMI less than 18.5 (underweight), 61.8% at BMI of 18.5 to 24.9 (normal weight), 24.8% at BMI of 25 to 29.9 (overweight), 7.8% at BMI of 30 to 34.9 (obesity grade 1), 2.4% at BMI of 35 to 39.9 (obesity grade 2), and 0.8% at BMI 40 or greater (obesity grade 3). The number of cerebral palsy cases in each BMI category was 64, 1487, 728, 239, 88, and 38; and the rates per 10 000 child-years were 2.58, 2.35, 2.92, 3.15, 4.00, and 5.19, respectively. Compared with children of normal-weight mothers, adjusted HR of cerebral palsy were 1.22 (95% CI, 1.11-1.33) for overweight, 1.28 (95% CI, 1.11-1.47) for obesity grade 1, 1.54 (95% CI, 1.24, 1.93) for obesity grade 2, and 2.02 (95% CI, 1.46-2.79) for obesity grade 3.

Results were statistically significant for children born at full term, who comprised 71% of all children with cerebral palsy, but not for preterm infants. An estimated 45% of the association between maternal BMI and rates of cerebral palsy in full-term children was mediated through asphyxia-related neonatal morbidity.

Conclusions and Relevance: Among Swedish women with singleton children, maternal overweight and obesity were significantly associated with the rate of cerebral palsy. The association was limited to children born at full term and was partly mediated through asphyxia-related neonatal complications.

DOI: 10.1001/jama.2017.0945

PMID: 28267854

### **Children born at 32 to 35 weeks with birth asphyxia and later cerebral palsy are different from those born after 35 weeks.**

Garfinkle J, Wintermark P, Shevell MI, Oskoui M; Canadian Cerebral Palsy Registry. Collaborators: Andersen J, Buckley D, Fehlings D, Kirton A, Moore A, van Rensburg E, Wood E.

*J Perinatol*. 2017 Mar 16. doi: 10.1038/jp.2017.23. [Epub ahead of print]

OBJECTIVE: The objectives of this study were to (1) establish the proportion of cerebral palsy (CP) that occurs with a history suggestive of birth asphyxia in children born at 32 to 35 weeks and (2) evaluate their characteristics in comparison with children with CP born at  $\geq 36$  weeks with such a history.

STUDY DESIGN: Using the Canadian CP Registry, children born at 32 to 35 weeks of gestation with CP with a history suggestive of birth asphyxia were compared with corresponding  $\geq 36$  weeks of gestation children.

RESULTS: Of the 163 children with CP born at 32 to 35 weeks and 738 born at  $\geq 36$  weeks, 26 (16%) and 105 (14%) had a history suggestive of birth asphyxia, respectively. The children born at 32 to 35 weeks had more frequent

abruptio placenta (35% vs 12%; odds ratio (OR) 4.1, 95% confidence interval (CI) 1.5 to 11.2), less frequent neonatal seizures (35% vs 72%; OR 0.20, 95% CI 0.08 to 0.52), more frequent white matter injury (47% vs 17%; OR 4.3, 95% CI 1.3 to 14.0), more frequent intraventricular hemorrhage (IVH) (40% vs 6%; OR 11.2, 95% CI 3.4 to 37.4) and more frequent spastic diplegia (24% vs 8%; OR 1.8, 95% CI 1.2 to 12.2) than the corresponding  $\geq 36$  weeks of gestation children.

**CONCLUSIONS:** Approximately 1 in 7 children with CP born at 32 to 35 weeks had a history suggestive of birth asphyxia. They had different magnetic resonance imaging patterns of injury from those born at  $\geq 36$  weeks and a higher frequency of IVH. Importantly, when considering hypothermia in preterm neonates with suspected birth asphyxia, prospective surveillance for IVH will be essential. *Journal of Perinatology* advance online publication, 16 March 2017; doi:10.1038/jp.2017.23.

DOI: 10.1038/jp.2017.23

PMID: 28300820

### **Chorioamnionitis at birth does not increase the risk of neurodevelopmental disability in premature infants with bronchopulmonary dysplasia.**

Bashir RA, Bhandari V, Vayaltrikkovil S, Rabi Y, Soraisham A, Tang S, Al Awad E, Lodha A

*Acta Paediatr.* 2016 Nov;105(11):e506-e512. doi: 10.1111/apa.13556.

**AIM:** To compare preterm infants with no bronchopulmonary dysplasia (BPD), BPD with chorioamnionitis (BPDC) and BPD with no chorioamnionitis (BPDNC) for the association with neurodevelopmental disability (NDD) at three years corrected age.

**METHODS:** Demographic and outcome data of infants with birthweight (BW)  $\leq 1250$  g born during two epochs (1995-2000 and 2002-2007 with an interim washout period of one year) were compared on the basis of whether they had BPD, chorioamnionitis or both. Any NDD was considered present if there was either mild-severe cerebral palsy (CP), cognitive delay, visual or hearing impairment. Logistic regression modelling was performed.

**RESULTS:** Infants (n = 1009) were included into three groups - no BPD (n = 442), BPDNC (n = 437) and BPDC (n = 130). The adjusted odds ratio (aOR) of any NDD at three years in infants with BPDC versus BPDNC was 1.37; 95% CI 0.85-2.20, and for CP the aOR was 1.66; 95% CI 0.76-3.62. Infants in the BPDC group were of lower BW, gestational age and had longer length of hospital stay, duration of mechanical ventilation, more blood transfusions and sepsis compared to BPDNC and no BPD groups (all p < 0.001).

**CONCLUSION:** Chorioamnionitis was not associated with any increase in the odds of NDD in infants with BPD at three years corrected age.

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PMID: 27552089 [Indexed for MEDLINE]

### **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.

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

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.

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PMCID: PMC4863509

PMID: 27453749 [Indexed for MEDLINE]

### **Could Perinatal Asphyxia Induce a Synaptopathy? New Highlights from an Experimental Model.**

Herrera MI, Otero-Losada M, Udovin LD, Kusnier C, Kölliker-Frers R, de Souza W, Capani F.

*Neural Plast.* 2017;2017:3436943. doi: 10.1155/2017/3436943. Epub 2017 Feb 23.

Birth asphyxia also termed perinatal asphyxia is an obstetric complication that strongly affects brain structure and function. Central nervous system is highly susceptible to oxidative damage caused by perinatal asphyxia while activation and maturity of the proper pathways are relevant to avoiding abnormal neural development. Perinatal asphyxia is associated with high morbimortality in term and preterm neonates. Although several studies have demonstrated a variety of biochemical and molecular pathways involved in perinatal asphyxia physiopathology, little is known about the synaptic alterations induced by perinatal asphyxia. Nearly 25% of the newborns who survive perinatal asphyxia develop neurological disorders such as cerebral palsy and certain neurodevelopmental and learning disabilities where synaptic connectivity disturbances may be involved. Accordingly, here we review and discuss the association of possible synaptic dysfunction with perinatal asphyxia on the basis of updated evidence from an experimental model.

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DOI: 10.1155/2017/3436943

PMCID: PMC5343259

PMID: 28326198

### **Pathogenesis of cerebral palsy through the prism of immune regulation of nervous tissue homeostasis: literature review.**

Lisovska N, Daribayev Z, Lisovskyy Y, Kussainova K, Austin L, Bulekbayeva S.

*Childs Nerv Syst.* 2016 Nov;32(11):2111-2117. Epub 2016 Sep 14.

**BACKGROUND:** The cerebral palsy is highly actual issue of pediatrics, causing significant neurological disability. Though the great progress in the neuroscience has been recently achieved, the pathogenesis of cerebral palsy is still poorly understood.

**METHODS:** In this work, we reviewed available experimental and clinical data concerning the role of immune cells in pathogenesis of cerebral palsy. Maintaining of homeostasis in nervous tissue and its transformation in case of periventricular leukomalacia were analyzed.

**RESULTS:** The reviewed data demonstrate involvement of immune regulatory cells in the formation of nervous tissue imbalance and chronicity of inborn brain damage. The supported opinion, that periventricular leukomalacia is not a static phenomenon, but developing process, encourages our optimism about the possibility of its correction.

**CONCLUSIONS:** The further studies of changes of the nervous and immune systems in cerebral palsy are needed to create fundamentally new directions of the specific therapy and individual schemes of rehabilitation.

DOI: 10.1007/s00381-016-3245-5

PMID: 27638717 [Indexed for MEDLINE]

### **Primary Human Cytomegalovirus (HCMV) Infection in Pregnancy.**

Buxmann H, Hamprecht K, Meyer-Wittkopf M, Friese K.

*Dtsch Arztebl Int.* 2017 Jan 27;114(4):45-52. doi: 10.3238/arztebl.2017.0045.

**BACKGROUND:** In 0.5-4% of pregnancies, the prospective mother sustains a primary infection with human cytomegalovirus (HCMV). An HCMV infection of the fetus in the first or second trimester can cause complex post-encephalitic impairment of the infant brain, leading to motor and mental retardation, cerebral palsy, epilepsy, retinal defects, and progressive hearing loss.

**METHODS:** This review is based on pertinent publications from January 2000 to October 2016 that were retrieved by a selective search in PubMed employing the terms "cytomegalovirus and pregnancy" and "congenital cytomegalovirus."

**RESULTS:** 85-90% of all neonates with HCMV infection are asymptomatic at birth. The main long-term sequela is hearing impairment, which develops in 8-15% of these affected children. Hygienic measures can lower the risk of primary HCMV infection in pregnancy by 50-85%. The first randomized and controlled trial (RCT) of passive immunization with an HCMV-specific hyper-immune globulin (HIG) preparation revealed a trend toward a lower risk of congenital transmission of the virus (30% versus 44% with placebo,  $p = 0.13$ ). The effect of HIG was more marked in the initial non-randomized trial (15% versus 40%,  $p = 0.02$ ). The RCT also showed HIG to be associated with a higher frequency of fetal growth retardation and premature birth (13% versus 2%,  $p = 0.06$ ). Valaciclovir is a further, non-approved treatment option.

**CONCLUSION:** In the absence of an active vaccine against HCMV, counseling about hygienic measures may currently be the single most effective way to prevent congenital HCMV infection. Moreover, HCMV serologic testing is recommended in the guideline of the Association of the Scientific Medical Societies in Germany (Arbeitsgemeinschaft der Wissenschaftlichen Medizinischen Fachgesellschaften, AWMF). Further randomized trials of treatment with HIG and with valaciclovir are urgently needed so that the options for the prevention and treatment of congenital HCMV infection can be assessed.

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DOI: 10.3238/arztebl.2017.0045

PMID: 28241924

## G n tique

### **Variants of the EAAT2 Glutamate Transporter Gene Promoter Are Associated with Cerebral Palsy in Preterm Infants.**

Rajatileka S, Odd D, Robinson MT, Spittle AC, Dwomoh L, Williams M, Harding D, Wagstaff M, Owen M, Crosby C, Ching J, Moln r E, Luyt K, V radi A.

*Mol Neurobiol.* 2017 Mar 7. doi: 10.1007/s12035-017-0462-1. [Epub ahead of print]

Preterm delivery is associated with neurodevelopmental impairment caused by environmental and genetic factors. Dysfunction of the excitatory amino acid transporter 2 (EAAT2) and the resultant impaired glutamate uptake can lead to neurological disorders. In this study, we investigated the role of single nucleotide polymorphisms (SNPs; g.-200C>A and g.-181A>C) in the EAAT2 promoter in susceptibility to brain injury and neurodisability in very preterm infants born at or before 32-week gestation. DNA isolated from newborns' dried blood spots were used for pyrosequencing to detect both SNPs. Association between EAAT2 genotypes and cerebral palsy, cystic periventricular leukomalacia and a low developmental score was then assessed. The two SNPs were concordant in 89.4% of infants resulting in three common genotypes all carrying two C and two A alleles in different combinations. However, in 10.6% of cases, non-concordance was found, generating six additional rare genotypes. The A alleles at both loci appeared to be detrimental and consequently, the risk of developing cerebral palsy increased four- and sixfold for each additional detrimental allele at -200 and -181 bp, respectively. The two SNPs altered the regulation of the EAAT2 promoter activity and glutamate homeostasis. This study highlights the significance of glutamate in the pathogenesis of preterm brain injury and subsequent development of cerebral palsy and neurodevelopmental disabilities. Furthermore, the described EAAT2 SNPs may be an early biomarker of vulnerability to neurodisability and may aid the development of targeted treatment strategies.

DOI: 10.1007/s12035-017-0462-1

PMID: 28271401

## **L sions - Pr vention des l sions**

### Donn es fondamentales

#### **Olig1 is required for Noggin-induced neonatal myelin repair.**

Sabo JK, Heine V, Silbereis JC, Schirmer L, Levison SW, Rowitch DH.

*Ann Neurol.* 2017 Mar 2. doi: 10.1002/ana.24907. [Epub ahead of print]

Objective - Neonatal white matter injury (NWMI) is a lesion found in preterm infants that can lead to cerebral palsy. Although antagonists of bone morphogenetic protein (BMP) signaling, such as Noggin, promote oligodendrocyte precursor cell (OPC) production after hypoxic-ischemic injury, the downstream functional targets are poorly understood. The bHLH protein Olig1 promotes oligodendrocyte (OL) development and is essential during remyelination in adult mice. Here, we investigated whether Olig1 function is required downstream of BMP antagonism for the response to injury in the neonatal brain. Methods - We used wild type and Olig1 mutant mice subjected to neonatal stroke and postnatal neural progenitor cultures, and we analyzed Olig1 expression in human postmortem samples from neonates that suffered hypoxic-ischemic encephalopathy (HIE).

Results -Olig1-null neonatal mice showed significant hypomyelination after moderate neonatal stroke. Surprisingly, damaged white matter tracts in Olig1<sup>-/-</sup> mice lacked Olig2<sup>+</sup> OPCs and instead proliferating neuronal precursors and GABAergic interneurons were present. We demonstrate that Noggin-induced OPC production requires Olig1 function. In postnatal neural progenitors, Noggin governs production of OLs versus interneurons through Olig1-mediated repression of Dlx1/2 transcription factors. Additionally, we observed that Olig1 and the BMP signaling effector pSMAD1/5/8 are elevated in the subventricular zone (SVZ) of human infants with HIE compared to controls. Interpretation - These findings indicate that Olig1 has a critical function in the regulation of the postnatal neural progenitor cell production in response to Noggin. This article is protected by copyright. All rights reserved.

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DOI: 10.1002/ana.24907

PMID: 28253550

### **Spinal cord injury in hypertonic newborns after antenatal hypoxia-ischemia in a rabbit model of cerebral palsy.**

Drobyshevsky A, Quinlan KA.

*Exp Neurol.* 2017 Mar 24;293:13-26. doi: 10.1016/j.expneurol.2017.03.017. [Epub ahead of print]

While antenatal hypoxia-ischemia (H-I) is a well-established cause of brain injury, the effects of H-I on the spinal cord remain undefined. This study examined whether hypertonia in rabbits was accompanied by changes in spinal architecture. Rabbit dams underwent global fetal H-I at embryonic day 25 for 40min. High resolution diffusion tensor imaging was performed on fixed neonatal CNS. Fractional anisotropy (FA) and regional volumetric measurements were compared between kits with and without hypertonia after H-I and sham controls using Tract Based Spatial Statistics. Hypertonic kits showed evidence of damage from hypoxia not only in the brain, but in spinal cord as well. Hypertonic kits showed reduced FA and thickness in corticospinal tracts, external capsule, fimbria, and in white and gray matter of both cervical and lumbar spinal cord. Dorsal white matter of the spinal cord was the exception, where there was thickening and increased FA in hypertonic kits. Direct damage to the spinal cord was demonstrated in a subset of dams imaged during H-I with a 3T magnetic resonance scanner, where apparent diffusion coefficient in fetal spinal cords acutely decreased during hypoxia. Hypertonic kits showed subsequent decreases in lumbar motoneuron counts and extensive TUNEL- and Fluoro-Jade C-positive labeling was present in the spinal cord 48h after H-I, demonstrating spinal neurodegeneration. We speculate that global H-I causes significant loss of both spinal white and gray matter in hypertonic newborns due to direct H-I injury to the spinal cord as well as due to upstream brain injury and consequent loss of descending projections.

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PMID: 28347765

## **Données cliniques**

### **Erythropoietin monotherapy in perinatal asphyxia with moderate to severe encephalopathy: a randomized placebo-controlled trial.**

Malla RR, Asimi R, Teli MA, Shaheen F, Bhat MA.

*J Perinatol.* 2017 Mar 9. doi: 10.1038/jp.2017.17. [Epub ahead of print]

OBJECTIVE: Erythropoietin (EPO) is neuroprotective after asphyxia in animal studies. The efficacy and safety of EPO monotherapy in term neonates with hypoxic ischemic encephalopathy (HIE) is uncertain.

STUDY DESIGN: Hundred term neonates with moderate or severe HIE were randomized by random permuted block algorithm to receive either EPO 500 U kg<sup>-1</sup> per dose in 2 ml saline intravenously (50 neonates) on alternate days for a total of five doses with the first dose given by 6 h of age (treatment group) or 2 ml of normal saline (50 neonates)

similarly for a total of five doses (placebo group) in a double-blind study. No hypothermia was given. The primary outcome was combined end point of death or moderate or severe disability at mean age of 19 months (s.d., 0.61).

**RESULTS:** Death or moderate or severe disability occurred in 40% of neonates in the treatment group vs 70% in the placebo group (risk ratio, 0.57; 95% confidence interval (CI) 0.38 to 0.85; P=0.003). Death occurred in 16% of patients in both the groups (risk ratio, 1.0; 95% CI 0.33 to 2.9; P=0.61). The risk of cerebral palsy was lower among survivors in the treatment group (risk ratio, 0.52; 95% CI 0.25 to 1.03; P=0.04) and lesser number of babies were on anticonvulsants at assessment (risk ratio, 0.47; 95% CI 0.20 to 1.01; P=0.03). Neonatal brain magnetic resonance imaging showed more abnormalities in the placebo group (relative risk, 0.66; 95% CI 0.42 to 1.03; P=0.04). Improvement in other neurological outcomes was not significant.

**CONCLUSION:** EPO monotherapy reduces the risk of death or disability in term neonates with moderate or severe encephalopathy. *Journal of Perinatology advance*

online publication, 9 March 2017; doi:10.1038/jp.2017.17.

DOI: 10.1038/jp.2017.17

PMID: 28277490

### **Extent of altered white matter in unilateral and bilateral periventricular white matter lesions in children with unilateral cerebral palsy.**

Scheck SM, Fripp J, Reid L, Pannek K, Fiori S, Boyd RN, Rose SE.

*Res Dev Disabil.* 2016 Aug;55:368-76. doi: 10.1016/j.ridd.2016.04.007.

**AIMS:** To investigate the extent of white matter damage in children with unilateral cerebral palsy (UCP) caused by periventricular white matter lesions comparing between unilateral and bilateral lesions; and to investigate a relationship between white matter microstructure and hand function.

**METHODS AND PROCEDURES:** Diffusion MRI images from 46 children with UCP and 18 children with typical development (CTD) were included. Subjects were grouped by side of hemiparesis and unilateral or bilateral lesions. A voxel-wise white matter analysis was performed to identify regions where fractional anisotropy (FA) was significantly different between UCP groups and CTD; and where FA correlated with either dominant or impaired hand function (using Jebsen Taylor Hand Function Test).

**OUTCOMES AND RESULTS:** Children with unilateral lesions had reduced FA in the corticospinal tract of the affected hemisphere. Children with bilateral lesions had widespread reduced FA extending into all lobes. In children with left hemiparesis, impaired hand function correlated with FA in the contralateral corticospinal tract. Dominant hand function correlated with FA in the posterior thalamic radiations as well as multiple other regions in both left and right hemiparesis groups.

**CONCLUSIONS AND IMPLICATIONS:** Periventricular white matter lesions consist of focal and diffuse components. Focal lesions may cause direct motor fibre insult resulting in motor impairment. Diffuse white matter injury is heterogeneous, and may contribute to more global dysfunction.

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PMID: 27280312 [Indexed for MEDLINE]

### **Relationship between brain lesion characteristics and communication in preschool children with cerebral palsy.**

Coleman A, Fiori S, Weir KA, Ware RS, Boyd RN.

*Res Dev Disabil.* 2016 Nov;58:55-64. doi: 10.1016/j.ridd.2016.08.015. Epub 2016 Sep 1.

**BACKGROUND:** MRI shows promise as a prognostic tool for clinical findings such as gross motor function in children with cerebral palsy (CP), however the relationship with communication skills requires exploration.

**AIMS:** To examine the relationship between the type and severity of brain lesion on MRI and communication skills in children with CP.

**METHODS AND PROCEDURES:** 131 children with CP (73 males(56%)), mean corrected age(SD) 28(5) months, Gross Motor Functional Classification System distribution: I=57(44%), II=14(11%), III=19(14%), IV=17(13%), V=24(18%). Children were assessed on the Communication and Symbolic Behavioral Scales Developmental Profile (CSBS-DP) Infant-Toddler Checklist. Structural MRI was analysed with reference to type and semi-quantitative assessment of the severity of brain lesion. Children were classified for motor type, distribution and GMFCS. The relationships between type/severity of brain lesion and communication ability were analysed using multivariable tobit regression.

**OUTCOMES AND RESULTS:** Children with periventricular white matter lesions had better speech than children with

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cortical/deep grey matter lesions ( $\beta=-2.6$ , 95%CI=-5.0, -0.2,  $p=0.04$ ). Brain lesion severity on the semi-quantitative scale was related to overall communication skills ( $\beta=-0.9$ , 95%CI=-1.4, -0.5,  $p<0.001$ ). Motor impairment better accounted for impairment in overall communication skills than brain lesion severity.

**IMPLICATIONS:** Structural MRI has potential prognostic value for communication impairment in children with CP. **WHAT THIS PAPER ADDS?:** This is the first paper to explore important aspects of communication in relation to the type and severity of brain lesion on MRI in a representative cohort of preschool-aged children with CP. We found a relationship between the type of brain lesion and communication skills, children who had cortical and deep grey matter lesions had overall communication skills  $>1$  SD below children with periventricular white matter lesions. Children with more severe brain lesions on MRI had poorer overall communication skills. Children with CP born at term had poorer communication than those born prematurely and were more likely to have cortical and deep grey matter lesions. Gross motor function better accounted for overall communication skills than the type of brain lesion or brain lesion severity.

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DOI: 10.1016/j.ridd.2016.08.015

PMID: 27591975 [Indexed for MEDLINE]

### **The clinical outcomes of deep gray matter injury in children with cerebral palsy in relation with brain magnetic resonance imaging.**

Choi JY, Choi YS, Rha DW, Park ES.

*Res Dev Disabil.* 2016 Aug;55:218-25. doi: 10.1016/j.ridd.2016.04.010. Epub 2016 May 20.

In the present study we investigated the nature and extent of clinical outcomes using various classifications and analyzed the relationship between brain magnetic resonance imaging (MRI) findings and the extent of clinical outcomes in children with cerebral palsy (CP) with deep gray matter injury. The deep gray matter injuries of 69 children were classified into hypoxic ischemic encephalopathy (HIE) and kernicterus patterns. HIE patterns were divided into four groups (I-IV) based on severity. Functional classification was investigated using the gross motor function classification system-expanded and revised, manual ability classification system, communication function classification system, and tests of cognitive function, and other associated problems. The severity of HIE pattern on brain MRI was strongly correlated with the severity of clinical outcomes in these various domains. Children with a kernicterus pattern showed a wide range of clinical outcomes in these areas. Children with severe HIE are at high risk of intellectual disability (ID) or epilepsy and children with a kernicterus pattern are at risk of hearing impairment and/or ID. Grading severity of HIE pattern on brain MRI is useful for predicting overall outcomes. The clinical outcomes of children with a kernicterus pattern range widely from mild to severe. **WHAT THIS PAPER ADDS:** Delineation of the clinical outcomes of children with deep gray matter injury, which are a common abnormal brain MRI finding in children with CP, is necessary. The present study provides clinical outcomes for various domains in children with deep gray matter injury on brain MRI. The deep gray matter injuries were divided into two major groups; HIE and kernicterus patterns. Our study showed that severity of HIE pattern on brain MRI was strongly associated with the severity of impairments in gross motor function, manual ability, communication function, and cognition. These findings suggest that severity of HIE pattern can be useful for predicting the severity of impairments. Conversely, children with a kernicterus pattern showed a wide range of clinical outcomes in various domains. Children with severe HIE pattern are at high risk of ID or epilepsy and children with kernicterus pattern are at risk of hearing impairment or ID. The strength of our study was the assessment of clinical outcomes after 3 years of age using standardized classification systems in various domains in children with deep gray matter injury.

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DOI: 10.1016/j.ridd.2016.04.010

PMID: 27214680 [Indexed for MEDLINE]

### **Understanding the Full Spectrum of Organ Injury Following Intrapartum Asphyxia.**

LaRosa DA, Ellery SJ, Walker DW, Dickinson H.

*Front Pediatr.* 2017 Feb 17;5:16. doi: 10.3389/fped.2017.00016. eCollection 2017.

Birth asphyxia is a significant global health problem, responsible for ~1.2 million neonatal deaths each year worldwide. Those who survive often suffer from a range of health issues including brain damage-manifesting as cerebral palsy (CP)-respiratory insufficiency, cardiovascular collapse, and renal dysfunction, to name a few. Although the majority of research is directed toward reducing the brain injury that results from intrapartum birth asphyxia, [Science Infos Paralysie Cérébrale, Mars 2017, FONDATION PARALYSIE CEREBRALE 67 rue Vergniaud 17 75013 Paris - tel +33 1 45 54 03 03 contact: Christine Doumergue cdoumergue@lafondationmotrice.org](#)

the multi-organ injury observed in surviving neonates is of equal importance. Despite the advent of hypothermia therapy for the treatment of hypoxic-ischemic encephalopathy (HIE), treatment options following asphyxia at birth remain limited, particularly in low-resource settings where the incidence of birth asphyxia is highest. Furthermore, although cooling of the neonate results in improved neurological outcomes for a small proportion of treated infants, it does not provide any benefit to the other organ systems affected by asphyxia at birth. The aim of this review is to summarize the current knowledge of the multi-organ effects of intrapartum asphyxia, with particular reference to the findings from our laboratory using the precocial spiny mouse to model birth asphyxia. Furthermore, we reviewed the current treatments available for neonates who have undergone intrapartum asphyxia, and highlight the emergence of maternal dietary creatine supplementation as a preventative therapy, which has been shown to provide multi-organ protection from birth asphyxia-induced injury in our preclinical studies. This cheap and effective nutritional supplement may be the key to reducing birth asphyxia-induced death and disability, particularly in low-resource settings where current treatments are unavailable.

### [Free PMC Article](#)

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PMCID: PMC5313537

PMID: 28261573

## Détection – Diagnostic

### +Données cliniques

#### **Cranial ultrasound findings in preterm infants predict the development of cerebral palsy.**

Skovgaard AL, Zachariassen G.

*Dan Med J.* 2017 Feb;64(2). pii: A5330.

**INTRODUCTION:** Our aim was to evaluate any association between gestational age, birth weight and findings on cranial ultrasounds during hospitalisation in very preterm infants and mortality and neurological outcome in childhood.

**METHOD:** This study was a retrospective cohort study based on a patient record review. The cohort consisted of very preterm born children (gestational age  $\leq 32 + 0$ ) born from 2004 to 2008. For each infant, we obtained results from all cranial ultrasounds performed during hospitalisation. In 2014, patient records were evaluated for cerebral palsy, Gross Motor Function Classification System, blindness and deafness.

**RESULTS:** A total of 249 infants were included. The mortality rate was 9.2%. In all, 217 children were evaluated at 5-9 years of age. Four children were diagnosed with germinal matrix haemorrhage - intraventricular haemorrhage grade 3 (GMH-IVH3) and periventricular haemorrhagic infarction (PVHI), of whom two developed cerebral palsy. Nine children were diagnosed with periventricular leukomalacia (PVL), of whom six developed cerebral palsy. Cerebral palsy was detected in 14 children (6.4%), and one (0.5%) child was in need of a hearing assistive device. Severe brain injury (GMH-IVH3, PVHI or PVL) ( $p = 0.000$ ) and being of male gender ( $p = 0.03$ ) were associated with cerebral palsy in childhood.

**CONCLUSION:** Severe brain injuries detected by neonatal cranial ultrasound in very preterm infants is associated with development of cerebral palsy in childhood.

**FUNDING:** none. **TRAIL REGISTRATION:** not relevant.

PMID: 28157062 [Indexed for MEDLINE]

#### **Early identification of motor delay: Family-centred screening tool.**

Harris SR.

*Can Fam Physician.* 2016 Aug;62(8):629-32.

**OBJECTIVE:** To describe the Harris Infant Neuromotor Test (HINT), an infant neuromotor test using Canadian norms published in 2010 that could be used to screen for motor delay during the first year of life.

**QUALITY OF EVIDENCE:** Extensive research has been published on the intrarater, interrater, and test-retest reliability and the content, concurrent, predictive, and known-groups validity of the HINT, as well as on the sensitivity, specificity, and positive and negative predictive values of parental concerns, as assessed by the HINT. Most evidence is level II.

MAIN MESSAGE: Diagnosing motor delays during the first year of life is important because these often indicate more generalized developmental delays or specific disabilities, such as cerebral palsy. Parental concerns about their children's motor development are strongly predictive of subsequent diagnoses involving motor delay.

CONCLUSION: Only through early identification of developmental motor delays, initially with screening tools such as the HINT, is it possible to provide referrals for early intervention that could benefit both the infant and the family.

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PMCID: PMC4982721

PMID: 27521388 [Indexed for MEDLINE]

### **Formal training in general movement assessment is required to effectively evaluate infants with perinatal asphyxia in outpatient settings.**

Brown AK, Greisen G, Haugsted U, Jonsbo F

*Acta Paediatr.* 2016 Sep;105(9):1056-60. doi: 10.1111/apa.13491. Epub 2016 Jun 24.

AIM: General movement assessment (GMA) can help to identify children with a high risk of developing neurological dysfunction, such as cerebral palsy, and certified training is provided in this specialism. The aim of this study was to investigate the feasibility and reliability of using video recordings to assess GMA, in a busy Danish outpatient clinic.

METHODS: The study comprised 30-term infants born with perinatal asphyxia, who were video recorded at three months. They were assessed by two certified GMA observers and re-assessed two weeks later. Interobserver and intra-observer agreements were analysed using proportional agreement, and nominal kappa statistics were used to calculate 95% confidence intervals (95% CI).

RESULTS: We found substantial and almost perfect interobserver and intra-observer reliability. Intra-observer agreement was 0.85 (95% CI: 0.65-1.00;  $p < 0.0001$ ) and 0.85 (95% CI: 0.62-1.00;  $p < 0.0001$ ), and interobserver agreement was 0.71 (95% CI: 0.45-0.96;  $p < 0.0001$ ) at time point one and 0.85 (95% CI: 0.63-1.00;  $p < 0.0001$ ) two weeks later. All video recordings were completed within our multidisciplinary outpatient clinic without delay.

CONCLUSION: This study demonstrated the reliability of the GMA method in a busy multidisciplinary Danish paediatric outpatient setting, when assessors had been formally trained in the method and used it regularly.

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DOI: 10.1111/apa.13491

PMID: 27240948 [Indexed for MEDLINE]

### **Motor trajectories from birth to 5 years of children born at less than 30 weeks' gestation: early predictors and functional implications. Protocol for a prospective cohort study.**

Spittle AJ, McGinley JL, Thompson D, Clark R, FitzGerald TL, Mentiplay BF, Lee KJ, Olsen JE, Burnett A, Treyvaud K, Josev E, Alexander B, Kelly CE, Doyle LW, Anderson PJ, Cheong JL.

*J Physiother.* 2016 Oct;62(4):222-3. doi: 10.1016/j.jphys.2016.07.002. Epub 2016 Aug 5.

INTRODUCTION: Motor impairments are one of the most frequently reported adverse neurodevelopmental consequences in children born < 30 weeks' gestation. Up to 15% of children born at < 30 weeks have cerebral palsy and an additional 50% have mild to severe motor impairment at school age. The first 5 years of life are critical for the development of fundamental motor skills. These skills form the basis for more complex skills that are required to competently and confidently participate in schooling, sporting and recreational activities. In children born at < 30 weeks' gestation, the trajectory of motor development from birth to 5 years is not fully understood. The neural alterations that underpin motor impairments in these children are also unclear. It is essential to determine if early clinical evaluations and neuroimaging biomarkers can predict later motor impairment and associated functional problems at 5 years of age. This will help to identify children who will benefit the most from early intervention and improve functional outcomes at school age.

RESEARCH AIMS: The primary aim of this study is to compare the prevalence of motor impairment from birth to 5 years of age between children born at < 30 weeks and term-born controls, and to determine whether persistent abnormal motor assessments in the newborn period in those born at < 30 weeks predict abnormal motor functioning at 5 years of age. Secondary aims for children born at < 30 weeks and term-born children are: 1) to determine whether novel early magnetic resonance imaging-based structural or functional biomarkers that can predict motor impairments at 5 years are detectable in the neonatal period; 2) to investigate the association between motor impairments and concurrent deficits in body structure and function at 5 years of age; and 3) to explore how motor impairments at 5 years (including abnormalities of gait, postural control and strength) are

associated with concurrent functional outcomes, including physical activity, cognitive ability, learning ability, and behavioural and emotional problems.

DESIGN: Prospective longitudinal cohort study.

PARTICIPANTS AND SETTING: 150 preterm children (born at < 30 weeks' gestation) and 151 term-born children (born at > 36 completed weeks' gestation and weighing > 2499g) admitted to the Royal Women's Hospital, Melbourne, were recruited at birth and will be invited to participate in a 5-year follow-up study.

PROCEDURE: This study will examine previously collected data (from birth to 2 years) that comprise detailed motor assessments, and structural and functional brain MRI images. At 5 years, preterm and term, children will be examined using comprehensive motor assessments, including: the Movement Assessment Battery for Children (2nd edition) and measures of gait function through spatiotemporal (assessed with the GAITRite® Walkway) and dynamic postural control (assessed with Microsoft Kinect) variables; and hand grip strength (assessed with a dynamometer); and measures of physical activity (assessed using accelerometry), cognitive development (assessed with Wechsler Preschool and Primary Scale of Intelligence), and emotional and behavioural status (assessed with the Strengths and Difficulties Questionnaire and the Developmental and Wellbeing Assessment). At the 5-year assessment, parents/caregivers will be asked to complete questionnaires on demographics, physical activity, activities of daily living, behaviour, additional therapy (eg, physiotherapy and occupational therapy), and motor function (assessed with Pediatric Evaluation of Disability Inventory, Pediatric Quality of Life Questionnaire, the Little Developmental Coordination Questionnaire and an activity diary).

ANALYSIS: For the primary aim, the prevalence of motor impairment from birth to 5 years will be compared between children born at < 30 weeks and at term, using the proportion of children classified as abnormal at each of the time points (term age, 1, 2 and 5 years). Persistent motor impairments during the neonatal period will be assessed as a predictor of severity of motor impairment at 5 years of age in children born < 30 weeks using linear regression. Models will be fitted using generalised estimating equations to allow for the clustering of multiple births. Analysis will be repeated with adjustment for predictors of motor outcome, including additional therapy, sex, brain injury and chronic lung disease.

DISCUSSION/SIGNIFICANCE: Understanding the developmental precursors of motor impairment in children born before 30 weeks is essential for limiting disruption to skill development, and potential secondary impacts on physical activity, participation, academic achievement, self-esteem and associated outcomes (such as obesity, poor physical fitness and social isolation). An improved understanding of motor skill development will enable targeting of interventions and streamlining of services to children at highest risk of motor impairments.

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## **Motricité - Mobilité – Posture**

### **Achilles tendon moment arm length is smaller in children with cerebral palsy than in typically developing children.**

Kalkman BM, Bar-On L, Cenni F, Maganaris CN, Bass A, Holmes G, Desloovere K, Barton GJ, O'Brien TD.

*J Biomech.* 2017 Mar 3. pii: S0021-9290(17)30128-8. doi: 10.1016/j.jbiomech.2017.02.027. [Epub ahead of print]

When studying muscle and whole-body function in children with cerebral palsy (CP), knowledge about both internal and external moment arms is essential since they determine the mechanical advantage of a muscle over an external force. Here we asked if Achilles tendon moment arm (MAAT) length is different in children with CP and age-matched typically developing (TD) children, and if MAAT can be predicted from anthropometric measurements. Sixteen children with CP (age: 10y 7m±3y, 7 hemiplegia, 12 diplegia, GMFCS level: I (11) and II (8)) and twenty TD children (age: 10y 6m±3y) participated in this case-control study. MAAT was calculated at 20° plantarflexion by differentiating calcaneus displacement with respect to ankle angle. Seven anthropometric variables were measured and related to MAAT. We found normalized MAAT to be 15% (~7mm) smaller in children with CP compared to TD children (p=0.003). MAAT could be predicted by all anthropometric measurements with tibia length explaining 79% and 72% of variance in children with CP and TD children, respectively. Our findings have important implications for clinical decision making since MAAT influences the mechanical advantage about the ankle, which contributes to movement function and is manipulated surgically.

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### **Accuracy and Reliability of Marker Based Approaches to Scale the Pelvis, Thigh and Shank Segments in Musculoskeletal Models.**

Kainz H, Hoang H, Stockton C, Boyd RR, Lloyd DG, Carty CP

*J Appl Biomech.* 2017 Mar 14;1-21. doi: 10.1123/jab.2016-0282. [Epub ahead of print]

Gait analysis together with musculoskeletal modelling is widely used for research. In the absence of medical images, surface marker locations are used to scale a generic model to the individual's anthropometry. Studies evaluating the accuracy and reliability of different scaling approaches in a paediatric and/or clinical population have not yet been conducted and, therefore, formed the aim of this study. Magnetic resonance images (MRI) and motion capture data were collected from twelve participants with cerebral palsy and six typically developed participants. Accuracy was assessed by comparing the scaled model's segments measures to the corresponding MRI measures, whereas reliability was assessed by comparing the model's segments scaled with the experimental marker locations from the first and second motion capture session. The inclusion of joint centres into the scaling process significantly increased the accuracy of thigh and shank segment length estimates compared to scaling with markers alone. Pelvis scaling approaches which included the pelvis depth measure led to the highest errors compared to the MRI measures. Reliability was similar between scaling approaches with mean ICC of 0.97. Pelvis should be scaled using pelvic width and height and the thigh and shank segment should be scaled using the proximal and distal joint centres.

DOI: 10.1123/jab.2016-0282

PMID: 28290736

### **Part 2: Adaptation of Gait Kinematics in Unilateral Cerebral Palsy Demonstrates Preserved Independent Neural Control of Each Limb.**

Bulea TC, Stanley CJ, Damiano DL.

*Front Hum Neurosci.* 2017 Feb 13;11:50. doi: 10.3389/fnhum.2017.00050. eCollection 2017.

Motor adaptation, or alteration of neural control in response to a perturbation, is a potential mechanism to facilitate motor learning for rehabilitation. Central nervous system deficits are known to affect locomotor adaptation; yet we demonstrated that similar to adults following stroke, children with unilateral brain injuries can adapt step length in response to unilateral leg weighting. Here, we extend our analysis to explore kinematic strategies underlying step length adaptation and utilize dynamical systems approaches to elucidate how neural control may differ in those with hemiplegic CP across legs and compared to typically developing controls. Ten participants with hemiplegic CP and ten age-matched controls participated in this study. Knee and hip joint kinematics were analyzed during unilateral weighting of each leg in treadmill walking to assess adaptation and presence and persistence of after-effects. Peak joint angle displacement was used to represent changes in joint angles during walking. We examined baseline and task-specific variability and local dynamic stability to evaluate neuromuscular control across groups and legs. In contrast to controls, children with unilateral CP had asymmetries in joint angle variability and local dynamic stability at baseline, showing increased variability and reduced stability in the dominant limb. Kinematic variability increased and local stability decreased during weighting of ipsilateral and contralateral limbs in both groups compared to baseline. After weight removal both measures returned to baseline. Analogous to the temporal-spatial results, children with unilateral CP demonstrated similar capability as controls to adapt kinematics to unilateral leg weighting, however, the group with CP differed across sides after weight removal with dominant limb after-effects fading more quickly than in controls. The change in kinematics did not completely return to baseline in the non-dominant limb of the CP group, producing a transient improvement in joint angle symmetry. Recent studies demonstrate that neural control of gait is multi-layered with distinct circuits for different types of walking and for each leg. Remarkably, our results demonstrate that children with unilateral brain injury retain these separate circuits for each leg during walking and, importantly, that those networks can be adapted independently from one another to improve symmetry in the short term.

[Free PMC Article](#)

DOI: 10.3389/fnhum.2017.00050

PMCID: PMC5303755

PMID: 28243195

## **Assisting Hand Assessment and Children's Hand-Use Experience Questionnaire -Observed Versus Perceived Bimanual Performance in Children with Unilateral Cerebral Palsy.**

Ryll UC, Bastiaenen CH, Eliasson AC.

*Phys Occup Ther Pediatr.* 2017 May;37(2):199-209. doi: 10.1080/01942638.2016.1185498. Epub 2016 Jun 9.

**AIMS:** To explore the differences, relationship, and extent of agreement between the Assisting Hand Assessment (AHA), measuring observed ability to perform bimanual tasks, and the Children's Hand-Use Experience Questionnaire (CHEQ), assessing experienced bimanual performance.

**METHODS:** This study investigates a convenience sample of 34 children (16 girls) with unilateral cerebral palsy aged 6-18 years (mean 12.1, SD 3.9) in a cross-sectional design.

**RESULTS:** The AHA and CHEQ subscales share 8-25% of their variance ( $R^2$ ). Bland-Altman plots for AHA and all three CHEQ subscales indicate good average agreement, with a mean difference approaching zero but large 95% confidence intervals. Limits of agreement were extremely wide, indicating considerable disagreement between AHA and CHEQ subscales.

**CONCLUSION:** AHA and CHEQ seem to measure different though somewhat related constructs of bimanual performance. Results of this investigation reinforce the recommendation to use both instruments to obtain complementary information about bimanual performance including observed and perceived performance of children with unilateral cerebral palsy.

DOI: 10.1080/01942638.2016.1185498

PMID: 27283785 [Indexed for MEDLINE]

## **Characterisation of the patellar tendon reflex in cerebral palsy children using motion analysis.**

O'Sullivan R, Kiernan D, Walsh M, O'Brien T, Elhassan Y.

*Ir J Med Sci.* 2016 Nov;185(4):813-817. Epub 2015 Oct 15.

**BACKGROUND:** The patellar tendon reflex (PTR) is an important spinal reflex and an important diagnostic tool assessing neurological disturbances. Reflexes are conveniently assessed but quantifying the response can be subjective. Motion analysis is commonly used to assess gait kinematics in a variety of populations. It can be used to objectively assess the PTR with the advantage that standard technique and hammer can be used without the need for bulky apparatus or fixing the subject position.

**AIM:** To compare the PTR in 15 cerebral palsy (CP) children with age and height matched controls.

**METHODS:** EMG reflex latency in the rectus femoris was assessed using a Noraxon 2400T unit. Knee movement latency, knee angular displacement and peak angular velocity were captured using the CODA mpx 30 system.

**RESULTS:** EMG reflex latency was significantly reduced in CP compared to control limbs (13.11 versus 18.11 ms;  $p < 0.01$ ) confirming a 'brisk' response in this population. The kinematic data found that while knee angular displacement was significantly reduced in CP (12.82° versus 20.06°;  $p < 0.01$ ) there was no significant difference in movement latency or peak angular velocity compared to controls.

**CONCLUSIONS:** Subjective evaluation of the PTR relies mostly on change in knee angle. Using motion analysis we have confirmed a difference in this variable in CP compared to controls. We have also shown reduced reflex latency associated with a brisk reflex. Knee movement latency and peak angular velocity did not differentiate CP from normal. Further examination of the knee angular response of the PTR is warranted in CP.

DOI: 10.1007/s11845-015-1369-3

PMID: 26472096 [Indexed for MEDLINE]

## **Children with moderate to severe cerebral palsy may not benefit from stochastic vibration when developing independent sitting.**

Kyvelidou A, Harbourne RT, Haworth J, Schmid KK, Stergiou N

*Dev Neurorehabil.* 2017 Mar 9:1-9. doi: 10.1080/17518423.2017.1290705. [Epub ahead of print]

**PURPOSE:** Determine sitting postural control changes for children with cerebral palsy (CP), using a perceptual-motor intervention and the same intervention plus stochastic vibration through the sitting surface.

**METHODS:** Two groups of children with moderate or severe CP participated in the 12 week interventions. The primary outcome measure was center of pressure data from which linear and nonlinear variables were extracted and the gross motor function measure (GMFM).

RESULTS: There were no significant main effects of intervention or time or an interaction. Both treatment groups increased the Lyapunov exponent values in the medial-lateral direction three months after the start of treatment as well as their GMFM scores in comparison with baseline.

CONCLUSIONS: The stochastic vibration did not seem to advance the development of sitting postural control in children between the ages of 2 and 6 years. However, perceptual-motor intervention was found beneficial in advancing sitting behavior.

DOI: 10.1080/17518423.2017.1290705

PMID: 28277811

### **Control of Walking Speed in Children With Cerebral Palsy.**

Davids JR, Cung NQ, Chen S, Sison-Williamson M, Bagley AM.

*J Pediatr Orthop.* 2017 Mar 21. doi: 10.1097/BPO.0000000000000978. [Epub ahead of print]

BACKGROUND: Children's ability to control the speed of gait is important for a wide range of activities. It is thought that the ability to increase the speed of gait for children with cerebral palsy (CP) is common. This study considered 3 hypotheses: (1) most ambulatory children with CP can increase gait speed, (2) the characteristics of free (self-selected) and fast walking are related to motor impairment level, and (3) the strategies used to increase gait speed are distinct among these levels.

METHODS: A retrospective review of time-distance parameters (TDPs) for 212 subjects with CP and 34 typically developing subjects walking at free and fast speeds was performed. Only children who could increase their gait speed above the minimal clinically important difference were defined as having a fast walk. Analysis of variance was used to compare TDPs of children with CP, among Gross Motor Function Classification System (GMFCS) levels, and children in typically developing group.

RESULTS: Eight-five percent of the CP group (GMFCS I, II, III; 96%, 99%, and 34%, respectively) could increase gait speed on demand. At free speed, children at GMFCS I and II were significantly faster than children at GMFCS level III. At free speed, children at GMFCS I and II had significantly greater stride length than those at GMFCS levels III. At free speed, children at GMFCS level III had significantly lower cadence than those at GMFCS I and II. There were no significant differences in cadence among GMFCS levels at fast speeds. There were no significant differences among GMFCS levels for percent change in any TDP between free and fast walking.

DISCUSSION: Almost all children with CP at GMFCS levels I and II can control the speed of gait, however, only one-third at GMFCS III level have this ability. This study suggests that children at GMFCS III level can be divided into 2 groups based on their ability to control gait speed; however, the prognostic significance of such categorization remains to be determined.

LEVEL OF EVIDENCE: Diagnostic level II.

DOI: 10.1097/BPO.0000000000000978

PMID: 28328565

### **Correlation Between Standard Upper Extremity Impairment Measures and Activity-based Function Testing in Upper Extremity Cerebral Palsy.**

James MA, Bagley A, Vogler JB 4th, Davids JR, Van Heest AE.

*J Pediatr Orthop.* 2017 Mar;37(2):102-106. doi: 10.1097/BPO.0000000000000591.

BACKGROUND: Although the treatment of cerebral palsy should be based on improving function as assessed by measures of impairment, activity, and participation, the standard indications for surgical treatment of upper extremity cerebral palsy (UECP) are impairment measures, primarily active and passive range of motion (ROM). Recently, validated activity measures have been developed for children with UECP. The purposes of this study were to determine the relationship between impairment and activity measures in this population, and whether measures of activity correlate with each other.

METHODS: A total of 37 children, ages 5 to 16 years, who met standard ROM surgical indications for UECP were evaluated with the impairment measures of active and passive ROM and stereognosis, as well as 3 activity measures [Assisting Hand Assessment (AHA), Box and Blocks test, and the Shriners Hospitals Upper Extremity Evaluation Dynamic Positional Analyses (SHUEE DPA)]. Impairment measures were correlated with activity measures using Spearman rank correlation coefficients.

RESULTS: Impairment measures showed inconsistent correlation with activity measures. Of the 12 comparisons, only 4 correlated: active forearm supination ( $\rho=0.47$ ,  $P=0.003$ ), wrist extension ( $\rho=0.55$ ,  $P=0.001$ ), and stereognosis scores

( $\rho=0.54$ ,  $P=0.001$ ) were correlated with AHA; and wrist extension was correlated with the SHUEE DPA ( $\rho=0.41$ ,  $P=0.01$ ). When the results of activity tests were compared, the AHA was correlated with the Box and Blocks tests ( $\rho=0.63$ ,  $P<0.001$ ), and the SHUEE DPA and Box and Blocks tests were correlated with each other ( $\rho=0.35$ ,  $P=0.04$ ).

**CONCLUSIONS:** The goal of surgery in UECP is to improve the child's ability to perform activities, and ultimately to participate in life situations. Impairment measures, such as ROM, were inconsistently correlated with validated measures of activity. Some activity measures correlated with each other, although they did not correlate with the same impairment measures. We conclude that impairment measures, including ROM, do not consistently predict functional dynamic ROM used to perform activities for children with UECP. Activity limitation measures may provide more appropriate indicators than impairment measures for upper extremity surgery for this population.

**LEVEL OF EVIDENCE:** Level II-diagnostic.

DOI: 10.1097/BPO.0000000000000591

PMID: 26177058 [Indexed for MEDLINE]

### **Deliberately Light Interpersonal Contact Affects the Control of Head Stability During Walking in Children and Adolescents with Cerebral Palsy.**

Schuller KH, Burfeind F, HöB-Zenker B, Feketené Szabó É, Herzig , Ledebt A, Johannsen L.

*Arch Phys Med Rehabil.* 2017 Feb 27. pii: S0003-9993(17)30099-0. doi: 10.1016/j.apmr.2017.01.026. [Epub ahead of print]

**OBJECTIVE:** To evaluate the potential of deliberately light interpersonal touch (IPT) for reducing excessive head and trunk sway during self-paced walking in children and adolescents with cerebral palsy (CP).

**DESIGN:** Quasi-experimental, proof-of-concept study with between-groups comparison.

**SETTING:** Ambulant care facility, community center.

**PARTICIPANTS:** 26 individuals with CP (spastic and ataxic; GMFCS I-III; mean=9.8y; f=11, m=15) and in 39 typically developed (TD) children and adolescents (mean=10.0y; f=23, m=16).

**INTERVENTIONS:** ipt applied by a therapist to locations at the back and the head.

**MAIN OUTCOME MEASURES:** As primary outcomes head and trunk sway during self-paced walking were assessed by inertial measurement units. Secondary outcomes were average step length and gait speed. **RESULTS:** CP group: apex and occiput IPT reduced head velocity sway compared to thoracic IPT (both  $p=0.04$ ) irrespective of individuals' specific clinical symptoms. TD group: all testing conditions reduced head velocity sway compared to walking alone (all  $p\leq 0.03$ ) as well as in apex and occiput IPT compared to paired walking (both  $p\leq 0.02$ ).

**CONCLUSIONS:** Deliberately light IPT at the apex of the head alters control of head sway in children and adolescents with CP. The effect of IPT varies as a function of contact location and acts differently in TD individuals.

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DOI: 10.1016/j.apmr.2017.01.026

PMID: 28254638

### **Effects of severity of gross motor disability on anticipatory postural adjustments while standing in individuals with bilateral spastic cerebral palsy.**

Tomita H, Fukaya Y, Takagi Y, Yokozawa A

*Res Dev Disabil.* 2016 Oct;57:92-101. doi: 10.1016/j.ridd.2016.06.017. Epub 2016 Jul 9.

**BACKGROUND:** Although individuals with bilateral spastic cerebral palsy (BSCP) exhibit several deficits in anticipatory postural adjustments (APAs) while standing, effects of severity of motor disability on their APAs are unclear.

**AIMS:** To determine whether individuals with BSCP exhibit severity-dependent deficits in APAs.

**METHODS AND PROCEDURES:** Seven individuals with level II BSCP (BSCP-II group) and seven with level III BSCP (BSCP-III group) according to the Gross Motor Function Classification System and seven healthy controls lifted a load under two different load conditions.

**OUTCOMES AND RESULTS:** Anticipatory activities of the erector spinae (ES), medial hamstring (MH), and gastrocnemius (GCM) were smaller in the two BSCP groups than in the control group. Although the anticipatory GCM activity was similar between the BSCP groups, the ES and MH activities were larger in the BSCP-II group than in the BSCP-III group. In the BSCP-II group, an increase in anticipatory activity with an increase in load was observed in the MH, but not in the GCM. In the BSCP-III group, load-related modulation was not found in the MH or GCM.

**CONCLUSIONS AND IMPLICATIONS:** The present findings suggest that in individuals with BSCP with severe motor disability, APA deficits extend to more proximal parts of the body.



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DOI: 10.1016/j.ridd.2016.06.017

PMID: 27399205 [Indexed for MEDLINE]

### **Energy cost during walking in association with age and body height in children and young adults with cerebral palsy.**

Bolster EA, Balemans AC, Brehm MA, Buizer AI, Dallmeijer AJ.

*Gait Posture*. 2017 Feb 27;54:119-126. doi: 10.1016/j.gaitpost.2017.02.026. [Epub ahead of print]

**AIM:** This cross-sectional study into children and young adults with cerebral palsy (CP) aimed to assess the association of gross energy cost (EC), net EC and net nondimensional (NN) EC during walking with age and body height, compared to typically developing (TD) peers.

**METHOD:** Data was collected in 128 participants with CP (mean age 11y9mo; GMFCS I,n=48; II,n=56; III, n=24) and in 63 TD peers (mean age 12y5mo). Energy cost was assessed by measuring the oxygen consumption during over-ground walking at comfortable speed. Outcome measures derived from the assessment included the gross and net EC, and NN EC. Differences between the groups in the association between gross, net and NN EC with age and body height, were investigated with regression analyses and interaction effects ( $p < 0.05$ ).

**RESULTS:** Interaction effects for age and body height by group were not significant, indicating similar associations for gross, net and NN EC with age or body height among groups. The models showed a significant decline for gross, net and NN EC with increasing age per year (respectively  $-0.201 \text{Jkg}^{-1}\text{m}^{-1}$ ;  $-0.073 \text{Jkg}^{-1}\text{m}^{-1}$ ;  $-0.007$ ) and body height per cm (respectively  $-0.057 \text{Jkg}^{-1}\text{m}^{-1}$ ;  $-0.021 \text{Jkg}^{-1}\text{m}^{-1}$ ;  $-0.002$ ).

**INTERPRETATION:** Despite higher gross and net EC values for CP compared to TD participants, similar declines in EC outcomes can be expected with growth for participants aged 4-22 years with CP. All energy cost outcomes showed a decline with growth, indicating that correcting for this decline is required when evaluating changes in gross EC, and, to a lesser extent, in net and NN EC in response to treatment or from natural course over time.

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DOI: 10.1016/j.gaitpost.2017.02.026

PMID: 28288332

### **Estimation of gait parameter using sonoelastography in children with cerebralpalsy.**

Mansouri M, Birgani PM, Kharazi MR, Lotfian M, Naeimipoor M, Mirbagheri MM.

*Conf Proc IEEE Eng Med Biol Soc*. 2016 Aug;2016:1729-1732. doi:10.1109/EMBC.2016.7591050.

We aimed to study the relationship between neuromuscular abnormalities associated with spasticity and gait impairments in spastic children with hemiplegia cerebral palsy (CP). Neuromuscular abnormalities of the tibialis anterior and medial gastrocnemius muscles of the spastic ankle were quantified using sonoelastography with two major features; i.e. entropy and histogram ratio of sonoelastography images. Gait impairments were evaluated in the gait laboratory using motion capture system, and the spatial and temporal features were extracted. The correlation analysis showed a significant relation between both the entropy and histogram ratio of sonoelastography images with walking speed and step time. The findings demonstrate that the neuromuscular abnormalities associated with spasticity may contribute to gait impairments in children with CP.

DOI: 10.1109/EMBC.2016.7591050

PMID: 28268660

### **Functional outcomes in children and young people with dyskinetic cerebral palsy.**

Monbaliu E, De La Peña MG, Ortibus E, Molenaers G, Deklerck J, Feys H

*Dev Med Child Neurol*. 2017 Mar 8. doi: 10.1111/dmnc.13406. [Epub ahead of print]

**AIM:** This cross-sectional study aimed to map the functional profile of individuals with dyskinetic cerebral palsy (CP), to determine interrelationships between the functional classification systems, and to investigate the relationship of functional abilities with dystonia and choreoathetosis severity.

**METHODS:** Fifty-five children (<15y) and young people (15-22y) (30 males, 25 females; mean age 14y 6mo, standard deviation 4y 1mo) with dyskinetic CP were assessed using the Gross Motor Function Classification System (GMFCS), Manual Ability Classification System (MACS), Communication Function Classification System (CFCS), Eating and

Drinking Ability Classification System (EDACS), and Viking Speech Scale (VSS), as well as the Dyskinesia Impairment Scale.

RESULTS: Over 50 per cent of the participants exhibited the highest limitation levels in GMFCS, MACS, and VSS. Better functional abilities were seen in EDACS and CFCS. Moderate to excellent interrelationship was found among the classification scales. All scales had significant correlation ( $r_s = 0.65 - 0.81$ ) with dystonia severity except for CFCS in the young people group. Finally, only MACS ( $r_s = 0.40$ ) and EDACS ( $r_s = 0.55$ ) in the young people group demonstrated significant correlation with choreoathetosis severity.

INTERPRETATION: The need for inclusion of speech, eating, and drinking in the functional assessment of dyskinetic CP is highlighted. The study further supports the strategy of managing dystonia in particular at a younger age followed by choreoathetosis in a later stage.

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DOI: 10.1111/dmnc.13406

PMID: 28272743

### **Gait Training With Visual Feedback and Proprioceptive Input to Reduce Gait Asymmetry in Adults With Cerebral Palsy: A Case Series.**

Levin I, Lewek MD, Feasel J, Thorpe DE.

*Pediatr Phys Ther.* 2017 Apr;29(2):138-145. doi: 10.1097/PEP.0000000000000362.

PURPOSE: The purpose of this case series was to investigate the feasibility of using visual feedback on gait asymmetry during gait retraining and whether this leads to reduced asymmetry, improvement in gait speed, cost of walking, and dynamic balance in ambulant adults with cerebral palsy (CP).

METHODS: Five adults with CP, who were ambulatory and had step length or stance time asymmetry, trained for 18 sessions on a split-belt treadmill with concurrent visual feedback from a virtual environment. Training also included overground gait training to encourage transfer of learning.

RESULTS: All participants reduced gait asymmetry and improved on outcomes at posttest and follow-up.

CONCLUSIONS: Outcome measures and training protocols were feasible in this sample of convenience of adults with CP who were ambulatory and who did not have visual impairment. The adults with CP in this study demonstrated individual improvements in gait and balance following training.

DOI: 10.1097/PEP.0000000000000362

PMID: 28350769

### **Hand Function in a Population-Based Sample of Young Children with Unilateral or Bilateral Cerebral Palsy.**

Klevberg GL, Østensjø S, Krumlinde-Sundholm L, Elkjær S, Jahnsen RB

*Phys Occup Ther Pediatr.* 2017 Mar 20:1-13. doi: 10.1080/01942638.2017.1280873. [Epub ahead of print]

AIM: To describe aspects of hand function in a population-based sample of young children with clinical signs of unilateral or bilateral cerebral palsy (CP).

METHOD: A cross-sectional study with data from national CP registers in Norway. Manual ability was classified with the Manual Ability Classification System (MACS) or Mini-MACS. Hand use in bimanual activities was measured with the Assisting Hand Assessment (AHA) for unilateral CP or the newly developed Both Hands Assessment (BoHA) for bilateral CP.

RESULTS: From 202 children, 128 (57 females) were included (Mini-MACS/MACS levels I-V, mean age 30.4 months; SD = 12.1). Manual abilities were distributed across levels I-III in unilateral CP and levels I-V in bilateral CP. Variations in AHA and BoHA units were large. One-way ANOVA revealed associations between higher AHA or BoHA units and Mini-MACS/MACS levels of higher ability ( $p < 0.01$ ) and higher age ( $p < 0.04$ ).

CONCLUSIONS: Compared with young children with unilateral CP, children with bilateral CP showed greater variation in Mini-MACS/MACS levels, and both sub-groups showed large variations in AHA or BoHA units. The classifications and assessments used in this study are useful to differentiate young children's ability levels. Such information is important to tailor upper limb interventions to the specific needs of children with CP.

DOI: 10.1080/01942638.2017.1280873

PMID: 28318401

### **Improving modified tardieu scale assessment using inertial measurement unit with visual biofeedback.**

Seoyoung Choi, Jonghyun Kim.

*Conf Proc IEEE Eng Med Biol Soc. 2016 Aug;2016:4703-4706. doi:10.1109/EMBC.2016.7591777.*

Reliable spasticity assessment is important to provide appropriate intervention for spasticity. Modified Tardieu scale (MTS) assessment is simple and convenient enough to be used in clinical environment, but has poor or moderate reliability due to irregular passive stretch velocity and goniometric measurement. We proposed a novel inertial measurement unit (IMU)-based MTS assessment with gyroscope-based visual biofeedback to improve the reliability of MTS by providing regular passive stretch velocity. With five children with cerebral palsy and two raters, the IMU-based MTS assessment was compared with conventional MTS assessment. The results showed that the proposed one has good test-retest and inter-rater reliabilities (ICC > .08) while the conventional MTS has poor or moderate reliability. Moreover, it was shown that the proposed visual biofeedback is effective enough to provide regular passive stretch velocity.

DOI: 10.1109/EMBC.2016.7591777

PMID: 28269321

### **Inter and Intra Rater Reliability of the 10 Meter Walk Test in the Community Dweller Adults with Spastic Cerebral Palsy.**

Bahrami F, Noorizadeh Dehkordi S, Dadgoo M.

*Iran J Child Neurol. 2017 Winter;11(1):57-64.*

**OBJECTIVE:** We aimed to investigate the intra-rater and inter-raters reliability of the 10 meter walk test (10 MWT) in adults with spastic cerebral palsy (CP).

**MATERIALS & METHODS:** Thirty ambulatory adults with spastic CP in the summer of 2014 participated (19 men, 11 women; mean age  $28 \pm 7$  yr, range 18- 46 yr). Individuals were non-randomly selected by convenient sampling from the Ra'ad Rehabilitation Goodwill Complex in Tehran, Iran. They had GMFCS levels below IV (I, II, and III). Retest interval for inter-raters study lasted a week. During the tests, participants walked with their maximum speed. Intraclass correlation coefficients (ICC) estimated reliability.

**RESULTS:** The 10 MWT ICC for intra-rater was 0.98 (95% confidence interval (CI) 0.96-0.99) for participants, and >0.89 in GMFCS subgroups (95% confidence interval (CI) lower bound >0.67). The 10 MWT inter-raters' ICC was 0.998 (95% confidence interval (CI) 0.996-0.999), and >0.993 in GMFCS subgroups (95% confidence interval (CI) lower bound >0.977). Standard error of the measurement (SEM) values for both studies was small ( $0.02 < SEM < 0.07$ ).

**CONCLUSION:** Excellent intra-rater and inter-raters reliability of the 10 MWT in adults with CP, especially in the moderate motor impairments (GMFCS level III), indicates that this tool can be used in clinics to assess the results of interventions.

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PMCID: PMC5329761

PMID: 28277557

### **Motor imagery difficulties in children with Cerebral Palsy: A specific or general deficit?**

Lust JM, Wilson PH, Steenbergen B.

*Res Dev Disabil. 2016 Oct;57:102-11. doi: 10.1016/j.ridd.2016.06.010. Epub 2016 Jul 9.*

**AIM:** The aim of this study was to examine the specificity of motor imagery (MI) difficulties in children with CP.

**METHOD:** Performance of 22 children with CP was compared to a gender and age matched control group. MI ability was measured with the Hand Laterality Judgment (HLJ) task, examining specifically the direction of rotation (DOR) effect, and the Praxis Imagery Questionnaire (PIQ).

**RESULTS:** In the back view condition of the HLJ task both groups used MI, as evidenced by longer response times for lateral compared with medial rotational angles. In the palm view condition children with CP did not show an effect of DOR, unlike controls. Error scores did not differ between groups. Both groups performed well on the PIQ, with no significant difference between them in response pattern.

**CONCLUSION AND IMPLICATION:** The present study suggests that children with CP show deficits on tasks that trigger implicit use of MI, whereas explicit MI ability was relatively preserved, as assessed using the PIQ. These results suggest that employing more explicit methods of MI training may well be more suitable for children with CP in rehabilitation of motor function.

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DOI: 10.1016/j.ridd.2016.06.010  
PMID: 27399206 [Indexed for MEDLINE]

### **Pendulum test measure correlates with gait parameters in children with cerebral palsy.**

Lotfian M, Mirbagheri MM, Kharazi MR, Dadashi F, Nourian R, Irani A, Mirbagheri A.  
*Conf Proc IEEE Eng Med Biol Soc. 2016 Aug;2016:1708-1711. doi:10.1109/EMBC.2016.7591045.*

Individuals with cerebral palsy (CP) usually suffer from different impairments including gait impairment and spasticity. Spastic hypertonia is a defining feature of spasticity and manifests as a mechanical abnormality. The objective of this study was to determine the relationship between spastic hypertonia and gait impairments in spastic children with CP, addressing an important controversial issue. Spastic hypertonia was quantified using the pendulum test. The gait impairments were evaluated using the motion capture system in a gait laboratory. Our results showed significant correlations among gait parameters; i.e. walking speed, step length, and the pendulum test measures. This indicates that neuromuscular abnormalities are associated with spasticity and may contribute to gait impairments. The clinical implication is that the impaired gait in children with CP may be improved with the treatment of neuromuscular abnormalities.

DOI: 10.1109/EMBC.2016.7591045  
PMID: 28268656

### **Position Between Trunk and Pelvis During Gait Depending on the Gross Motor Function Classification System.**

Sanz-Mengibar JM, Altschuck N, Sanchez-de-Munian P, Bauer C, Santonja-Medina F.  
*Pediatr Phys Ther. 2017 Apr;29(2):130-137. doi: 10.1097/PEP.0000000000000361.*

**PURPOSE:** To understand whether there is a trunk postural control threshold in the sagittal plane for the transition between the Gross Motor Function Classification System (GMFCS) levels measured with 3-dimensional gait analysis.

**METHOD:** Kinematics from 97 children with spastic bilateral cerebral palsy from spine angles according to Plug-In Gait model (Vicon) were plotted relative to their GMFCS level.

**RESULTS:** Only average and minimum values of the lumbar spine segment correlated with GMFCS levels. Maximal values at loading response correlated independently with age at all functional levels. Average and minimum values were significant when analyzing age in combination with GMFCS level.

**CONCLUSION:** There are specific postural control patterns in the average and minimum values for the position between trunk and pelvis in the sagittal plane during gait, for the transition among GMFCS I-III levels. Higher classifications of gross motor skills correlate with more extended spine angles.

DOI: 10.1097/PEP.0000000000000361  
PMID: 28319490

### **Power Mobility Training for Young Children with Multiple, Severe Impairments: A Case Series.**

Kenyon LK, Farris JP, Gallagher C, Hammond L, Webster LM, Aldrich NJ  
*Phys Occup Ther Pediatr. 2017 Feb;37(1):19-34. doi: 10.3109/01942638.2015.1108380. Epub 2016 Jan 6.*

**AIMS:** Young children with neurodevelopmental conditions are often limited in their ability to explore and learn from their environment. The purposes of this case series were to (1) describe the outcomes of using an alternative power mobility device with young children who had multiple, severe impairments; (2) develop power mobility training methods for use with these children; and (3) determine the feasibility of using various outcome measures.

**METHODS:** Three children with cerebral palsy (Gross Motor Function Classification System Levels IV, V, and V) ages 17 months to 3.5 years participated in the case series. Examination included the Pediatric Evaluation of Disability Inventory-Computer Adaptive Test (PEDI-CAT) and the Dimensions of Mastery Questionnaire (DMQ). An individualized, engaging power mobility training environment was created for each participant. Intervention was provided for 60 minutes per week over 12 weeks.

**RESULTS:** All participants exhibited improvements in power mobility skills. Post-intervention PEDI-CAT scores increased in various domains for all participants. Post-intervention DMQ scores improved in Participants 1 and 2.

**DISCUSSION:** The participants appeared to make improvements in their beginning power mobility skills. Additional research is planned to further explore the impact of power mobility training in this unique population.

DOI: 10.3109/01942638.2015.1108380  
PMID: 26735082 [Indexed for MEDLINE]

### **Recent perspectives of cerebral palsy (CP) in children: a review.**

Qiu A, Yang Z, Li Z.

*Minerva Pediatr.* 2017 Mar 27. doi: 10.23736/S0026-4946.17.04880-0. [Epub ahead of print]

The movement and posture disorder of cerebral palsy (CP) is presumed to mainly be a consequence of the motor disorder, but accompanying disturbances with sensations and perception have also been suggested to influence motor function. The heterogeneous condition of cerebral palsy (CP) is caused by an injury to the immature brain affecting movement and posture development. The attainment of standing and walking can be difficult and an assistive device to accomplish the tasks may be required for some children with CP. In this review, we enlightened the role of possible sensory and perceptual disturbances for standing difficulties in children with CP.

DOI: 10.23736/S0026-4946.17.04880-0

PMID: 28353322

### **Relationship between muscle-tendon length, range of motion, and resistance to passive movement in children with normal and increased tone.**

Matsukiyo A, Goh AC, Asagai Y.

*J Phys Ther Sci.* 2017 Feb;29(2):349-355. doi: 10.1589/jpts.29.349. Epub 2017 Feb 24.

[Purpose] The aim of this study was to quantify the resistance to passive movement by measuring changes in muscle-tendon length and joint range of motion (ROM), before and after applying a standardized 5-kilogram tension force, and to correlate and compare these changes to muscle tone.

[Subjects and Methods] Children with cerebral palsy (n=29) and typically developed children (n=12) participated in this observational study. The modified Ashworth scale (MAS) was used to assess tone in the right plantarflexor muscle. An ultrasound-imaging device was used to measure  $\Delta$ muscle-tendon length in the right medial gastrocnemius muscle, and a goniometer was used to measure right ankle  $\Delta$ ROM.

[Results] Compared with the MAS, the results showed that  $\Delta$ ROM had the highest construct validity (convergent and discriminant) followed by  $\Delta$ muscle-tendon unit length. Therefore, these parameters may be better alternatives to the MAS for the quantitative assessment of resistance to passive movement in patients with increased tone.

[Conclusion] This study demonstrated that measuring the change in the passive properties of the muscle-tendon unit, as well as the corresponding change in ROM, might provide better options for assessing resistance to passive movement or muscle tone.

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DOI: 10.1589/jpts.29.349

PMCID: PMC5333003

PMID: 28265172

### **Reliability and Construct Validity of the 6-Minute Racerunner Test in Children and Youth with Cerebral Palsy, GMFCS Levels III and IV.**

Bolster EA, Dallmeijer AJ, de Wolf GS, Versteegt M, Schie PE.

*Phys Occup Ther Pediatr.* 2017 May;37(2):210-221. doi: 10.1080/01942638.2016.1185502. Epub 2016 Jun 17.

AIM: To determine the test-retest reliability and construct validity of a novel 6-Minute Racerunner Test (6MRT) in children and youth with cerebral palsy (CP) classified as Gross Motor Function Classification System (GMFCS) levels III and IV. The racerunner is a step-propelled tricycle.

METHODS: The participants were 38 children and youth with CP (mean age 11 y 2 m, SD 3 y 7 m; GMFCS III, n = 19; IV, n = 19). Racerunner capability was determined as the distance covered during the 6MRT on three occasions. The intraclass correlation coefficient (ICC), standard error of measurement (SEM), and smallest detectable differences (SDD) were calculated to assess test-retest reliability.

RESULTS: The ICC for tests 2 and 3 were 0.89 (SDD 37%; 147 m) for children in level III and 0.91 for children in level IV (SDD 52%; 118 m). When the average of two separate test occasions was used, the SDDs were reduced to 26% (104 m; level III) and 37% (118 m; level IV). For tests 1 to 3, the mean distance covered increased from 345 m (SD 148 m) to 413 m (SD 137 m) for children in level III, and from 193 m (SD 100 m) to 239 m (SD 148 m) for children in level IV.

CONCLUSIONS: Results suggest high test-retest reliability. However, large SDDs indicate that a single 6MRT measurement is only useful for individual evaluation when large improvements are expected, or when taking the average of two tests. The 6MRT discriminated the distance covered between children and youth in levels III and IV, supporting construct validity.

DOI: 10.1080/01942638.2016.1185502

PMID: 27314415 [Indexed for MEDLINE]

### **The Differential Effect of Arm Movements during Gait on the Forward Acceleration of the Centre of Mass in Children with Cerebral Palsy and Typically Developing Children.**

Meyns P, Molenaers G, Duysens J, Jonkers I

*Front Hum Neurosci.* 2017 Mar 1;11:96. doi: 10.3389/fnhum.2017.00096. eCollection 2017.

Background: We aimed to study the contribution of upper limb movements to propulsion during walking in typically developing (TD) children (n = 5) and children with hemiplegic and diplegic cerebral palsy (CP; n = 5 and n = 4, respectively). Methods: Using integrated three-dimensional motion capture data and a scaled generic musculoskeletal model that included upper limbs, we generated torque driven simulations of gait in OpenSim. Induced acceleration analyses were then used to determine the contributions of the individual actuators located at the relevant degrees of freedoms of the upper and lower limb joints to the forward acceleration of the COM at each time point of the gait simulation. The mean values of the contribution of the actuators of upper limbs, lower limbs, and gravity in different phases of the gait cycle were compared between the three groups. Findings: The results indicated a limited contribution of the upper limb actuators to COM forward acceleration compared to the contribution of lower limbs and gravity, in the three groups. In diplegic CP, the contribution of the upper limbs seemed larger compared to TD during the preswing and swing phases of gait. In hemiplegic CP, the unaffected arm seemed to contribute more to COM deceleration during (pre)swing, while the affected side contributed to COM acceleration. Interpretation: These findings suggest that in the presence of lower limb dysfunction, the contribution of the upper limbs to forward propulsion is altered, although they remain negligible compared to the lower limbs and gravity.

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DOI: 10.3389/fnhum.2017.00096

PMCID: PMC5331063

PMID: 28298890

### **The Influence of the Unaffected Hip on Gait Kinematics in Patients With Hemiplegic Cerebral Palsy.**

Tretiakov M, Do KP, Aiona M.

*J Pediatr Orthop.* 2017 Apr/May;37(3):217-221. doi: 10.1097/BPO.0000000000000620.

BACKGROUND: Hemiplegic cerebral palsy (HCP) patients have transverse-plane gait deviations that may include the "uninvolved" side. The aim of this study is to quantify the static rotational profile, the dynamic position during gait and determine whether any correlations between the involved and uninvolved side exist.

METHODS: A total of 171 subjects that met the inclusion criteria of HCP and no prior history of bony surgery were reviewed. Clinical and gait measurements were analyzed and compared between subjects and a population of typically developing (TD) children.

RESULTS: Among children with HCP, static internal hip rotation of the affected limb was strongly correlated to static internal hip rotation on the unaffected limb ( $r=0.543$ ,  $P<0.0001$ ). There were 100 patients with maximum static internal rotation  $\geq 66\%$  of the total arc of motion in the affected hip. These subjects showed significant differences of static range of motion measures of the affected hip compared with TD. They also showed statistical significant differences between the dynamic measures of the affected limb of HCP and TD for mean pelvic rotation, mean hip rotation, and mean knee progression. In these 100 subjects, 23 patients had a maximum static internal rotation  $\geq 66\%$  of the total arc of motion on the unaffected hip and there were 77 subjects with  $<66\%$  static internal rotation. Pelvic rotation and hip rotation were statistically different between these 2 groups, but knee progression angle was not significant.

CONCLUSIONS: The "unaffected" side in patients with HCP influence gait kinematics. If static internal hip rotation exceeds 66% of the total arc of motion, almost all studied static and gait parameters were abnormal in HCP children, regardless if it was the affected side. Compensations on the "unaffected" side seem to be somewhat limited if the

anatomic alignment is significantly asymmetric. This may be 1 reason pelvic transverse-plane changes after femoral rotation osteotomy are unpredictable.

LEVEL OF EVIDENCE: Level II.

DOI: 10.1097/BPO.0000000000000620

PMID: 28278135

### **Upper limb kinematics of adults with cerebral palsy on bilateral functional tasks.**

Lott C, Johnson MJ.

*Conf Proc IEEE Eng Med Biol Soc. 2016 Aug;2016:5676-5679. doi:10.1109/EMBC.2016.7592015.*

Adults with cerebral palsy (CP) often show upper limb impairments which impact their ability to execute activities of daily living (ADLs). Three adults with CP and five healthy adults performed three types of bilateral and unilateral ADLs: drink, pour, and pick and place tasks. An affordable bilateral assessment system (BiAS) was used to measure wrist kinematic trajectories. Four metrics, total completion time, maximum velocity, smoothness, and phase difference, were used to evaluate each functional task. Overall, adults with CP took a longer time than the healthy subjects to complete all unilateral functional tasks with their non-dominant hand. Moreover, while the healthy controls had similar mean velocities in the dominant and non-dominant hands during the bilateral tasks, adults with CP typically exhibited slower mean velocities in the dominant hand during the bilateral tasks than during the unilateral dominant tasks. Similar to existing literature, we found that adults with CP compensated by slowing the dominant arm to match the non-dominant arm in order to complete the tasks, showing the importance of utilizing bilateral training in upper limb rehabilitation treatments.

DOI: 10.1109/EMBC.2016.7592015

PMID: 28269543

### **Validity and reliability of a locomotor stage-based functional rating scale in spinal cord injury.**

Maurer-Burkhard B, Smoor I, von Reumont A, Deckstein G, Stierle I, Rupp R, Schuld C.

*Spinal Cord. 2016 Aug;54(8):619-25. doi: 10.1038/sc.2015.223. Epub 2016 Jan 12.*

STUDY DESIGN: This is a prospective observational cohort study.

OBJECTIVES: The objectives of this study were to apply and adapt a rating scale based on locomotor stages (LSs) derived from cerebral palsy (CP) to spinal cord injury (SCI) and to quantify its inter-rater reliability and construct validity.

METHODS: The inter-rater reliability of LSs originally developed for children with CP was tested in a chronic SCI cohort. On the basis of the distribution of the LSs for CP, Locomotor Stages in Spinal Cord Injury (LOSSCI) were defined. Their validity was then tested with the Spinal Cord Independence Measure (SCIM) in another acute SCI cohort.

RESULTS: The 10-point LSs for CP were assessed by two raters in 65 chronic patients. Weighted Cohen's kappa (WCK) was 0.985 ( $P < 0.0001$ ). Only four mismatches were found, resulting in an accuracy of 93.4%. On the basis of the distribution of the LSs for CP in SCI, the five-point LOSSCI grading scale was developed. WCK of LOSSCI was 0.976 ( $P < 0.0001$ ). Only three mismatches between raters were found, resulting in an overall accuracy of 95.1%. The validity data sets consisted of 448 SCIM records from 161 patients obtained within the first year after injury. Spearman's correlation coefficients were the highest between LOSSCI and SCIM indoor mobility (room and toilet;  $R = 0.82$ ) and the lowest between LOSSCI and SCIM respiration and sphincter management ( $R = 0.68$ ).

CONCLUSION: LOSSCI provides a reliable and valid clinical tool to assess locomotor function in SCI. LOSSCI not only reflects bipedal walking but also covers a wide range of key motor skills.

DOI: 10.1038/sc.2015.223

PMID: 26754473 [Indexed for MEDLINE]

### **Validity and Responsiveness of the Trunk Impairment Scale and Trunk Control Measurement Scale in Young Individuals with Cerebral Palsy.**

Pham HP, Eidem A, Hansen G, Nyquist A, Vik T, Sæther R.

*Phys Occup Ther Pediatr. 2016 Nov;36(4):440-52. doi:10.3109/01942638.2015.1127867. Epub 2016 Feb 18.*

AIM: This study examines construct validity and responsiveness of the Trunk Impairment Scale (TIS) and Trunk Control Measurement Scale (TCMS) in individuals with cerebral palsy (CP).

METHODS: Twenty-six individuals with CP (nine males), 8-29 years (mean age 17.6) with gross motor function corresponding to GMFCS I-IV, participated in three weeks of intensive and varied physical training at a health sports center. Trunk control was assessed with the TIS (includes three subscales) and TCMS (includes three subscales), and gross motor function with the Gross Motor Function Measure 66 item set (GMFM-66-IS), before and after the training period. The GMFM-66-IS was used as a comparison measure.

RESULTS: The median score of the TCMS subscale dynamic sitting balance, reaching (DSB-R), increased from 6 to 7 (range: 1-10;  $p = .031$ ), and there was a median change of 3 points in GMFM-66-IS score ( $p = .036$ ). There were no significant changes in the TIS. The correlations (Spearman's rho), between the TIS, TCMS, and the GMFM-66-IS (pre-scores), ranged between 0.57 and 0.75 ( $p < .003$ ). Correlations between change scores (pre- and post-scores) were low, and not statistically significant. However, the TCMS DSB-R change score correlated significantly with hours spent on "trunk-targeted training" like paddling/rowing ( $\rho = 0.66$ ;  $p = .003$ ) and horseback riding ( $\rho = 0.54$ ;  $p = .011$ ).

CONCLUSIONS: Our results support construct validity of the TIS and TCMS in young individuals with CP, whereas responsiveness could not be documented. However, the correlations between the TCMS DSB-R change score and hours spent on "trunk-targeted training" suggest that this subscale may have the potential to be used in intervention studies.

DOI: 10.3109/01942638.2015.1127867

PMID: 26890372 [Indexed for MEDLINE]

## Cognition

### **Cognitive Orientation to daily Occupational Performance (CO-OP): A New Approach for Children with Cerebral Palsy.**

Cameron D, Craig T, Edwards B, Missiuna C, Schwellnus H, Polatajko HJ.

*Phys Occup Ther Pediatr.* 2017 May;37(2):183-198. doi: 10.1080/01942638.2016.1185500. Epub 2016 Jun 9.

AIMS: The results of a small single-case study series suggested that Cognitive Orientation to daily Occupational Performance (CO-OP) may be a successful approach for children with cerebral palsy (CP). Therefore a pilot randomized controlled trial was conducted with the following research questions-is CO-OP a feasible approach to use with children with CP, what are the effects of CO-OP when compared to usual practice, and is a larger study warranted?

METHODS: 18 children between age 7 and 12 (nine in CO-OP group and nine in Current Usual Practice Approach (CUPA) group) received ten 1-hour sessions of intervention on average once per week at home. Primary outcome measures were the Canadian Occupational Performance Measure and the Performance Quality Rating Scale (PQRS). PQRS assessors were blind to group allocation and timing of assessment.

RESULTS: All children in the CO-OP group were able to learn the strategies and achieve their chosen goals, thus demonstrating the feasibility of the approach. Both approaches equally promoted skill acquisition and skill maintenance at follow-up. Effect sizes suggest that CO-OP may show some advantage for transfer and maintenance.

CONCLUSION: Based on these initial findings, further research is warranted.

DOI: 10.1080/01942638.2016.1185500

PMID: 27282077 [Indexed for MEDLINE]

### **Measuring intellectual ability in cerebral palsy: The comparison of three tests and their neuroimaging correlates.**

Ballester-Plané J, Laporta-Hoyos O, Macaya A, Póo P, Meléndez-Plumed M, Vázquez É, Delgado I, Zubiaurre-Elorza L, Narberhaus A, Toro-Tamargo E, Russi ME, Tenorio V, Segarra D, Pueyo R.

*Res Dev Disabil.* 2016 Sep;56:83-98. doi: 10.1016/j.ridd.2016.04.009. Epub 2016 Jun 2.

Standard intelligence scales require both verbal and manipulative responses, making it difficult to use in cerebral palsy and leading to underestimate their actual performance. This study aims to compare three intelligence tests suitable for the heterogeneity of cerebral palsy in order to identify which one(s) could be more appropriate to use. Forty-four subjects with bilateral dyskinetic cerebral palsy (26 male, mean age 23 years) conducted the Raven's Coloured Progressive Matrices (RCPM), the Peabody Picture Vocabulary Test-3rd (PPVT-III) and the Wechsler Nonverbal Scale of Ability (WNV). Furthermore, a comprehensive neuropsychological battery and magnetic

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resonance imaging were assessed. The results show that PPVT-III gives limited information on cognitive performance and brain correlates, getting lower intelligence quotient scores. The WNV provides similar outcomes as RCPM, but cases with severe motor impairment were unable to perform it. Finally, the RCPM gives more comprehensive information on cognitive performance, comprising not only visual but also verbal functions. It is also sensitive to the structural state of the brain, being related to basal ganglia, thalamus and white matter areas such as superior longitudinal fasciculus. So, the RCPM may be considered a standardized easy-to-administer tool with great potential in both clinical and research fields of bilateral cerebral palsy.

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DOI: 10.1016/j.ridd.2016.04.009

PMID: 27262445 [Indexed for MEDLINE]

### **Motor learning paradigm and contextual interference in manual computer tasks in individuals with cerebral palsy.**

Prado MT, Fernani DC, Silva TD, Smorenburg AR, Abreu LC, Monteiro CB.

*Res Dev Disabil.* 2017 Mar 25;64:56-63. doi: 10.1016/j.ridd.2017.03.006. [Epub ahead of print]

**BACKGROUND:** Cerebral palsy (CP) is a group of disorders of movement and posture that cause activity limitations. Due to the different motor problems these individuals encounter there is a need to offer rehabilitation programs that promote motor learning. Additionally, the understanding of the learning patterns of these individuals can help us attend to their learning needs to maximize their learning efficiency.

**AIMS:** The present study aimed to add to the knowledge base in regards to motor learning and the contextual interference (CI) effect.

**METHODS AND PROCEDURES:** The study included 40 individuals with CP and 40 typically developing (TD) participants matched for age and gender with the CP group. Both groups were divided into 2 subgroups regarding the practice schedule (random or constant practice) of a manual maze test on the computer. The participants who performed in the constant practice schedule performed the same standard maze 30 times, while participants in the random practice schedule performed a total of 30 trials on 5 mazes with a different spatial layout including the standard maze. After 5min of rest, retention was studied with a task in which all participants performed the standard maze. To examine the transfer effect, all participants also performed a maze with a new layout. Time of completion was registered in seconds for each trial.

**OUTCOMES AND RESULTS:** The results showed that the performance was lower in individuals with CP compared to typically developing individuals. In addition, only the participants with CP showed a contextual interference effect, with performance after the random practice schedule being superior compared to participants who practiced with a constant practice schedule.

**CONCLUSIONS AND IMPLICATIONS:** Overall performance was lower in individuals with CP compared to individuals with TD. Additionally, both TD individuals and individuals with CP showed the contextual interference effect in the transfer phase, with the execution of random practice leading to better performance than constant practice. These findings provide important information to assist clinicians in developing rehabilitation programs for children with CP.

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PMID: 28351764

### **Parameters and Measures in Assessment of Motor Learning in Neurorehabilitation; A Systematic Review of the Literature.**

Shishov N, Melzer I, Bar-Haim S.

*Front Hum Neurosci.* 2017 Feb 24;11:82. doi: 10.3389/fnhum.2017.00082. eCollection 2017.

Upper limb function, essential for daily life, is often impaired in individuals after stroke and cerebral palsy (CP). For an improved upper limb function, learning should occur, and therefore training with motor learning principles is included in many rehabilitation interventions. Despite accurate measurement being an important aspect for examination and optimization of treatment outcomes, there are no standard algorithms for outcome measures selection. Moreover, the ability of the chosen measures to identify learning is not well established. We aimed to review and categorize the parameters and measures utilized for identification of motor learning in stroke and CP populations. PubMed, Pedro, and Web of Science databases were systematically searched between January 2000 and March 2016 for studies assessing a form of motor learning following upper extremity training using motor control measures. Thirty-two studies in persons after stroke and 10 studies in CP of any methodological quality were

included. Identified outcome measures were sorted into two categories, "parameters," defined as identifying a form of learning, and "measures," as tools measuring the parameter. Review's results were organized as a narrative synthesis focusing on the outcome measures. The included studies were heterogeneous in their study designs, parameters and measures. Parameters included adaptation (n = 6), anticipatory control (n = 2), after-effects (n = 3), de-adaptation (n = 4), performance (n = 24), acquisition (n = 8), retention (n = 8), and transfer (n = 14). Despite motor learning theory's emphasis on long-lasting changes and generalization, the majority of studies did not assess the retention and transfer parameters. Underlying measures included kinematic analyses in terms of speed, geometry or both (n = 39), dynamic metrics, measures of accuracy, consistency, and coordination. There is no exclusivity of measures to a specific parameter. Many factors affect task performance and the ability to measure it necessitating the use of several metrics to examine different features of movement and learning. Motor learning measures' applicability to clinical setting can benefit from a treatment-focused approach, currently lacking. The complexity of motor learning results in various metrics, utilized to assess its occurrence, making it difficult to synthesize findings across studies. Further research is desirable for development of an outcome measures selection algorithm, while considering the quality of such measurements.

[Free PMC Article](#)

DOI: 10.3389/fnhum.2017.00082

PMCID: PMC5324661

PMID: 28286474

## Traitement - Rééducation motrice et cognitive

### Breakthroughs in the spasticity management: Are non-pharmacological treatments the future?

Naro A, Leo A, Russo M, Casella C, Buda A, Crespantini A, Porcari B, Carioti L, Billeri L, Bramanti A, Bramanti P, Calabrò RS.

*J Clin Neurosci.* 2017 Mar 3. pii: S0967-5868(16)31350-9. doi: 10.1016/j.jocn.2017.02.044. [Epub ahead of print]

The present paper aims at providing an objective narrative review of the existing non-pharmacological treatments for spasticity. Whereas pharmacologic and conventional physiotherapy approaches result well effective in managing spasticity due to stroke, multiple sclerosis, traumatic brain injury, cerebral palsy and incomplete spinal cord injury, the real usefulness of the non-pharmacological ones is still debated. We performed a narrative literature review of the contribution of non-pharmacological treatments to spasticity management, focusing on the role of non-invasive neurostimulation protocols (NINM). Spasticity therapeutic options available to the physicians include various pharmacological and non-pharmacological approaches (including NINM and vibration therapy), aimed at achieving functional goals for patients and their caregivers. A successful treatment of spasticity depends on a clear comprehension of the underlying pathophysiology, the natural history, and the impact on patient's performances. Even though further studies aimed at validating non-pharmacological treatments for spasticity should be fostered, there is growing evidence supporting the usefulness of non-pharmacologic approaches in significantly helping conventional treatments (physiotherapy and drugs) to reduce spasticity and improving patient's quality of life. Hence, non-pharmacological treatments should be considered as a crucial part of an effective management of spasticity.

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PMID: 28262404

### Therapy service use in children and adolescents with cerebral palsy: An Australian perspective.

Meehan E, Harvey A, Reid SM, Reddihough DS, Williams K, Crompton KE, Omar S, Scheinberg A

*J Paediatr Child Health.* 2016 Mar;52(3):308-14. doi: 10.1111/jpc.13021. Epub 2015 Nov 26.

**AIM:** The aim of this study was to describe the patterns of therapy service use for a sample of children and adolescents with cerebral palsy over a 1 year period and to identify factors associated with frequency of therapy and parental satisfaction with therapy frequency.

**METHODS:** Parents of 83 children completed a survey on their child's use of occupational therapy, physiotherapy and speech and language pathology services over the previous year. Participants were randomly selected from a sample stratified by age and Gross Motor Function Classification System (GMFCS) level.

RESULTS: During the year prior to survey completion, 83% of children had received occupational therapy, 88% had received physiotherapy and 60% had received speech and language pathology services. Frequency of therapy was higher for younger children ( $P < 0.01$ ), those classified at GMFCS levels IV-V ( $P < 0.05$ ) and those attending schools specifically for children with disabilities.

CONCLUSIONS: Current structures for therapy service delivery for children with cerebral palsy are systems-based, and age-based funding systems and the organisation of services around the education system are preventing the delivery of needs-based therapy. Paediatricians that care for children and young people with cerebral palsy need to pay particular attention to those that may miss out on therapy due to age or school type, and support these families in accessing appropriate therapy.

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DOI: 10.1111/jpc.13021

PMID: 26607781 [Indexed for MEDLINE]

### Pharmacologie Efficacite Tolérance

#### **Long-term therapy with intrathecal baclofen improves quality of life in children with severe spastic cerebral palsy.**

Kraus T, Gegenleitner K, Svehlik M, Novak M, Steinwender G, Singer G.

*Eur J Paediatr Neurol.* 2017 Feb 11. pii: S1090-3798(17)30098-3. doi: 10.1016/j.ejpn.2017.01.016. [Epub ahead of print]

INTRODUCTION: Children with severe spastic cerebral palsy (CP) are highly limited in daily life activities causing a reduced quality of life (QoL). This is partly due to an increased muscle tone causing pain and contractures. Continuous intrathecal infusion of baclofen (ITB) reduces the spasticity of affected patients. The hypothesis of the present study was that ITB leads to a significant improvement of QoL in non-ambulant children with CP.

PATIENTS AND METHODS: 13 patients (10 male, 3 female, mean age 14 years) were included. Mean time between pump implantation and follow-up was 60 months (range, 12-100). QoL was assessed before and after baclofen pump implantation using standardized questionnaires (CP CHILD, KINDL). Spasticity was evaluated using the modified Ashworth Scale (MAS) at the two time points.

RESULTS: QoL evaluated with the CPCHILD questionnaire and the KINDL improved from pre - implantation to follow-up. MAS markedly decreased from 3.8 to 1.7. All interviewed participants indicated that their expectations had been met and that they would choose ITB treatment again.

CONCLUSION: Intrathecal treatment of baclofen is an excellent method for spasticity management in children with severe cerebral palsy. Quality of life sustainably improves, parents' satisfaction is high and the level of spasticity decreases. Therefore, baclofen treatment can be highly recommended in non-ambulant children with CP suffering from spasticity.

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DOI: 10.1016/j.ejpn.2017.01.016

PMID: 28237420

#### **Lumbar translaminar fenestration for insertion of intrathecal baclofen catheter: a novel technique.**

Heran MK, Al-Shikarchy H, Chowne C.

*Pediatr Radiol.* 2017 Mar 20. doi: 10.1007/s00247-017-3816-y. [Epub ahead of print]

Intrathecal baclofen has long been known to be an efficacious treatment of spasticity in children with cerebral palsy. Test bolus administration is often necessary to ensure patients will benefit from this treatment. The introduction of an intrathecal catheter for test bolus administration can prove challenging in a subset of this population, particularly those who have received surgery with postoperative spinal fusion masses. We outline a novel technique of inserting a spinal catheter for test bolus administration in a patient with a postoperative fusion mass whereby a fenestration is created through the lamina using an osteotomy needle.

DOI: 10.1007/s00247-017-3816-y

PMID: 28317070

## **Quantitative assessment of muscle stiffness with acoustic radiation force impulse elastography after botulinum toxin A injection in children with cerebral palsy.**

Ceyhan Bilgici M, Bekci T, Ulus Y, Bilgici A, Tomak L, SelcukMB.

*J Med Ultrason* (2001). 2017 Mar 7. doi: 10.1007/s10396-017-0780-y. [Epub ahead of print]

**PURPOSE:** Our objective in this study was to assess the changes in medial gastrocnemius muscle (GCM) stiffness after botulinum toxin A (BTA) injection in children with cerebral palsy (CP) by using acoustic radiation force impulse (ARFI) elastography and to research the usability of this technique in clinical practice.

**MATERIALS AND METHODS:** Twenty-four spastic lower extremities of 12 children with CP were assessed. BTA injection treatment was applied to the medial GCM. Muscle stiffness was measured with the ARFI technique before the procedure and a month after the procedure. The patients were assessed with the modified Ashworth scale (MAS) in the physiotherapy department at about the same time. Shear wave velocity (SWV) values and MAS scores before and after the treatment were compared.

**RESULTS:** Mean SWV values were measured as  $3.20 \pm 0.14$  m/s before BTA and as  $2.45 \pm 0.21$  m/s after BTA, and the difference between them was found to be statistically significant ( $p < 0.001$ ). Mean MAS score ( $2.33 \pm 0.70$ ) after BTA decreased significantly when compared to the score before BTA ( $2.96 \pm 0.62$ ) ( $p = 0.001$ ). SWV values positively correlated with MAS scores ( $\rho = 0.578$ ,  $p = 0.003$ ). The interobserver agreement expressed as interclass correlation coefficient (ICC) was 0.65 (95% CI 0.33-0.84,  $p < 0.001$ ).

**CONCLUSION:** ARFI elastography for identifying structural changes that occur in the spastic muscle after BTA injection in children with CP can yield more valuable information with combined use of MAS.

DOI: 10.1007/s10396-017-0780-y

PMID: 28271231

### **Chirurgie**

## **A Modification to the McHale Procedure Reduces Operative Time and Blood Loss.**

Godfrey J, McGraw J, Kallur A, Silva S, Szalay E.

*J Pediatr Orthop*. 2016 Dec;36(8):e89-e95.

**BACKGROUND:** Treatment of symptomatic spastic hip dislocations in adolescent patients with cerebral palsy includes a variety of described salvage type procedures. In 1990, McHale and colleagues described a technique involving a femoral head resection, valgus-producing proximal femoral osteotomy, and advancement of the lesser trochanter into the acetabulum. We have modified this technique in 3 ways by: performing it in the lateral position with a more posterior approach, not advancing the lesser trochanter into the acetabulum, and closing the capsule over the acetabulum. The purpose of this paper is to describe our technique and to compare the results to Castle type procedures and McHale procedures performed as originally described.

**METHODS:** We retrospectively reviewed all salvage type procedures performed at our institution for spastic hip dislocations in children with cerebral palsy from 2003 to 2013. Preoperative and postoperative pain, estimated blood loss, operative time, length of stay in the hospital, and postoperative pelvis radiographs were reviewed for heterotopic ossification formation and proximal femoral migration.

**RESULTS:** Twenty-six patients with 30 hip procedures were reviewed. The modified McHale technique had shorter operative times when compared with the supine McHale technique and the Castle procedure (134, 171, and 139 min, respectively). There was a trend toward less blood loss in the modified McHale technique, but this was not significant. There was no difference in length of stay in the hospital. The majority of McHale patients (>63%) had pain relief postoperatively, where half of the Castle patients required a revision surgery for pain (4 of 8). There was less heterotopic ossification seen in the modified McHale technique (6.25%) when compared with supine McHale and Castle techniques (both 50%). However, there was more proximal femoral migration in the modified McHale group.

**CONCLUSIONS:** The modified McHale technique is faster with otherwise equivocal results in the immediate operative periods. There is less heterotopic bone formation but more proximal femoral migration with this new technique.

**LEVEL OF EVIDENCE:** Level IV-case series.

DOI: 10.1097/BPO.0000000000000634

PMID: 26368855 [Indexed for MEDLINE]

## **Ability of PROMIS Pediatric Measures to Detect Change in Children With Cerebral Palsy Undergoing Musculoskeletal Surgery.**

Mulcahey MJ, Haley SM, Slavin MD, Kisala PA, Ni P, Tulsy DS, Jette AM.

*J Pediatr Orthop.* 2016 Oct-Nov;36:749-56. doi: 10.1097/BPO.0000000000000533.

**BACKGROUND:** The Patient Reported Outcomes Measurement Information System (PROMIS) was developed to provide patient-reported outcome measures that are designed as being universally relevant across health conditions, low burden, and precise. A major problem for research and clinical practice in cerebral palsy (CP) is the void of outcomes instruments that are capable of evaluating the wide range of abilities and broad age spectrum inherent in this clinical population. Given the tremendous potential of PROMIS, the research questions for this study were "How do PROMIS pediatric computer adaptive tests and short forms detect change in children with CP following elective musculoskeletal surgery?" and "How do PROMIS instruments compare to the Pediatric Quality of Life Inventory Cerebral Palsy Module Version 3.0 (PedsQL CP), Pediatric Outcomes Data Collection Instrument (PODCI), the Timed Up and Go (TUG), and the Gross Motor Functional Measure (GMFM)."

**METHODS:** PROMIS Pediatric computer adaptive tests and short forms and the PedsQL, PODCI, TUG, and GMFM were administered before and after surgery. Effect size (ES) and standardized response mean (SRM) were calculated. Floor and ceiling effects were evaluated and, exposure rates for the PROMIS item banks were examined.

**RESULTS:** ES and SRM for all PROMIS Pediatric Measures were nonsignificant. PedsQL CP detected significant, positive change in mobility at 6 (ES=0.26; SRM=0.31) and 12 (ES=0.36; SRM=0.36) months; pain at 12 months (ES=0.29; SRM=0.34); and fatigue at 6 (ES=0.24; SRM=0.22) and 12 (ES=0.36; SRM=0.41) months. Significant negative changes were detected by the PODCI (ES=-0.20; SRM=-0.26), GMFM (ES=-0.13; SRM=-0.24), and TUG (ES=-0.29; SRM=-0.25). Ceiling effects were high. Exposure to an appropriate range of the PROMIS Mobility item bank was limited.

**CONCLUSIONS:** PROMIS measures were less able to detect change than other measures. PROMIS measures may be improved by tailoring start/stop rules or by adding items to include content appropriate for children with mobility impairments.

**LEVEL OF EVIDENCE:** Level III-diagnostic study.

DOI: 10.1097/BPO.0000000000000533

PMCID: PMC4670604 [Available on 2017-10-01]

PMID: 26057065 [Indexed for MEDLINE]

## **Comparison of Rectus Femoris Transfer Surgery Done Concomitant With Hamstring Lengthening or Delayed in Patients With Cerebral Palsy.**

Aiona M, Do KP, Feng J, Jabur M.

*J Pediatr Orthop.* 2017 Mar;37(2):107-110. doi: 10.1097/BPO.0000000000000596.

**BACKGROUND:** Children with spastic cerebral palsy frequently develop stiff knee gait. A common treatment of flexed knee gait is lengthening of the hamstring tendons. It has been shown that minimum knee extension improves after hamstring surgeries. However, it has been observed that a decreased peak knee flexion in swing may be a complication of hamstring lengthening (HSL). This has been noted to occur because of an overactive rectus femoris during the swing phase of gait. A common treatment of decreased knee flexion in swing is distal rectus femoris transfer (DRFT). The purpose of this study is to compare the differences between doing DRFT concomitantly with HSL and doing delayed DRFT after HSL.

**METHODS:** A total of 111 children with cerebral palsy (74 males and 37 females) who underwent HSL were reviewed retrospectively. All patients who met the inclusion criteria were divided into 3 groups, 28 subjects in the HSL alone group (H), 57 subjects in the HSL with concomitant rectus femoris transfer group (C), and 26 subjects in the HSL with delayed rectus femoris transfer group (D).

**RESULTS:** The groups had similar minimum knee flexion in stance preoperatively and postoperatively. Group D's minimum knee flexion in stance improved to  $5.5 \pm 12.7$  degrees after HSL, but increased to  $8.8 \pm 11.6$  degrees after DRFT. Groups D and H had statistically significant reduction in maximum knee flexion in swing after HSL ( $P < 0.05$ ). Maximum knee flexion in swing was statistically significantly reduced in the D group after DRFT ( $P < 0.05$ ), but the C group was not statistically different from preoperative after DRFT ( $P > 0.05$ ). The C and D groups had similar total knee excursion postoperatively. The H group had less knee excursion than the other 2 groups, but it was not significant.

CONCLUSIONS: The group that had DRFT concomitantly with HSL maintained maximum knee flexion in swing phase postoperatively. Although the group that had delayed DRFT had a reduction in maximum knee flexion after isolated HSL, gains in swing phase motion were achieved after delayed DRFT (comparable to that of the simultaneous group).

LEVEL OF EVIDENCE: Level II.

DOI: 10.1097/BPO.0000000000000596

PMID: 26192881 [Indexed for MEDLINE]

### **Correction of Tibial Torsion in Children With Cerebral Palsy by Isolated Distal Tibia Rotation Osteotomy: A Short-term, In Vivo Anatomic Study.**

Andrisevic E, Westberry DE, Pugh LI, Bagley AM, Tanner S, Davids JR.

*J Pediatr Orthop.* 2016 Oct-Nov;36(7):743-8. doi: 10.1097/BPO.0000000000000525.

BACKGROUND: Excessive internal or external tibial torsion is frequently present in children with cerebral palsy. Several surgical techniques have been described to correct excessive tibial torsion, including isolated distal tibial rotation osteotomy (TRO). The anatomic changes surrounding this technique are poorly understood. The goal of the study was to examine the anatomic relationship between the tibia and fibula following isolated distal TRO in children with cerebral palsy.

METHODS: Twenty patients with 29 limbs were prospectively entered for study. CT scans of the proximal and distal tibiofibular (TF) articulations were obtained preoperatively, at 6 weeks, and 1 year postoperatively. Measurements of tibia and fibula torsion were performed at each interval. Qualitative assessments of proximal and distal TF joint congruency were also performed.

RESULTS: The subjects with internal tibia torsion (ITT, 19 limbs) showed significant torsional changes for the tibia between preoperative, postoperative, and 1 year time points (mean torsion 13.21, 31.05, 34.84 degrees, respectively). Measurement of fibular torsion in the ITT treatment group also showed significant differences between time points (mean -36.77, -26.77, -18.54 degrees, respectively). Proximal and distal TF joints remained congruent at all time points in the study. Subjects with external tibia torsion (ETT, 10 limbs) showed significant differences between preoperative and postoperative tibial torsion, but not between postoperative and 1 year (mean torsion 54, 19.3, 23.3 degrees, respectively). Measurement of fibular torsion in the ETT treatment group did not change significantly between preoperative and postoperative, but did change significantly between postoperative and 1 year (mean torsion -9.8, -16.9, -30.7 degrees, respectively). Nine of 10 proximal TF joints were found to be subluxated at 6 weeks postoperatively. At 1 year, all 9 of these joints had reduced.

CONCLUSIONS: Correction of ITT by isolated distal tibial external rotation osteotomy resulted in acute external fibular torsion. The fibular torsion alignment remodeled over time to accommodate the corrected tibial torsional alignment and reduce the strain associated with the plastic deformity of the fibula. Correction of ETT by isolated distal internal TRO resulted in acute subluxation of the proximal TF articulation in almost all cases. Subsequent torsional remodeling of the fibula resulted in correction of the TF subluxation in all cases. Acute correction of TT by isolated distal TRO occurs by distinct mechanisms, based upon the direction of rotational correction.

LEVEL OF EVIDENCE: Level II-Diagnostic.

DOI: 10.1097/BPO.0000000000000525

PMID: 27603097 [Indexed for MEDLINE]

### **Effect of Hip Reconstructive Surgery on Health-Related Quality of Life of Non-Ambulatory Children with Cerebral Palsy.**

DiFazio R, Shore B, Vessey JA, Miller PE, Snyder BD.

*J Bone Joint Surg Am.* 2016 Jul 20;98(14):1190-8. doi: 10.2106/JBJS.15.01063.

BACKGROUND: The primary aim of this study was to evaluate the relationship of the migration percentage (a radiographic metric quantifying hip displacement) in children with Gross Motor Function Classification System (GMFCS) level-IV or V cerebral palsy and spastic hip dysplasia to the acetabular index and the health-related quality of life (HRQOL) as measured with the Caregiver Priorities and Child Health Index of Life with Disabilities (CPCHILD) before and after reconstructive hip surgery.

METHODS: In a prospective cohort study (n = 38), the migration percentage, acetabular index, and CPOCHILD scores were analyzed using the Pearson correlation analysis immediately before reconstructive hip surgery and at 6 weeks and 3, 6, 12, and 24 months after the surgery. Subgroup analysis was used to compare patients who had a

preoperative migration percentage of  $\geq 50\%$  with those who had a preoperative migration percentage of  $< 50\%$  and to compare the acetabular index between patients who had a pelvic osteotomy and those who had not. Linear mixed models were used to analyze changes in the migration percentage, acetabular index, and CPCHILD scores over time.

**RESULTS:** The preoperative migration percentage negatively correlated with the preoperative CPCHILD score ( $r = -0.50$ ;  $p = 0.002$ ). This relationship continued throughout the follow-up period such that, for each additional 1% correction in migration percentage, the CPCHILD total score increased by 0.2 point ( $p < 0.001$ ). There was no correlation between the acetabular index and CPCHILD total score before or after surgery ( $p = 0.09$  to  $0.71$ ). The preoperative CPCHILD total scores differed between the migration-percentile groups (mean difference = 13 points; 95% confidence interval = 3.3 to 22.8;  $p = 0.01$ ). However, after hip surgery, the CPCHILD score improved similarly for both groups.

**CONCLUSIONS:** These data support the effectiveness of reconstructive hip surgery for the treatment of spastic hip dysplasia to improve the HRQOL of non-ambulatory children with severe cerebral palsy.

**LEVEL OF EVIDENCE:** Prospective Level IV. See Instructions for Authors for a complete description of levels of evidence.

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DOI: 10.2106/JBJS.15.01063

PMID: 27440567 [Indexed for MEDLINE]

### **Effectiveness of surgical and non-surgical management of crouch gait in cerebral palsy: A systematic review.**

Galey SA, Lerner ZF, Bulea TC, Zimblor S, Damiano DL.

*Gait Posture.* 2017 Feb 24;54:93-105. doi: 10.1016/j.gaitpost.2017.02.024. [Epub ahead of print]

**BACKGROUND:** Cerebral palsy (CP) is a prevalent group of neuromotor disorders caused by early injury to brain regions or pathways that control movement. Patients with CP exhibit a range of functional motor disabilities and pathologic gait patterns. Crouch gait, characterized by increased knee flexion throughout stance, is a common gait pattern in CP that increases energy costs of walking and contributes to ambulatory decline. Our aim was to perform the first systematic literature review on the effectiveness of interventions utilized to ameliorate crouch gait in CP.

**METHODS:** Comprehensive searches of five medical databases yielded 38 papers with 30 focused on orthopaedic management.

**RESULTS:** Evidence supports the use of initial hamstring lengthenings and rectus femoris transfers, where indicated, for improving objective gait measures with limited data on improving gait speed or gross motor function. In contrast, evidence argues against hamstring transfers and revision hamstring lengthening, with recent interest in more technically demanding corrective procedures. Only eight studies evaluated alternatives to surgery, specifically strength training, botulinum toxin or orthoses, with inconsistent and/or short-lived results.

**CONCLUSIONS:** Although crouch in CP is recognized clinically as a complex multi-joint, multi-planar gait disorder, this review largely failed to identify interventions beyond those which directly address sagittal plane knee motion, indicating a major knowledge gap. Quality of existing data was notably weak, with few studies properly controlled or adequately sized. Outcomes from specific procedures are confounded by multilevel surgeries. Successful longer term strategies to prevent worsening of crouch and subsequent functional decline are needed.

**LEVEL OF EVIDENCE:** Systematic review.

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DOI: 10.1016/j.gaitpost.2017.02.024

PMID: 28279852

### **Infra-Conus Single-Level Laminectomy for Selective Dorsal Rhizotomy: Technical Advance.**

Bales J, Apkon S, Osorio M, Kinney G, Robison RA, Hooper E, Browd S.

*Pediatr Neurosurg.* 2016;51(6):284-291. Epub 2016 Aug 23.

**BACKGROUND/AIMS:** Selective dorsal rhizotomy for spastic cerebral palsy is an effective and well-validated surgical approach. Multiple techniques have been described in the past including multiple laminectomies and a single-level laminectomy at the level of the conus. There is considerable technical challenge involved with a single-level laminectomy approach.

**METHODS:** We report here a modification of the single-level laminectomy that selectively analyzes each individual nerve root with electromyography to separate dorsal and ventral nerve roots through comparison of stimulus responses.

**RESULTS:** In 18 children with cerebral palsy who underwent this operation there was a mean improvement in the Modified Ashworth Scale of 2.0 with no reported incidence of muscle weakness, sensory loss, or neurogenic bladder.

**CONCLUSION:** This approach allows for a modification of selective dorsal rhizotomy through a single-level laminectomy and tailors the selection of nerve root sectioning to the individual patient of interest while still maintaining its effectiveness.

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DOI: 10.1159/000448046

PMID: 27548353 [Indexed for MEDLINE]

### **Incidence and risk factors of hardware-related complications after proximal femoral osteotomy in children and adolescents.**

Chung MK, Kwon SS, Cho BC, Lee GW, Kim J, Moon SJ, Lee JW, Chung CY, Sung KH, Lee KM, Park MS.

*J Pediatr Orthop B.* 2017 Mar 8. doi: 10.1097/BPB.0000000000000448. [Epub ahead of print]

Proximal femoral osteotomy has been used in cerebral palsy, Perthes disease, hip dysplasia, idiopathic femoral anteversion, and various hip diseases in children and adolescents. Conventionally, a blade plate (BP) has been used. However, the pediatric locking compression plate (LCP) has recently been applied widely. We compared the hardware-related complications of the BP and the LCP as well as the factors influencing these complications in patients who have undergone a proximal femoral osteotomy in children and adolescents. We enrolled consecutive patients aged less than or equal to 20 years who had undergone proximal femoral osteotomy with BP or LCP between May 2003 and December 2014, and who were followed up until 6 months after hardware removal. Following consensus building, hardware-related complications were identified from the patients' medical records and hip radiographs. Patient age, sex, type of plate, and Gross Motor Function Classification System (GMFCS) level in cerebral palsy patients were evaluated as possible risk factors, and a generalized estimating equation was used to assess the risk factors for hardware-related complications. A total of 417 hips from 251 patients were finally included in this study. Seven losses of fixation around the plate (five patients, 3.0%) occurred in the BP, three implant-related fractures (three patients, 3.6%) occurred in the LCP, and there was no significant difference ( $P=0.74$ ). All hardware-related complications occurred in cerebral palsy patients, and the implant-related fractures occurred in patients with GMFCS IV/V. The risk of complications increased with age ( $P=0.002$ ). The risk of loss of fixation around the BP is a well-known complication. However, LCP is not without hardware-related complications. The LCP provides strong stability of fixation. However, it is speculated that the LCP is related to implant-related fractures because of the stress shielding effect. Therefore, care should be exercised when using a locking plate in patients with osteoporosis, such as cerebral palsy with

GMFCS IV/V. LEVEL OF EVIDENCE: Therapeutic Level III.

DOI: 10.1097/BPB.0000000000000448

PMID: 28277416

### **Outcomes after scoliosis surgery for children with cerebral palsy: a systematic review.**

Toovey R, Harvey A, Johnson M, Baker L, Williams K.

*Dev Med Child Neurol.* 2017 Mar 6. doi: 10.1111/dmcn.13412. [Epub ahead of print]

**AIM:** This study aims (1) to evaluate and synthesize the evidence for the postoperative outcomes after scoliosis surgery for children with cerebral palsy (CP), and (2) to identify preoperative risk factors for adverse outcomes after surgery.

**METHOD:** Medline, EMBASE, CINAHL, and PubMed were searched for relevant literature. Included studies were assessed for risk of bias using the Cochrane Effective Practice and Organisation of Care tool. Quality of evidence for overall function, quality of life (QoL), gross motor function, caregiver outcomes, deformity correction, and postoperative complications were assessed using GRADE (Grades of Recommendation, Assessment, Development and Evaluation).

**RESULTS:** Fifty-one studies met inclusion criteria, including 35 case series designs. Risk of bias was high across all studies. On average good deformity correction was achieved, the trend appears positive for caregiver and QoL outcomes, but there was minimal to no change for gross motor or overall function. Inconsistent measurement



limited synthesis. A mean overall complication rate of 38.1% (95% confidence interval 27.3-53.3) was found. The quality of evidence was very low across all functional outcomes.

**INTERPRETATION:** Limited high-quality evidence exists for outcomes after scoliosis surgery in children with CP, a procedure associated with a moderately high complication rate. The intervention appears indicated for deformity correction, but currently there is insufficient evidence to make recommendations for this surgery as a way to also improve functional outcomes, caregiver outcomes, and quality of life.

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DOI: 10.1111/dmnc.13412

PMID: 28262923

### **Outcomes of Cutaneous Scar Revision During Surgical Implant Removal in Children with Cerebral Palsy.**

Davids JR, Diaz K, Leba TB, Adams S, Westberry DE, Bagley AM.

*J Bone Joint Surg Am.* 2016 Aug 17;98(16):1351-8. doi: 10.2106/JBJS.15.01418.

**BACKGROUND:** Children who have had surgery involving the placement of an implant frequently undergo a subsequent surgery for hardware removal. The cosmesis of surgical scars following initial and subsequent surgeries is unpredictable. Scar incision (subsequent surgical incision through the initial scar) or excision (around the initial scar) is selected on the basis of the quality of the initial scar. The outcomes following these techniques have not been determined.

**METHODS:** This prospective, consecutive case series was designed to compare outcomes following surgical scar incision versus excision at the time of implant removal in children with cerebral palsy. Photographs of the scars were made preoperatively and at 6 and 12 months following implant removal and were graded for scar quality utilizing the modified Stony Brook Scar Evaluation Scale (SBSES). Parental assessment of scar appearance was performed at the same time points utilizing a visual analog cosmetic scale (VACS).

**RESULTS:** The scars that were selected for incision had significantly worse SBSES scores at 6 and 12 months following the second surgery compared with preoperative values. However, parents' VACS scores of the incised scars, although worse at 6 months, were comparable with preoperative scores at 12 months. Scars that were selected for excision had significantly worse SBSES scores at 6 months but scores that were comparable with preoperative values at 12 months. VACS scores for the excised scars were comparable at the 3 time points.

**CONCLUSIONS:** Surgical incisions that initially healed with good scar quality generally healed well (from the parents' perspective) following subsequent incision through the previous scar. Surgical incisions that initially healed with poor scar quality did not heal better following excision of the previous scar. In such situations, surgical excision of the existing scar should occur in conjunction with additional adjuvant therapies to improve cosmesis.

**LEVEL OF EVIDENCE:** Therapeutic Level II. See Instructions for Authors for a complete description of levels of evidence.

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DOI: 10.2106/JBJS.15.01418

PMID: 27535437 [Indexed for MEDLINE]

### **Outcomes of Orthopaedic Surgery With and Without an External Femoral Derotational Osteotomy in Children With Cerebral Palsy.**

McMulkin ML, Gordon AB, Caskey PM, Tompkins BJ, Baird GO.

*J Pediatr Orthop.* 2016 Jun;36(4):382-6. doi: 10.1097/BPO.0000000000000465.

**BACKGROUND:** Ambulatory children with cerebral palsy (CP) often present with multiple deviations in all planes including increased internal hip rotation during gait. Excessive femoral anteversion is a common cause of deviation managed surgically with an external femoral derotational osteotomy (FDO). The purpose of this study was to evaluate the gait and functional outcomes of a group of subjects with CP who underwent surgical intervention that included an FDO compared with a match group with indications of internal hip rotation that did not receive an FDO.

**METHODS:** For this retrospective study, subjects were identified from the Motion Analysis Laboratory database that had orthopaedic surgery including an FDO (FDO group). A control group was established from a chart review identifying subjects that had indications for an FDO, but did not have this surgery (No-FDO group). All subjects had preoperative and postoperative gait studies. Subjects categorized as Gross Motor Function Classification System (GMFCS) levels I and II in both FDO and No-FDO groups were combined for analysis. Subjects rated as GMFCS level III

were analyzed separately. Preoperative to postoperative kinematic and kinetic variables, Gait Deviation Index, net oxygen cost, and PODCI scores were analyzed with paired t tests.

**RESULTS:** Typical sagittal plane kinematic variables improved significantly by equivalent magnitudes for both FDO and No-FDO groups (GMFCS I/II and III). Transverse plane improvements were only seen for the FDO group (GMFCS I/II and III). The Gait Deviation Index, an overall index of kinematics, improved by a significantly greater amount for the FDO group across GMFCS levels I/II and III. Net oxygen cost improved for both FDO and No-FDO for GMFCS I/II. PODCI scores improved for FDO and No-FDO in GMFCS I/II, but only the FDO group for GMFCS III.

**CONCLUSIONS:** For children with CP, inclusion of an FDO in the surgical intervention, when indicated, resulted in improved outcomes. Overall gait kinematic improvements were significantly greater when an FDO was included in the surgical management.

**LEVEL OF EVIDENCE:** Level III-retrospective comparative study.

DOI: 10.1097/BPO.0000000000000465

PMID: 25851681 [Indexed for MEDLINE]

### **Percutaneous Subtrochanteric Osteotomy for Painful Dislocated Hips in Patients With Cerebral Palsy.**

Martinez M, Kim SJ, Sabharwal S.

*J Pediatr Orthop.* 2017 Mar;*37*(2):111-120. doi: 10.1097/BPO.0000000000000600.

**BACKGROUND:** Treatment of a painful, chronically dislocated hip in nonambulatory children with cerebral palsy (CP) is challenging and controversial. Although many surgical options have been described, there is limited information, including patient-centered outcomes, following treatment. The purpose of our study was to evaluate the effect of a percutaneous subtrochanteric valgus osteotomy (SVO) using external fixation (EF) on hip abduction, radiographic parameters, and quality of life (QOL) measures in such patients.

**METHODS:** Fifteen nonambulatory patients (8 male, 7 female) with CP with 19 chronically dislocated hips underwent SVO using EF and adductor tenotomy at an average age of 14.3 years (range, 10.7 to 26.8 y). Changes in hip abduction and radiographic angular correction following surgery were assessed. Caregivers completed 2 surveys detailing differences in the patient's QOL measures, including severity and duration of pain and ease of nursing care, and the modified Child Health Index of Life with Disabilities (CPCHILD).

**RESULTS:** Caregivers of 11 patients completed both surveys at an average follow-up of 50 months (range, 17 to 119 mo) after fixator removal. There was improvement in pain, sitting tolerance, ease of transfers, and perineal care in the majority (9/11) of patients. The modified CCHILD (possible score, 10 to 50) improved from 27.2 to 16.23 ( $P=0.05$ ). Hip abduction improved from -7 degrees (range, -32 to 5 degrees) to 24 degrees (range, 0 to 40 degrees) ( $P<0.0001$ ). The average valgus osteotomy correction was 48.2 degrees (range, 2.2 to 93.2 degrees). The pelvic femoral shaft angle improved from -15.2 degrees (range, -47.7 to 7.4 degrees) to 15.4 degrees (-44.3 to 44.6 degrees). There was some correlation of both, change in hip abduction ( $R=0.55$ ) and osteotomy angle ( $R=0.60$ ), with improvement in QOL measures. There were 3 major complications (20%) in 15 patients.

**CONCLUSIONS:** On the basis of preliminary results, percutaneous SVO stabilized with EF improves QOL in the majority of nonambulatory CP patients despite untoward events and is a viable alternative to open osteotomy with internal fixation. More robust comparative studies are needed to further assess the optimal salvage technique in this patient population.

**LEVEL OF EVIDENCE:** Level IV.

DOI: 10.1097/BPO.0000000000000600

PMID: 26214329 [Indexed for MEDLINE]

### **Presurgical Concerns of Primary Family Caregivers of Children With Cerebral Palsy.**

Yu LC, Chen LC, Lin HC, Lin YE, Chang CH, Chen SC.

*Orthop Nurs.* 2017 Mar/Apr;*36*(2):140-146. doi: 10.1097/NOR.0000000000000328.

**BACKGROUND:** Primary family caregivers (PFCs) of children with cerebral palsy have many worries and concerns when their children face orthopedic surgery. Levels of PFC stress about the upcoming surgery is related to the child's level of gross motor function as well as the support they receive from medical professionals.

**PURPOSE:** The purposes of the present study were to (1) explore the levels of concern about orthopedic surgery; and (2) explore the predictive factors associated with concerns about orthopedic surgery among PFCs of children with cerebral palsy during the preoperative period.

**METHODS:** A cross-sectional, correlational study was conducted. Primary family caregivers were assessed preoperatively using the Single-event Multilevel Surgery Scale, Social Support Scale, Gross Motor Function Classification System-Expanded and Revised, and background information form. Primary family caregivers were recruited from the outpatient department of orthopedic surgery and pediatric rehabilitation of a medical center in northern Taiwan. Data were analyzed by descriptive analysis, Pearson product-moment correlation, and multiple regression analysis.

**RESULTS:** A total of 63 eligible subjects were enrolled in this study. Primary family caregivers had moderate levels of concern and mild-to-moderate levels of social support. The higher severity of motor function impairment in children with cerebral palsy, prior caregiving by PFCs for another family member, and PFCs' lower level of social support from healthcare providers were associated with higher levels of PFC concern.

**CONCLUSIONS:** Concerns about orthopedic surgery is an overlooked issue that needs more attention from healthcare providers. This study determined that PFCs who perceived a lack of social support from their healthcare providers and those with children who had limited gross motor function were more concerned and anxious about their children's upcoming orthopedic surgery. Health professionals should provide adequate health education and counseling to help PFCs of children with cerebral palsy in the decision-making process prior to orthopedic surgery.

DOI: 10.1097/NOR.0000000000000328

PMID: 28358778

### **Predictors for anterior pelvic tilt following surgical correction of flexed knee gait including patellar tendon shortening in children with cerebral palsy.**

Böhm H, Hösl M, Döderlein L.

*Gait Posture.* 2017 Feb 21;54:8-14. doi: 10.1016/j.gaitpost.2017.02.015. [Epub ahead of print]

**INTRODUCTION:** Patellar tendon shortening procedure within single event multilevel surgeries was shown to improve crouch gait in Cerebral Palsy (CP) patients. However, one of the drawbacks associated to the correction of flexed knee gait may be increased pelvic anterior tilt with compensatory lumbar lordosis.

**RESEARCH QUESTION:** Which CP patients are at risk for excessive anterior pelvic tilt following correction of flexed knee gait including patellar tendon shortening?

**METHODS:** 32 patients with CP between 8 and 18 years GMFCS I&II were included. They received patellar tendon shortenings within multilevel surgery. Patients with concomitant knee flexor lengthening were excluded. Gait analysis and clinical testing was performed pre- and 24.1 (SD=1.9) months postoperatively. Patients were subdivided into more/less than 5° increase in anterior pelvic tilt. Preoperative measures indicating m. rectus and m. psoas shortness, knee flexor over-length, hip extensor and abdominal muscle weakness and equinus gait were compared between groups. Stepwise multilinear regression of the response value increase in pelvic tilt during stance phase was performed from parameters that were significantly different between groups.

**RESULTS:** 34% of patients showed more than 5° increased pelvic anterior tilt postoperatively. Best predictors for anterior pelvic tilt from preoperative measures were increased m. rectus tone and reduced hip extension during walking that explained together 39% of the variance in increase of anterior pelvic tilt.

**DISCUSSION:** Every third patient showed considerable increased pelvic tilt following surgery of flexed knee gait. In particular patients with preoperative higher muscle tone in m. rectus and lower hip extension during walking were at risk and both features need to be addressed in the therapy.

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DOI: 10.1016/j.gaitpost.2017.02.015

PMID: 28242571

### **Risk Factors of Refracture and Morbidity During Removal of Titanium Pediatric Proximal Femoral Locking Plates in Children With Cerebral Palsy.**

Inan M, Sarikaya IA, Seker A, Guven MF.

*J Pediatr Orthop.* 2016 Jun;36(4):387-91. doi: 10.1097/BPO.0000000000000455.

**BACKGROUND:** Pediatric proximal femoral locking plates (PFLPs) are widely used when performing proximal femoral osteotomy in children with cerebral palsy (CP). The purpose of this study is to report the difficulties and risk factors of titanium PFLPs removal in CP.

**METHODS:** PFLP removal was performed in 58 hips of 33 patients (17 males, 16 females). The mean age at the time of surgery (plate removal) was 10.9 (range, 5.7 to 19.2) years. The patients were divided into 2 groups as group 1 and 2, if any difficulty was observed during surgery or not.

**RESULTS:** Difficulty was not detected in 42 (72.4%) hips (group 1). Difficulties were encountered in 16 (27.6%) hips (group 2). A total of 364 screws were used (259 in group 1, 105 in group 2). The mean plate screw density ratios were 0.88 in group 1 and 0.94 in group 2. The difference between group 1 and 2 was statistically significant. The mean duration between the insertion and removal of the PFLP was 14.9 months (11.9 mo in group 1, 22.7 mo in group 2). The difference between group 1 and 2 was statistically significant. The screw heads were cut and the shafts were left in the bone in 4 hips (4 screws); 3 of these 4 screws were calcar screws. Therefore, calcar screw application can be accepted as a handicap for screw removal.

**CONCLUSIONS:** As a conclusion, this study suggested that difficulty in titanium PFLP removal in CP is common and PFLP removal is not a harmless procedure. A longer time from internal fixation to removal, increased plate screw density ratio, and calcar screw application are risk factors for difficulties in titanium PFLP removal in CP.

### **Surgical treatment using The Unit Rod in children with neuromuscular scoliosis.**

Nedelcu T, Georgescu I, Leroux J, Lechevallier J, Barbilian A, Tuhar I.

*J Med Life. 2016 Oct-Dec;9(4):399-407.*

The article represents a retrospective clinical and radiological study.

**Objective.** To assess the safety and the stability in time of the Unit Rod instrumentation in the treatment of severe neuromuscular scoliosis in children and adolescents. **Summary.** The treatment of patients with neuromuscular scoliosis always represents a challenge. The patients are debilitated and usual interventions are very long with great loss of blood. Serious complications can compromise the result of the surgery. The technique we used (the Unit Rod) is worldwide recognized, is simple, and gives excellent stability with a low rate of complications. **Methods.** We conducted a clinical and radiological retrospective study with a follow-up of at least 4 years in 58 patients with serious neuromuscular conditions, most of them being non-walkers. They were surgically treated by using mostly the Unit Rod technique, in the department of Paediatric Orthopaedics of the Rouen University Hospital, France, between 2000 and 2008. The back fusion was generally from T2 to pelvis. We used the Galveston technique for the patients who needed a pelvic fixation. **Results.** The mean Cobb angle correction was of 67% immediately after surgery; the correction of the curve decreased in time only in 4% of the cases. Pelvic obliquity was also very well corrected: 73% immediately and 70% at the last radiological follow-up. The mean operative time was of 175 minutes compared to 269 minutes for screws and hooks instrumentation. The most common complication for our technique was the radiolucent halo that appeared around the pelvic inserts. There was no significant degradation in time of the correction obtained. **Conclusions.** The use of this technique is safe, gives excellent results, achieving significant improvements in the postoperative functional status of the patients. The intra- and postoperative complications were minor. The advantage of using this method is the low cost of the material and technical simplicity, the corrective results being the same as the ones obtained with other techniques.

PMCID: PMC5141401

PMID: 27928445 [Indexed for MEDLINE]

### **Total Hip Arthroplasty in Patients with Cerebral Palsy: A Cohort Study Matched to Patients with Osteoarthritis.**

Houdek MT, Watts CD, Wyles CC, Trousdale RT, Milbrandt TA, Taunton MJ.

*J Bone Joint Surg Am. 2017 Mar 15;99(6):488-493. doi: 10.2106/JBJS.16.00528.*

**BACKGROUND:** The spasticity and increased muscle tone observed in patients with cerebral palsy can lead to hip degeneration, subluxation, and pain. Currently, there is hesitation to perform total hip arthroplasty in patients with cerebral palsy because of fears of early wear and dislocation. The purpose of this study was to review the outcomes of total hip arthroplasty in patients with cerebral palsy and to compare outcomes with those of matched patients with a diagnosis of osteoarthritis.

**METHODS:** Over a 24-year period, 39 patients undergoing a total hip arthroplasty with a diagnosis of cerebral palsy were identified. The cohort included 26 male patients (67%), and the mean patient age was 49 years. The mean follow-up was 7 years. Patients with cerebral palsy were matched 1:2 with a group of patients undergoing total hip arthroplasty for osteoarthritis.

RESULTS: There was no difference in the rate of reoperation, implant survival, or complications, specifically dislocation. Prior to the surgical procedure, all patients had severe or moderate pain, and postoperatively no patient had moderate or severe pain. Twenty-three patients had an improvement in their ability to independently walk, and all preoperative hip flexion contractures were corrected (n = 9). There was also a significant improvement ( $p < 0.0001$ ) in functional Harris hip scores.

CONCLUSIONS: This study refutes previous evidence showing increased risk of complications following total hip arthroplasty in patients with cerebral palsy. Total hip arthroplasty is a durable treatment option and provides clinically important pain relief and functional improvement in patients with cerebral palsy.

LEVEL OF EVIDENCE: Therapeutic Level III. See Instructions for Authors for a complete description of levels of evidence.

DOI: 10.2106/JBJS.16.00528

PMID: 28291181

### **Réadaptation fonctionnelle**

#### **Anaerobic exercise testing in rehabilitation: A systematic review of available tests and protocols.**

Krops LA, Albada T, van der Woude LH, Hijmans JM, Dekker R.

*J Rehabil Med.* 2017 Mar 28. doi: 10.2340/16501977-2213. [Epub ahead of print]

OBJECTIVE: Anaerobic capacity assessment in rehabilitation has received increasing scientific attention in recent years. However, anaerobic capacity is not tested consistently in clinical rehabilitation practice. This study reviews tests and protocols for anaerobic capacity in adults with various disabilities (spinal cord injury, cerebral palsy, cerebral vascular accident, lower-limb amputation(s)) and (able-bodied) wheelchair users.

DATA SOURCES: PubMed, CINAHL and Web of Science.

STUDY SELECTION: Papers were screened by 2 independent assessors, and were included when anaerobic exercise tests were performed on the above-selected subject groups.

DATA EXTRACTION: Included articles were checked for methodological quality.

DATA SYNTHESIS: A total of 57 papers was included. Upper-body testing [56 protocols] was conducted with arm crank [16] and wheelchair tests [40]. With a few [2] exceptions, modified Wingate (Wingate) protocols and wheelchair sprint tests dominated upper-body anaerobic testing. In lower-body anaerobic work [11], bicycle [3] and recumbent [1], and overground tests [7] were used, in which Wingate, sprint or jump protocols were employed.

CONCLUSION: When equipment is available a Wingate protocol is advised for assessment of anaerobic capacity in rehabilitation. When equipment is not available a 20-45 s sprint test is a good alternative. Future research should focus on standardized tests and protocols specific to different disability group

#### **Free Articles.**

DOI: 10.2340/16501977-2213

PMID: 28350415

#### **Can an anti-gravity treadmill improve stability of children with cerebral palsy?**

Birgani PM, Ashtiyani M, Rasooli A, Shahrokhnia M, Shahrokhi A, Mirbagheri MM.

*Conf Proc IEEE Eng Med Biol Soc.* 2016 Aug;2016:5465-5468. doi:10.1109/EMBC.2016.7591963.

We aimed to study the effects of an anti-gravity treadmill (AlterG) training on balance and postural stability in children with cerebral palsy (CP). AlterG training was performed 3 days/week for 8 weeks, with up to 45 minutes of training per session. The subject was evaluated before and after the 8-week training. The effects of training on the balance and postural stability was evaluated based on the Romberg test that was performed by using a posturography device. The parameters quantifying Center-of-Pressure (CoP) were calculated using different analytical approaches including power spectral density and principal components analyses. All of the key parameters including the Stabilogram, the Fast Fourier Transform (FFT) Energy, the Eigenvectors, and the Eigenvalues of CoP were modified between 14%-84%. The results indicated that the balance features were improved substantially after training. The clinical implication is that the AlterG has the potential to effectively improve postural stability in children with cerebral palsy.

DOI: 10.1109/EMBC.2016.7591963

PMID: 28269494

### **Cardiac Autonomic System Response to Submaximal Test in Children With Cerebral Palsy.**

Amichai T, Eylon S, Dor-Haim H, Berger I, Katz-Leurer M.

*Pediatr Phys Ther.* 2017 Apr;29(2):125-128. doi: 10.1097/PEP.0000000000000368.

AIM: To describe the heart rate (HR) and heart rate variability at rest, during a submaximal treadmill test and at rest posttreadmill in children with cerebral palsy (CP).

METHODS: Twenty children (6-11 years) with CP participated, who had Gross Motor Function Classification System levels I to III. The HR was monitored for 5 minutes seated, during a submaximal treadmill test, and after 5 minutes rest posttreadmill. Outcome variables were HR and the square root of the mean squared differences of successive differences between adjacent heart beats (RMSSD).

RESULTS: HR increased during the last stage of the treadmill test compared with rest. RMSSD was reduced during the last 2 minutes of the treadmill test compared with rest. The HR and RMSSD mean value at the second minute posttest were not significantly different from the pretreadmill rest value.

INTERPRETATION: The cardiac system in children with CP responded to the submaximal testing

DOI: 10.1097/PEP.0000000000000368

PMID: 28350766

### **Child-Focused and Context-Focused Behaviors of Physical and Occupational Therapists during Treatment of Young Children with Cerebral Palsy.**

Kruijssen-Terpstra AJ, Ellens M, Ketelaar M, Verschuren O, Di Rezze B, Gorter JW, Visser-Meily AM, Jongmans MJ.

*Phys Occup Ther Pediatr.* 2016 Nov;36(4):363-75. doi:10.1080/01942638.2016.1202877. Epub 2016 Sep 3.

AIMS: To (1) describe the child- and context-focused behaviors of physical and occupational therapists, and (2) compare the behaviors of therapists in a standard therapy session with those of therapists trained to deliver child- and context-focused services.

METHOD: Videos of 49 therapy sessions provided by 36 therapists were analyzed using the intervention domains of the Paediatric Rehabilitation Observational measure of Fidelity (PROF) to examine the therapeutic behaviors of physical and occupational therapists with young children with cerebral palsy (CP) (24 to 48 months) in a Dutch rehabilitation setting. The PROF ratings of 18 standard therapy sessions were compared with the ratings of 16 child- and 15 context-focused therapy sessions.

RESULTS: Therapists who provided standard therapy demonstrated a mix of child- and context-focused behaviors. PROF ratings indicated fewer child- and context-focused behaviors during standard therapy sessions compared with sessions where therapists were instructed to use either child- or context-focused behaviors.

CONCLUSIONS: A sample of Dutch physical and occupational therapists of young children with CP demonstrated a mix of child- and context-focused therapy behaviors during standard therapy. Further research is recommended on clinical reasoning and the effect of setting to better understand therapists' use of child- and context-focused behaviors during therapy sessions.

DOI: 10.1080/01942638.2016.1202877

PMID: 27593569 [Indexed for MEDLINE]

### **Constraint-induced movement therapy improves upper limb activity and participation in hemiplegic cerebral palsy: a systematic review.**

Chiu HC, Ada L.

*J Physiother.* 2016 Jul;62(3):130-7. doi: 10.1016/j.jphys.2016.05.013. Epub 2016 Jun 17.

QUESTIONS: Does constraint-induced movement therapy improve activity and participation in children with hemiplegic cerebral palsy? Does it improve activity and participation more than the same dose of upper limb therapy without restraint? Is the effect of constraint-induced movement therapy related to the duration of intervention or the age of the children?

DESIGN: Systematic review of randomised trials with meta-analysis.

PARTICIPANTS: Children with hemiplegic cerebral palsy with any level of motor disability.

INTERVENTION: The experimental group received constraint-induced movement therapy (defined as restraint of the less affected upper limb during supervised activity practice of the more affected upper limb). The control group received no intervention, sham intervention, or the same dose of upper limb therapy.

OUTCOME MEASURES: Measures of upper limb activity and participation were used in the analysis.

RESULTS: Constraint-induced movement therapy was more effective than no/sham intervention in terms of upper limb activity (SMD 0.63, 95% CI 0.20 to 1.06) and participation (SMD 1.21, 95% CI 0.41 to 2.02). However, constraint-induced movement therapy was no better than the same dose of upper limb therapy without restraint either in terms of upper limb activity (SMD 0.05, 95% CI -0.21 to 0.32) or participation (SMD -0.02, 95% CI -0.34 to 0.31). The effect of constraint-induced movement therapy was not related to the duration of intervention or the age of the children.

CONCLUSIONS: This review suggests that constraint-induced movement therapy is more effective than no intervention, but no more effective than the same dose of upper limb practice without restraint.

REGISTRATION: PROSPERO CRD42015024665. [Chiu H-C, Ada L (2016) Constraint-induced movement therapy improves upper limb activity and participation in hemiplegic cerebral palsy: a systematic review. *Journal of Physiotherapy* 62: 130-137].

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DOI: 10.1016/j.jphys.2016.05.013

PMID: 27323932 [Indexed for MEDLINE]

### **Current Rehabilitation Practices for Children with Cerebral Palsy: Focus and Gaps.**

Anaby D, Korner-Bitensky N, Steven E, Tremblay S, Snider L, Avery L, Law M.

*Phys Occup Ther Pediatr.* 2017 Feb;37(1):1-15. doi: 10.3109/01942638.2015.1126880. Epub 2016 Feb 11.

Comment in *Phys Occup Ther Pediatr.* 2017 Feb;37(1):16-18.

AIMS: To describe the focus of therapy practices in occupational and physical therapy for school-aged children with cerebral palsy, and better understand whether it is congruent with recommended practices.

METHODS: A Canada-wide Web-based survey was completed by 62 occupational and 61 physical therapists to identify problems, assessments, and treatment interventions for two case-based scenarios. Data were coded using the International Classification of Functioning, Disability and Health (ICF) definitions for "body functions and structure," "activity and participation," and "environment."

RESULTS: Physical therapists, in comparison to occupational therapists, were more likely to select interventions classed in the "body functions and structure" category (34-42% and 18-20%, respectively). Both professions focused on "activity and participation" (34-61%) when identifying problems, assessing, and intervening; attention, however, was mainly directed towards task-oriented activities such as activities of daily living and mobility. Participation in leisure or community-based activities received less attention (2-15%). The environment received limited attention for problems and assessments (4-25%), though it was an important focus of intervention (19-37%).

CONCLUSIONS: While body functions and structure are well-addressed, other ICF elements, specifically participation, are poorly integrated into practice. The emerging focus on the environment in therapy intervention, by modifying the context rather than changing aspects of the child, is consistent with current approaches and evidence. Knowledge translation implementation initiatives are recommended to bridge identified gaps.

DOI: 10.3109/01942638.2015.1126880

PMID: 26865220 [Indexed for MEDLINE]

### **Does intensive upper limb treatment modality Hybrid Constrained Induced Movement Therapy (H-CIMT) improve grip and pinch strength or fatigability of the affected hand?**

Brauers L, Geijen MM, Speth LA, Rameckers EA.

*J Pediatr Rehabil Med.* 2017;10(1):11-17. doi: 10.3233/PRM-170406.

PURPOSE: To investigate the effects of Hybrid-Constrained Induced Movement Therapy (H-CIMT), defined as CIMT combined with Bimanual Intensive Movement Therapy (BIMT), on grip and pinch strength and fatigability we measured grip and pinch strength and fatigability during clinical H-CIMT.

METHODS: The children participated in a H-CIMT model organized in a therapeutic summer-camp. Children received 90 hours of intensive treatment. Grip and pinch strength and fatigability was measured and fatigue was calculated according to a Static Fatigue Index (SFI).

RESULTS: Pinch strength significantly increased, grip strength did not increase significantly. A non-significant decrease was seen in SFI in pinch and grip.

CONCLUSIONS: H-CIMT showed to be effective in increasing muscle pinch strength in the AH. Effectiveness in decreasing muscle fatigue during grip and pinch tests is not yet shown although there was a tendency towards a decrease in muscle fatigue. However, the long-term effects on these aspects are also important in future research.

DOI: 10.3233/PRM-170406

PMID: 28339406

### **Do we really know what they were testing? Incomplete reporting of interventions in randomised trials of upper limb therapies in unilateral cerebral palsy.**

Sakzewski L, Reedman S, Hoffmann T.

*Res Dev Disabil.* 2016 Dec;59:417-427. doi: 10.1016/j.ridd.2016.09.018. Epub 2016 Oct 11.

BACKGROUND: Incomplete reporting of components of interventions limits uptake of evidence into clinical practice.

AIMS: To evaluate the completeness of reporting of research and control interventions in randomised trials of upper limb therapies for children with unilateral cerebral palsy.

METHODS AND PROCEDURES: Sixty randomized trials were included, encompassing 60 research and 68 control interventions. Using the 12-item Template for Intervention Description and Replication (TIDieR) checklist, two reviewers independently rated intervention and control descriptions.

OUTCOMES AND RESULTS: When using 50% of studies as the benchmark, five of the 12 TIDieR items for the research intervention, eight of the 12 items for the control intervention and 11 of 12 items for "usual care" interventions were inadequately reported. Procedures used to deliver the research intervention were adequately reported for 63% of studies. Materials were used in 94% of research interventions, yet only 27% provided details to access/replicate materials. Training materials for interventionists were used in 38% of trials, 10 (17%) had procedure manuals, yet only 3 reported details to access materials. The location where the research intervention was provided was detailed in 65% of studies. Reporting of all items was poorer for the control intervention.

CONCLUSIONS: No study adequately reported all elements on the TIDieR checklist. Details crucial for replication of interventions and interpretation of results were missing. Authors, reviewers, and editors all have a responsibility to improve the quality of intervention reporting in published trials. The TIDieR guide is a potential solution, helping to structure accounts of interventions.

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DOI: 10.1016/j.ridd.2016.09.018

PMID: 27736712 [Indexed for MEDLINE]

### **Effects of elastic therapeutic taping on motor function in children with motor impairments: a systematic review.**

Cunha AB, Lima-Alvarez CD, Rocha AC, Tudella E.

*Disabil Rehabil.* 2017 Mar 22:1-9. doi: 10.1080/09638288.2017.1304581. [Epub ahead of print]

BACKGROUND: The elastic therapeutic taping has been considered a promising resource for disabled children.

OBJECTIVE: To systematically review the evidence of the effects of elastic therapeutic taping on motor function in children with motor impairments.

METHOD: Three independent evaluators conducted searches in electronic databases (MEDLINE/PubMed, Scopus, LILACS, BIREME/BVS, Science Direct, SciELO, and PEDro). Clinical studies design, published until 2016, involving elastic therapeutic taping and children aged 0-12 years with motor impairments were included. The variables considered were the methodological aspects (study design, participants, outcome measurements, and experimental conditions); results presented in the studies, and also the methodological quality of studies.

RESULTS: Final selection was composed by 12 manuscripts (five randomized controlled trials), published in the last 10 years. Among them, cerebral palsy (CP) was the most recurrent disorder (n = 7), followed by congenital muscular torticollis (n = 2) and brachial plexus palsy (n = 2). Positive results were associated with taping application: improvement in the upper limb function, gross motor skills, postural control, muscular balance, and performance in the dynamics functional and daily activities.

LIMITATIONS: Lower quality of the studies, clinical and population heterogeneity existed across studies.

CONCLUSIONS: The elastic therapeutic taping has been shown to be a promising adjunct resource to the conventional rehabilitation in children with motor impairments. However, high methodological studies about its efficacy in this population are already scarce. Implications for Rehabilitation Elastic therapeutic taping has been shown to be a promising adjunct resource to the conventional rehabilitation in disabled children. Clinical trials have



indicated improvement in the postural control and functional activities with both, upper and lower limbs, and increase in the functional independency resulting from the taping use. Randomized control trials and well-established protocols are needed to increase the confidence in applying elastic therapeutic taping to specific clinical conditions.

DOI: 10.1080/09638288.2017.1304581

PMID: 28325096

### **Efficacy of Intensive Neurodevelopmental Treatment for Children With Developmental Delay, With or Without Cerebral Palsy.**

Lee KH, Park JW, Lee HJ, Nam KY, Park TJ, Kim HJ, Kwon BS.

*Ann Rehabil Med.* 2017 Feb;41(1):90-96. doi: 10.5535/arm.2017.41.1.90. Epub 2017 Feb 28.

**OBJECTIVE:** To evaluate the effectiveness of intensive neurodevelopmental treatment (NDT) on gross motor function for the children having developmental delay (DD), with or without cerebral palsy (CP).

**METHODS:** Forty-two children had intensive NDT three times weekly, 60 minutes a day, for 3 months, immediately followed by conventional NDT once or twice a week, 30 minutes a day, for another 3 months. We assessed Gross Motor Function Measure (GMFM) over three time points: before conventional NDT, before and after intensive NDT, and after 3 months of additional conventional NDT.

**RESULTS:** The GMFM score in DD children significantly improved after intensive NDT, and the improvement maintained after 3 months of conventional NDT ( $p < 0.05$ ). The children were further divided into two groups: DD with CP and DD without CP. Both groups showed significant improvement and maintained the improvements, after intensive NDT ( $p < 0.05$ ). Also, there was no significant difference in treatment efficacy between the two groups. When we calculate the absence rate for comparing the compliance between intensive and conventional NDT, the absence rate was lower during the intensive NDT.

**CONCLUSION:** Intensive NDT showed significantly improved gross motor function and higher compliance than conventional NDT. Additionally, all improvements were maintained through subsequent short-term conventional NDT. Thus, we recommend the intensive NDT program by day-hospital centers for children with DD, irrespective of accompanying CP.

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DOI: 10.5535/arm.2017.41.1.90

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PMID: 28289640

Conflict of interest statement: CONFLICT OF INTEREST: No potential conflict of interest relevant to this article was reported.

### **Exploring the feasibility and use of accelerometers before, during, and after a camp-based CIMT program for children with cerebral palsy.**

Coker-Bolt P, Downey RJ, Connolly J, Hoover R, Shelton D, Seo NJ.

*J Pediatr Rehabil Med.* 2017;10(1):27-36. doi: 10.3233/PRM-170408.

**PURPOSE:** The aim of this pilot study was to determine the feasibility and use of accelerometers before, during, and after a camp-based constraint-induced movement therapy (CIMT) program for children with hemiplegic cerebral palsy.

**METHODS:** A pre-test post-test design was used for 12 children with CP (mean = 4.9 yrs) who completed a 30-hour camp-based CIMT program. The accelerometer data were collected using ActiGraph GT9X Link. Children wore accelerometers on both wrists one day before and after the camp and on the affected limb during each camp day. Three developmental assessments were administered pre-post CIMT program.

**RESULTS:** Accelerometers were successfully worn before, during, and directly after the CIMT program to collect upper limb data. Affected upper limb accelerometer activity significantly increased during the CIMT camp compared to baseline ( $p < 0.05$ ). Significant improvements were seen in all twelve children on all assessments of affected upper limb function ( $p < 0.05$ ) measuring capacity and quality of affected upper limb functioning.

**CONCLUSION:** Accelerometers can be worn during high intensity pediatric CIMT programs to collect data about affected upper limb function. Further study is required to determine the relationship between accelerometer data, measure of motor capacity, and real-world performance post-CIMT.

DOI: 10.3233/PRM-170408

PMID: 28339408

## **Extrinsic feedback and upper limb motor skill learning in typically-developing children and children with cerebral palsy: Review.**

Robert MT, Sambasivan K, Levin MF.

*Restor Neurol Neurosci.* 2017;35:171-184. doi: 10.3233/RNN-160688.

**BACKGROUND:** Improvement of upper limb motor skills occurs through motor learning that can be enhanced by providing extrinsic feedback. Different types and frequencies of feedback are discussed but specific guidelines for use of feedback for motor learning in typically-developing (TD) children and children with Cerebral Palsy (CP) are not available.

**OBJECTIVE:** Identify the most effective modalities and frequencies of feedback for improving upper limb motor skills in TD children and children with CP.

**METHODS:** Ovid MEDLINE, Cochrane, PEDro and PubMed-NCBI were searched from 1950 to December 2015 to identify English-language articles addressing the role of extrinsic feedback on upper limb motor learning in TD children and children with CP. Nine studies were selected with a total of 243 TD children and 102 children with CP. Study quality was evaluated using the Downs and Black scale and levels of evidence were determined with Sackett's quality ratings.

**RESULTS:** There was a lack of consistency in the modalities and frequencies of feedback delivery used to improve motor learning in TD children and in children with CP. Moreover, the complexity of the task to be learned influenced the degree of motor learning achieved.

**CONCLUSION:** A better understanding of the influence of feedback on motor learning is needed to optimize motor skill acquisition in children with CP.

DOI: 10.3233/RNN-160688

PMID: 28282845

## **Feasibility and effect of home-based therapy programmes for children with cerebral palsy: a protocol for a systematic review.**

Beckers LW, Schnackers ML, Janssen-Potten YJ, Kleijnen J, Steenbergen B.

*BMJ Open.* 2017 Feb 24;7(2):e013687. doi: 10.1136/bmjopen-2016-013687.

**INTRODUCTION:** Given the promising advantages of upper extremity home-based programmes in children with cerebral palsy (CP), a systematic review of the available literature on this topic is warranted. The purpose of the systematic review described in this protocol is to investigate currently available home-based occupational therapy and physiotherapy programmes regarding both their feasibility and effect.

**METHODS AND ANALYSIS:** This protocol describes a systematic review, developed in accordance with the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) 2015. Studies will be included in which primary data are collected, participants are children aged <18 years with any type of CP and the intervention of interest is a home-based occupational therapy or physiotherapy intervention. Comparators of interest are: no therapy, care as usual, centre-based occupational therapy or physiotherapy, an alternative home-based programme and a medical intervention. Studies will be included that report either on feasibility (ie, acceptability, demand, implementation, practicality, adaptation, expansion or integration) or on efficacy/effectiveness (ie, child-related upper extremity outcomes within all International Classification of Functioning, Disability and Health levels or parent-related/caregiver-related outcomes on the psychological and social domain). Relevant studies will be identified by searching the databases MEDLINE, EMBASE, CINAHL, PsycINFO, PEDro, OTSeeker and CPCI-S as well as the trial registers ICTRP and CENTRAL, the reference lists of included records and by circulating a bibliography of the included records to authors of included studies. There will be no restrictions on language or year of publication. The search strategy consists of terms related to the population and intervention. Data will be extracted in duplicate using a digital data extraction form.

**ETHICS AND DISSEMINATION:** The proposed study does not involve collection of primary data. Accordingly, no ethical approval is required. The authors will disseminate the findings of this systematic review through publication in a peer-reviewed journal and conference presentation(s).

**TRIAL REGISTRATION NUMBER:** CRD42016043743; pre-results.

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DOI: 10.1136/bmjopen-2016-013687

**Impact of loaded sit-to-stand exercises at different speeds on the physiological cost of walking in children with spastic diplegia: A single-blind randomized clinical trial.**

Kusumoto Y, Nitta O, Takaki K.

*Res Dev Disabil.* 2016 Oct;57:85-91. doi: 10.1016/j.ridd.2016.06.006. Epub 2016 Jul 7.

**PURPOSE:** In the present study, we aimed to determine whether similarly loaded sit-to-stand exercises at different speeds improve the physiological cost of walking in children with spastic diplegia.

**METHODS:** This design was a single-blind randomized clinical trial. Sixteen children with cerebral palsy (CP), aged 12-18 years, with a diagnosis of spastic diplegia, were randomly allocated to a slow loaded sit-to-stand exercise group (n=8) and a self-paced loaded sit-to-stand exercise group (n=8). Loaded sit-to-stand exercise was conducted at home for 15min, 4 sets per day, 3-4days per week, for 6 weeks. The patients were evaluated immediately before the intervention and after the training. Lower limb muscle strength using a hand-held dynamometer, selective voluntary motor control using SCALE, 6-min walk distance (6MWD), and Physiological Cost Index (PCI) were measured.

**RESULTS:** The 6MWD showed a significant difference before and after intervention. PCI showed a significant difference between the two groups and the two time points. 6MWD and the PCI improved after intervention in the slow sit-to-stand exercise group.

**CONCLUSIONS:** Compared to loaded sit-to-stand exercise at a regular speed, slow low-loaded sit-to-stand exercise improved the 6MWD and PCI in children with CP, suggesting that this decrease in speed during exercise improves the physiological cost of walking in these children.

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PMID: 27394691 [Indexed for MEDLINE]

**Interactive wearable systems for upper body rehabilitation: a systematic review.**

Wang Q, Markopoulos P, Yu B, Chen W, Timmermans A.

*J Neuroeng Rehabil.* 2017 Mar 11;14(1):20. doi: 10.1186/s12984-017-0229-y.

**BACKGROUND:** The development of interactive rehabilitation technologies which rely on wearable-sensing for upper body rehabilitation is attracting increasing research interest. This paper reviews related research with the aim: 1) To inventory and classify interactive wearable systems for movement and posture monitoring during upper body rehabilitation, regarding the sensing technology, system measurements and feedback conditions; 2) To gauge the wearability of the wearable systems; 3) To inventory the availability of clinical evidence supporting the effectiveness of related technologies.

**METHOD:** A systematic literature search was conducted in the following search engines: PubMed, ACM, Scopus and IEEE (January 2010-April 2016).

**RESULTS:** Forty-five papers were included and discussed in a new cuboid taxonomy which consists of 3 dimensions: sensing technology, feedback modalities and system measurements. Wearable sensor systems were developed for persons in: 1) Neuro-rehabilitation: stroke (n = 21), spinal cord injury (n = 1), cerebral palsy (n = 2), Alzheimer (n = 1); 2) Musculoskeletal impairment: ligament rehabilitation (n = 1), arthritis (n = 1), frozen shoulder (n = 1), bones trauma (n = 1); 3) Others: chronic pulmonary obstructive disease (n = 1), chronic pain rehabilitation (n = 1) and other general rehabilitation (n = 14). Accelerometers and inertial measurement units (IMU) are the most frequently used technologies (84% of the papers). They are mostly used in multiple sensor configurations to measure upper limb kinematics and/or trunk posture. Sensors are placed mostly on the trunk, upper arm, the forearm, the wrist, and the finger. Typically sensors are attachable rather than embedded in wearable devices and garments; although studies that embed and integrate sensors are increasing in the last 4 years. 16 studies applied knowledge of result (KR) feedback, 14 studies applied knowledge of performance (KP) feedback and 15 studies applied both in various modalities. 16 studies have conducted their evaluation with patients and reported usability tests, while only three of them conducted clinical trials including one randomized clinical trial.

**CONCLUSIONS:** This review has shown that wearable systems are used mostly for the monitoring and provision of feedback on posture and upper extremity movements in stroke rehabilitation. The results indicated that accelerometers and IMUs are the most frequently used sensors, in most cases attached to the body through ad hoc contraptions for the purpose of improving range of motion and movement performance during upper body

rehabilitation. Systems featuring sensors embedded in wearable appliances or garments are only beginning to emerge. Similarly, clinical evaluations are scarce and are further needed to provide evidence on effectiveness and pave the path towards implementation in clinical settings.

DOI: 10.1186/s12984-017-0229-y

PMCID: PMC5346195

PMID: 28284228

### **Measuring neuroplasticity associated with cerebral palsy rehabilitation: An MRI based power analysis.**

Reid LB, Pagnozzi AM, Fiori S, Boyd RN, Dowson N, Rose SE.

*Int J Dev Neurosci.* 2017 May;58:17-25. doi: 10.1016/j.ijdevneu.2017.01.010. Epub 2017 Jan 24.

Researchers in the field of child neurology are increasingly looking to supplement clinical trials of motor rehabilitation with neuroimaging in order to better understand the relationship between behavioural training, brain changes, and clinical improvements. Randomised controlled trials are typically accompanied by sample size calculations to detect clinical improvements but, despite the large cost of neuroimaging, not equivalent calculations for concurrently acquired imaging neuroimaging measures of changes in response to intervention. To aid in this regard, a power analysis was conducted for two measures of brain changes that may be indexed in a trial of rehabilitative therapy for cerebral palsy: cortical thickness of the impaired primary sensorimotor cortex, and fractional anisotropy of the impaired, delineated corticospinal tract. Power for measuring fractional anisotropy was assessed for both region-of-interest-seeded and fMRI-seeded diffusion tractography. Taking into account practical limitations, as well as data loss due to behavioural and image-processing issues, estimated required participant numbers were 101, 128 and 59 for cortical thickness, region-of-interest-based tractography, and fMRI-seeded tractography, respectively. These numbers are not adjusted for study attrition. Although these participant numbers may be out of reach of many trials, several options are available to improve statistical power, including careful preparation of participants for scanning using mock simulators, careful consideration of image processing options, and enrolment of as homogeneous a cohort as possible. This work suggests that smaller and moderate sized studies give genuine consideration to harmonising scanning protocols between groups to allow the pooling of data.

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DOI: 10.1016/j.ijdevneu.2017.01.010

PMID: 28130065 [Indexed for MEDLINE]

### **On the Adaptation of Pelvic Motion by Applying 3-dimensional Guidance Forces using TPAD.**

Kang J, Vashista V, Agrawal S.

*IEEE Trans Neural Syst Rehabil Eng.* 2017 Mar 8. doi: 10.1109/TNSRE.2017.2679607. [Epub ahead of print]

Pelvic movement is important to human locomotion as the center of mass is located near the center of pelvis. Lateral pelvic motion plays a crucial role to shift the center of mass on the stance leg while swinging the other leg and keeping the body balanced. In addition, vertical pelvic movement helps to reduce metabolic energy expenditure by exchanging potential and kinetic energy during the gait cycle. However, patient groups with cerebral palsy or stroke have excessive pelvic motion that leads to high energy expenditure. In addition, they have higher chances of falls as the center of mass could deviate outside the base of support. In this study, a novel control method is suggested using Tethered Pelvic Assist Device (TPAD) to teach subjects to walk with a specified target pelvic trajectory while walking on a treadmill. In this method, a force field is applied to the pelvis to guide it to move on a target trajectory and correctional forces are applied if the pelvis motion has excessive deviations from the target trajectory. Three different experiments with healthy subjects were conducted to teach them to walk on a new target pelvic trajectory with the presented control method. For all three experiments, the baseline trajectory of the pelvis was experimentally determined for each participating subject. To design a target pelvic trajectory which is different from the baseline, Experiment I scaled up the lateral component of the baseline pelvic trajectory, while Experiment II scaled down the lateral component of the baseline trajectory. For both Experiments I and II, the controller generated a two dimensional force field in the transverse plane to provide the guidance force. In this study, seven subjects were recruited for each experiment who walked on the treadmill with suggested control methods and visual feedback of their pelvic trajectory. The results show that the subjects were able to learn the target pelvic trajectory in each experiment and also retained the training effects after the completion of the experiment. In Experiment III, both lateral and vertical components of the pelvic trajectory were scaled down from the baseline trajectory. The force field was extended to three dimensions in order to correct the vertical pelvic movement as well. Three

subgroups (force feedback alone, visual feedback alone, and both force and visual feedback) were recruited to understand the effects of force feedback and visual feedback alone to distinguish the results from Experiments I and II. The results show that a training method that combines visual and force feedback is superior to the training methods with visual or force feedback alone. We believe that the present control strategy holds potential in training and correcting abnormal pelvic movements in different patient populations.

DOI: 10.1109/TNSRE.2017.2679607

PMID: 28287978

### **Pediatric Rehabilitation Services for Children With Cerebral Palsy: What Can Existing Data Sources Tell Us?**

Gannotti ME, Bailes A, Bjornson K, O'Neil M, Grant-Buettler M, Dusing S.

*Pediatr Phys Ther.* 2017 Apr;29(2):179-186. doi: 10.1097/PEP.0000000000000377.

Knowledge about associated service utilization patterns and positive outcomes in children with cerebral palsy (CP) of varying levels of severity is a national priority. Families, clinicians, program directors, and policy makers need this information for clinical decision-making and service planning. Existing data sources in the United States that contain information about children with CP, their health, function, well being, and utilization of health services may add to our existing knowledge. We provide a summary of fourteen national, state, and local sources' data: where the data come from, challenges and/or specific considerations when using or accessing information, and specific data elements included. Currently available sources of data can provide meaningful information for policy, practice, and program development. We propose questions for future inquiry and suggest elements that may be useful for when developing data sources specific to physical therapy and individuals with CP. A physical therapy specific registry is warranted.

DOI: 10.1097/PEP.0000000000000377

PMID: 28350778

### **Practice-based evidence from a clinical cohort that received pediatric constraint- induced movement therapy.**

DeLuca SC, Trucks MR, Wallace DA, Ramey SL.

*J Pediatr Rehabil Med.* 2017;10(1):37-46. doi: 10.3233/PRM-170409.

**PURPOSE:** Constraint-Induced Movement Therapy (CIMT) is now designated a highly efficacious treatment for children with cerebral palsy, based on rigorous clinical trials. Yet virtually no evidence confirms that these moderate to large size effects can be replicated in clinical practice for a more heterogeneous clinical population. Thus there is a need to collect and report treatment outcome data based on actual clinical practice as a critical next step for implementation.

**METHODS:** This study presents results from a prospective study conducted on a clinical cohort of 88 children, 18 months to 12 years old (M = 55 months, SD = 5 months), who received high-intensity CIMT known as ACQUIREc. The children varied in severity and etiology of their hemiparesis and a subset was diagnosed with asymmetric quadriparesis.

**RESULTS:** Pre- to post-CIMT assessments confirmed highly significant and clinically meaningful changes based on both parental report (Pediatric Motor Activity Log,  $p < 0.0001$ ) and standardized measures (The Assisting Hand Assessment,  $p = 0.04$ ).

**CONCLUSIONS:** Clinical practice of high-intensity CIMT (120 hours in 4 weeks) with full-time casting of the less-impaired upper extremity produced benefits of comparable magnitude to those from rigorous randomized controlled trials (RCTs). Therapists were highly trained and actively monitored. Children across a wide range of etiologies and severity levels realized positive outcomes.

DOI: 10.3233/PRM-170409

PMID: 28339409

### **Psychometric and Clinimetric Properties of the Melbourne Assessment 2 in Children with Cerebral Palsy.**

Wang TN, Liang KJ, Liu YC, Shieh JY, Chen HL.

*Arch Phys Med Rehabil.* 2017 Feb 27. pii: S0003-9993(17)30097-7. doi: 10.1016/j.apmr.2017.01.024. [Epub ahead of print]

**OBJECTIVE:** The Melbourne Assessment 2 (MA2) is increasingly used as an outcome measurement in clinical studies. The purposes of this study were to examine its psychometric and clinimetric properties.

DESIGN: Psychometric and clinimetric study.

SETTING: Community.

PARTICIPANTS: Seventeen children with CP from 5 to 12 years were recruited for the estimation of the test-retest reliability and minimal detectable change (MDC). Thirty-five children with CP were recruited to receive an eight-week intensive neurorehabilitation intervention to estimate the validity, responsiveness, and minimal clinically important difference (MCID).

INTERVENTIONS: Thirty-five children with CP received upper limb neurorehabilitation programs for eight weeks.

MAIN OUTCOME MEASURES: The Melbourne Assessment 2 (MA2) and the criterion measures, including the Bruininks-Oseretsky Test of Motor Proficiency 2(nd)(BOT-2), the Box and Blocks Test (BBT), and the Pediatric Motor Activity Log-Revised (PMAL-R) were evaluated at pretreatment and posttreatment.

RESULTS: The MA2 has four subscales: range of motion, fluency, accuracy, and dexterity. The test-retest reliability of the MA2 is high (ICC=0.92-0.98). The significant relationships between the MA2 and BBT, BOT-2, and PMAL-R support its validity. The significance of paired t test results ( $p<0.001$ ) and large magnitudes of the SRM (1.70-2.00) confirm the responsiveness of the MA2. The MDC values of the four subscales of the MA2 are 2.85, 1.63, 1.97, and 1.84, respectively, and the suggested MCID values of these four subscales are 2.35, 3.20, 2.09, and 2.22, respectively, indicating the minimum scores of improvement to be interpreted as both statistically significant and clinically important.

CONCLUSIONS: The findings of this study indicate that the MA2 has sound psychometric and clinimetric properties and is thus an adequate measurement for research and clinical applications.

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PMID: 28254639

### **Single blind randomised controlled trial of GAME (Goals - Activity – Motor Enrichment) in infants at high risk of cerebral palsy.**

Morgan C, Novak I, Dale RC, Guzzetta A, Badawi N

*Res Dev Disabil.* 2016 Aug;55:256-67. doi: 10.1016/j.ridd.2016.04.005. Epub 2016 May 7.

BACKGROUND: Cerebral palsy (CP) is caused by a lesion in the developing infant brain. Recent neuroplasticity literature suggests that intensive, task-specific intervention ought to commence early, during the critical period of neural development.

AIMS: To determine whether "GAME" (Goals - Activity - Motor Enrichment), a motor learning, environmental enrichment intervention, is effective for improving motor skills in infants at high risk of CP.

METHODS AND PROCEDURES: Single blind randomised controlled trial of GAME versus standard care. Primary outcome was motor skills on the Peabody Developmental Motor Scales-2 (PDMS-2). Secondary outcomes included Canadian Occupational Performance Measure (COPM), Bayley Scales of Infant and Toddler Development (BSID-III) and Gross Motor Function Measure-66 (GMFM-66). Outcome assessors were masked to group allocation and data analyzed with multiple regression.

OUTCOMES AND RESULTS: All  $n=30$  infants enrolled received the assigned intervention until 16 weeks post enrolment. At 12 months of age,  $n=26$  completed assessments. Significant between group differences were found in raw scores on the PDMS-2 in favour of GAME ( $B=20.71$ , 95%CI 1.66-39.76,  $p=0.03$ ) and at 12 months on the total motor quotient ( $B=8.29$ , 95%CI 0.13-16.45,  $p=0.05$ ). Significant between group differences favored GAME participants at 12 months on the cognitive scale of the BSID-III and satisfaction scores on the COPM.

CONCLUSION: GAME intervention resulted in advanced motor and cognitive outcomes when compared with standard care.

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DOI: 10.1016/j.ridd.2016.04.005

PMID: 27164480 [Indexed for MEDLINE]

### **The Design, Implementation, and Evaluation of a Physiotherapist-Led Clinic for Orthopedic Surveillance for Children with Cerebral Palsy.**

Hurtubise K, Shanks R, Benard L.

*Phys Occup Ther Pediatr.* 2017 Mar 7:1-14. doi: 10.1080/01942638.2017.1280869. [Epub ahead of print]

AIM: To describe the development process and the evaluation results of a new physiotherapy-led clinic for orthopedic monitoring of secondary impairments for children with cerebral palsy (CP).

METHODS: A new clinic model was developed and implemented, guided by the Framework for the Development of Advanced Practice Roles and the Model for Improvement. Patient visits and wait-time statistics were measured during the implementation phase. Once implemented, an evaluation of the clinic model objectives was conducted. The Visit Specific Satisfaction (VSQ-9) Instrument and the Measure of Processes of Care (MPOC-20) questionnaire measured parent satisfaction, while the Collaboration and Satisfaction about Care Decisions (CSACD) surveyed staff's satisfaction. Means and frequencies described the data, and the Mann-Wittney U test was used to compare the VSQ-9 and MPOC-20 scores of the physiotherapist-led and the traditional physician-led model.

RESULTS: Ninety-eight additional children were seen in 1 year. Mean wait time decreased by 930 days. No statistically significant difference was demonstrated in the VSQ-9 total score ( $p = .84$ ) or any of the five MPOC-20 subscales (Enabling and Partnership:  $p = .55$ ; Providing General Information:  $p = .99$ ; Providing Specific Information:  $p = .46$ ; Coordinated and Comprehensive Care for the Child and Family:  $p = .33$ ; Respective and Supportive Care:  $p = .86$ ) when the two models were compared. Physiotherapist-led clinic staff members were satisfied with physician collaboration.

CONCLUSIONS: A physiotherapist-led clinic model for orthopedic monitoring provides increased access to service for children with CP and their families without compromising the perceived quality of care.

DOI: 10.1080/01942638.2017.1280869

PMID: 28266885

### **The Effect of Bimanual Training with or Without Constraint on Hand Functions in Children with Unilateral Cerebral Palsy: A Non-Randomized Clinical Trial.**

Cohen-Holzer M, Katz-Leurer M, Meyer S, Green D, Parush S.

*Phys Occup Ther Pediatr.* 2017 Mar 7:1-12. doi: 10.1080/01942638.2017.1280871. [Epub ahead of print]

AIM: To compare the effect of bimanual training with or without constraint on manual functions in children with unilateral cerebral palsy (UCP).

METHODS: Seventeen children aged 6-11 years with UCP participated in one of two intensive therapeutic camps: bimanual ( $n = 9$ ) incorporating one hour of constraint ("Hybrid") or Bimanual ( $n = 8$ ). Each camp met for 2 weeks, 5 days per week for 6 hours each day. The Assisting Hand Assessment (AHA) and the Jebsen Taylor Test of Hand Function (JTTHF) examined bimanual and unimanual functions pre, post- and 3-months post-intervention.

RESULTS: A significant improvement was noted in AHA scores for both groups between the pre-, post- and three months post-intervention [Hybrid ( $F_2; 16 = 85.5, p < 0.01$ ); Bimanual ( $F_2; 16 = 15.4, p < 0.01$ )] with no significant differences between groups over time ( $F_2; 30 = 0.74, p = 0.48$ ). For the JTTHF, a significant improvement was noted in the affected hand following the Hybrid program ( $F_2; 30 = 7.45, p = 0.01$ ), while following the Bimanual program a significant difference was noted only in the less-affected hand ( $F_2; 16 = 6.02, p < 0.01$ ).

CONCLUSION: Both interventions Hybrid and Bimanual were similarly effective for improving use of the affected hand in bimanual tasks. The unique contribution of each intervention, the Hybrid program on the affected and the Bimanual on the less-affected side, warrants further examination.

DOI: 10.1080/01942638.2017.1280871

PMID: 28266881

### **The impact of strength training on skeletal muscle morphology and architecture in children and adolescents with spastic cerebral palsy: A systematic review.**

Gillett JG, Boyd RN, Carty CP, Barber LA.

*Res Dev Disabil.* 2016 Sep;56:183-96. doi: 10.1016/j.ridd.2016.06.003.

AIM: The aim of this study was to systematically review the current literature to determine the impact of strength training on skeletal muscle morphology and architecture in individuals aged 4-20 years with spastic type cerebral palsy.

METHODS: A comprehensive search for randomised and non-randomised controlled trials, cohort studies and cross-comparison trials was performed on five electronic databases. Included studies were graded according to level of evidence and assessed for methodological quality using the Downs and Black scale. Quantitative data was analysed using effect sizes.

RESULTS: Six of 304 articles met the inclusion criteria. Methodological quality of the included papers ranged from 14 to 19 (out of 32). A large effect was found on muscle cross-sectional area following strength training, with small to moderate effects on muscle volume and thickness.

CONCLUSION AND IMPLICATIONS: There is preliminary evidence that strength training leads to hypertrophy in children and adolescents with CP. A paucity of studies exist measuring morphological and architectural parameters following strength training in these individuals. Overall low study methodological quality along with heterogeneous study design, dissimilar outcome measures, and lack of adequate control groups, indicated that care is needed when interpreting the results of these studies in isolation.

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DOI: 10.1016/j.ridd.2016.06.003

PMID: 27337690 [Indexed for MEDLINE]

### **The Influence of Intense Combined Training on Upper Extremity Function in Children With Unilateral Cerebral Palsy: Does Initial Ability Matter?**

Cohen-Holzer M, Sorek G, Kerem J, Schless S, Freedman R, Rotem H, Schweitzer M, Katz-Leurer M

*Phys Occup Ther Pediatr.* 2016 Nov;36(4):376-87. doi:10.3109/01942638.2015.1108379. Epub 2016 Jan 6.

AIM: To examine whether level of manual ability modifies the response to an intensive program combining modified constraint and bimanual training on arm functioning children with unilateral cerebral palsy (UCP).

METHODS: Thirty-four children aged 6-11 years, with Manual Ability Classification System (MACS) levels I-III (I:8, II:15, III:11), participated in a 2-week program, combining an hour of modified constraint with 5 hr of bimanual practice daily. The Assisting Hand Assessment (AHA) and the Jebsen-Taylor Test of Hand Function (JTTHF) were done pre-, post-, and 3-months post-intervention.

RESULTS: Mean AHA logits unit scores increased overtime ( $F_{2;50} = 5, p = 0.01$ ). There was no significant difference in AHA logits units change score between MACS levels ( $F_{4;56} = 1.4, p = 0.22$ ). JTTHF scores did not change for either the affected or less-affected hand, although a significant interaction of time and MACS level was found in the less-affected side ( $F_{4;58} = 6.5, p < 0.01$ ). Children in MACS levels I and II improved by similar degrees, in comparison to children at MACS level III who demonstrated significantly greater change over time.

CONCLUSION: While a similar trend of improvement was found in the bimanual abilities of children at all MACS levels, only children at MACS level III had improved performance in unilateral abilities in the less-affected side following intervention.

DOI: 10.3109/01942638.2015.1108379

PMID: 26734890 [Indexed for MEDLINE]

### **Translating Evidence to Increase Quality and Dose of Upper Limb Therapy for Children with Unilateral Cerebral Palsy: A Pilot Study.**

Sakzewski L, Ziviani J, Boyd RN.

*Phys Occup Ther Pediatr.* 2016 Aug;36(3):305-29. doi: 10.3109/01942638.2015.1127866. Epub 2016 Feb 9.

AIMS: To pilot efficacy of a tailored multifaceted implementation program to change clinical practice of occupational therapists (OTs) providing upper limb (UL) therapy for children with unilateral cerebral palsy (UCP).

METHODS: This before and after study piloted a multifaceted implementation program comprising audit/feedback, barrier identification, and education. Medical chart audits were conducted prior to and 12 months after the intervention. Primary process outcomes included proportion of children with UCP with (1) goals set; (2) goals measured; (3) received contemporary motor learning approach; (4) an adequate dose (30-40 hours); and measured UL outcomes.

RESULTS: Three teams of OTs ( $n = 9$ ) participated. Forty-three audits at baseline and 53 at 12 months postimplementation program were conducted. Average time to complete audits was 10 min and four out of the five evidence criteria had complete data extracted from files. Changes in clinical behavior included greater measurement of goals before (+17%) and after (+22%) therapy; use of constraint therapy (+38%), bimanual therapy (+26%), home programs (+14%); measurement of UL outcomes before (+29%) and after (+23%) therapy. Children receiving the target dose increased from 0 to 10%.

CONCLUSIONS: A tailored multifaceted implementation program was feasible to implement and led to meaningful changes in clinical practice behavior.

DOI: 10.3109/01942638.2015.1127866



**Unimanual versus bimanual therapy in children with unilateral cerebral palsy: Same, same, but different.**

Hoare B, Greaves S.

*J Pediatr Rehabil Med.* 2017;10(1):47-59. doi: 10.3233/PRM-170410.

**BACKGROUND:** There is high-level evidence supporting constraint-induced movement therapy (CIMT) and bimanual therapy for children with unilateral cerebral palsy. Evidence-based intervention includes time-limited, goal-directed, skills-based, intensive blocks of practice based on motor learning theory.

**AIM AND METHODS:** Using supporting literature and clinical insight, we provide a theoretical rationale to highlight previously unreported differences between CIMT and bimanual therapy.

**DISCUSSION:** The current emphasis on total dosage of practice for achieving positive outcomes fails to recognise the influence of other critical concepts within motor learning. Limitations exist in the application of motor learning principles using CIMT due to its unimanual nature. CIMT is effective for development of unimanual actions brought about by implicit learning, however it is difficult to target explicit learning that is required for learning how to use two hands together. Using bimanual therapy, object properties can be adapted to trigger goal-related perceptual and cognitive processes required for children to learn to recognise when two hands are required for task completion.

**CONCLUSION:** CIMT and bimanual should be viewed as complementary. CIMT could be used to target unimanual actions. Once these actions are established, bimanual therapy could be used for children to learn how to use these actions for bimanual skill development.

DOI: 10.3233/PRM-170410

PMID: 28339410

**Upper extremity muscle activation in children with unilateral cerebral palsy during an auditory cued repetitive task: Effects on bimanual coordination.**

Charles J.

*J Pediatr Rehabil Med.* 2017;10(1):19-26. doi: 10.3233/PRM-170407.

**PURPOSE:** The aim of this exploratory study was to investigate mirror muscle activation in the upper limbs of children with unilateral cerebral palsy during an auditory-cued repetitive squeezing task and to compare upper limb muscle activation patterns to typically developing peers engaged in the same task.

**METHODS:** A convenience sample of six children with unilateral cerebral palsy and six typically developing peers (7-17 y) participated in the study. Muscle activity was measured using a 16 channel Zerowire EMG system (Noraxon, USA Inc. Scottsdale, AZ) in the anterior deltoid, biceps brachii, extensor carpi radialis, flexor carpi radialis, and lateral triceps muscles bilaterally as children squeezed a pediatric bulb dynamometer to 3 pounds per square inch (PSI) for a one second duration, 10 times in one minute. Squeezing activity was cued by a computer generated auditory beep. Between hand differences in muscle onset times and onset amplitude for each muscle were determined using paired t-tests. Two group by two hand ANOVA measured between group differences.

**RESULTS:** Results supported increased later muscle onset and lack of significant differences in onset amplitude bilaterally when the dominant hand was working in the CP population.

**CONCLUSIONS:** There are differences in motor control mechanisms of muscle activation between populations.

DOI: 10.3233/PRM-170407

PMID: 28339407

**Orthèses**

**An articulated ankle-foot orthosis with adjustable plantarflexion resistance, dorsiflexion resistance and alignment: A pilot study on mechanical properties and effects on stroke hemiparetic gait.**

Kobayashi T, Orendurff MS, Hunt G, Lincoln LS, Gao F, LeCursi N, Foreman KB.

*Med Eng Phys.* 2017 Mar 8. pii: S1350-4533(17)30064-4. doi: 10.1016/j.medengphy.2017.02.012. [Epub ahead of print]

Mechanical properties of an articulated ankle-foot orthosis (AFO) are closely related to gait performance in individuals post-stroke. This paper presents a pilot study on the mechanical properties of a novel articulated AFO

with adjustable plantarflexion resistance, dorsiflexion resistance and alignment, and its effect on ankle and knee joint kinematics and kinetics in an individual post-stroke during gait. The mechanical properties of the AFO were quantified. Gait analysis was performed using a 3D motion capture system with a split-belt instrumented treadmill under 12 different settings of the mechanical properties of the AFO [i.e. 4 plantarflexion resistances (P1<P4), 4 dorsiflexion resistances (D1<D4), 4 initial alignments (A1<A4)]. The AFO demonstrated systematic changes in moment-angle relationship in response to changes in AFO joint settings. The gait analysis demonstrated that the ankle and knee angle and moment were responsive to changes in the AFO joint settings. Mean ankle angle at initial contact changed from -0.86° (P1) to 0.91° (P4) and from -1.48° (A1) to 4.45° (A4), while mean peak dorsiflexion angle changed from 12.01° (D1) to 6.40° (D4) at mid-stance. The novel articulated AFO appeared effective in influencing lower-limb joint kinematics and kinetics of gait in the individual post-stroke.

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DOI: 10.1016/j.medengphy.2017.02.012

PMID: 28284572

### **Rationale for prescription, and effectiveness of, upper limb orthotic intervention for children with cerebral palsy: a systematic review.**

Garbellini S, Robert Y, Randall M, Elliott C, Imms C.

*Disabil Rehabil.* 2017 Mar 12;1-11. doi: 10.1080/09638288.2017.1297498. [Epub ahead of print]

**PURPOSE:** To explore (i) reasons for upper limb orthosis prescription for children with cerebral palsy (CP), (ii) the link between reason and effect according to intended outcome and outcome measure utilized and (iii) to classify the prescribed orthoses using standard terminology.

**METHOD:** A prospectively registered (center for reviews and dissemination: 42015022067) systematic review searched for experimental and observational studies investigating rigid/thermoplastic upper limb orthotic intervention for children aged 0-18 with CP. The Cochrane central register, MEDLINE, CINAHL, Embase, SCOPUS and Web of Science databases were searched. Included studies were assessed for risk of bias.

**RESULTS:** Sixteen studies met selection criteria. Two studies described a specific reason for orthosis prescription, six prescribed orthoses to manage a clinical symptom and eight did not describe a reason. Eight studies were analyzed for effect according to intended outcome with no clear connection found between reasons for prescription, outcome measures utilized and effect reported.

**INTERPRETATION:** The lack of evidence for upper limb orthotic intervention for children with CP leads to uncertainty when considering this treatment modality. Future research is needed to evaluate the effect of orthosis wear in relation to intended outcome utilizing robust methods and valid and reliable outcome measures. Implications for rehabilitation: Insufficient evidence exists about the reason for prescription of upper limb orthoses. The connection between reason for orthosis prescription, intended outcome, outcome measure utilized and observed effect is unclear. Recommend orthosis prescription to be accompanied by clear documentation of the aim of the orthosis and description using orthosis classification system terminology. Outcome measures consistent with the reason for orthosis prescription and intended outcome of the intervention are essential to measure effectiveness of the intervention.

DOI: 10.1080/09638288.2017.1297498

PMID: 28286982

### **Robots – Exosquelette**

#### **Effectiveness of robot-assisted gait training in children with cerebral palsy: a bicenter, pragmatic, randomized, cross-over trial (PeLoGAIT).**

Ammann-Reiffer C, Bastiaenen CH, Meyer-Heim AD, van Hedel HJ.

*BMC Pediatr.* 2017 Mar 2;17(1):64. doi: 10.1186/s12887-017-0815-y.

**BACKGROUND:** Walking ability is a priority for many children with cerebral palsy (CP) and their parents when considering domains of importance regarding treatment interventions. Partial body-weight supported treadmill training has become an established therapeutic treatment approach to address this demand. Further, new robotic rehabilitation technologies have increasingly been implemented in the clinical setting to allow for longer training sessions with increased step repetitions while maintaining a consistent movement pattern. But the current evidence about its clinical effectiveness in pediatric rehabilitation is weak. The aim of this research project is therefore to

investigate the effectiveness of robot-assisted gait training on improvements of functional gait parameters in children with cerebral palsy.

**METHODS/DESIGN:** Children aged 6 to 18 years with bilateral spastic cerebral palsy who are able to walk at least 14 m with or without walking aids will be recruited in two pediatric therapy centers in Switzerland. Within a pragmatic cross-over design with randomized treatment sequences, they perform 5 weeks of robot-assisted gait training (three times per week with a maximum of 45 min walking time each) or a 5-week period of standard treatment, which is individually customized to the needs of the child and usually consists of 1-2 sessions of physiotherapy per week and additional hippotherapy, circuit training as well as occupational therapy as necessary. Both interventions take place in an outpatient setting. The percentage score of the dimension E of the Gross Motor Function Measure-88 (GMFM-88) as primary outcome as well as the dimension D of the GMFM-88, 6-minute and 10-meter walking tests as secondary outcomes are assessed before and at the end of each intervention period. Additionally, a 5-week follow-up assessment is scheduled for the children who are assigned to the standard treatment first. Treatment effects, period effects as well as follow-up effects are analyzed with paired analyses and independent test statistics are used to assess carry-over effects.

**DISCUSSION:** Although robot-assisted gait training has become an established treatment option to address gait impairments, evidence for its effectiveness is vague. This pragmatic trial will provide important information on its effects under clinical outpatient conditions.

**TRIAL REGISTRATION:** ClinicalTrials.gov: NCT00887848 . Registered 23 April 2009.

[Free PMC Article](#)

DOI: 10.1186/s12887-017-0815-y

PMID: 28253887

### **Playfulness in Children with Limited Motor Abilities When Using a Robot.**

Ríos-Rincón AM, Adams K, Magill-Evans J, Cook A.

*Phys Occup Ther Pediatr.* 2016 Aug;*36(3):232-46.* doi: 10.3109/01942638.2015.1076559. Epub 2015 Nov 13.

**AIMS:** Children with limited gross motor and manual abilities have fewer opportunities to engage in free play. We investigated the effect of a robotic intervention on the playfulness of children with cerebral palsy (CP).

**METHODS:** We used a partially nonconcurrent multiple baseline design with four children and their mothers. Children were classified in level IV or V on the Gross Motor Function and Manual Ability Classification Systems. The intervention was the availability of an adapted Lego robot during a 15-min free play session between the child and mother. There were two sessions per week for about 14 weeks. Playfulness was measured using the Test of Playfulness.

**RESULTS:** Statistical comparisons using the 2 SD band and X-moving range chart methods revealed that all the children's levels of playfulness increased significantly while they played with the robot. Comparison of baseline and follow-up phase indicated that three children had retention of improved level of playfulness.

**CONCLUSION:** Play with adapted Lego robots increased the level of playfulness in all four children during free play with their mothers. The findings have implications for providing children with limitations in motor abilities opportunities for free play with family and friends.

DOI: 10.3109/01942638.2015.1076559

PMID: 26566226 [Indexed for MEDLINE]

### **Robust control of a cable-driven soft exoskeleton joint for intrinsic human-robot interaction.**

arrett C, McDaid A.

*IEEE Trans Neural Syst Rehabil Eng.* 2017 Mar 1. doi: 10.1109/TNSRE.2017.2676765. [Epub ahead of print]

A novel, cable-driven soft joint is presented for use in robotic rehabilitation exoskeletons to provide intrinsic, comfortable human-robot interaction. The torque-displacement characteristics of the soft elastomeric core contained within the joint are modelled. This knowledge is used in conjunction with a dynamic system model to derive a sliding mode controller (SMC) to implement low-level torque control of the joint. The SMC controller is experimentally compared to a baseline feedback-linearised PD controller across a range of conditions and shown to be robust to un-modelled disturbances. The torque controller is then tested with six healthy subjects while they perform a selection of ADLs, which has validated its range of performance. Finally, a case study with a participant with spastic cerebral palsy is presented to illustrate the potential of both the joint and controller to be used in a physiotherapy setting to assist clinical populations.

### Stimulation cérébrale - Stimulation neurosensorielle

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

Kirton A.

*Eur J Paediatr Neurol.* 2017 Jan;21(1):75-103. doi: 10.1016/j.ejpn.2016.07.002. Epub 2016 Jul 9.

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.

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DOI: 10.1016/j.ejpn.2016.07.002

PMID: 27470654 [Indexed for MEDLINE]

#### **Bilateral globus pallidus internus deep brain stimulation for dyskinetic cerebral palsy supports success of cochlear implantation in a 5-year old ex-24 week preterm twin with absent cerebellar hemispheres.**

Lin JP, Kaminska M, Perides S, Gimeno H, Baker L, Lumsden DE, Britz A, Driver S, Fitzgerald-O'Connor A, Selway R.

*Eur J Paediatr Neurol.* 2017 Jan;21(1):202-213. doi: 10.1016/j.ejpn.2016.11.017. Epub 2016 Dec 10.

**BACKGROUND:** Early onset dystonia (dyskinesia) and deafness in childhood pose significant challenges for children and carers and are the cause of multiple disability. It is particularly tragic when the child cannot make use of early cochlear implantation (CI) technology to relieve deafness and improve language and communication, because severe cervical and truncal dystonia brushes off the magnetic amplifier behind the ears. Bilateral globus pallidus internus (GPI) deep brain stimulation (DBS) neuromodulation can reduce dyskinesia, thus supporting CI neuromodulation success.

**METHODS:** We describe the importance of the order of dual neuromodulation surgery for dystonia and deafness. First with bilateral GPI DBS using a rechargeable ACTIVA-RC neurostimulator followed 5 months later by unilateral CI with a Harmony (BTE) Advanced Bionics Hi Res 90 K cochlear device. This double neuromodulation was performed in series in a 12.5 kg 5 year-old ex-24 week gestation-born twin without a cerebellum.

**RESULTS:** Relief of dyskinesia enabled continuous use of the CI amplifier. Language understanding and communication improved. Dystonic storms abated. Tolerance of sitting increased with emergence of manual function. Status dystonicus ensued 10 days after ACTIVA-RC removal for infection-erosion at 3 years and 10 months. He required intensive care and DBS re-implantation 3 weeks later together with 8 months of hospital care. Today he is virtually back to the level of functioning before the DBS removal in 2012 and background medication continues to be slowly weaned.

**CONCLUSION:** This case illustrates that early neuromodulation with DBS for dystonic cerebral palsy followed by CI for deafness is beneficial. Both should be considered early i.e. under the age of five years. The DBS should precede the CI to maximise dystonia reduction and thus benefits from CI. This requires close working between the paediatric DBS and CI services.

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DOI: 10.1016/j.ejpn.2016.11.017

PMID: 28017556 [Indexed for MEDLINE]

### **Deep brain stimulation in cerebral palsy: Challenges and opportunities.**

Koy A, Timmermann L.

*Eur J Paediatr Neurol.* 2017 Jan;21(1):118-121. doi: 10.1016/j.ejpn.2016.05.015. Epub 2016 May 27.

Cerebral palsy (CP) is the most common cause for acquired dystonia in childhood. Pharmacological treatment is often unsatisfactory and side effects are frequently dose-limiting. Data on outcome of DBS in paediatric patients with dyskinetic CP is very limited and heterogeneous. Reasons for the variability in responses are not entirely known yet. Interestingly, some CP-patients seem to improve subjectively on pallidal stimulation but without measurable changes in impairment scales. Besides dystonia scales, the use of sensitive age-dependent assessments tools is therefore reasonable to capture the full effect. As the course of disease duration as well as the age at operation seem to correlate with DBS outcome in patients with dystonia, DBS at an early stage of development might be beneficial for some of these patients. For the future, well-conducted trials as well as data collection in the international registry is of major importance to increase knowledge about DBS in CP patients, especially those implanted at a young age. Furthermore, selection criteria and guidelines or treatment standards are needed to improve the service for children with dyskinetic CP - especially in light of unsatisfactory medical treatment options.

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DOI: 10.1016/j.ejpn.2016.05.015

PMID: 27289260 [Indexed for MEDLINE]

### **Stable cognitive functioning with improved perceptual reasoning in children with dyskinetic cerebral palsy and other secondary dystonias after deep brain stimulation.**

Owen T, Adegboye D, Gimeno H, Selway R, Lin JP.

*Eur J Paediatr Neurol.* 2017 Jan;21(1):193-201. doi: 10.1016/j.ejpn.2016.10.003. Epub 2016 Oct 21.

**BACKGROUND:** Dystonia is characterised by involuntary movements (twisting, writhing and jerking) and postures. Secondary dystonias are described as a heterogeneous group of disorders with both exogenous and endogenous causes. There is a growing body of literature on the effects of deep brain stimulation (DBS) surgery on the motor function in childhood secondary dystonias, however research on cognitive function after DBS is scarce.

**METHODS:** Cognitive function was measured in a cohort of 40 children with secondary dystonia following DBS surgery using a retrospective repeated measures design. Baseline pre-DBS neuropsychological measures were compared to scores obtained at least one year following DBS. Cognitive function was assessed using standardised measures of intellectual ability and memory.

**RESULTS:** There was no significant change in the assessed domains of cognitive function following DBS surgery. A significant improvement across the group was found on the Picture Completion subtest, measuring perceptual reasoning ability, following DBS.

**CONCLUSION:** Cognition remained stable in children with secondary dystonia following DBS surgery, with some improvements noted in a domain of perceptual reasoning. Further research with a larger sample is necessary to further explore this, in particular to further subdivide this group to account for its heterogeneity. This preliminary data has potentially positive implications for the impact of DBS on cognitive functioning within the childhood secondary dystonia population.

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DOI: 10.1016/j.ejpn.2016.10.003

PMID: 27836441 [Indexed for MEDLINE]

### **The correlation between transcranial magnetic stimulation parameters and neuromuscular properties in children with cerebral palsy.**

Marzbani H, Parvin S, Amiri S, Lotfian M, Kharazi MR, Azizi S, Mirbagheri MM.

*Conf Proc IEEE Eng Med Biol Soc.* 2016 Aug;2016:5473-5476. doi:10.1109/EMBC.2016.7591965.

We studied the correlation between corticospinal signaling and neuromuscular properties in children with Cerebral Palsy (CP). Corticospinal signaling was evaluated using Transcranial Magnetic Stimulation (TMS). Neuromuscular properties were quantified using Hoffmann reflex (H-reflex), sonoelastography, clinical measurements, and isokinetic measures. In particular, we determined the relationship between the TMS parameters of the ankle joint and the

neuromuscular features of ankle extensors and flexors as well as popular clinical measures of gait speed, endurance, balance and mobility. Seventeen CP patients and twelve healthy control subjects were evaluated. Our findings showed that the motor evoked potential (MEP) latency of TMS was significantly longer in CP than in healthy subjects. The MEP-latency was significantly correlated with the H-reflex response ( $r=0.71$ ,  $p\text{-value}=0.04$ ) and isokinetic features; i.e. max acceleration extension time ( $r=0.5$ ,  $p\text{-value}=0.005$ ), and max flexion time in the cycle ( $r=0.5$ ,  $p\text{-value}=0.002$ ). No significant correlation was observed between MEP-latency and clinical measurements of gait and sonoelastography of ankle muscles. The results suggest that the changes in corticospinal signaling could contribute to muscle weakness and hyperexcitability of reflexes observed in children with CP.

DOI: 10.1109/EMBC.2016.7591965

PMID: 28269496

### **The International Classification of Functioning (ICF) to evaluate deep brain stimulation neuromodulation in childhood dystonia-hyperkinesia informs future clinical & research priorities in a multidisciplinary model of care.**

Gimeno H, Lin JP.

*Eur J Paediatr Neurol.* 2017 Jan;21(1):147-167. doi: 10.1016/j.ejpn.2016.08.016. Epub 2016 Sep 8.

The multidisciplinary team (MDT) approach illustrates how motor classification systems, assessments and outcome measures currently available have been applied to a national cohort of children and young people with dystonia and other hyperkinetic movement disorders (HMD) particularly with a focus on dyskinetic cerebral palsy (CP). The paper is divided in 3 sections. Firstly, we describe the service model adopted by the Complex Motor Disorders Service (CMDS) at Evelina London Children's Hospital and King's College Hospital (ELCH-KCH) for deep brain stimulation. We describe lessons learnt from available dystonia studies and discuss/propose ways to measure DBS and other dystonia-related intervention outcomes. We aim to report on current available functional outcome measures as well as some impairment-based assessments that can encourage and generate discussion among movement disorders specialists of different backgrounds regarding choice of the most important areas to be measured after DBS and other interventions for dystonia management. Finally, some recommendations for multi-centre collaboration in regards to functional clinical outcomes and research methodologies for dystonia-related interventions are proposed. Crown Copyright © 2016. Published by Elsevier Ltd. All rights reserved.

#### **Free Article**

DOI: 10.1016/j.ejpn.2016.08.016

PMID: 27707656 [Indexed for MEDLINE]

### **What parents think and feel about deep brain stimulation in paediatric secondary dystonia including cerebral palsy: A qualitative study of parental decision-making.**

Austin A, Lin JP, Selway R, Ashkan K, Owen T.

*Eur J Paediatr Neurol.* 2017 Jan;21(1):185-192. doi: 10.1016/j.ejpn.2016.08.011. Epub 2016 Sep 6.

**BACKGROUND:** Dystonia is characterised by involuntary movements and postures. Deep Brain Stimulation (DBS) is effective in reducing dystonic symptoms in primary dystonia in childhood and to lesser extent in secondary dystonia. How families and children decide to choose DBS surgery has never been explored.

**AIMS:** To explore parental decision-making for DBS in paediatric secondary dystonia.

**METHODS:** Data was gathered using semi-structured interviews with eight parents of children with secondary dystonia who had undergone DBS. Interviews were analysed using Interpretative Phenomenological Analysis.

**RESULTS:** For all parents the decision was viewed as significant, with life altering consequences for the child. These results suggested that parents were motivated by a hope for a better life and parental duty. This was weighed against consideration of risks, what the child had to lose, and uncertainty of DBS outcome. Decisions were also influenced by the perspectives of their child and professionals.

**CONCLUSIONS:** The decision to undergo DBS was an ongoing process for parents, who ultimately were struggling in the face of uncertainty whilst trying to do their best as parents for their children. These findings have important clinical implications given the growing referrals for consideration of DBS childhood dystonia, and highlights the importance of further quantitative research to fully establish the efficacy of DBS in secondary dystonia to enhance informed decision-making.

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DOI: 10.1016/j.ejpn.2016.08.011

PMID: 27658770 [Indexed for MEDLINE]

## Réalité virtuelle - Jeux video

### **Balancing for Gross Motor Ability in Exergaming Between Youth with Cerebral Palsy at Gross Motor Function Classification System Levels II and III.**

MacIntosh A, Switzer L, Hernandez H, Hwang S, Schneider AL, Moran D, Graham TC, Fehlings DL  
*Games Health J.* 2017 Mar 6. doi: 10.1089/g4h.2016.0073. [Epub ahead of print]

**OBJECTIVE:** To test how three custom-built balancing algorithms minimize differences in game success, time above 40% heart rate reserve (HRR), and enjoyment between youth with cerebral palsy (CP) who have different gross motor function capabilities. Youth at Gross Motor Function Classification System (GMFCS) level II (unassisted walking) and level III (mobility aids needed for walking) competed in a cycling-based exercise video game that tested three balancing algorithms.

**MATERIALS AND METHODS:** Three algorithms: a control (generic-balancing [GB]), a constant non-person specific (One-Speed-For-All [OSFA]), and a person-specific (Target-Cadence [TC]) algorithms were built. In this prospective repeated measures intervention trial with randomized and blinded algorithm assignment, 10 youth with CP aged 10-16 years ( $X \pm$  standard deviation = 12.4  $\pm$  1.8 years; GMFCS level II n = 4, III n = 6) played six exergaming sessions using each of the three algorithms. Outcomes included game success as measured by a normalized game score, time above 40% HRR, and enjoyment.

**RESULTS:** The TC algorithm balanced game success between GMFCS levels similarly to GB (P = 0.11) and OSFA (P = 0.41). TC showed poorer balancing in time above 40% HRR compared to GB (P = 0.02) and OSFA (P = 0.02). Enjoyment ratings were high (6.4  $\pm$  0.7/7) and consistent between all algorithms (TC vs. GB: P = 0.80 and TC vs. OSFA: P = 0.19).

**CONCLUSION:** TC shows promise in balancing game success and enjoyment but improvements are needed to balance between GMFCS levels for cardiovascular exercise.

DOI: 10.1089/g4h.2016.0073

PMID: 28263666

### **The cost-effectiveness of a web-based multimodal therapy for unilateral cerebral palsy: the Mitii randomized controlled trial.**

Comans T, Mihala G, Sakzewski L, Boyd RN, Scuffham P.

*Dev Med Child Neurol.* 2017 Mar 1. doi: 10.1111/dmcn.13414. [Epub ahead of print]

**AIM:** To estimate the cost-effectiveness of the Mitii training system for improvements in upper limb function for children with unilateral cerebral palsy (CP). Mitii is a web-based programme delivered at home with set-up and monitoring by therapists.

**METHOD:** A randomized controlled trial was conducted comparing the Mitii training programme to usual care. The Assessment of Motor and Process Skills (AMPS) and Canadian Occupational Performance Measure (COPM) were collected for each child at baseline and 20 weeks. Responders to training were characterized as those who met a minimally important difference on either the AMPS (0.3 logits) or COPM (2points). Costs of the intervention were calculated by quantifying the equipment and staff cost. A cost per responder was calculated for each of the outcome measures.

**RESULTS:** A total of 102 participants (52 males, 50 females) were included in the analysis. There were significantly more responders in the training group on both the AMPS motor and process scales and the COPM performance and satisfaction scales. The cost per responder for the Mitii programme ranged from AU\$3078 to AU\$4191 depending on the scale used.

**INTERPRETATION:** The cost of delivering the Mitii training system is modest relative to the improvements in function.

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DOI: 10.1111/dmcn.13414

PMID: 28247406

## Thérapies cellulaires

### **Comparative analysis of curative effect of bone marrow mesenchymal stem cell and bone marrow mononuclear cell transplantation for spastic cerebral palsy.**

Liu X, Fu X, Dai G, Wang X, Zhang Z, Cheng H, Zheng P, An Y.

Science Infos Paralyse Cérébrale, Mars 2017, FONDATION PARALYSIE CEREBRALE 67 rue Vergniaud  
75013 Paris - tel +33 1 45 54 03 03 contact: Christine Doumergue cdoumergue@lafondationmotrice.org

**BACKGROUND:** Bone marrow mesenchymal stem cells (BMMSCs) and bone marrow mononuclear cells (BMMNCs) are both used to treat spastic cerebral palsy. However, the differences in therapeutic effect remain unknown.

**METHODS:** A total of 105 patients with spastic cerebral palsy were enrolled and randomly assigned to three groups: the BMMSC group, the BMMNC group and the control group. Patients in both transplantation groups received four intrathecal cell injections. Patients in the control group received Bobath therapy. The gross motor function measure (GMFM) and the fine motor function measure (FMFM) were used to evaluate the therapeutic efficacy before transplantation and 3, 6, and 12 months after transplantation.

**RESULTS:** Three months after cell transplantation, scores in the A dimension of GMFM and the A and C dimensions of FMFM scores in the BMMSC group are all higher than those of the BMMNC and the control groups ( $P < 0.05$ ). Six months after cell transplantation, scores in the A, B dimensions of GMFM and the A, B, C, D, and E dimensions of FMFM scores in the BMMSC group are higher than those of the BMMNC and the control groups ( $P < 0.05$ ). Twelve months after cell transplantation, scores in the A, B, and C dimensions of GMFM and the A, B, C, D, and E dimensions of FMFM scores in the BMMSC group are all higher than those of the BMMNC and the control groups ( $P < 0.05$ ). No obvious adverse effects were investigated during follow-up.

**CONCLUSIONS:** BMMSC transplantation for the treatment of cerebral palsy is safe and feasible, and can improve gross motor and fine motor function significantly. In addition, compared with BMMNC, the motor function of children improved significantly in terms of gross motor and fine motor functions.

DOI: 10.1186/s12967-017-1149-0

PMCID: PMC5324263

PMID: 28235424

### **Effect of Intravenous Infusion of G-CSF-Mobilized Peripheral Blood Mononuclear Cells on Upper Extremity Function in Cerebral Palsy Children.**

Park KI, Lee YH, Rah WJ, Jo SH, Park SB, Han SH, Koh H, Suh JY, Um JS, Choi EH, Park *Ann Rehabil Med.* 2017 Feb;41(1):113-120. doi: 10.5535/arm.2017.41.1.113. Epub 2017 Feb 28.

UJ, Kim MJ.

**OBJECTIVE:** To investigate the effect of intravenous infusion of peripheral blood mononuclear cells (mPBMC) mobilized by granulocyte-colony stimulating factor (G-CSF) on upper extremity function in children with cerebral palsy (CP).

**METHODS:** Fifty-seven children with CP were enrolled. Ten patients were excluded due to follow-up loss. In total, 47 patients (30 males and 17 females) were analyzed. All patients' parents provided signed consent before the start of the study. After administration of G-CSF for 5 days, mPBMC was collected and cryopreserved. Patients were randomized into two groups 1 month later. Twenty-two patients were administered mPBMC and 25 patients received normal saline as placebo. Six months later, the two groups were switched, and administered mPBMC and placebo, respectively. Quality of Upper Extremity Skills Test (QUEST) and the Manual Ability Classification System (MACS) were used to evaluate upper motor function.

**RESULTS:** All subdomain and total scores of QUEST were significantly improved after mPBMC and placebo infusion, without significant differences between mPBMC and placebo groups. A month after G-CSF, all subdomain and total scores of QUEST were improved. The level of MACS remained unchanged in both mPBMC and placebo groups.

**CONCLUSION:** In this study, intravenously infused mPBMC showed no significant effect on upper extremity function in children with CP, as compared to placebo. The effect of mPBMC was likely masked by the effect of G-CSF, which was used in both groups and/or G-CSF itself might have other neurotrophic potentials in children with CP.

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DOI: 10.5535/arm.2017.41.1.113

PMCID: PMC5344812

PMID: 28289643

Conflict of interest statement: CONFLICT OF INTEREST: No potential conflict of interest relevant to this article was reported.

### **Induction of Neurorestoration From Endogenous Stem Cells.**

Yu JH, Seo JH, Lee JY, Lee MY, Cho SR.

*Cell Transplant.* 2016;25(5):863-82. doi: 10.3727/096368916X690511. Epub 2016 Jan 18.



Neural stem cells (NSCs) persist in the subventricular zone lining the ventricles of the adult brain. The resident stem/progenitor cells can be stimulated *in vivo* by neurotrophic factors, hematopoietic growth factors, magnetic stimulation, and/or physical exercise. In both animals and humans, the differentiation and survival of neurons arising from the subventricular zone may also be regulated by the trophic factors. Since stem/progenitor cells present in the adult brain and the production of new neurons occurs at specific sites, there is a possibility for the treatment of incurable neurological diseases. It might be feasible to induce neurogenesis, which would be particularly efficacious in the treatment of striatal neurodegenerative conditions such as Huntington's disease, as well as cerebrovascular diseases such as ischemic stroke and cerebral palsy, conditions that are widely seen in the clinics. Understanding of the molecular control of endogenous NSC activation and progenitor cell mobilization will likely provide many new opportunities as therapeutic strategies. In this review, we focus on endogenous stem/progenitor cell activation that occurs in response to exogenous factors including neurotrophic factors, hematopoietic growth factors, magnetic stimulation, and an enriched environment. Taken together, these findings suggest the possibility that functional brain repair through induced neurorestoration from endogenous stem cells may soon be a clinical reality.

DOI: 10.3727/096368916X690511

PMID: 26787093 [Indexed for MEDLINE]

### **Susceptibility-Weighted Imaging Identifies Iron-Oxide-Labeled Human Neural Stem Cells: Automated Computational Detection.**

Baghchechi M, Plaia A, Hamer M, Ghosh N, Ashwal S, Obenaus A.

*Dev Neurosci.* 2017 Mar 25. doi: 10.1159/000455837. [Epub ahead of print]

Neonatal hypoxic-ischemic brain injury (HII) can lead to devastating neurological outcomes such as cerebral palsy, epilepsy, and mental retardation. Human neural stem cell (hNSC) therapy provides new hope for the treatment of neonatal HII. These multipotent cells can aid in HII recovery by activating multiple reparative mechanisms including secretion of neurotrophic factors that enhance brain repair and plasticity. For clinical use of implanted hNSCs, methods are required to identify, quantify, track, and visualize migration and replication in an automated and reproducible fashion. In the current study, we used a model of unilateral HII in 10-day-old rat pups that were implanted with 250,000 Feridex-labeled hNSCs into the contralateral ventricle 3 days after HII. In addition to standard noninvasively acquired serial magnetic resonance imaging (MRI) sequences (11.7 and 4.7 T) that included diffusion-weighted imaging and T2-weighted imaging, we also acquired susceptibility-weighted imaging (SWI) 1-90 days after hNSC implantation. SWI is an advanced MRI method that enhances the visualization of iron-oxide-labeled hNSCs within affected regions of the injured neonatal brain. hNSC contrast was further enhanced by creating minimal intensity projections from the raw SWI magnitude images combined with phase information. Automated computational analysis using hierarchical region splitting (HRS) was applied for semiautomatic detection of hNSCs from SWI images. We found hNSCs in the ipsilateral HII lesion within the striatum and cortex adjacent to the lesion that corresponded to histological staining for iron. Quantitative phase values (radians) obtained from SWI revealed temporally evolving increased phase which reflects a decreased iron oxide content that is possibly related to cell division and the replicative capacity of the implanted hNSCs. SWI images also revealed hNSC migration from the contralateral injection site towards the ipsilateral HII lesion. Our results demonstrate that MRI-based SWI can monitor iron-labeled hNSCs in a clinically relevant manner and that automated computational methods such as HRS can rapidly identify iron-oxide-labeled hNSCs.

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DOI: 10.1159/000455837

PMID: 28343216

### **Autres**

### **Changes in Cardiorespiratory Responses and Kinematics With Hippotherapy in Youth With and Without Cerebral Palsy.**

Rigby BR, Gloeckner AR, Sessums S, Lanning BA, Grandjean PW.

*Res Q Exerc Sport.* 2017 Mar;88:26-35. doi: 10.1080/02701367.2016.1266458. Epub 2017 Jan 11.

**PURPOSE:** The purpose of this study was to characterize pelvic displacement and cardiorespiratory responses to simulated horseback riding and walking in youth with cerebral palsy and to compare responses to youth without cerebral palsy before and after 8 weeks of hippotherapy.

**METHOD:** Eight youth with cerebral palsy (M<sub>age</sub> = 10 ± 4 years; M<sub>height</sub> = 137 ± 24 cm; M<sub>weight</sub> = 32 ± 16 kg) and 8 youth without cerebral palsy (M<sub>age</sub> = 11 ± 2 years; M<sub>height</sub> = 149 ± 14 cm; M<sub>weight</sub> = 48 ± 15 kg) underwent a hippotherapy intervention. Participants completed simulated horseback riding at an intensity approximating a fast walk (0.65 Hz) and walked on a treadmill (1 mph, 0% grade) before and after hippotherapy. Pelvic displacement along the anterior-posterior, vertical, and medial-lateral axes, heart rate, oxygen consumption, ventilation, and blood pressure were measured at rest and during steady-state exercise in both exercise modes.

**RESULTS:** Kinematics and cardiorespiratory responses were similar between the 2 groups during simulated horseback riding ( $p > .05$  for all) before the intervention. Significantly greater cardiorespiratory responses were observed in the youth with cerebral palsy compared with the group without cerebral palsy while walking before and after the intervention ( $p < .05$ , effect sizes 26% to 237% greater). Eight weeks of hippotherapy did not alter responses, but anecdotal improvements in gait, balance, posture, and range of motion were observed in those with cerebral palsy.

**CONCLUSION:** These results contribute to our understanding regarding the efficacy of hippotherapy as an intervention to improve functional abilities in those with cerebral palsy.

DOI: 10.1080/02701367.2016.1266458

PMID: 28075704 [Indexed for MEDLINE]

### **Complementary traditional Chinese medicine use in Children with cerebral palsy: a nationwide retrospective cohort study in Taiwan.**

Liao HH, Yen HR, Muo CH, Lee YC, Wu MY, Chou LW, Sun MF, Chang TT.

*BMC Complement Altern Med.* 2017 Mar 14;17(1):155. doi: 10.1186/s12906-017-1668-5.

**BACKGROUND:** Complementary traditional Chinese medicine (TCM) has been used to treat patients with cerebral palsy (CP). However, large-scale surveys examining its use in the treatment of CP and associated disorders are lacking.

**METHODS:** We enrolled 11,218 patients ≤ 18 years of age with CP in the Taiwanese National Health Insurance Research Database from 1995 to 2011. Patients were categorized as TCM users (n = 6,997; 62.37%) and non-TCM users (n = 4,221; 37.63%) based on the inclusion of TCM in their treatment plan.

**RESULTS:** Children with higher proportions of complementary TCM use were male, younger, and lived in urbanized areas. Most TCM users (n = 5332, 76.2%) visited TCM outpatient departments more than 20 times per year. In both groups, the three most common reasons for clinical visits were problems of the nervous system, respiratory system, and digestive system. Acupuncture was commonly used in problems of injury, musculoskeletal system and connective tissue, and nervous system. Chinese herbal medicine was used to improve the primary symptoms of CP in patients, as well as its associated disorders. The incidence rate ratios in allergic rhinitis, dyspepsia, menstrual disorders, and musculoskeletal system and connective tissue diseases among TCM users were significantly higher than non-TCM users. Although patients receiving complementary TCM therapies had higher medical expenditure for utilizing outpatient clinical consultations, their medical costs for visiting ER and hospitalization were significantly lower than that of non-TCM user within one year of the diagnosis of CP.

**CONCLUSION:** This study was a large-scale survey to characterize patterns of complementary TCM use among children with CP. The complementary use of TCM in children with CP was considerably high. Future clinical trials and basic researches can be developed based on the findings of this study.

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DOI: 10.1186/s12906-017-1668-5

PMCID: PMC5348761

PMID: 28288600

### **Effect of Hippotherapy on Motor Proficiency and Function in Children with Cerebral Palsy Who Walk.**

Champagne D, Corriveau H, Dugas C.

*Phys Occup Ther Pediatr.* 2017 Feb;37(1):51-63. doi: 10.3109/01942638.2015.1129386. Epub 2016 Mar 1.

**AIMS:** To evaluate the effects of hippotherapy on physical capacities of children with cerebral palsy.

**METHODS:** Thirteen children (4-12 years old) with cerebral palsy classified in Gross Motor Function Classification System Level I or II were included in this prospective quasi-experimental ABA design study. Participants received 10 weeks of hippotherapy (30 min per week). Gross motor function and proficiency were measured with the Bruininks-Oseretski Motor Proficiency short form [BOT2-SF] and the Gross Motor Function Measure-88 [GMFM-88] (Dimension D and E) twice before the program (T1 and T1'), immediately after (T2), and 10 weeks following the end of the program (T3).

**RESULTS:** Mean scores for dimensions D and E of the GMFM-88 Dimension scores ( $p = .005$ ) and three out of the eight items of the BOT2-SF (fine motor precision ( $p = .013$ ), balance ( $p = .025$ ), and strength ( $p = .012$ )) improved between baseline and immediately after intervention; mean scores immediately following and 10 weeks following intervention did not differ.

**CONCLUSIONS:** Hippotherapy provided by a trained therapist who applies an intense and graded session for 10 weeks can improve body functions and performance of gross motor and fine motor activities in children with cerebral palsy.

DOI: 10.3109/01942638.2015.1129386

PMID: 26930110 [Indexed for MEDLINE]

### **Hyperbaric oxygen therapy is safe and effective for the treatment of sleep disorders in children with cerebral palsy.**

Long Y, Tan J, Nie Y, Lu Y, Mei X, Tu C.

*Neurol Res.* 2017 Mar;*39*(3):239-247. doi: 10.1080/01616412.2016.1275454. Epub 2017 Jan 12.

**OBJECTIVE:** To observe the effects of hyperbaric oxygen (HBO2) therapy on the treatment of sleep disorders and its safety in children with cerebral palsy (CP).

**METHODS:** A total of 71 recruited children were divided into two groups based on age: group 1, aged between 2 and 4 years; and group 2, aged between 4 and 6 years. The effects of HBO2 therapy on sleep quality were observed.

**RESULTS:** The total sleep items (TSIs) were significantly different in the two groups between pre-HBO2, post 10 HBO2 sessions, and post 20 HBO2 sessions ( $p < 0.01$ ). A total of 15/38 (39.5%) participants in group 1 and 8/21 (38.0%) in group 2 presented difficulty in falling asleep; 17/38 (44.7%) in group 1 and 4/21 (19.0%) in group 2 had a short duration of sleep during the night; and 20/38 (52.6%) in group 1 and 11/21 (52.4%) in group 2 woke up easily in the night. No significant difference in the average TSIs in 59 participants was found after 10 HBO2 sessions. Eight participants had insomnia after the first 5 sessions, and three in group 2 had nocturnal hyperkinesia after 15 sessions. A seizure during decompression was observed in 2/59 participants (2/419 sessions).

**DISCUSSION:** These results indicate that HBO2 therapy is beneficial to improve sleep and is safe for children with CP; however, further studies are necessary to explore the mechanisms of HBO2 on sleep.

DOI: 10.1080/01616412.2016.1275454

PMID: 28079475 [Indexed for MEDLINE]

## **Langage – Communication**

### **Speech production gains following constraint-induced movement therapy in children with hemiparesis .**

Allison KM, Reidy TG, Boyle M, Naber E, Carney J, Pidcock FS.

*J Pediatr Rehabil Med.* 2017;*10*(1):3-9. doi: 10.3233/PRM-170405.

**PURPOSE:** The purpose of this study was to investigate changes in speech skills of children who have hemiparesis and speech impairment after participation in a constraint-induced movement therapy (CIMT) program. While case studies have reported collateral speech gains following CIMT, the effect of CIMT on speech production has not previously been directly investigated to the knowledge of these investigators.

**METHODS:** Eighteen children with hemiparesis and co-occurring speech impairment participated in a 21-day clinical CIMT program. The Goldman-Fristoe Test of Articulation-2 (GFTA-2) was used to assess children's articulation of speech sounds before and after the intervention. Changes in percent of consonants correct (PCC) on the GFTA-2 were used as a measure of change in speech production.

**RESULTS:** Children made significant gains in PCC following CIMT. Gains were similar in children with left and right-sided hemiparesis, and across age groups.

**CONCLUSION:** This study reports significant collateral gains in speech production following CIMT and suggests benefits of CIMT may also spread to speech motor domains.

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DOI: 10.3233/PRM-170405  
PMID: 28339405

### **Teaching phonics to groups of middle school students with autism, intellectual disabilities and complex communication needs.**

Ainsworth MK, Evmenova AS, Behrmann M, Jerome M.

*Res Dev Disabil.* 2016 Sep;56:165-76. doi: 10.1016/j.ridd.2016.06.001.

For students who have severe and multiple disabilities including intellectual disability, complex communication needs, physical and/or sensory disabilities, and autism, there are many barriers to literacy acquisition. The purpose of this study was to teach letter-sound correspondence to small groups of students with significant intellectual disabilities and comorbid communication disorders using the ALL (Accessible Literacy Learning) curriculum. The eight participants in this study, who ranged in age from 11 to 16 years of age and had primary diagnoses of cerebral palsy, autism, Rett syndrome, Down syndrome, and intellectual disability, were placed into four groups for instruction in phonics. The instruction followed the scripted lessons of ALL Curriculum. There was moderate evidence of the functional relation between the use of the ALL Curriculum and participants' progress towards letter-sound correspondence. Each group of participants demonstrated an increased performance in the treatment phase. The results of the visual analysis were supported by the statistically significant differences yielded by the randomization test analysis. Implications are discussed in terms of the importance of literacy instruction for students with all abilities and needs.

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DOI: 10.1016/j.ridd.2016.06.001

PMID: 27318612 [Indexed for MEDLINE]

## **Douleur**

### **Pain in children and adolescents with cerebral palsy: a population-based registry study.**

Alriksson-Schmidt A, Hägglund G.

*Acta Paediatr.* 2016 Jun;105(6):665-70. doi: 10.1111/apa.13368. Epub 2016 Mar 30.

AIM: We assessed prevalence and location of pain in a total population of children and adolescents with cerebral palsy (CP) based on the Gross Motor Function Classification System (GMFCS), age and gender.

METHODS: This cross-sectional study was based on the last assessment of children aged 1-14 years in the combined Swedish follow-up programme and national quality register programme for CP. All were born 2001-2012 and reported to the registry in 2013-2014. Logistic regression was used to regress age, gender and the GMFCS level on the presence of pain. We also assessed pain sites among GMFCS groups.

RESULTS: We included 2777 children (57% boys) at a median age of 7 years; 32.4% reported pain, with significantly more girls than boys experiencing pain and significantly more children at GMFCS levels III and V than GMFCS I. Pain frequency increased with age and differences among GMFCS levels were found in the lower extremities and abdomen. Pain in the abdomen and hips was most frequent at GMFCS V, knee pain at level III and foot pain at level I. CONCLUSION: Our results showed that although a lower prevalence than in many other studies, pain constituted a significant problem in children and adolescents with CP.

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PMCID: PMC5071732

PMID: 26880375 [Indexed for MEDLINE]

### **Salvage Options in the Cerebral Palsy Hip: A Systematic Review.**

Kolman SE, Ruzbarsky JJ, Spiegel DA, Baldwin KD.

*J Pediatr Orthop.* 2016 Sep;36(6):645-50. doi: 10.1097/BPO.0000000000000501.

BACKGROUND: No preferred procedure exists for the chronically painful, unreconstructable subluxated or dislocated hip in cerebral palsy. The purpose of this study was to compare pain relief and complication rates of salvage procedures in cerebral palsy for ambulatory and nonambulatory populations.

**METHODS:** We searched Medline, Embase, and Cochrane databases using the search terms "cerebral palsy" and "hip dislocation." Inclusion and exclusion criteria were established to maintain data quality for analysis. A systematic review yielded 28 studies. Relevant information for postoperative pain and complications were extracted from each study and described. Our initial search identified 721 articles. Two hundred twenty duplications were excluded. Five hundred one were screened by title and abstract. One hundred articles underwent further full text and reference evaluation, yielding 25 studies. An additional 3 studies were then identified from the list of 25, yielding a total of 28 studies, which met our inclusion criteria.

**RESULTS:** Among nonambulators, femoral head resection (FHR), valgus osteotomy (VO), and total hip arthroplasty (THA) were found to relieve pain better than arthrodesis [odds ratio (OR) 7.3, 95% confidence interval (CI), 2.2-24.8; OR 5.9, 95% CI, 1.6-22.8; OR 11.7, 95% CI, 1.1-297.5, respectively]. Arthrodesis had a significantly higher complication rate than FHR, VO, THA, and shoulder prosthetic interposition. No significant differences in complication rate were found between FHR and VO. Pain relief rates among nonambulators for FHR, VO, THA, shoulder prosthetic interposition, and arthrodesis were 90.4%, 88.4%, 93.8%, 90.9%, and 56.3%, respectively. Complication rates among nonambulators were 24.0%, 33.3%, 35.3%, 28.6%, and 106.3%, respectively. Comparison of pain relief and complication rates among ambulatory cerebral palsy patients in all procedures except THA was not possible because the populations could not be separated from nonambulators in numbers sufficient to perform statistical analysis. Data were available for 32 confirmed cases of THA in ambulators and was associated with a 93.3% pain relief rate and a 38.2% complication rate.

**CONCLUSIONS:** Among nonambulators, the available literature suggests that FHR, VO, and THA may be superior at relieving pain than arthrodesis. FHR had the lowest absolute percentage of complications; however, no significant differences in complication rate or pain relief were found in nonambulators undergoing FHR or VO. Most of the complications for VO were implant related, and potentially amenable to hardware removal versus complications in FHR, which were related to the procedure itself such as proximal migration and heterotopic bone formation. THA in nonambulators was associated with complications such as dislocation and revision. Arthrodesis in nonambulators was associated with >100% complication rate and inferior pain relief compared with other procedures. Ambulatory patients had excellent pain relief with THA; however, the complication rate is higher than can be expected with non-neurological populations. Insufficient data exist to support use of other salvage procedures in ambulators. These conclusions should be interpreted with caution as all studies involved level IV evidence.

**LEVEL OF EVIDENCE:** IV (systematic review of level IV studies).

DOI: 10.1097/BPO.0000000000000501

PMID: 25887836 [Indexed for MEDLINE]

## **Autres Troubles / Troubles concomitants**

### **Prevalence of secondary impairments of adults with cerebral palsy according to gross motor function classification system.**

Park EY, Kim WH.

*J Phys Ther Sci.* 2017 Feb;29(2):266-269. doi: 10.1589/jpts.29.266. Epub 2017 Feb 24.

[Purpose] This study aimed to investigate the prevalence of secondary impairments in adults with cerebral palsy.

[Subjects and Methods] The study sample included 52 adults with cerebral palsy who attended a convalescent or rehabilitation center for disabled individuals or a special school for physical disabilities in South Korea.

[Results] The univariate analysis showed that the Gross Motor Functional Classification System level was a significant predictor of spondylopathies, general pain, arthropathies, and motor ability loss. The prevalence of these impairments at Gross Motor Functional Classification System level I and II was low compared with the prevalence found at Gross Motor Functional Classification System level III-V. The prevalence of secondary impairments among adults with cerebral palsy at Gross Motor Functional Classification System level III-V was high: loss of motor ability, 42.3%; spondylopathies, 38.4%; general pain, 32.7%; and arthropathies, 28.8%. [Conclusion] In this study, adults with severe cerebral palsy showed a high prevalence of motor ability loss, spondylopathies, arthropathies, and pain. It is necessary to develop intervention programs to prevent secondary impairments in adults with cerebral palsy.

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DOI: 10.1589/jpts.29.266

PMCID: PMC5332985

PMID: 28265154

## ✚ Troubles respiratoires

### **Comparison of differences in respiratory function and pressure as a predominant abnormal movement of children with cerebral palsy.**

Kwon HY.

*J Phys Ther Sci.* 2017 Feb;29(2):261-265. doi: 10.1589/jpts.29.261. Epub 2017 Feb 24.

[Purpose] The purpose of this study was to determine differences in respiratory function and pressure among three groups of children with cerebral palsy as a predominant abnormal movement which included spastic type, dyskinetic type, and ataxic type. [Subjects and Methods] Forty-three children with cerebral palsy of 5-13 years of age in I-III levels according to the Gross Motor Function Classification System, the study subjects were divided by stratified random sampling into three groups of spastic type, dyskinetic type, and ataxic type. For reliability of the measurement results, respiratory function and pressure of the children with cerebral palsy were measured by the same inspector using Spirometer Pony FX (Cosmed Ltd., Italy) equipment, and the subject's guardians (legal representative) was always made to observe. [Results] In the respiratory function, there were significant differences among three groups in all of forced vital capacity, forced expiratory volume at one second, and peak expiratory flow. For respiratory pressure, the maximal inspiratory pressure had significant differences among three groups, although the maximal expiratory pressure had no significant difference. [Conclusion] Therefore, pediatric physical therapists could be provided with important clinical information in understanding the differences in respiratory function and pressure for the children with cerebral palsy showing predominantly abnormal movement as a diverse qualitative characteristics of the muscle tone and movement patterns, and in planning intervention programs for improvement of respiratory capacity.

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DOI: 10.1589/jpts.29.261

PMCID: PMC5332984

PMID: 28265153

## ✚ Troubles musculosquelettiques, des tissus conjonctifs et osseux

### **Bone mineral density and insulin-like growth factor-1 in children with spastic cerebral palsy.**

Nazif H, Shatla R, Elsayed R, Tawfik E, Osman N, Korra S, Ibrahim A.

*Childs Nerv Syst.* 2017 Feb 24. doi: 10.1007/s00381-017-3346-9. [Epub ahead of print]

BACKGROUND: Children with cerebral palsy (CP) have significant decrease linear growth rate and low bone mineral density (BMD).

AIMS: This study is to evaluate BMD in children with CP and its relation to the levels of insulin-like growth factor-1 (IGF-1).

SUBJECTS AND METHODS: This cross-sectional study was carried out on 58 children suffering from spastic CP with the age range 4-12 years compared to 19 controls. All assessed by dual energy x-ray absorptiometry (DXA) to measure BMD, serum level of IGF-1, and serum vitamin D. The patients were classified according to their GMFCS.

RESULTS: Fractures were reported in seven (12.1%) of cases. Our study demonstrated that, IGF-1 level and BMD decrease in correlation with the severity of CP. IGF-1 correlates positively with serum vitamin D, BMI, and BMD. CP children with severe GMFCS level or who use anticonvulsive drugs are at a high risk for low BMD and low levels of IGF-1.

CONCLUSION: Both BMD and IGF-1 were significantly in low children with spastic CP; IGF-1 negatively correlates with the severity of osteopenia in children with spastic. Children with CP who are not independently ambulant or with severe GMFCS level or who use anticonvulsive drugs are at a high risk for developing low BMD.

DOI: 10.1007/s00381-017-3346-9

PMID: 28236062

### **Bone mineral density and vitamin D status in children with epilepsy, cerebral palsy, and cerebral palsy with epilepsy.**

Tosun A, Erisen Karaca S, Unuvar T, Yurekli Y, Yenisey C, Omurlu IK.

**PURPOSE:** We aimed to evaluate the relationship between bone mineral density (BMD) disorders and possible risk factors in patients with epilepsy only (EO), cerebral palsy only (CPO), and cerebral palsy-epilepsy (CP + E).

**METHODS:** A total of 122 patients [EO (n = 54), CPO (n = 30), CP + E (n = 38)] and 30 healthy children were evaluated. BMD was only measured in patient groups, not in control subjects. BMD of lumbar vertebrae was determined by dual energy X-ray absorptiometry (DXA). An abnormal BMD was defined as low or low normal BMD.

**RESULTS:** Low BMD rate in EO, CPO, and CP + E group was 3.7, 50, and 39.5 %, respectively. Abnormal BMD values were significantly related to inadequate dietary Ca intake (p = 0.017), severe intellectual disability (p < 0.001), and immobility (p = 0.018). In multivariate regression analysis, the risk of abnormal BMD was higher (3.9-fold) in patients not able to walk independently than the others (p = 0.029). However, serum Ca-Vitamin D levels, insufficient exposure to sunlight, low BMI, and use of AED were not correlated with abnormal BMD.

**CONCLUSION:** Abnormal BMD is a common problem in patients with CP and CP + E. Abnormal BMD was related to the severity of CP, but not to vitamin D levels or AED treatment.

DOI: 10.1007/s00381-016-3258-0

PMID: 27757568 [Indexed for MEDLINE]

*Medicine (Baltimore).* 2017 Mar;96(10):e5896. doi: 10.1097/MD.0000000000005896.

The effect of weight bearing on bone mineral density and bone growth in children with cerebral palsy: A randomized controlled preliminary trial.

Han EY, Choi JH, Kim SH, Im SH.

**BACKGROUND:** The present study aims to explore the effect of weight bearing exercise on bone mineral density (BMD) and bone growth in children with cerebral palsy (CP).

**METHODS:** Twelve children with CP of functional level of gross motor functional classification scale (GMFCS) V and 6 healthy children (control group) were included in the study. Participants underwent a dual-energy X-ray absorptiometry scan to measure the BMD of the femur and full-length anteroposterior radiography to measure the bone length of the femur and tibia at baseline and after 6 months. Patients were randomly divided into 2 groups: group A with programmed standing exercises and assisted standing for more than 2 hours a day, more than 5 days a week; and group B with conventional physiotherapy with a standing program for 20 minutes a day, 2 to 3 days a week.

**RESULTS:** A 6-month follow-up showed significantly increased BMD on the femur neck in the control group. Although the changes in BMD were not significant in both groups, group A demonstrated an increased trend of BMD, whereas group B showed a decreased trend. Bone length was significantly increased in all 3 groups at the 6-month follow-up. Although this increase was not significant, the change in bone length was greatest in the control group. The smallest changes were observed in group B.

**CONCLUSIONS:** Weight bearing exercise may play an important role in increasing or maintaining BMD in children with CP and is also expected to promote bone growth. Programmed standing may be used as an effective treatment method to increase BMD in children with CP. However, further studies with a larger cohort and longer follow-up period are required to reveal further information on the benefit of weight bearing exercise and to develop a detailed program.

DOI: 10.1097/MD.0000000000005896

PMCID: PMC5348145

PMID: 28272197 [Indexed for MEDLINE]

## Nutrition – Troubles nutritionnels - Métabolisme

### **Body mass index in ambulatory children with cerebral palsy: A cohort study.**

Pascoe J, Thomason P, Graham HK, Reddihough D, Sabin MA.

*J Paediatr Child Health.* 2016 Apr;52(4):417-21. doi: 10.1111/jpc.13097.

**AIM:** Children with cerebral palsy (CP) have reduced levels of physical activity compared with children without physical disability and experience risk factors for becoming overweight or obese. In the Australian CP population, there is little information available about the weight status of children with CP. The aims of this study were to

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compare the distribution of body mass index (BMI) in a cohort of ambulant children with CP with the BMI distribution of Australian children and explore the relationship between BMI and gross motor function.

**METHODS:** A retrospective cohort study of 587 children with CP Gross Motor Function Classification System (GMFCS) levels I-III who attended a Gait Laboratory between July 1995 and January 2012 was carried out. The BMI and Z-score were calculated at each assessment. Data were grouped into the categories of underweight, healthy, overweight and obese according to age-specific and sex-specific percentiles.

**RESULTS:** There were 348 boys and 240 girls with a mean age 11.2 (standard deviation 3.2) years. Mean BMI Z-score was 0.11 (standard deviation 1.33). Seven percent of children were underweight, 73.6% healthy, 7.3% overweight and 12.1% obese. This was similar to the distribution of children without disability. The largest percentage of children in the healthy group were classified GMFCS I. The largest percentage of children in the obese group were classified GMFCS III.

**CONCLUSIONS:** In this cohort, 19.4% of ambulant children with CP were overweight or obese. This is of concern as BMI may impact on the outcomes of surgical intervention and rehabilitation. Further research is needed to determine the consequences of obesity for children with CP.

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DOI: 10.1111/jpc.13097

PMID: 27145505 [Indexed for MEDLINE]

### **Effects of maternal low-protein diet on parameters of locomotor activity in a rat model of cerebral palsy.**

Silva KO, Pereira Sda C, Portovedo M, Milanski M, Galindo LC, Guzmán-Quevedo O, Manhães-de-Castro R, Toscano AE.

*Int J Dev Neurosci.* 2016 Aug;52:38-45. doi: 10.1016/j.ijdevneu.2016.05.002. Epub

Children with cerebral palsy have feeding difficulties that can contribute to undernutrition. The aim of this study was to investigate the effect of early undernutrition on locomotor activity and the expression of the myofibrillar protein MuRF-1 in an experimental model of cerebral palsy (CP). In order to achieve this aim, pregnant rats were divided into two groups according to the diet provided: Normal Protein (NP, n=9) and Low Protein (LP, n=12) groups. After birth, the pups were divided into four groups: Normal Protein Sham (NPS, n=16), Normal Protein Cerebral Palsy (NPCP, n=21), Low Protein Sham (LPS, n=20) and Low Protein Cerebral Palsy (LPCP, n=18) groups. The experimental cerebral palsy protocol consisted of two episodes of anoxia at birth and during the first days of life. Each day, nitrogen flow was used (9l/min during 12min). After nitrogen exposure, sensorimotor restriction was performed 16h per day, from the 2nd to the 28th postnatal day (PND). Locomotor activity was evaluated at 8th, 14th, 17th, 21th and 28th PND. At PND 29, soleus muscles were collected to analyse myofibrillar protein MuRF-1. Our results show that CP animals decreased body weight ( $p<0.001$ ), which were associated with alterations of various parameters of locomotor activity ( $p<0.05$ ), compared to their control. Undernourished animals also showed a decrease ( $p<0.05$ ) in body weight and locomotor activity parameters. Moreover, CP decreased MuRF-1 levels in nourished rats ( $p=0.015$ ) but not in undernourished rats. In summary, perinatal undernutrition exacerbated the negative effects of cerebral palsy on locomotor activity and muscle atrophy, but it appears not be mediated by changes in MuRF-1 levels.

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DOI: 10.1016/j.ijdevneu.2016.05.002

PMID: 27211347 [Indexed for MEDLINE]

### **Nutritional assessment and intervention in children with cerebral palsy: a practical approach.**

Scarpato E, Staiano A, Molteni M, Terrone G, Mazzocchi A, Agostoni C.

*Int J Food Sci Nutr.* 2017 Feb 16:1-8. doi: 10.1080/09637486.2017.1289502. [Epub ahead of print]

Cerebral palsy (CP) is associated with the presence of feeding disorders in almost 60% of the affected children with subsequent undernutrition reported in up to 46% of the subjects. Since undernutrition may have a detrimental impact on physical and cognitive development, the introduction of an adequate nutritional support should always be considered in children with neurological impairment. The aim of the present review is to provide a practical guide to the assessment of nutritional status in children with CP, in order to identify individuals at risk for malnutrition that need the introduction of an adequate and personalized nutritional support. This review summarizes the methods for the evaluation of oral-motor function, anthropometric parameters, body composition and energy balance in children



with CP. Moreover, we reviewed the indications for the introduction of nutritional support, and the suggested modalities of intervention.

DOI: 10.1080/09637486.2017.1289502

PMID: 28276905

### **Pharyngeal Residue and Aspiration and the Relationship with Clinical/Nutritional Status of Patients with Oropharyngeal Dysphagia Submitted to Videofluoroscopy.**

*J Nutr Health Aging. 2017;21(3):336-341. doi: 10.1007/s12603-016-0754-6.*

Oliveira DL, Moreira EA, de Freitas MB, Gonçalves JA, Furkim AM, Clavé P.

**OBJECTIVES:** The aim of this study was to investigate the association between the videofluoroscopic (VFS) signs of impaired efficacy (pharyngeal residue) and safety (aspiration) swallowing and the clinical/nutritional status of patients with suspect of dysphagia.

**DESIGN:** A cross-sectional study was conducted with patients submitted to videofluoroscopy.

**SETTING AND PARTICIPANTS:** Data of 76 patients were analyzed between March 2011 and December 2014.

**MEASUREMENTS:** The clinical history and VFS exams of patients  $\geq 38$  years were retrospectively analyzed.

**RESULTS:** 88% patients presented Oropharyngeal Dysphagia (OD), 44.7% presented laryngeal penetration and 32% presented aspiration. 78% patients presented pharyngeal residue. Aspiration was associated with Head Neck Cancer (HNC) [Prevalence Ratio (PR): 2.27,  $p = 0.028$ ] and cardiovascular disease (PR 1.96,  $p = 0.027$ ). Underweight [Body Mass Index  $< 18.5$  kg/m<sup>2</sup>] was not associated with the presence of aspiration. Underweight patients with OD had a higher prevalence rate of pharyngeal residue than those normally nourished (100% vs. 78%) (PR 1.34,  $p = 0.011$ ). Pharyngeal residue was associated with male sex (PR 1.32,  $p = 0.040$ ), neurodegenerative disease (PR 1.57,  $p = 0.021$ ), stroke (PR 1.62,  $p = 0.009$ ), cerebral palsy (PR 1.76,  $p = 0.006$ ) and HNC (PR 1.73,  $p = 0.002$ ).

**CONCLUSION:** In the present study, neurologic diseases, HNC, male sex and underweight were associated to impaired swallowing efficacy. Underweight, independently of the other variables, was not associated with impaired swallowing safety.

DOI: 10.1007/s12603-016-0754-6

PMID: 28244575

Conflict of interest statement: None.

### **The Eating and Drinking Ability Classification System in a population-based sample of preschool children with cerebral palsy.**

Benfer KA, Weir KA, Bell KL, Ware RS, Davies PS, Boyd RN.

*Dev Med Child Neurol. 2017 Mar 9. doi: 10.1111/dmcn.13403. [Epub ahead of print]*

**AIM:** To determine (1) the reproducibility of the Eating and Drinking Ability Classification System (EDACS); (2) EDACS classification distribution in a population-based cohort with cerebral palsy (CP); and (3) the relationships between the EDACS and clinical mealtime assessment, other classifications, and health outcomes.

**METHOD:** This was a cross-sectional population-based cohort study of 170 children with CP at 3 years to 5 years (mean 57.6mo, standard deviation [SD] 8.3mo; 105 males, n=65 females). Functional abilities were representative of a population sample (Gross Motor Function Classification System level I=74, II=34, III=21, IV=18, V=23). The EDACS was the primary classification of mealtime function. The Dysphagia Disorders Survey was the clinical mealtime assessment. Gross motor function was classified using the Gross Motor Function Classification System.

**RESULTS:** EDACS classification had 88.3% intrarater agreement ( $\kappa=0.84$ , intraclass correlation coefficient=0.95;  $p<0.001$ ) and 51.7% interrater agreement ( $\kappa=0.36$ , intraclass correlation coefficient=0.79;  $p<0.001$ ). In total, 56.5% of children were classified as EDACS level I. There was a strong stepwise relationship between the Dysphagia Disorders Survey and EDACS ( $r=0.96$ ,  $p<0.001$ ). Parental stress (odds ratio=1.3,  $p=0.05$ ) and feeding tubes (odds ratio=6.4,  $p<0.001$ ) were significantly related to more limited function on the EDACS.

**INTERPRETATION:** The EDACS presents a viable adjunct to clinical assessment of feeding skills in children with CP for use in surveillance trials and clinical practice. A rating addendum would be a useful contribution to the tool to enhance reproducibility.

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DOI: 10.1111/dmcn.13403

PMID: 28276586

**A telehealth approach to conducting clinical swallowing evaluations in children with cerebral palsy.**

Kantarcigil C, Sheppard JJ, Gordon AM(3), Friel KM, Malandraki GA.

*Res Dev Disabil.* 2016 Aug;55:207-17. doi: 10.1016/j.ridd.2016.04.008. Epub 2016 Apr 29.

**BACKGROUND:** Accurate and timely evaluation of dysphagia in children with cerebral palsy (CP) is critical. For children with limited access to quality healthcare, telehealth is an option; however, its reliability needs to be investigated.

**AIM:** To test the reliability of an asynchronous telehealth model for evaluating dysphagia in children with CP using a standardized clinical assessment.

**METHODS AND PROCEDURES:** Nineteen children (age range 6.9-17.5) were assessed at three mealtimes via the Dysphagia Disorder Survey (DDS) by three clinicians (face-to-face evaluations). Mealtimes were video-recorded to allow asynchronous evaluations by a remote clinician who also completed approximately 1/3 of face-to-face evaluations. Agreement was tested on DDS variables and dysphagia severity.

**OUTCOMES AND RESULTS:** Results revealed substantial to excellent agreement between face-to-face and remote assessments by the same rater (78-100%, KW=0.64-1) on all, but two variables (oral transport and oral pharyngeal swallow) and by different raters (69-89%, KW=0.6-0.86) on all but one variable (orienting). For dysphagia severity, intrarater agreement was excellent (100%, KW=1); interrater agreement was substantial (85%; KW=0.76).

**CONCLUSIONS AND IMPLICATIONS:** Asynchronous clinical swallowing evaluations using standardized tools have acceptable levels of agreement with face-to-face evaluations, and can be an alternative for children with limited access to expert swallowing care.

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DOI: 10.1016/j.ridd.2016.04.008

PMID: 27132060 [Indexed for MEDLINE]

**Botulinum toxin injections for chronic sialorrhoea in children are effective regardless of the degree of neurological dysfunction: A single tertiary institution experience.**

Mahadevan M, Gruber M, Bilish D, Edwards K, Davies-Payne D, van der Meer G.

*Int J Pediatr Otorhinolaryngol.* 2016 Sep;88:142-5. doi: 10.1016/j.ijporl.2016.06.031. Epub 2016 Jun 11.

**OBJECTIVE:** To determine the effectiveness of submandibular salivary gland Botulinum Toxin Type-A (BTX-A) injection in the treatment of drooling in children with varying degrees of neurological dysfunction.

**METHODS:** A retrospective review of pre- and post-procedure drooling frequency and severity scores of patients receiving BTX-A between January 2008 and January 2013. Stratification to different subgroups of neurological impairment was performed according to Gross Motor Function Classification System (GMFCS) score. Drooling severity was assessed using Thomas-Stonell and Greenberg symptom questionnaires administered at time of initial consultation and 3 months after treatment.

**RESULTS:** 48 sets of BTX-A injections in 26 patients with an average age of 9.45 years (range 7 months-18 years) were included in the study. Marked improvement in drooling was seen in 60.4% of patients, a marginal or brief improvement was seen in 20.8% and there was no improvement in 18.8%. No adverse events were reported following any of the BTX-A injections. BTX-A was safe and effective in the eight patients with pre-existing swallowing dysfunction. Subsequent drooling surgery was performed in 15 (57.7%) of the cohort, all 15 patients responded to BTX-A injections. In patients with Cerebral Palsy, there was no correlation between the severity of the neurological dysfunction as measured by the Gross Motor Function Classification System (GMFCS) score and the response to BTX-A treatment.

**CONCLUSIONS:** Injection of BTX-A to the submandibular glands of children with neurological disorders is a safe procedure and results in a reduction in drooling in the majority of patients. Children with severe neurological dysfunction respond to BTX-A injections as effectively as their less impaired peers and the degree of response does not appear to be associated with the severity of neurological disability. BTX-A injection is a good initial procedure when drooling surgery is being considered.

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DOI: 10.1016/j.ijporl.2016.06.031

PMID: 27497402 [Indexed for MEDLINE]

## **Differences between the activity of the masticatory muscles of adults with cerebral palsy and healthy individuals while at rest and in function.**

Matsui MY, Giannasi LC, Batista SR, Amorim JB, Oliveira CS, Oliveira LV, Gomes MF.

*Arch Oral Biol.* 2017 Jan;73:16-20. doi: 10.1016/j.archoralbio.2016.08.035. Epub 2016 Sep 1.

**OBJECTIVE:** The aim of the present study was to compare the electromyographic activity of masticatory muscles of adult patients with different degrees of oral motor impairment (cerebral palsy) with the electromyographic activity of healthy individuals in a control group. Electromyographic activity was compared when the masticatory muscles were at rest and in motion.

**DESIGN:** Thirty adult patients with cerebral palsy and 30 subjects without neuromotor disorders were enrolled in the present study. Oral motor function impairment was classified for each subject according to the Orofacial Motor Function Assessment Scale. Surface electromyography was bilaterally recorded in the masseter and anterior temporalis muscles at rest, during maximal voluntary clench and mouth opening. Comparisons between the groups were statistically assessed using Mann-Whitney test.

**RESULTS:** At rest and mouth opening, electromyographic values were higher among patients with cerebral palsy than control group. During maximal voluntary clench, the opposite occurred. The degree of oral motor impairment affected mouth opening.

**CONCLUSION:** There are significant differences in masticatory muscle activity between adult patients with CP and healthy individuals, and the degree of oral motor impairment is important.

**SIGNIFICANCE:** To improve the masticatory function of these patients, muscle therapy should approach rest, mouth opening and clenching differently.

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DOI: 10.1016/j.archoralbio.2016.08.035

PMID: 27648849 [Indexed for MEDLINE]

## **Managing children with sialorrhoea (drooling): Experience from the first 301 children in our saliva control clinic.**

Montgomery J, McCusker S, Lang K, Grosse S, Mace A, Lumley R, Kubba H.

*Int J Pediatr Otorhinolaryngol.* 2016 Jun;85:33-9. doi: 10.1016/j.ijporl.2016.03.010. Epub 2016 Mar 19.

**OBJECTIVES:** Sialorrhoea (drooling) is defined as the involuntary escape of saliva from the mouth. It is considered normal in young children but may cause social problems in older children. Sialorrhoea is frequently seen in children with cerebral palsy, with rates between 10% and 58% and in other neurodevelopmental diseases. Management of these children can be challenging and often requires an individual and stepwise approach. This is a large case series of children managed at the saliva control clinic in Glasgow, Scotland.

**METHODS:** A chart review of all children attending the saliva control clinic between 2006 and June 2012 was performed. This was to ensure that all children would have long term follow up (3 years minimum). Drooling severity was assessed on the child's first attendance at clinic, and at review following a treatment option, using the Teacher Drooling Scale (TDS).

**RESULTS:** The total number of children attending this clinic was 301, of which 274 had adequate records for inclusion in the study. 176 (64%) were male. The mean age was 7.3 (median 5) years. In terms of development 35 (13%) of children were developing normally and 50 (18%) had general developmental delay. There were 105 (38%) children with cerebral palsy. The final management of sialorrhoea in these children was simple reassurance and advice for 34 (12%), speech and language therapy for 62 (23%) anticholinergics in 90 patients (33%), botox for 30 (11%) and surgery for 71 (26%) children. The rate of non-tolerance of anticholinergics is 30%; 90 of the 298 children tried on anticholinergics had side effects leading to the treatment being stopped. The average teachers drooling score was 4.24 before clinic and 1.59 after clinic. Satisfactory results were achieved in 215 (78%) of children.

**CONCLUSION:** Our data illustrates that effective patient management requires all treatment options to be available, including speech therapy, medications, botulinum toxin and surgery. This is one of the larger case series of children attending a saliva control clinic.

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DOI: 10.1016/j.ijporl.2016.03.010

PMID: 27240493 [Indexed for MEDLINE]

## **Teeth grinding, oral motor performance and maximal bite force in cerebral palsy children.**

Botti Rodrigues Santos MT, Duarte Ferreira MC, de Oliveira Guaré R, Guimarães AS, Lira Ortega A.  
*Spec Care Dentist. 2015 Jul-Aug;35(4):170-4. doi: 10.1111/scd.12106. Epub 2015 Feb 11.*

AIM: Identify whether the degree of oral motor performance is related to the presence of teeth grinding and maximal bite force values in children with spastic cerebral palsy.

METHODS: Ninety-five spastic cerebral palsy children with and without teeth grinding, according to caregivers' reports, were submitted to a comprehensive oral motor performance evaluation during the feeding process using the Oral Motor Assessment Scale. Maximal bite force was measured using an electronic gnathodynamometer.

RESULTS: The teeth grinding group (n = 42) was younger, used anticonvulsant drugs, and was more frequently classified within the subfunctional oral motor performance category. Teeth grinding subfunctional spastic cerebral palsy children presented lower values of maximal bite force. The functional groups showing the presence or absence of teeth grinding presented higher values of maximal bite force compared with the subfunctional groups.

CONCLUSION: In spastic cerebral palsy children, teeth grinding is associated with the worse oral motor performance.

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DOI: 10.1111/scd.12106

PMID: 25676552 [Indexed for MEDLINE]

## Troubles visuels

### **Methods for conceptualising 'visual ability' as a measurable construct in children with cerebral palsy.**

Deramore Denver B, Adolfsson M, Froude E, Rosenbaum P, Imms C.

*BMC Med Res Methodol. 2017 Mar 21;17(1):46. doi: 10.1186/s12874-017-0316-6.*

BACKGROUND: Vision influences functioning and disability of children with cerebral palsy, so there is a growing need for psychometrically robust tools to advance assessment of children's vision abilities in clinical practice and research. Vision is a complex construct, and in the absence of clarity about this construct it is challenging to know whether valid, reliable measures exist. This study reports a method for conceptualising 'visual ability' as a measurable construct.

METHODS: Using the items from 19 assessment tools previously identified in a systematic review, this study used a two-phase process: first, deductive content analysis linked items to the International Classification of Functioning, Disability and Health - Child and Youth version (ICF-CY), and second, vision-specific 'Activity'-level items were explored using inductive thematic analysis.

RESULTS: The linking and content analysis identified that existing assessment tools are measuring vision across the ICF-CY domains of Body Functions, Activities and Participation, and Environmental and Personal Factors. Items specifically coded to vision at the Activity level were defined as measuring 'how vision is used', and these items form the basis of the conceptualisation that 'visual ability' is measurable as a single construct. The thematic analysis led to the identification of 3 categories containing 13 themes that reflect a child's observable visual behaviours. Seven abilities reflect how a child uses vision: responds or reacts, initiates, maintains or sustains looking, changes or shifts looking, searches, locates or finds, and follows. Four interactions reflect the contexts in which a child uses their vision to purposefully interact: watches and visually interacts with people and faces, objects, over distance, and with hands. Finally, two themes reflect a child's overall use of vision in daily activities: frequency of use, and efficiency of use.

CONCLUSIONS: This study demonstrates an approach to exploring and explaining a complex topic utilising World Health Organization language and building on existing research. Despite the complexity of vision, the concept of 'how vision is used' can be clearly defined as a measurable construct at the Activity level of the ICF-CY. This study has identified observable visual behaviours that may be developed into items assessing how vision is used in daily activities.

[Free PMC Article](#)

DOI: 10.1186/s12874-017-0316-6

PMCID: PMC5359986

PMID: 28320348

### **Setting up of a cerebral visual impairment clinic for children: Challenges and future developments.**

Philip SS.

Science Infos Paralysie Cérébrale, Mars 2017, FONDATION PARALYSIE CEREBRALE 67 rue Vergniaud  
75013 Paris - tel +33 1 45 54 03 03 contact: Christine Doumergue [cdoumergue@lafondationmotrice.org](mailto:cdoumergue@lafondationmotrice.org)

**AIM:** The aim of this study is to describe the setting up of a cerebral visual impairment (CVI) clinic in a tertiary care hospital in South India and to describe the spectrum of cases seen.

**MATERIALS AND METHODS:** The CVI clinic, set up in February 2011, receives interdisciplinary input from a core team involving a pediatrician, neurologist, psychiatrist, occupational therapist, pediatric ophthalmologist, and an optometrist. All children, <18 years of age, with cerebral palsy (CP), learning disability, autism, neurodegenerative diseases, and brain trauma are referred to the clinic for functional vision assessment and opinion for further management.

**RESULTS:** One thousand four hundred and seventy-eight patients were seen in the CVI clinic from February 2011 to September 2015. Eighty-five percent of the patients were from different parts of India. In the clinic, 61% had CP, 28% had seizure disorders, autism was seen in 9.5%, and learning disability, neurodegenerative conditions, and brain injury together constituted 1.5%. Most of the children (45%) had moderate CP. Forty percent of CVI was due to birth asphyxia, but about 20% did not have any known cause for CVI. Seventy percent of patients, who came back for follow-up, were carrying out the habilitation strategies suggested.

**CONCLUSIONS:** Average attendance of over 300 new patients a year suggests a definite need for CVI clinics in the country. These children need specialized care to handle their complex needs. Although difficult to coordinate, an interdisciplinary team including the support groups and voluntary organizations is needed to facilitate the successful implementation of such specialized service.

[Free Article](#)

DOI: 10.4103/0301-4738.202303

PMID: 28300737

## ✚ Troubles du sommeil

### **Cerebral palsy and sleep disordered breathing.**

Morley A.

*Breathe (Sheff).* 2016 Dec;12(4):357-363. doi: 10.1183/20734735.012016.

Despite the known correlation between neurodisability and sleep disordered breathing, cases are still missed <http://ow.ly/2pNS305KII3>.

[Free PMC Article](#)

DOI: 10.1183/20734735.012016

PMCID: PMC5335572

PMID: 28270864

Conflict of interest statement: Conflict of interest Disclosures can be found alongside this article at [breathe.ersjournals.com](http://breathe.ersjournals.com)

## Qualité de vie et rapport au monde

### ✚ Qualité de vie – Retentissement dans la vie quotidienne

#### **Course of employment in adults with cerebral palsy over a 14-year period.**

Benner JL, Hilberink SR, Veenis T, van der Slot WM, Roebroek ME.

*Dev Med Child Neurol.* 2017 Mar 17. doi: 10.1111/dmcn.13423. [Epub ahead of print]

**AIM:** To explore the course of employment in adults with cerebral palsy (CP) over 14 years, and to identify subgroups at risk for unemployment.

**METHOD:** Sixty-five adults with CP (33 males, 32 females; baseline age 25y 8mo, standard deviation [SD] 3y 2mo; intellectual impairment 25%; bilateral CP 65%) participated in a prospective cohort study. Self-reports of employment and work hours per week in 1996, 2000, and 2010 were documented. The course of employment (including sheltered work) and work hours per week were analysed, using generalized estimating equations (GEE).

**RESULTS:** Overall, employment rate was stable over time (38-45%,  $p=0.413$ ), but lower than in the general population (75-86%,  $p<0.001$ ). Employment rates were specifically low in adults with intellectual impairment, bilateral CP, and in

adults with Gross Motor Function Classification System (GMFCS) levels IV and V. Work hours per week declined (35.0 [SD 7.9] to 31.2 [SD 10.3],  $p=0.033$ ), especially among females (32.3 [SD 6.4] to 23.4 [SD 7.4],  $p<0.001$ ). Similar to the general population, females often worked part-time.

INTERPRETATION: Employment was low compared with the general population, but remained stable in the long term; however, work hours per week decreased. Adults with intellectual impairment, bilateral CP, and GMFCS levels IV and V are subgroups at risk for unemployment.

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DOI: 10.1111/dmcm.13423

PMID: 28304081

### **Effects of gross motor function and manual function levels on performance-based ADL motor skills of children with spastic cerebral palsy.**

Park MO.

*J Phys Ther Sci.* 2017 Feb;29:345-348. doi: 10.1589/jpts.29.345. Epub 2017 Feb 24.

[Purpose] The purpose of this study was to determine effects of Gross Motor Function Classification System and Manual Ability Classification System levels on performance-based motor skills of children with spastic cerebral palsy. [Subjects and Methods] Twenty-three children with cerebral palsy were included. The Assessment of Motor and Process Skills was used to evaluate performance-based motor skills in daily life. Gross motor function was assessed using Gross Motor Function Classification Systems, and manual function was measured using the Manual Ability Classification System.

[Results] Motor skills in daily activities were significantly different on Gross Motor Function Classification System level and Manual Ability Classification System level. According to the results of multiple regression analysis, children categorized as Gross Motor Function Classification System level III scored lower in terms of performance based motor skills than Gross Motor Function Classification System level I children. Also, when analyzed with respect to Manual Ability Classification System level, level II was lower than level I, and level III was lower than level II in terms of performance based motor skills. [Conclusion] The results of this study indicate that performance-based motor skills differ among children categorized based on Gross Motor Function Classification System and Manual Ability Classification System levels of cerebral palsy.

[Free PMC Article](#)

DOI: 10.1589/jpts.29.345

PMCID: PMC5333002

PMID: 28265171

### **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.

*Res Dev Disabil.* 2016 Oct;57:125-35. doi: 10.1016/j.ridd.2016.03.015. Epub 2016 Jul 14.

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.

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DOI: 10.1016/j.ridd.2016.03.015

PMID: 27423104 [Indexed for MEDLINE]

**Leisure participation-preference congruence of children with cerebral palsy: a Children's Assessment of Participation and Enjoyment International Network descriptive study.**

Imms C, King G, Majnemer A, Avery L, Chiarello L, Palisano R, Orlin M, Law M.

*Dev Med Child Neurol.* 2017 Apr;59(4):380-387. doi: 10.1111/dmcn.13302. Epub 2016 Nov 5.

**AIM:** To examine participation-preference congruence, regional differences in participation-preference congruence, and predictors of whether children with cerebral palsy participate in preferred activities.

**METHOD:** The sample (n=236) included 148 males and 88 females aged 10 to 13 years, living in Victoria, Australia (n=110), Ontario (n=80), or Quebec (n=46), Canada. Ninety-nine (41.9%) were classed at Gross Motor Function Classification System (GMFCS) level I; 89 (37.7%) at GMFCS level II/III; and 48 (20.3%) at GMFCS level IV/V. Participants completed the Children's Assessment of Participation and Enjoyment and Preferences for Activity of Children questionnaires. Regional comparisons were performed using one-way analyses of variance and factors influencing participation-preference congruence were explored using multiple linear regression.

**RESULTS:** The proportion of children doing non-preferred activities in each activity type was generally low (2-17%), with only one regional difference. Higher proportions were not doing preferred active physical (range 23.2-29.1% across regions), skill-based (range 21.7-27.9% across regions), and social activities (range 12.8-14.5% across regions). GMFCS level was the most important predictor associated with not doing preferred activities.

**INTERPRETATION:** Children with cerebral palsy did not always participate in preferred active physical and skill-based activities. Understanding discrepancies between preferences and actual involvement may allow families and rehabilitation professionals to address participation barriers.

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DOI: 10.1111/dmcn.13302

PMID: 28252187

**Maltreatment Risk Among Children With Disabilities.**

Macleon MJ, Sims S, Bower C, Leonard H, Stanley FJ, O'Donnell M.

*Pediatrics.* 2017 Mar 6. pii: e20161817. doi: 10.1542/peds.2016-1817. [Epub ahead of print]

**BACKGROUND:** Children with disabilities are at increased risk of child maltreatment; however, there is a gap in the evidence about whether all disabilities are at equal risk and whether risk factors vary according to the type of disability.

**METHODS:** A population-based record-linkage study of all children born in Western Australia between 1990 and 2010. Children with disabilities were identified by using population-based registers and risk of maltreatment determined by allegations reported to the Department for Child Protection and Family Support.

**RESULTS:** Although children with disabilities make up 10.4% of the population, they represent 25.9% of children with a maltreatment allegation and 29.0% of those with a substantiated allegation; however, increased risk of maltreatment was not consistent across all disability types. Children with intellectual disability, mental/behavioral problems, and conduct disorder continued to have increased risk of an allegation and substantiated allegation after adjusting for child, family, and neighborhood risk factors. In contrast, adjusting for these factors resulted in children with autism having a lower risk, and children with Down syndrome and birth defects/cerebral palsy having the same risk as children without disability.

**CONCLUSIONS:** The prevalence of disabilities in the child protection system suggests a need for awareness of the scope of issues faced by these children and the need for interagency collaboration to ensure children's complex needs are met. Supports are needed for families with children with disabilities to assist in meeting the child's health and developmental needs, but also to support the parents in managing the often more complex parenting environment.

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DOI: 10.1542/peds.2016-1817

PMID: 28264988

**Pain and hospital admissions are important factors associated with quality of life in nonambulatory children.**

Elema A, Zalmstra TA, Boonstra AM, Narayanan UG, Reinders-Messelink HA, V D Putten AA.

*Acta Paediatr.* 2016 Sep;105(9):e419-25. doi: 10.1111/apa.13493. Epub 2016 Jun 29.

AIM: This was the first study to investigate the factors associated with health-related quality of life (HRQoL) in nonambulatory children with cerebral palsy (CP), based on a HRQoL measure specifically developed for this population.

METHODS: The Dutch version of the Caregiver Priorities and Child Health Index of Life with Disabilities (CPCHILD-DV) was used to measure HRQoL. It was completed by 66 parents of 47 boys and 19 girls with nonambulatory CP aged between five and 18 years with gross motor function classification system (GMFCS) levels of IV and V. Factors measured were the child's motor and cognitive impairments, comorbidities, pain, parents' education and occupations and family structure. Multiple linear regression analyses were used to determine the significant factors and the relative contribution of these factors to the CPOCHILD-DV scores.

RESULTS: The most important factors associated with poorer HRQoL scores were pain and hospital admissions in the previous six months. Other factors were as follows: increased GMFCS level, feeding by gastrostomy tube, inability to communicate verbally, cognitive impairment, poor seizure control and higher parents' educational qualifications.

CONCLUSION: Pain and hospital admissions were the most important factors that were negatively associated with HRQoL in nonambulatory children with CP between five to 18 years.

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### **Participation of Iranian Cerebral Palsy Children in Life Areas: A Systematic Review Article.**

Pashmdarfard M, Amini M, Hassani Mehraban A.

*Iran J Child Neurol.* 2017 Winter;11(1):1-12.

OBJECTIVE: Cerebral palsy (CP) is the most common cause of chronic disability that restricts participation in areas of occupations for children. The main aim of rehabilitation is enhancement of their clients for participation in occupations. The aim of this study was to overview of the factors influencing the participations of children with CP in Iran.

MATERIALS & METHODS: A systematic, evidence-based process (Duffy 2005) was used. For data gathering electronic databases including Google scholar and Iranian and foreigner famous journals in the fields of pediatrics, were used. The main key words for search were Activity of Daily Living (ADL), Instrumental Activity of Daily Living (IADL), play, leisure, work, rest/sleep, social participation, and education. All the papers of this study were about the factors influencing the participation of Iranian CP children during 2000-2016. Totally, 156 articles were found eligible as for Iranian CP children study, of which 100 articles were discarded. Because of repetitive and duplicability of some articles, 17 articles were removed as well.

RESULTS: The most studies about Iranian CP children participations in life areas were in the ADL area of participation (N=12), and the lowest articles were in the area in the field of: Work (N=2), play (N=2), and sleep/rest (N=2). Most of the occupational therapists do not focus on the all life areas.

CONCLUSION: In Iran, many researchers do not pay attention to the participation of CP children. Many articles just paid attention to the sensory, motor or cognitive components of their clients.

[Free PMC Article](#)

PMCID: PMC5329754

PMID: 28277550

### **Theory of mind, emotional and social functioning, and motor severity in children and adolescents with dystonic cerebral palsy.**

Adegboye D, Sterr A, Lin JP, Owen TJ.

*Eur J Paediatr Neurol.* 2017 Jan 31. pii: S1090-3798(17)30073-9. doi: 10.1016/j.ejpn.2017.01.013. [Epub ahead of print]

AIMS: This cross-sectional study aimed to investigate whether children and adolescents with dystonic cerebral palsy (CP) present with emotional and social difficulties along side motor limitations.

PARTICIPANTS/MEASURES: Twenty-two verbal and nonverbal children and adolescents with dystonic CP were compared with a normative sample of twenty children and adolescents on measures of theory of mind (ToM), emotion regulation (ER), and social difficulties (SD).

RESULTS: Higher social and emotional difficulties were found in the dystonic CP group compared to the control group. Nonverbal participants with dystonic CP were found to present with greater social impairment and lower



ToM ability than their verbal counterparts. Emotional regulation and hyperactivity and attentional difficulties (HAD) significantly predicted ToM ability and social difficulties. Lower Gross Motor Function Classification System (GMFCS) level and IQ also contributed to differences in ToM ability.

INTERPRETATION: Findings support the need for greater attention to the emotional health and social development of children/adolescents with dystonic CP, along with assessments of motor difficulties in the planning and implementation of interventions and individual care plans. Further research is needed to explore links between motor disorder and mental state understanding in this clinical group.

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## **Activité physique**

### **ACTIVLIM-CP a new Rasch-built measure of global activity performance for children with cerebral palsy.**

Bleyenheuft Y, Paradis J, Renders A, Thonnard JL, Arnould C.

*Res Dev Disabil.* 2017 Jan;60:285-294. doi: 10.1016/j.ridd.2016.10.005. Epub 2016 Oct 27.

OBJECTIVE: Children with cerebral palsy (CP) often have upper extremity (UE) and lower extremity (LE) impairments. While tools measuring separately UE and LE abilities are currently used, activities in which UE and LE are used in combination - numerous in everyday life - cannot be assessed because no instrument allows capturing global activity performance in children with CP. This study aimed to develop a clinical tool for measuring their global activity performance using the Rasch model.

STUDY DESIGN: The caregivers of 226 children with CP (2-18 years old) answered a 154-item experimental questionnaire. Within 4-6 weeks, 129 of them filled in the questionnaire a second time. Responses were analyzed using the Rasch RUMM2020 software.

RESULTS: The final 43 item scale presented a high reliability (R=0.98) and reproducibility (R=0.97). The item difficulty hierarchy was consistent over time and did not vary according to age, gender, or clinical form, allowing the follow-up of children from 2 to 18 years old.

CONCLUSIONS: ACTIVLIM-CP is a unidimensional scale specifically developed to measure global activity performance in children with CP providing a reliable tool to follow children's evolution and document changes related to neurorehabilitation, especially where a combination of UE and LE is targeted. Its responsiveness is still to be tested.

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PMID: 28341237

### **Consensus Planning Toward a Community-Based Approach to Promote Physical Activity in Youth with Cerebral Palsy.**

Gorter JW, Galuppi BE, Gulko R, Wright M, Godkin E.

*Phys Occup Ther Pediatr.* 2017 Feb;37(1):35-50. doi: 10.3109/01942638.2015.1127868. Epub 2016 Feb 11.

AIMS: To engage researchers and knowledge-users in six Ontario communities in knowledge translation initiatives to identify community-informed elements to guide the development of an optimal physical activity program for youth with cerebral palsy (CP) and to support research efforts.

METHODS: The project included three iterative steps, i.e., an environmental scan of five communities, six regional planning meetings, and a member-checking survey, followed by a Delphi survey to reach consensus on the elements deemed most important.

RESULTS: Twenty-four elements were identified to include in programs promoting physical activity in youth with CP, which were organized in five categories: raise awareness of the options and opportunities (n = 4); pique interest and motivate youth to become and stay active (n = 9); ensure community programs are ready for youth with a disability (n = 2); be fit, fit in, and finding the best fit (n = 5); and explore the layers of physical activity and how they interact (n = 4).

CONCLUSIONS: The 24 elements established characterize the key concepts that families and community stakeholders value when developing physical activity programs for youth with CP. When incorporated into clinical practice, each of the elements may be used to evaluate key aspects of outcome for individuals with CP.

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PMID: 26865106 [Indexed for MEDLINE]

### **The efficacy of interventions to increase physical activity participation of children with cerebral palsy: a systematic review and meta-analysis.**

Reedman S, Boyd RN, Sakzewski L.

*Dev Med Child Neurol.* 2017 Mar 20. doi: 10.1111/dmcn.13413. [Epub ahead of print]

**AIM:** To determine efficacy of therapy and behaviour change interventions to increase the level of participation in leisure-time physical activities (LTPAs) and habitual physical activity in children and young people with cerebral palsy. **METHOD:** Five databases were systematically searched. Included studies were randomized or comparison designs. Methodological quality was assessed with a modified Downs and Black Scale. Quantitative analysis was performed using RevMan 5.3 (The Nordic Cochrane Centre, The Cochrane Collaboration, Copenhagen, Denmark). Intervention components and behaviour change constructs were mapped against (1) the International Classification of Functioning, Disability and Health (ICF) and (2) the Theoretical Domains Framework.

**RESULTS:** Searches yielded 2487 unique articles. Eight studies (nine articles) were included. Interventions included physical training, activity level training, combined physical training and behaviour change therapy, online behaviour change modules, and context-focused therapy. Study quality varied from moderate to high. There was a small, significant effect of physical activity intervention compared with passive usual care on level of habitual physical activity, of approximately 1000 additional steps per day (standardized mean difference 0.34, 95% confidence interval 0.03-0.66,  $p=0.030$ ). There was no significant effect on LTPA participation (standardized mean difference 0.40, 95% confidence interval -0.40 to 1.19,  $p=0.330$ ).

**INTERPRETATION:** Therapy and behaviour change interventions have the potential to increase LTPA participation of children and young people with cerebral palsy, although there is a need to depart from impairment-focused approaches. Inappropriate selection of outcomes and inadequate reporting of complex interventions are barriers to progress in this field.

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### **Prise en charge et Accompagnant/Accompagnement**

#### **Family-centred practices in the provision of interventions and services in primary health care: A survey of parents of preschool children with cerebral palsy.**

Myrhaug HT, Jahnsen R, Østensjø S.

*J Child Health Care.* 2016 Mar;20(1):109-19. doi: 10.1177/1367493514551312. Epub 2014 Oct 21.

The aims of this study were to explore how parents of preschoolers with cerebral palsy (CP) experienced the level of family-centred services using the Measure of Processes of Care (MPOC-20) within primary health care in Norway and to examine the relationships between these experiences and the provided everyday skills interventions and services. A survey was sent to 360 parents of preschool children with CP. The response rate was 34%. Of the MPOC scales respectful and supportive care and coordinated and comprehensive care received the highest ratings, and providing general information received the lowest. Our findings indicate lower levels of family centredness in primary health-care contexts than that reported in specialist health care. Significant positive associations were found between all the five MPOC-20 scales and the parents' satisfaction with the amount of service coordination ( $p = .000-.004$ ). The high scores for respectful and supportive care and the low scores for general information indicate that the families experienced relational help giving practices to a larger extent and participatory practices to a lesser extent. To increase the participatory aspects of family-centred practice, further research needs to address facilitators and barriers of information sharing and ways of giving this information both in specialist and primary health care.

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#### **Family-centred service: differences in what parents of children with cerebral palsy rate important.**

Terwiel M, Alsem MW, Siebes RC, Bieleman K, Verhoef M, Ketelaar M.

**BACKGROUND:** A family-centred approach to services of children with disabilities is widely accepted as the foundational approach to service delivery in paediatric health care. The 56 items of the Measure of Processes of Care questionnaire (MPOC-56) all reflect elements of family-centred service. In this study, we investigated which elements of family-centred service are rated important by parents of children with cerebral palsy by adding a question on importance to each item of the MPOC-56 (MPOC-56-I).

**METHODS:** In total, 175 parents of children with cerebral palsy completed the MPOC-56-I. For each MPOC item, parents were asked to rate the importance on a 5-point scale ranging from 0 (not important at all) up to and including 4 (very important). We used Spearman's rank correlation coefficient to further explore the variation in parents' importance ratings.

**RESULTS:** Parents' importance ratings of the MPOC-56 items varied. The percentage of parents rating an item important (importance rating 3 or 4) varied between 43.8% and 96.8%. The percentage of parents rating an item unimportant (rating 0 or 1) varied between 0.0% and 20.3%, and the percentage of parents rating an item neutral (rating 2) varied between 3.0% and 36.0%. Most diverse importance ratings were found for five items concerning the provision of general information. Three correlations between these items and child and parent characteristics were found. Six items were rated important by almost all ( $\geq 95\%$ ) parents. These items concern elements of specific information about the child, co-ordinated and comprehensive care for child and family and enabling and partnership.

**CONCLUSIONS:** Parents rate the importance of family-centred services for their situation in various ways. These findings endorse that family-centred services should recognize the uniqueness of families and should be tailored to what parents find important.

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#### **Quality of life in mothers of children with cerebral palsy: The role of children's gross motor function.**

Dehghan L, Dalvand H, Feizi A, Samadi SA, Hosseini SA.

*J Child Health Care.* 2016 Mar;20(1):17-26. doi: 10.1177/1367493514540816. Epub 2014 Jul 15.

Four hundred and twenty-four Iranian mothers of children with cerebral palsy (CP) were recruited using the convenience sampling approach in a cross-sectional study. The researchers assessed the quality of life (QOL) in mothers according to the gross motor function levels and types of CP. The evaluation was done using a well-validated Persian version of the 36-item Short Form Health Survey (SF-36) questionnaire. In 2012, demographic data and clinical relevant information were also collected in rehabilitation clinics affiliated to Tehran University of Medical Sciences. The results indicated that the mean score for the study sample on physical component summary (PCS) and mental component summary (MCS) was 39.21 and 41.23, respectively. This suggests that participants considered themselves to have a low QOL ( $p < .05$ ). The mean PCS scores for SF-36 were significantly different between mothers having CP children of different age, levels of motor function, and CP types ( $p < .05$  and  $p < .01$ , respectively). The results indicate that mothers of children with CP suffer from poor physical and mental health. Therefore, particular attention should be paid to the QOL in mothers of children with CP, and rehabilitation professionals should offer supportive strategies to promote aspects of their QOL.

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