

# Science Infos

## Paralysie Cérébrale

N°38 JUILLET 2017



FONDATION  
PARALYSIE CÉRÉBRALE  
LA FONDATION MOTRICE

### FOCUS

#### INVITATION WCPD

À l'occasion de la Journée Mondiale de la Paralysie Cérébrale, nous sommes très heureux de vous inviter à rencontrer les chercheurs lauréats 2017 et assister à la remise de leurs bourses de recherche sur la paralysie cérébrale, en présence de Madame Sophie Cluzel, Secrétaire d'État auprès du Premier Ministre, chargée des Personnes handicapées\*.

Vous pourrez assister à la présentation de ces projets, de leur impact attendu et poser vos questions aux chercheurs. Nous aurons également le plaisir de vous présenter la Fondation Paralysie Cérébrale et les avancées de la recherche sur la Paralysie Cérébrale au cours des dernières années.

Nous vous attendons nombreux :

**Mardi 3 octobre 2017 à 18 h précises**

**À la Cité Internationale de Paris, salon Victor Lyon, 17 boulevard Jourdan 75014 Paris**  
(Métro et tramway Cité Universitaire)

Dr Alain Chatelin  
Président

Entrée libre, à 18 h précises, fin de la cérémonie à 20 h.

Réservation : tél. 01 45 54 03 03 ou [secretariat@lafondationmotrice.org](mailto:secretariat@lafondationmotrice.org)

*\*Sous réserve d'agenda*

**ENSEMBLE, FAMILLES, CHERCHEURS, DONATEURS, NOUS POUVONS AGIR SUR LE FUTUR.**

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# Manifestations et congrès

## 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/>

## Novembre 2017

### 12th Mediterranean congress og Physical an Rehailitation Medicine

9-12 Novembre 2017

Malte, Malte

<http://prmcongress2017malta.org/>

### Journées d'études polyhandicap Paralysie cérébrale 2017

16-17 Novembre 2017

Paris, France

<https://www.institutmc.org/index.php/annonce-journe-es-polyhandicap-paralysie-ce-re-brale-novembre-2017>

## Décembre 2017

### 24<sup>ème</sup> Congrès de la SOFPEL Société Francophone Posture Equilibre Locomotion

01-02 Décembre 2017

Montpellier, France

<http://www.posture-equilibre.asso.fr/xxiveme-congres-de-sofpel-montpellier/>

### Journées d'études annuelles du CDI

#### « L'axe corporel du paralysé cérébral dans ses dimensions motrice, perceptives et orthopédiques »

11-12 décembre 2017

Lyon, France

<https://www.institutmc.org/index.php/24-news-colloques/133-journee-d-etude-du-cdi-2017-a-lyon>

## Mai 2018

### 21st European Congress of Physical and Rehabilitation Medecine

01-06 mai 2018

Vilnius, Lithanie

<http://www.esprm2018.com/>

## Juillet 2018

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

08-12 juillet 2018

Paris, France

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

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# 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

### ✚ Prévalence – Incidence

#### **Accuracy of administrative claims data for cerebral palsy diagnosis: a retrospective cohort study.**

Oskoui M , Ng P , Dorais M , Pigeon N , Koclas L , Lamarre C , Malouin F , Richards CL , Shevell M , Joseph L .  
*CMAJ Open*. 2017 Jul 18;5(3):E570-E575. doi: 10.9778/cmajo.20170013.

**BACKGROUND:** Cerebral palsy is the most common cause of childhood physical disability, with multiple associated comorbidities. Administrative claims data provide population-level prevalence estimates for cerebral palsy surveillance; however, their diagnostic accuracy has never been validated in Quebec. This study aimed to assess the accuracy of administrative claims data for the diagnosis of cerebral palsy.

**METHODS:** We conducted a retrospective cohort study of children with cerebral palsy born between 1999 and 2002 within 6 health administrative regions of Quebec. Provincial cerebral palsy registry data (reference standard) and administrative physician claims were linked. We explored differences between true-positive and false-negative cases using subgroup sensitivity analysis.

**RESULTS:** A total of 301 children were identified with confirmed cerebral palsy from the provincial registry, for an estimated prevalence of 1.8 (95% confidence interval [CI] 1.6-2.1) per 1000 children 5 years of age. The sensitivity and specificity of administrative claims data for cerebral palsy were 65.5% (95% CI 59.8%-70.8%) and 99.9% (95% CI 99.9%-99.9%), respectively, yielding a prevalence of 2.0 (95% CI 1.9-2.3) per 1000 children 5 years of age. The positive and negative predictive values were 58.8% (95% CI 53.3%-64.1%) and 99.9% (95% CI 99.9%-99.9%), respectively. The  $\kappa$  value was 0.62 (95% CI 0.57-0.67). Administrative claims data were more sensitive for children from rural regions, born preterm, with spastic quadriplegia and with higher levels of motor impairment.

**INTERPRETATION:** Administrative claims data do not capture the full spectrum of children with cerebral palsy. This suggests the need for a more sensitive case definition and caution when using such data without validation.

[Free Article](#)

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DOI: 10.9778/cmajo.20170013

PMID: 28720597

Conflict of interest statement: Competing interests: Maryam Oskoui reports grants from the SickKids Foundation during the conduct of the study. No other competing interests were declared.

#### **Predicting the prevalence of cerebral palsy by severity level in children aged 3 to 15 years across England and Wales by 2020.**

Glinianaia SV , Best KE , Lingam R , Rankin J .

*Dev Med Child Neurol*. 2017 Aug;59(8):864-870. doi: 10.1111/dmcn.13475. Epub 2017 Jun 2.

**AIM:** To estimate the number of children living with cerebral palsy (CP) in England and Wales in 2013 by severity, and to extrapolate this figure to 2020.

**METHOD:** Data from the North of England Collaborative Cerebral Palsy Survey for births during the period 1991 to 2000 were restricted to individuals aged at or above 3 years to estimate the prevalence of CP and to calculate 15-year survival by severity according to the number of severe impairments and lifestyle assessment score. The number



of 3- to 15-year-olds with CP of different severity in England and Wales was estimated in 2013 and 2019 using actual and nationally projected births.

RESULTS: Cumulative survival estimates up to the age of 16 years in children with CP differ significantly by severity, ranging between 97 per cent and 100 per cent for children with non-severe CP, and between 64 per cent and 67 per cent for those with the most severe CP. By the end of 2013, the estimated number of children aged 3 to 15 years living with CP in England and Wales will be about 20 500 rising to approximately 22 100 by 2020, a 7.5 per cent increase.

INTERPRETATION: Owing to an increasing population, the number of children living with CP in England and Wales will increase by 2020. This will have significant implications for health and social care service planning.

© 2017 Mac Keith Press.

DOI: 10.1111/dmnc.13475

PMID: 28574167 [Indexed for MEDLINE]

## Facteurs de risque – Causes

### **Adverse events in women and children who have received intrapartum antibiotic prophylaxis treatment: a systematic review.**

Seedat F , Stinton C , Patterson J , Geppert J , Tan B , Robinson ER , McCarthy ND , Uthman OA , Freeman K , Johnson SA , Fraser H , Brown CS , Clarke A , Taylor-Phillips S .

*BMC Pregnancy Childbirth.* 2017 Jul 26;17(1):247. doi: 10.1186/s12884-017-1432-3.

BACKGROUND: Adverse events from intrapartum antibiotic prophylaxis (IAP) are poorly documented yet essential to inform clinical practice for neonatal group B *Streptococcus* (GBS) disease prevention. In this systematic review, we appraised and synthesised the evidence on the adverse events of IAP in the mother and/or her child.

METHODS: We searched MEDLINE, MEDLINE In-Process & Other Non-Indexed Citations, EMBASE, Cochrane, and Science Citation Index from date of inception until October 16th 2016. Reference lists of included studies and relevant systematic reviews were hand-searched. We included primary studies in English that reported any adverse events from intrapartum antibiotics for any prophylactic purpose compared to controls. The search was not restricted to prophylaxis for GBS but excluded women with symptoms of infection or undergoing caesarean section. Two reviewers assessed the methodological quality of studies, using the Cochrane Risk of Bias tool, and the Risk of Bias Assessment Tool for Nonrandomised Studies. Results were synthesised narratively and displayed in text and tables.

RESULTS: From 2364 unique records, 30 studies were included. Despite a wide range of adverse events reported in 17 observational studies and 13 randomised controlled trials (RCTs), the evidence was inconsistent and at high risk of bias. Only one RCT investigated the long-term effects of IAP reporting potentially serious outcomes such as cerebral palsy; however, it had limited applicability and unclear biological plausibility. Seven observational studies showed that IAP for maternal GBS colonisation alters the infant microbiome. However, study populations were not followed through to clinical outcomes, therefore clinical significance is unknown. There was also observational evidence for increased antimicrobial resistance, however studies were at high or unclear risk of bias.

CONCLUSIONS: The evidence base to determine the frequency of adverse events from intrapartum antibiotic prophylaxis for neonatal GBS disease prevention is limited. As RCTs may not be possible, large, better quality, and longitudinal observational studies across countries with widespread IAP could fill this gap.

[Free PMC Article](#)

TRIAL REGISTRATION: CRD42016037195 .

DOI: 10.1186/s12884-017-1432-3

PMCID: PMC5530570

PMID: 28747160

### **Association Between Moderate and Late Preterm Birth and Neurodevelopment and Social-Emotional Development at Age 2 Years.**

Cheong JL , Doyle LW , Burnett AC , Lee KJ , Walsh JM , Potter CR , Treyvaud K , Thompson DK , Olsen JE , Anderson PJ , Spittle AJ .

*JAMA Pediatr.* 2017 Apr 3;171(4):e164805. doi: 10.1001/jamapediatrics.2016.4805. Epub 2017 Apr 3.

Importance: Moderate and late preterm (MLPT) births comprise most preterm infants. Therefore, long-term developmental concerns in this population potentially have a large public health influence. While there are increasing reports of developmental problems in MLPT children, detail is lacking on the precise domains that are affected.

Objective: To compare neurodevelopment and social-emotional development between MLPT infants and term-born control infants at age 2 years.

Design, Setting, and Participants: This investigation was a prospective longitudinal cohort study at a single tertiary hospital. Participants were MLPT infants (32-36 weeks' completed gestation) and healthy full-term controls ( $\geq 37$  weeks' gestation) recruited at birth. During a 3-year period between December 7, 2009, and November 7, 2012, MLPT infants were recruited at birth from the neonatal unit and postnatal wards of the Royal Women's Hospital, Melbourne, Australia. The term control recruitment extended to March 26, 2014. The dates of the data developmental assessments were February 23, 2012, to April 8, 2016. Exposure: Moderate and late preterm birth.

Main Outcomes and Measures: Cerebral palsy, blindness, and deafness assessed by a pediatrician; cognitive, language, and motor development assessed using the Bayley Scales of Infant Development-Third Edition (developmental delay was defined as less than -1 SD relative to the mean in controls in any domain of the scales); and social-emotional and behavioral problems assessed by a parent questionnaire (Infant Toddler Social Emotional Assessment). Outcomes were compared between birth groups using linear and logistic regression, adjusted for social risk.

Results: In total, 198 MLPT infants (98.5% of 201 recruited) and 183 term-born controls (91.0% of 201 recruited) were assessed at 2 years' corrected age. Compared with controls, MLPT children had worse cognitive, language, and motor development at age 2 years, with adjusted composite score mean differences of -5.3 (95% CI, -8.2 to -2.4) for cognitive development, -11.4 (95% CI, -15.3 to -7.5) for language development, and -7.3 (95% CI, -10.6 to -3.9) for motor development. The odds of developmental delay were higher in the MLPT group compared with controls, with adjusted odds ratios of 1.8 (95% CI, 1.1-3.0) for cognitive delay, 3.1 (95% CI, 1.8-5.2) for language delay, and 2.4 (95% CI, 1.3-4.5) for motor delay. Overall social-emotional competence was worse in MLPT children compared with controls (t statistic mean difference, -3.6 (95% CI, -5.8 to -1.4), but other behavioral domains were similar. The odds of being at risk for social-emotional competence were 3.9 (95% CI, 1.4-10.9) for MLPT children compared with controls.

Conclusions and Relevance: Moderate and late preterm children exhibited developmental delay compared with their term-born peers, most marked in the language domain. This knowledge of developmental needs in MLPT infants will assist in targeting surveillance and intervention.

DOI: 10.1001/jamapediatrics.2016.4805

PMID: 28152144 [Indexed for MEDLINE]

### **Bilirubin enzyme biosensor: potentiality and recent advances towards clinical bioanalysis.**

Hooda V, Gahlaut A, Gothwal A, Hooda V.

*Biotechnol Lett.* 2017 Jul 19. doi: 10.1007/s10529-017-2396-0. [Epub ahead of print]

Bilirubin detection plays a major role in healthcare. Its high concentration in human serum is lethal and must be determined accurately. Clinically, it is vital for assessing patients with deleterious health conditions such as jaundice or icterus, hepatitis, mental disorders, cerebral palsy and brain damage especially in the case of neonates. In evaluating the drawbacks regarding the conventional methodology of bilirubin detection, there is need for a superior analytical tool. Bilirubin oxidase (BOx)-based sensors have been designed for the ultrasensitive analysis of bilirubin and quality deliverance of treatment and this review highlights the different mechanisms of bilirubin detection using different modified electrodes. Further, it also addresses the exploitation of highly attractive electrocatalytic properties of elite nanoparticles such as gold and zirconia-coated silica nanoparticles in enhancing the reproducibility and specificity of bilirubin biosensors.

DOI: 10.1007/s10529-017-2396-0

PMID: 28726079

### **Congenital Cytomegalovirus among Children with Cerebral Palsy.**

Smithers-Sheedy H, Raynes-Greenow C, Badawi N, Fernandez MA, Kesson A, McIntyre S, Leung KC, Jones CA

*J Pediatr.* 2017 Feb;181:267-271.e1. doi: 10.1016/j.jpeds.2016.10.024. Epub 2016 Nov 3.

**OBJECTIVES:** To determine the proportion of children with cerebral palsy (CP) and cytomegalovirus (CMV) DNA detected retrospectively in their newborn screening cards (NBSC), to compare the proportion of children with CMV DNA in their NBSC across spastic subtypes of CP, and to compare the sex and other characteristics of children with CP and CMV detected on their NSBC with those in whom CMV DNA was not detected.

**STUDY DESIGN:** Retrospective observational study. Data were extracted from patient records on children with CP (birth years 1996-2014) from 2 Australian state CP registers and state-wide paediatric rehabilitation services with consent. NBSCs were retrospectively analyzed for CMV DNA by nested polymerase chain reaction (PCR) using primers against gB. Positive samples were validated using real time PCR for CMV UL83. **RESULTS:** Of 401 children recruited, 323 (80.5%) had an available NBSC. Of these, 31 (9.6%; 95% CI, 6.8-13.3) tested positive for CMV DNA by nested PCR for CMV gB, of whom 28 (8.7%; 95% CI, 6.1-12.2) also had CMV DNA detected by real-time PCR for CMV UL83. Detection of CMV DNA was significantly associated with epilepsy, but not with clinical or epidemiologic characteristics, including sex and pattern of spasticity.

**CONCLUSIONS:** CMV viremia in the newborn period, indicating congenital CMV infection, is highly prevalent among children with CP. Further research is needed to investigate the mechanisms and contribution of congenital CMV to the causal pathways to CP.

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DOI: 10.1016/j.jpeds.2016.10.024

PMID: 27816221 [Indexed for MEDLINE]

### **No association of labor epidural analgesia with cerebral palsy in children.**

Zhang L , Graham JH , Feng W , Lewis MW , Zhang X , Kirchner HL .

*J Anesth. 2016 Dec;30(6):1008-1013. doi: 10.1007/s00540-016-2244-8. Epub 2016 Sep2.*

**BACKGROUND:** Some pregnant women avoid labor epidural analgesia because of their concerns about risk of cerebral palsy in children. Although it is believed that labor epidural does not contribute to cerebral palsy, to our knowledge no study has been published to specifically address this concern. We carried out a retrospective case-control study to investigate whether labor epidural analgesia is associated with cerebral palsy in children.

**METHODS:** This study used data that were collected and entered into the Geisinger electronic health records between January 2004 and January 2013. During this period, 20,929 children were born at Geisinger hospitals. Among them, 50 children were diagnosed with cerebral palsy, and 20 of those were born vaginally. Each of these 20 cerebral palsy children was matched with up to 5 non-cerebral palsy children born at the same hospitals in the same timeframe using propensity scoring methods. Analgesia was classified as epidural (including epidural or combined spinal and epidural) or non-epidural. Conditional logistic regression was used to compare the percentages of deliveries with each analgesia type between the cerebral palsy and non-cerebral palsy groups.

**RESULTS:** In the non-cerebral palsy group, the percentage of patients receiving labor epidural analgesia was 72 %, and in the cerebral palsy group the percentage was 45 %. There was no significant difference between non-cerebral palsy and cerebral palsy groups (odds ratio, 0.57; 95 % confidence interval, 0.14-2.24;  $p = 0.42$ ).

**CONCLUSION:** We found no association between the use of labor epidural analgesia and the occurrence of cerebral palsy in children.

DOI: 10.1007/s00540-016-2244-8

PMID: 27590523 [Indexed for MEDLINE]

### **Perspectives in neonatal and childhood arterial ischemic stroke.**

Fluss J , Dinomais M , Kossorotoff M , Vuillerot C , Darteyre S , Chabrier S .

*Expert Rev Neurother. 2017 Feb;17 :135-142. doi: 10.1080/14737175.2017.1243471. Epub 2016 Oct 12.*

**INTRODUCTION:** Over the last decade considerable advances have been made in the identification, understanding and management of pediatric arterial ischemic stroke. Such increasing knowledge has also brought new perspectives and interrogations in the current acute and rehabilitative care of these patients. Areas covered: In developed countries, focal cerebral arteriopathy is one of the most common causes of arterial ischemic stroke in childhood and imaging features are well characterized. However, there are ongoing debates regarding its underlying mechanisms, natural evolution and proper management. The implementation of thrombolytic therapy in acute pediatric stroke has been shown to be efficient in anecdotal cases but is still limited by a number of caveats, even in large tertiary centers. Finally, neonatal stroke represents a unique circumstance of possible early

Science Infos Paralyse Cérébrale, Juillet 2017, FONDATION PARALYSIE CEREBRALE 67 rue Vergniaud 11  
75013 Paris - tel +33 1 45 54 03 03 contact: Christine Doumergue cdoumergue@lafondationmotrice.org

intervention before the onset of any neurological disability but this appears meaningful only in a selective group of neonates. Expert commentary: While perinatal stroke, a leading cause of cerebral palsy, appears to be multifactorial, a large number of childhood ischemic stroke are probably essentially triggered by infectious factors leading to vessel wall damage. Current research is aiming at better identifying risk factors in both conditions, and to define optimal acute and preventive therapeutic strategies in order to reduce significant long-term morbidity.

DOI: 10.1080/14737175.2017.1243471

PMID: 27687767 [Indexed for MEDLINE]

## Lésions - Prévention des lésions- relation structure fonction

### ⚡Données fondamentales

#### **Aberrant Pyramidal Tract in Comparison with Pyramidal Tract on Diffusion Tensor Tractography: A Mini-Review.**

Jang S , Kwak S .

*Front Neurol.* 2017 Jun 28;8:314. doi: 10.3389/fneur.2017.00314. eCollection 2017.

The pyramidal tract (PT) is a major neural tract that controls voluntary movements in the human brain. The PT has several collateral pathways, including the aberrant pyramidal tract (APT), which passes through the medial lemniscus location at the midbrain and pons. Diffusion tensor tractography (DTT) allows visualization and estimation of the APT in three dimensions. In this mini-review, eight DTT studies on the APT were reviewed. Two studies for normal subjects reported the prevalence (17-18% of hemispheres) and the different characteristics (different cortical origin, less directionality, and fewer neural fibers) of the APT compared with the PT. Six studies reported on the APT in patients with cerebral infarct, traumatic brain injury, and cerebral palsy and suggested that the APT could contribute to motor recovery following brain injury. The research on the APT in patients with brain injury has important implications for neuro-rehabilitation because understanding of the motor recovery mechanism can provide the basis for scientific rehabilitation strategies. Therefore, studies involving various brain pathologies with large numbers of patients on this topic should be encouraged. In addition, further studies are needed on the exact role of the APT in normal subjects.

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PMCID: PMC5487406

PMID: 28701996

#### **Mitochondria, Bioenergetics and Excitotoxicity: New Therapeutic Targets in Perinatal Brain Injury.**

Leaw B , Nair S , Lim R , Thornton C , Mallard C , Hagberg H .

*Front Cell Neurosci.* 2017 Jul 12;11:199. doi: 10.3389/fncel.2017.00199. eCollection 2017.

Injury to the fragile immature brain is implicated in the manifestation of long-term neurological disorders, including childhood disability such as cerebral palsy, learning disability and behavioral disorders. Advancements in perinatal practice and improved care mean the majority of infants suffering from perinatal brain injury will survive, with many subtle clinical symptoms going undiagnosed until later in life. Hypoxic-ischemia is the dominant cause of perinatal brain injury, and constitutes a significant socioeconomic burden to both developed and developing countries. Therapeutic hypothermia is the sole validated clinical intervention to perinatal asphyxia; however it is not always neuroprotective and its utility is limited to developed countries. There is an urgent need to better understand the molecular pathways underlying hypoxic-ischemic injury to identify new therapeutic targets in such a small but critical therapeutic window. Mitochondria are highly implicated following ischemic injury due to their roles as the powerhouse and main energy generators of the cell, as well as cell death processes. While the link between impaired mitochondrial bioenergetics and secondary energy failure following loss of high-energy phosphates is well established after hypoxia-ischemia (HI), there is emerging evidence that the roles of mitochondria in disease extend far beyond this. Indeed, mitochondrial turnover, including processes such as mitochondrial biogenesis, fusion, fission and mitophagy, affect recovery of neurons after injury and mitochondria are involved in the regulation of the innate immune response to inflammation. This review article will explore these

mitochondrial pathways, and finally will summarize past and current efforts in targeting these pathways after hypoxic-ischemic injury, as a means of identifying new avenues for clinical intervention.

[Free PMC Article](#)

DOI: 10.3389/fncel.2017.00199

PMCID: PMC5506196

PMID: 28747873

### **Systemic activation of Toll-like receptor 2 suppresses mitochondrial respiration and exacerbates hypoxic-ischemic injury in the developing brain.**

Je l'aurais mis dans **Lésions/Données Fondamentales**

Mottahedin A , Svedin P , Nair S , Mohn CJ , Wang X , Hagberg H , Ek J , Mallard C .

*J Cereb Blood Flow Metab.* 2017 Apr;37 :1192-1198. doi: 10.1177/0271678X17691292. Epub 2017 Jan 1.

Infection and inflammation are known risk factors for neonatal brain injury. Mycoplasma and Gram-positive bacteria, for which Toll-like receptor 2 (TLR2) plays a key role in recognition and inflammatory response, are among the most common pathogens in the perinatal period. Here, we report that systemic activation of TLR2 by Pam3CSK4 (P3C) increases neural tissue loss and demyelination induced by subsequent hypoxia-ischemia (HI) in neonatal mice. High-resolution respirometry of brain isolated mitochondria revealed that P3C suppresses ADP-induced oxidative phosphorylation, the main pathway of cellular energy production. The results suggest that infection and inflammation might contribute to HI-induced energy failure.

DOI: 10.1177/0271678X17691292

PMCID: PMC5453473 [Available on 2018-04-01]

PMID: 28139935 [Indexed for MEDLINE]

### **Uptake of dendrimer-drug by different cell types in the hippocampus after hypoxic-ischemic insult in neonatal mice: Effects of injury, microglial activation and hypothermia.**

Nemeth CL , Drummond GT , Mishra MK , Zhang F , Carr P , Garcia MS , Doman S , Fatemi A , Johnston MV , Kannan RM , Kannan S , Wilson MA .

*Nanomedicine.* 2017 Jun 30. pii: S1549-9634(17)30122-3. doi:10.1016/j.nano.2017.06.014. [Epub ahead of print]

Perinatal hypoxic-ischemic encephalopathy (HIE) can result in neurodevelopmental disability, including cerebral palsy. The only treatment, hypothermia, provides incomplete neuroprotection. Hydroxyl polyamidoamine (PAMAM) dendrimers are being explored for targeted delivery of therapy for HIE. Understanding the biodistribution of dendrimer-conjugated drugs into microglia, neurons and astrocytes after brain injury is essential for optimizing drug delivery. We conjugated N-acetyl-L-cysteine to Cy5-labeled PAMAM dendrimer (Cy5-D-NAC) and used a mouse model of perinatal HIE to study effects of timing of administration, hypothermia, brain injury, and microglial activation on uptake. Dendrimer conjugation delivered therapy most effectively to activated microglia but also targeted some astrocytes and injured neurons. Cy5-D-NAC uptake was correlated with brain injury in all cell types and with activated morphology in microglia. Uptake was not inhibited by hypothermia, except in CD68+ microglia. Thus, dendrimer-conjugated drug delivery can target microglia, astrocytes and neurons and can be used in combination with hypothermia for treatment of HIE.

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PMID: 28669854

## **Données cliniques**

### **Aberrant Pyramidal Tract in Comparison with Pyramidal Tract on Diffusion Tensor Tractography: A Mini-Review.**

Jang S, Kwak S.

*Front Neurol.* 2017 Jun 28;8:314. doi: 10.3389/fneur.2017.00314. eCollection 2017.

The pyramidal tract (PT) is a major neural tract that controls voluntary movements in the human brain. The PT has several collateral pathways, including the aberrant pyramidal tract (APT), which passes through the medial lemniscus location at the midbrain and pons. Diffusion tensor tractography (DTT) allows visualization and estimation of the APT in three dimensions. In this mini-review, eight DTT studies on the APT were reviewed. Two studies for normal

subjects reported the prevalence (17-18% of hemispheres) and the different characteristics (different cortical origin, less directionality, and fewer neural fibers) of the APT compared with the PT. Six studies reported on the APT in patients with cerebral infarct, traumatic brain injury, and cerebral palsy and suggested that the APT could contribute to motor recovery following brain injury. The research on the APT in patients with brain injury has important implications for neuro-rehabilitation because understanding of the motor recovery mechanism can provide the basis for scientific rehabilitation strategies. Therefore, studies involving various brain pathologies with large numbers of patients on this topic should be encouraged. In addition, further studies are needed on the exact role of the APT in normal subjects.

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DOI: 10.3389/fneur.2017.00314

PMCID: PMC5487406

PMID: 28701996

### **Analysis of structure-function network decoupling in the brain systems of spastic diplegic cerebral palsy.**

Lee D , Pae C , Lee JD , Park ES , Cho SR , Um MH , Lee SK , Oh MK , Park HJ .

*Hum Brain Mapp.* 2017 Jul 21. doi: 10.1002/hbm.23738. [Epub ahead of print]

Manifestation of the functionalities from the structural brain network is becoming increasingly important to understand a brain disease. With the aim of investigating the differential structure-function couplings according to network systems, we investigated the structural and functional brain networks of patients with spastic diplegic cerebral palsy with periventricular leukomalacia compared to healthy controls. The structural and functional networks of the whole brain and motor system, constructed using deterministic and probabilistic tractography of diffusion tensor magnetic resonance images and Pearson and partial correlation analyses of resting-state functional magnetic resonance images, showed differential embedding of functional networks in the structural networks in patients. In the whole-brain network of patients, significantly reduced global network efficiency compared to healthy controls were found in the structural networks but not in the functional networks, resulting in reduced structural-functional coupling. On the contrary, the motor network of patients had a significantly lower functional network efficiency over the intact structural network and a lower structure-function coupling than the control group. This reduced coupling but reverse directionality in the whole-brain and motor networks of patients was prominent particularly between the probabilistic structural and partial correlation-based functional networks. Intact (or less deficient) functional network over impaired structural networks of the whole brain and highly impaired functional network topology over the intact structural motor network might subserve relatively preserved cognitions and impaired motor functions in cerebral palsy. This study suggests that the structure-function relationship, evaluated specifically using sparse functional connectivity, may reveal important clues to functional reorganization in cerebral palsy. *Hum Brain*

*Mapp*, 2017. © 2017 Wiley Periodicals, Inc.© 2017 Wiley Periodicals, Inc.

DOI: 10.1002/hbm.23738

PMID: 28731515

### **Contralesional Corticomotor Neurophysiology in Hemiparetic Children With Perinatal Stroke.**

Zewdie E , Damji O , Ciechanski P , Seeger T , Kirton A .

*Neurorehabil Neural Repair.* 2017 Mar;31(3):261-271. doi:10.1177/1545968316680485. Epub 2016 Nov 24.

**BACKGROUND:** Perinatal stroke causes most hemiparetic cerebral palsy. Ipsilateral connections from nonlesioned hemisphere to affected hand are common. The nonlesioned primary motor cortex (M1) determines function and is a potential therapeutic target but its neurophysiology is poorly understood.

**OBJECTIVE:** We aimed to characterize the neurophysiological properties of the nonlesioned M1 in children with perinatal stroke and their relationship to clinical function.

**METHODS:** Fifty-two participants with hemiparetic cerebral palsy and magnetic resonance imaging-confirmed perinatal stroke and 40 controls aged 8 to 18 years completed the same transcranial magnetic stimulation (TMS) protocol. Single-pulse TMS to nonlesioned M1 determined rest and active motor thresholds (RMT/AMT), motor-evoked potential (MEP) latencies, and stimulus recruitment curves (SRC: 100%-150% RMT). Paired-pulse TMS evaluated short-latency intracortical inhibition (SICI) and intracortical facilitation (ICF). Ipsilateral (IP) participants

(ipsilateral MEP  $\geq 0.05$  mV in  $\geq 5/20$  trials) were compared with contralateral MEP only, nonipsilateral (NI) participants. Assisting Hand and Melbourne assessments quantified clinical function.

RESULTS: Twenty-five IP were compared with 13 NI (n = 38, median age 12 years, 66% male). IP had lower motor function. SRC to unaffected hand were comparable between IP and NI while IP had smaller ipsilateral SRC. Ipsilateral MEP latencies were prolonged ( $23.5 \pm 1.8$  vs  $22.2 \pm 1.5$  ms contra,  $P < .001$ ). Contralateral SICI was different between IP (-42%) and NI (-20%). Ipsilateral SICI was reduced (-20%). Contralateral ICF was comparable between groups (+43%) and ipsilaterally (+43%). Measures correlated between contralateral and ipsilateral sides.

CONCLUSION: Neurophysiology of nonlesioned M1 and its relationship to motor function is measurable in children with perinatal stroke. Correlation of excitability and intracortical circuitry measures between contralateral and ipsilateral sides suggests common control mechanisms.

DOI: 10.1177/1545968316680485

PMID: 27885162 [Indexed for MEDLINE]

### **Effects of targeting lower versus higher arterial oxygen saturations on death or disability in preterm infants.**

Askie LM, Darlow BA, Davis PG, Finer N, Stenson B, Vento M, Whyte R.

*Cochrane Database Syst Rev.* 2017 Apr 11;4:CD011190. doi: 10.1002/14651858.CD011190.pub2.

BACKGROUND: The use of supplemental oxygen in the care of extremely preterm infants has been common practice since the 1940s. Despite this, there is little agreement regarding which oxygen saturation (SpO<sub>2</sub>) ranges to target to maximise short- or long-term growth and development, while minimising harms. There are two opposing concerns. Lower oxygen levels (targeting SpO<sub>2</sub> at 90% or less) may impair neurodevelopment or result in death. Higher oxygen levels (targeting SpO<sub>2</sub> greater than 90%) may increase severe retinopathy of prematurity or chronic lung disease. The use of pulse oximetry to non-invasively assess neonatal SpO<sub>2</sub> levels has been widespread since the 1990s. Until recently there were no randomised controlled trials (RCTs) that had assessed whether it is better to target higher or lower oxygen saturation levels in extremely preterm infants, from birth or soon thereafter. As a result, there is significant international practice variation and uncertainty remains as to the most appropriate range to target oxygen saturation levels in preterm and low birth weight infants.

OBJECTIVES: 1. What are the effects of targeting lower versus higher oxygen saturation ranges on death or major neonatal and infant morbidities, or both, in extremely preterm infants? 2. Do these effects differ in different types of infants, including those born at a very early gestational age, or in those who are outborn, without antenatal corticosteroid coverage, of male sex, small for gestational age or of multiple birth, or by mode of delivery?

SEARCH METHODS: We used the standard search strategy of Cochrane Neonatal to search the Cochrane Central Register of Controlled Trials (CENTRAL 2016, Issue 4), MEDLINE via PubMed (1966 to 11 April 2016), Embase (1980 to 11 April 2016) and CINAHL (1982 to 11 April 2016). We also searched clinical trials databases, conference proceedings and the reference lists of retrieved articles for randomised controlled trials.

SELECTION CRITERIA: Randomised controlled trials that enrolled babies born at less than 28 weeks' gestation, at birth or soon thereafter, and targeted SpO<sub>2</sub> ranges of either 90% or below or above 90% via pulse oximetry, with the intention of maintaining such targets for at least the first two weeks of life.

DATA COLLECTION AND ANALYSIS: We used the standard methods of Cochrane Neonatal to extract data from the published reports of the included studies. We sought some additional aggregate data from the original investigators in order to align the definitions of two key outcomes. We conducted the meta-analyses with Review Manager 5 software, using the Mantel-Haenszel method for estimates of typical risk ratio (RR) and risk difference (RD) and a fixed-effect model. We assessed the included studies using the Cochrane 'Risk of bias' and GRADE criteria in order to establish the quality of the evidence. We investigated heterogeneity of effects via pre-specified subgroup and sensitivity analyses.

MAIN RESULTS: Five trials, which together enrolled 4965 infants, were eligible for inclusion. The investigators of these five trials had prospectively planned to combine their data as part of the NeOProM (Neonatal Oxygen Prospective Meta-analysis) Collaboration. We graded the quality of evidence as high for the key outcomes of death, major disability, the composite of death or major disability, and necrotising enterocolitis; and as moderate for blindness and retinopathy of prematurity requiring treatment. When an aligned definition of major disability was used, there was no significant difference in the composite primary outcome of death or major disability in extremely preterm infants when targeting a lower (SpO<sub>2</sub> 85% to 89%) versus a higher (SpO<sub>2</sub> 91% to 95%) oxygen saturation range (typical RR 1.04, 95% confidence interval (CI) 0.98 to 1.10; typical RD 0.02, 95% CI -0.01 to 0.05; 5 trials, 4754

infants) (high-quality evidence). Compared with a higher target range, a lower target range significantly increased the incidence of death at 18 to 24 months corrected age (typical RR 1.16, 95% CI 1.03 to 1.31; typical RD 0.03, 95% CI 0.01 to 0.05; 5 trials, 4873 infants) (high-quality evidence) and necrotising enterocolitis (typical RR 1.24, 95% CI 1.05 to 1.47; typical RD 0.02, 95% CI 0.01 to 0.04; 5 trials, 4929 infants;  $I^2 = 0\%$ ) (high-quality evidence). Targeting the lower range significantly decreased the incidence of retinopathy of prematurity requiring treatment (typical RR 0.72, 95% CI 0.61 to 0.85; typical RD -0.04, 95% CI -0.06 to -0.02; 5 trials, 4089 infants;  $I^2 = 69\%$ ) (moderate-quality evidence). There were no significant differences between the two treatment groups for major disability including blindness, severe hearing loss, cerebral palsy, or other important neonatal morbidities. A subgroup analysis of major outcomes by type of oximeter calibration software (original versus revised) found a significant difference in the treatment effect between the two software types for death (interaction  $P = 0.03$ ), with a significantly larger treatment effect seen for those infants using the revised algorithm (typical RR 1.38, 95% CI 1.13 to 1.68; typical RD 0.06, 95% CI 0.01 to 0.10; 3 trials, 1716 infants). There were no other important differences in treatment effect shown by the subgroup analyses using the currently available data.

**AUTHORS' CONCLUSIONS:** In extremely preterm infants, targeting lower (85% to 89%) SpO<sub>2</sub> compared to higher (91% to 95%) SpO<sub>2</sub> had no significant effect on the composite outcome of death or major disability or on major disability alone, including blindness, but increased the average risk of mortality by 28 per 1000 infants treated. The trade-offs between the benefits and harms of the different oxygen saturation target ranges may need to be assessed within local settings (e.g. alarm limit settings, staffing, baseline outcome risks) when deciding on oxygen saturation targeting policies.

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PMID: 28398697 [Indexed for MEDLINE]

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

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

*Ann Neurol.* 2017 Apr;81(4):560-571. doi: 10.1002/ana.24907.

**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 (HI) injury, the downstream functional targets are poorly understood. The basic helix-loop-helix protein, oligodendrocyte transcription factor 1 (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 response to injury in the neonatal brain.

**METHODS:** We used wild-type and Olig1-null mice subjected to neonatal stroke and postnatal neural progenitor cultures, and we analyzed Olig1 expression in human postmortem samples from neonates that suffered HI encephalopathy (HIE).

**RESULTS:** Olig1-null neonatal mice showed significant hypomyelination after moderate neonatal stroke. Surprisingly, damaged white matter tracts in Olig1-null mice lacked Olig2(+) 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, phosphorylated SMADs (Sma- and Mad-related proteins) 1, 5, and 8, were elevated in the subventricular zone of human infants with HIE compared to controls.

**INTERPRETATION:** These findings indicate that Olig1 has a critical function in regulation of postnatal neural progenitor cell production in response to Noggin. *Ann Neurol* 2017;81:560-571.

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DO: 10.1002/ana.24907

PMCID: PMC5401646 [Available on 2018-04-01]

PMID: 28253550 [Indexed for MEDLINE]

#### **Segmental Diffusion Properties of the Corticospinal Tract and Motor Outcome in Hemiparetic Children With Perinatal Stroke.**

Hodge J, Goodyear B, Carlson H, Wei XC, Kirton A.

*J Child Neurol.* 2017 May;32(6):550-559. doi: 10.1177/0883073817696815. Epub 2017 Mar 22.



Perinatal stroke injures developing motor systems, resulting in hemiparetic cerebral palsy. Diffusion tensor imaging can explore structural connectivity. We used diffusion tensor imaging to assess corticospinal tract diffusion in hemiparetic children with perinatal stroke. Twenty-eight children (6-18 years) with unilateral stroke underwent diffusion tensor imaging. Four corticospinal tract assessments included full tract, partial tract, minitract and region of interest. Diffusion characteristics (fractional anisotropy, mean, axial, and radial diffusivity) were calculated. Ratios (lesioned/nonlesioned) were compared across segments and to validated long-term motor outcomes (Pediatric Stroke Outcome Measure, Assisting Hand Assessment, Melbourne Assessment). Fractional anisotropy and radial diffusivity ratios decreased as tract size decreased, while mean diffusivity showed consistent symmetry. Poor motor outcomes were associated with lower fractional anisotropy in all segments and radial diffusivity correlated with both Assisting Hand Assessment and Melbourne Assessment. Diffusion imaging of segmented corticospinal tracts is feasible in hemiparetic children with perinatal stroke. Correlations with disability support clinical relevance and utility in model development for personalized rehabilitation.

DOI: 10.1177/0883073817696815

PMID: 28424004 [Indexed for MEDLINE]

### **The Impact of Low-Grade Germinal Matrix-Intraventricular Hemorrhage on Neurodevelopmental Outcome of Very Preterm Infants.**

Reubsæet P, Brouwer AJ, van Haastert IC, Brouwer MJ, Koopman C, Groenendaal F, de Vries LS.

*Neonatology*. 2017 Jul 14;112(3):203-210. doi: 10.1159/000472246. [Epub ahead of print]

**BACKGROUND:** Very preterm infants often show germinal matrix-intraventricular hemorrhage (GMH-IVH) on cranial ultrasound (cUS).

**AIM:** To determine the impact of low-grade GMH-IVH on early neurodevelopmental outcome in very preterm infants.

**METHODS:** A retrospective case-control study in very preterm infants with and without low-grade GMH-IVH on cUS. Additional magnetic resonance imaging (MRI) was available in all infants with a gestational age (GA) <28 weeks and high-risk infants >28 weeks. Infants were seen at 2 years' corrected age to assess neurodevelopment.

**RESULTS:** In total, 136 infants (GA 24-32 weeks) with low-grade GMH-IVH on cUS were matched with 255 controls. Outcome data was available for 342 (87%) infants. Adverse outcome (i.e., cerebral palsy [CP], neurodevelopmental delay) was present in 11 (9%) cases and 20 (9%) controls. No statistically significant differences in outcome were found between cases and controls. Additional MRI was performed in 165/391 infants (42%) and showed additional lesions in 73 (44%) infants that could explain subsequent development of CP in 2 out of 5 infants and epilepsy in 1 of 2 infants.

**CONCLUSION:** Very preterm infants with low-grade GMH-IVH on cUS have a similar early neurodevelopmental outcome compared with controls. Additional MRI showed mostly subtle abnormalities that were missed with cUS, but these could not explain subsequent development of CP and developmental delay in all infants.

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DOI: 10.1159/000472246

PMID: 28704824

### **White matter integrity in dyskinetic cerebral palsy: Relationship with intelligence quotient and executive function.**

Laporta-Hoyos O, Pannek K, Ballester-Plané J, Reid LB, Vázquez É, Delgado I, Zubiaurre-Elorza L, Macaya A, Póo P, Meléndez-Plumed M, Junqué C, Boyd R, Pueyo R.

*Neuroimage Clin*. 2017 May 12;15:789-800. doi: 10.1016/j.nicl.2017.05.005. eCollection 2017.

**BACKGROUND:** Dyskinetic cerebral palsy (CP) is one of the most disabling motor types of CP and has been classically associated with injury to the basal ganglia and thalamus. Although cognitive dysfunction is common in CP, there is a paucity of published quantitative analyses investigating the relationship between white matter (WM) microstructure and cognition in this CP type.

**AIMS:** This study aims (1) to compare brain WM microstructure between people with dyskinetic CP and healthy controls, (2) to identify brain regions where WM microstructure is related to intelligence and (3) to identify brain regions where WM microstructure is related to executive function in people with dyskinetic CP and (4) to identify

brain regions where the correlations are different between controls and people with CP in IQ and executive functions.

**PATIENTS AND METHODS:** Thirty-three participants with dyskinetic CP (mean  $\pm$  SD age:  $24.42 \pm 12.61$ , 15 female) were age and sex matched with 33 controls. Participants underwent a comprehensive neuropsychological battery to assess intelligence quotient (IQ) and four executive function domains (attentional control, cognitive flexibility, goal setting and information processing). Diffusion weighted MRI scans were acquired at 3T. Voxel-based whole brain groupwise analyses were used to compare fractional anisotropy (FA) and of the CP group to the matched controls using a general lineal model. Further general linear models were used to identify regions where white matter FA correlated with IQ and each of the executive function domains.

**RESULTS:** White matter FA was significantly reduced in the CP group in all cerebral lobes, predominantly in regions connected with the parietal and to a lesser extent the temporal lobes. There was no significant correlation between IQ or any of the four executive function domains and WM microstructure in the control group. In participants with CP, lower IQ was associated with lower FA in all cerebral lobes, predominantly in locations that also showed reduced FA compared to controls. Attentional control, goal setting and information processing did not correlate with WM microstructure in the CP group. Cognitive flexibility was associated with FA in regions known to contain connections with the frontal lobe (such as the superior longitudinal fasciculus and cingulum) as well as regions not known to contain tracts directly connected with the frontal lobe (such as the posterior corona radiata, posterior thalamic radiation, retrolenticular part of internal capsule, tapetum, body and splenium of corpus callosum).

**CONCLUSION:** The widespread loss in the integrity of WM tissue is mainly located in the parietal lobe and related to IQ in dyskinetic CP. Unexpectedly, executive functions are only related with WM microstructure in regions containing fronto-cortical and posterior cortico-subcortical pathways, and not being specifically related to the state of fronto-striatal pathways which might be due to brain reorganization. Further studies of this nature may improve our understanding of the neurobiological bases of cognitive impairments after early brain insult.

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PMCID: PMC5496484

PMID: 28702354

## Détection – Diagnostic

### +Données cliniques

#### **Computer-based video analysis identifies infants with absence of fidgety movements.**

Støen R, Songstad NT, Silberg IE, Fjørtoft T, Jensenius AR, Adde L.

*Pediatr Res.* 2017 Jul 26. doi: 10.1038/pr.2017.121. [Epub ahead of print]

**Background**Absence of fidgety movements (FMs) at 3 months' corrected age is a strong predictor of cerebral palsy (CP) in high-risk infants. This study evaluates the association between computer-based video analysis and the temporal organization of FMs assessed with the General Movement Assessment (GMA).  
**Methods**Infants were eligible for this prospective cohort study if referred to a high-risk follow-up program in a participating hospital. Video recordings taken at 10-15 weeks post term age were used for GMA and computer-based analysis. The variation of the spatial center of motion, derived from differences between subsequent video frames, was used for quantitative analysis.  
**Results**Of 241 recordings from 150 infants, 48 (24.1%) were classified with absence of FMs or sporadic FMs using the GMA. The variation of the spatial center of motion (CSD) during a recording was significantly lower in infants with normal (0.320; 95% confidence interval (CI) 0.309, 0.330) vs. absence of or sporadic (0.380; 95% CI 0.361, 0.398) FMs ( $P < 0.001$ ). A triage model with CSD thresholds chosen for sensitivity of 90% and specificity of 80% gave a 40% referral rate for GMA.  
**Conclusion**Quantitative video analysis during the FMs' period can be used to triage infants at high risk of CP to early intervention or observational GMA.  
*Pediatric Research advance online publication, 26 July 2017;*

doi:10.1038/pr.2017.121.

DOI: 10.1038/pr.2017.121

PMID: 28745715

## **Early, Accurate Diagnosis and Early Intervention in Cerebral Palsy: Advances in Diagnosis and Treatment.**

Novak I , Morgan C , Adde L , Blackman J , Boyd RN , Brunstrom-Hernandez J , Cioni G , Damiano D , Darrach J , Eliasson AC , de Vries LS , Einspieler C , Fahey M , Fehlings D , Ferriero DM(14), Fetters L(15), Fiori S , Forssberg H , Gordon AM(16), Greaves S(17), Guzzetta A , Hadders-Algra M(18), Harbourne R(19), Kakooza-Mwesige A(20), Karlsson P , Krumlinde-Sundholm L , Latal B(21), Loughran-Fowlds A(22), Maitre N(23), McIntyre S , Noritz G(23), Pennington L(24), Romeo DM(25), Shepherd R(26), Spittle AJ(27), Thornton M , Valentine J(28), Walker K(29), White R , Badawi N(29).

*JAMA Pediatr.* 2017 Jul 17. doi: 10.1001/jamapediatrics.2017.1689. [Epub ahead of print]

**Importance:** Cerebral palsy describes the most common physical disability in childhood and occurs in 1 in 500 live births. Historically, the diagnosis has been made between age 12 and 24 months but now can be made before 6 months' corrected age.

**Objectives:** To systematically review best available evidence for early, accurate diagnosis of cerebral palsy and to summarize best available evidence about cerebral palsy-specific early intervention that should follow early diagnosis to optimize neuroplasticity and function.

**Evidence Review:** This study systematically searched the literature about early diagnosis of cerebral palsy in MEDLINE (1956-2016), EMBASE (1980-2016), CINAHL (1983-2016), and the Cochrane Library (1988-2016) and by hand searching. Search terms included cerebral palsy, diagnosis, detection, prediction, identification, predictive validity, accuracy, sensitivity, and specificity. The study included systematic reviews with or without meta-analyses, criteria of diagnostic accuracy, and evidence-based clinical guidelines. Findings are reported according to the PRISMA statement, and recommendations are reported according to the Appraisal of Guidelines, Research and Evaluation (AGREE) II instrument. **Findings:** Six systematic reviews and 2 evidence-based clinical guidelines met inclusion criteria. All included articles had high methodological Quality Assessment of Diagnostic Accuracy Studies (QUADAS) ratings. In infants, clinical signs and symptoms of cerebral palsy emerge and evolve before age 2 years; therefore, a combination of standardized tools should be used to predict risk in conjunction with clinical history. Before 5 months' corrected age, the most predictive tools for detecting risk are term-age magnetic resonance imaging (86%-89% sensitivity), the Precht Qualitative Assessment of General Movements (98% sensitivity), and the Hammersmith Infant Neurological Examination (90% sensitivity). After 5 months' corrected age, the most predictive tools for detecting risk are magnetic resonance imaging (86%-89% sensitivity) (where safe and feasible), the Hammersmith Infant Neurological Examination (90% sensitivity), and the Developmental Assessment of Young Children (83% C index). Topography and severity of cerebral palsy are more difficult to ascertain in infancy, and magnetic resonance imaging and the Hammersmith Infant Neurological Examination may be helpful in assisting clinical decisions. In high-income countries, 2 in 3 individuals with cerebral palsy will walk, 3 in 4 will talk, and 1 in 2 will have normal intelligence.

**Conclusions and Relevance:** Early diagnosis begins with a medical history and involves using neuroimaging, standardized neurological, and standardized motor assessments that indicate congruent abnormal findings indicative of cerebral palsy. Clinicians should understand the importance of prompt referral to diagnostic-specific early intervention to optimize infant motor and cognitive plasticity, prevent secondary complications, and enhance caregiver well-being.

DOI: 10.1001/jamapediatrics.2017.1689

PMID: 28715518

## **Frequency Analysis and Feature Reduction Method for Prediction of Cerebral Palsy in Young Infants.**

Rahmati H, Martens H, Aamo OM, Stavadahl O, Stoen R, Adde L.

*IEEE Trans Neural Syst Rehabil Eng.* 2016 Nov;24(11):1225-1234. Epub 2016 Mar 8.

The aim of this paper is to achieve a model for prediction of cerebral palsy based on motion data of young infants. The prediction is formulated as a classification problem to assign each of the infants to one of the healthy or with cerebral palsy groups. Unlike formerly proposed features that are mostly defined in the time domain, this study proposes a set of features derived from frequency analysis of infants' motions. Since cerebral palsy affects the variability of the motions, and frequency analysis is an intuitive way of studying variability, suggested features are suitable and consistent with the nature of the condition. In the current application, a well-known problem, few subjects and many features, was initially encountered. In such a case, most classifiers get trapped in a suboptimal model and, consequently, fail to provide sufficient prediction accuracy. To solve this problem, a feature selection

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method that determines features with significant predictive ability is proposed. The feature selection method decreases the risk of false discovery and, therefore, the prediction model is more likely to be valid and generalizable for future use. A detailed study is performed on the proposed features and the feature selection method: the classification results confirm their applicability. Achieved sensitivity of 86%, specificity of 92% and accuracy of 91% are comparable with state-of-the-art clinical and expert-based methods for predicting cerebral palsy.

DOI: 10.1109/TNSRE.2016.2539390

PMID: 27046852 [Indexed for MEDLINE]

### **PREDICT-CP: study protocol of implementation of comprehensive surveillance to predict outcomes for school-aged children with cerebral palsy.**

Boyd RN , Davies PS , Ziviani J , Trost S , Barber L , Ware R , Rose S(7) , Whittingham K , Sakzewski L , Bell K , Carty C , Obst S , Benfer K , Reedman S , Edwards P , Kentish M , Copeland L , Weir K , Davenport C , Brooks D , Coulthard A , Pelekanos R , Guzzetta A , Fiori S , Wynter M , Finn C , Burgess A , Morris K , Walsh J , Lloyd O , Whitty JA , Scuffham PA .

*BMJ Open. 2017 Jul 12;7(7):e014950. doi: 10.1136/bmjopen-2016-014950.*

**OBJECTIVES:** Cerebral palsy (CP) remains the world's most common childhood physical disability with total annual costs of care and lost well-being of \$A3.87b. The PREDICT-CP (NHMRC 1077257 Partnership Project: Comprehensive surveillance to PREDICT outcomes for school age children with CP) study will investigate the influence of brain structure, body composition, dietary intake, oropharyngeal function, habitual physical activity, musculoskeletal development (hip status, bone health) and muscle performance on motor attainment, cognition, executive function, communication, participation, quality of life and related health resource use costs. The PREDICT-CP cohort provides further follow-up at 8-12 years of two overlapping preschool-age cohorts examined from 1.5 to 5 years (NHMRC 465128 motor and brain development; NHMRC 569605 growth, nutrition and physical activity).

**METHODS AND ANALYSES:** This population-based cohort study undertakes state-wide surveillance of 245 children with CP born in Queensland (birth years 2006-2009). Children will be classified for Gross Motor Function Classification System; Manual Ability Classification System, Communication Function Classification System and Eating and Drinking Ability Classification System. Outcomes include gross motor function, musculoskeletal development (hip displacement, spasticity, muscle contracture), upper limb function, communication difficulties, oropharyngeal dysphagia, dietary intake and body composition, participation, parent-reported and child-reported quality of life and medical and allied health resource use. These detailed phenotypical data will be compared with brain macrostructure and microstructure using 3 Tesla MRI (3T MRI). Relationships between brain lesion severity and outcomes will be analysed using multilevel mixed-effects models.

**ETHICS AND DISSEMINATION:** The PREDICT-CP protocol is a prospectively registered and ethically accepted study protocol. The study combines data at 1.5-5 then 8-12 years of direct clinical assessment to enable prediction of outcomes and healthcare needs essential for tailoring interventions (eg, rehabilitation, orthopaedic surgery and nutritional supplements) and the projected healthcare utilisation.

**TRIAL REGISTRATION NUMBER:** ACTRN: 12616001488493.

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PMID: 28706091

### **Robotic Quantification of Position Sense in Children With Perinatal Stroke.**

Kuczynski AM , Dukelow SP , Semrau JA , Kirton A .

*Neurorehabil Neural Repair. 2016 Sep;30(8):762-72. doi: 10.1177/1545968315624781. Epub 2016 Jan 7.*

**Background** Perinatal stroke is the leading cause of hemiparetic cerebral palsy. Motor deficits and their treatment are commonly emphasized in the literature. Sensory dysfunction may be an important contributor to disability, but it is difficult to measure accurately clinically.

**Objective** Use robotics to quantify position sense deficits in hemiparetic children with perinatal stroke and determine their association with common clinical measures.

Methods Case-control study. Participants were children aged 6 to 19 years with magnetic resonance imaging-confirmed unilateral perinatal arterial ischemic stroke or periventricular venous infarction and symptomatic hemiparetic cerebral palsy. Participants completed a position matching task using an exoskeleton robotic device (KINARM). Position matching variability, shift, and expansion/contraction area were measured with and without vision. Robotic outcomes were compared across stroke groups and controls and to clinical measures of disability (Assisting Hand Assessment) and sensory function.

Results Forty stroke participants (22 arterial, 18 venous, median age 12 years, 43% female) were compared with 60 healthy controls. Position sense variability was impaired in arterial ( $6.01 \pm 1.8$  cm) and venous ( $5.42 \pm 1.8$  cm) stroke compared to controls ( $3.54 \pm 0.9$  cm,  $P < .001$ ) with vision occluded. Impairment remained when vision was restored. Robotic measures correlated with functional disability. Sensitivity and specificity of clinical sensory tests were modest.

Conclusions Robotic assessment of position sense is feasible in children with perinatal stroke. Impairment is common and worse in arterial lesions. Limited correction with vision suggests cortical sensory network dysfunction. Disordered position sense may represent a therapeutic target in hemiparetic cerebral palsy.

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PMID: 26747126 [Indexed for MEDLINE]

### **The Structured Observation of Motor Performance in Infants can detect cerebral palsy early in neonatal intensive care recipients.**

Montgomery C , Johansen K , Lucas S , Strömberg B , Persson K .

*Early Hum Dev.* 2017 Jul 17;113:31-39. doi: 10.1016/j.earlhumdev.2017.07.009. [Epub ahead of print]

BACKGROUND: The detection of motor problems in infancy requires a detailed assessment method that measures both the infants' level of motor development and movement quality.

AIMS: To evaluate the ability of the Structured Observation of Motor Performance in Infants (SOMP-I) to detect cerebral palsy (CP) in neonatal intensive care recipients.

STUDY DESIGN: Prospective cohort study analyzed retrospectively. SUBJECTS: 212 (girls: 96) neonatal intensive care recipients (mean gestational age 34weeks, range: 23-43). Twenty infants were diagnosed with CP.

OUTCOME MEASURES: The infants were assessed using SOMP-I at 2, 4, 6 and 10months' corrected age. Accuracy measures were calculated for level of motor development, quality of motor performance and a combination of the two to detect CP at single and repeated assessments.

RESULTS: At 2months, 17 of 20 infants with CP were detected, giving a sensitivity of 85% (95% CI 62-97%) and a specificity of 48% (95% CI 40-55%), while the negative likelihood ratio was 0.3 (95% CI 0.1-0.9) and the positive likelihood ratio was 1.6 (95% CI 1.3-2.0). At 6months all infants with CP were detected using SOMP-I, and all infants had repeatedly been assessed outside the cut-offs. Specificity was generally lower for all assessment ages, however, for repeated assessments sensitivity reached 90% (95% CI 68-99%) and specificity 85% (95% CI 79-90%).

CONCLUSIONS: SOMP-I is sensitive for detecting CP early, but using the chosen cut-off can lead to false positives for CP. Assessing level and quality in combination and at repeated assessments improved predictive ability.

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PMID: 28728014

## **Motricité - Mobilité – Posture -Spasticité**

### **A systematic review of scales to measure dystonia and choreoathetosis in children with dyskinetic cerebral palsy.**

Stewart K , Harvey A , Johnston LM .

*Dev Med Child Neurol.* 2017 Aug;59(8):786-795. doi: 10.1111/dmcn.13452. Epub 2017 May 9.

AIM: To identify and systematically review the psychometric properties and clinical utility of dystonia and choreoathetosis scales reported for children with cerebral palsy (CP).

METHOD: Six electronic databases were searched for dystonia and choreoathetosis scales with original psychometric data for children with CP aged 0 to 18 years. RESULTS: Thirty-four papers met the inclusion criteria,

which contained six scales purported to measure dystonia and/or choreoathetosis in children with CP: the Burke-Fahn-Marsden Dystonia Rating Scale; Barry-Albright Dystonia Scale; Unified Dystonia Rating Scale; Movement Disorder-Childhood Rating Scale; Movement Disorder-Childhood Rating Scale 0-3 Years; and the Dyskinesia Impairment Scale.

INTERPRETATION: Each scale provides useful information about dyskinesia, with most focusing on dystonia. The Barry-Albright Dystonia Scale, which was designed for CP, is the most commonly reported scale and least complex to use clinically. The Dyskinesia Impairment Scale is the only tool to consider both dystonia and choreoathetosis in CP. All tools are designed to classify movement disorders at the level of body functions and structures, rather than activity limitations or participation restrictions, although many provide some insight into the impact of dystonia on activities. Further studies are required to fully examine the validity, reliability, responsiveness, and clinical utility of each scale specifically for children with CP.

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### **Application of the International Classification of Functioning, Disability and Health - Children and Youth in Children With Cerebral Palsy.**

Jeevanantham D .

*Indian Pediatr.* 2016 Sep 8;53(9):805-810. Epub 2016 Jun 1.

The International Classification of Functioning, Disability and Health (ICF) is a framework for describing health status; however, there is a gap in literature for supporting its use as a classification tool. The purpose of this paper is to provide a perspective on its use in describing children with cerebral palsy. The interconnected concepts of the ICF are more important than the classification elements itself. Further research is required to prove its use as a classification tool in clinical practice.

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PMID: 27395840 [Indexed for MEDLINE]

### **Classification of upper limb disability levels of children with spastic unilateral cerebral palsy using K-means algorithm.**

Raouafi S , Achiche S , Begon M , Sarcher A , Raison M .

*Med Biol Eng Comput.* 2017 Jul 1. doi: 10.1007/s11517-017-1678-y. [Epub ahead of print]

Treatment for cerebral palsy depends upon the severity of the child's condition and requires knowledge about upper limb disability. The aim of this study was to develop a systematic quantitative classification method of the upper limb disability levels for children with spastic unilateral cerebral palsy based on upper limb movements and muscle activation. Thirteen children with spastic unilateral cerebral palsy and six typically developing children participated in this study. Patients were matched on age and manual ability classification system levels I to III. Twenty-three kinematic and electromyographic variables were collected from two tasks. Discriminative analysis and K-means clustering algorithm were applied using 23 kinematic and EMG variables of each participant. Among the 23 kinematic and electromyographic variables, only two variables containing the most relevant information for the prediction of the four levels of severity of spastic unilateral cerebral palsy, which are fixed by manual ability classification system, were identified by discriminant analysis: (1) the Falconer index (CAI E) which represents the ratio of biceps to triceps brachii activity during extension and (2) the maximal angle extension ( $\theta$  Extension,max). A good correlation (Kendall Rank correlation coefficient = -0.53,  $p = 0.01$ ) was found between levels fixed by manual ability classification system and the obtained classes. These findings suggest that the cost and effort needed to assess and characterize the disability level of a child can be further reduced.

DOI: 10.1007/s11517-017-1678-y

PMID: 28667591

### **Clinical assessment and three-dimensional movement analysis: An integrated approach for upper limb evaluation in children with unilateral cerebral palsy.**

Mailleux L , Jaspers E , Ortibus E , Simon-Martinez C , Desloovere K , Molenaers G , Klingels K , Feys H .

**INTRODUCTION:** The clinical application of upper limb (UL) three-dimensional movement analysis (3DMA) in children with unilateral cerebral palsy (uCP) remains challenging, despite its benefits compared to conventional clinical scales. Moreover, knowledge on UL movement pathology and how this relates to clinical parameters remains scarce. Therefore, we investigated UL kinematics across different manual ability classification system (MACS) levels and explored the relation between clinical and kinematic parameters in children with uCP.

**PATIENTS AND METHODS:** Fifty children (MACS: I = 15, II = 26, III = 9) underwent an UL evaluation of sensorimotor impairments (grip force, muscle strength, muscle tone, two-point discrimination, stereognosis), bimanual performance (Assisting Hand Assessment, AHA), unimanual capacity (Melbourne Assessment 2, MA2) and UL-3DMA during hand-to-head, hand-to-mouth and reach-to-grasp tasks. Global parameters (Arm Profile Score (APS), duration, (timing of) maximum velocity, trajectory straightness) and joint specific parameters (angles at task endpoint, ROM and Arm Variable Scores (AVS)) were extracted. The APS and AVS refer respectively to the total amount of movement pathology and movement deviations of wrist, elbow, shoulder, scapula and trunk.

**RESULTS:** Longer movement durations and increased APS were found with higher MACS-levels ( $p < 0.001$ ). Increased APS was also associated with more severe sensorimotor impairments ( $r = -0.30$ - $(-0.73)$ ) and with lower AHA and MA2-scores ( $r = -0.50$ - $(-0.86)$ ). For the joint specific parameters, stronger movement deviations distally were significantly associated with increased muscle weakness ( $r = -0.32$ - $(-0.74)$ ) and muscle tone ( $r = 0.33$ - $(-0.61)$ ); proximal movement deviations correlated only with muscle weakness ( $r = -0.35$ - $0.59$ ). Regression analysis exposed grip force as the most important predictor for the variability in APS ( $p < 0.002$ ).

**CONCLUSION:** We found increased movement pathology with increasing MACS-levels and demonstrated the adverse impact of especially muscle weakness. The lower correlations suggest that 3DMA provides additional information regarding UL motor function, particularly for the proximal joints. Integrating both methods seems clinically meaningful to obtain a comprehensive representation of all aspects of a child's UL functioning.

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DOI: 10.1371/journal.pone.0180196

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PMID: 28671953

### **Coordination of Reach-to-Grasp Kinematics in Individuals With Childhood-Onset Dystonia Due to Hemiplegic Cerebral Palsy.**

De Luca SN, Curatalo LA, de Campos AC, Hallett M, Alter KE, Damiano DL.

*IEEE Trans Neural Syst Rehabil Eng.* 2016 May;24(5):582-590. doi: 10.1109/TNSRE.2015.2458293. Epub 2015 Jul 20.

Functional reaching is impaired in dystonia. Here, we analyze upper extremity kinematics to quantify timing and coordination abnormalities during unimanual reach-to-grasp movements in individuals with childhood-onset unilateral wrist dystonia. Kinematics were measured during movements of both upper limbs in a patient group ( $n = 11$ , age =  $17.5 \pm 5$  years), and a typically developing control group ( $n = 9$ , age =  $16.6 \pm 5$  years). Hand aperture was computed to study the coordination of reach and grasp. Time-varying joint synergies within one upper limb were calculated using a novel technique based on principal component analysis to study intra-limb coordination. In the non-dominant arm, results indicate reduced coordination between reach and grasp in patients who could not lift the grasped object compared to those who could lift it. Lifters exhibit incoordination in distal upper extremity joints later in the movement and non-lifters lacked coordination throughout the movement and in the whole upper limb. The amount of atypical coordination correlates with dystonia severity in patients. Reduced coordination during movement may reflect deficits in the execution of simultaneous movements, motor planning, or muscle activation. Rehabilitation efforts can focus on particular time points when kinematic patterns deviate abnormally to improve functional reaching in individuals with childhood-onset dystonia.

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PMCID: PMC4720582

PMID: 26208359 [Indexed for MEDLINE]

### **Correlation of the torsion values measured by rotational profile, kinematics, and CT study in CP patients.**

Kim HY , Cha YH , Chun YS , Shin HS .

*Gait Posture*. 2017 Sep;57:241-245. doi: 10.1016/j.gaitpost.2017.06.014. Epub 2017 Jun 22.

**BACKGROUND:** The purpose of study was to analyze correlations between bony torsions measured by Staheli's rotation profile, computed tomography (CT) torsional study, and gait analysis in patients with cerebral palsy (CP).

**MATERIALS & METHOD:** The study group comprised of 26 children with CP (spastic diplegia, Gross Motor Function Classification System (GMFCS) 1-2, mean age 12.6 years) with torsional deformities. All subjects were assessed by examining: 1) rotational profile [internal rotation (IR) and external rotation (ER)], 2) CT torsional profile [femoral anteversion (FAV) and tibial torsion (TT)], and 3) gait analysis [mean hip rotation (HR) and mean knee rotation (KR)]. Statistical analysis was performed using the Pearson correlation test.

**RESULTS:** In the femur, there was good correlation between FAV and Staheli's rotational profile of IR and ER (Pearson correlation coefficient (PC=0.69, 0.52,  $p<0.05$ )). ER correlated very strongly with mean HR during gait (PC=0.8,  $p<0.05$ ). There was, however, poor correlation between HR and IR ( $p>0.05$ ), and between HR and FAV ( $p>0.05$ ). In the tibia, mean KR correlated well with thigh-foot angle (TFA) (PC=0.72) and CT tibia torsion (TT) (PC=0.62). TT also correlated with TFA (PC=0.62).

**CONCLUSION:** Gait analysis and Staheli's rotational profile reflect both static and dynamic factors of gait abnormalities. However, CT study reflect static factor primarily. Dynamic factors tend to influence the measurements of the femoral torsion only due to large rotational arc of hip joint. In surgical planning, it must be considered that HR sometimes does not correlate with CT anteversion angle. Similarly, it must also be considered that KR correlates well with TFA and CT TT angle.

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PMID: 28668738

### **Crouch severity is a poor predictor of elevated oxygen consumption in cerebral palsy.**

Steele KM , Shuman BR , Schwartz MH .

*J Biomech*. 2017 Jul 26;60:170-174. doi: 10.1016/j.jbiomech.2017.06.036. Epub 2017 Jul 5.

Children with cerebral palsy (CP) expend more energy to walk compared to typically-developing peers. One of the most prevalent gait patterns among children with CP, crouch gait, is often singled out as especially exhausting. The dynamics of crouch gait increase external flexion moments and the demand on extensor muscles. This elevated demand is thought to dramatically increase energy expenditure. However, the impact of crouch severity on energy expenditure has not been investigated among children with CP. We evaluated oxygen consumption and gait kinematics for 573 children with bilateral CP. The average net nondimensional oxygen consumption during gait of the children with CP ( $0.18\pm 0.06$ ) was 2.9 times that of speed-matched typically-developing peers. Crouch severity was only modestly related to oxygen consumption, with measures of knee flexion angle during gait explaining only 5-20% of the variability in oxygen consumption. While knee moment and muscle activity were moderately to strongly correlated with crouch severity ( $r(2)=0.13-0.73$ ), these variables were only weakly correlated with oxygen consumption ( $r(2)=0.02-0.04$ ). Thus, although the dynamics of crouch gait increased muscle demand, these effects did not directly result in elevated energy expenditure. In clinical gait analysis, assumptions about an individual's energy expenditure should not be based upon kinematics or kinetics alone. Identifying patient-specific factors that contribute to increased energy expenditure may provide new pathways to improve gait for children with CP.

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PMID: 28734543

### **Evaluation of speed-accuracy trade-off in a computer task in individuals with cerebral palsy: a cross-sectional study.**

Fernani DCGL , Prado MTA , da Silva TD , Massetti T , de Abreu LC , Magalhães FH , Dawes H , de Mello Monteiro CB .

*BMC Neurol*. 2017 Jul 27;17(1):143. doi: 10.1186/s12883-017-0920-4.

**BACKGROUND:** Individuals with Cerebral Palsy (CP) present with sensorimotor dysfunction which make the control and execution of movements difficult. This study aimed to verify the speed-accuracy trade-off in individuals with CP.

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**METHODS:** Forty eight individuals with CP and 48 with typical development (TD) were evaluated (32 females and 64 males with a mean age of  $15.02 \pm 6.37$  years: minimum 7 and maximum 30 years). Participants performed the "Fitts' Reciprocal Aiming Task v.1.0 (Horizontal)" on a computer with different sizes and distance targets, composed by progressive indices of difficulty (IDs): ID2, ID4a and ID4b.

**RESULTS:** There were no statistical differences between the groups in relation to the slope of the curve ( $b_1$ ) and dispersion of the movement time ( $r(2)$ ). However, the intercept ( $b_0$ ) values presented significant differences ( $F(1.95) = 11.3$ ;  $p = .001$ ), with greater movement time in the CP group compared to the TD group. It means that for individuals with CP, regardless of index difficulty, found the task more difficult than for TD participants. Considering CP and TD groups, speed-accuracy trade-off was found when using different indices of difficulty (ID2 and ID4). However, when the same index of difficulty was used with a larger target and longer distance (ID4a) or with a narrow target and shorter distance (ID4b), only individuals with CP had more difficulty performing the tasks involving smaller targets. Marginally significant inverse correlations were identified between the values of  $b_1$  and age ( $r = -0.119$ ,  $p = .052$ ) and between  $r(2)$  and Gross Motor Function Classification System ( $r = -0.280$ ,  $p = .054$ ), which did not occur with the Manual Ability Classification System.

**CONCLUSION:** We conclude that the individuals with CP presented greater difficulty when the target was smaller and demanded more accuracy, and less difficulty when the task demanded speed. It is suggested that treatments should target tasks with accuracy demands, that could help in daily life tasks, since it is an element that is generally not considered by professionals during therapy.

**TRIAL REGISTRATION:** ClinicalTrials.gov, NCT03002285, retrospectively registered on 20 Dec 2016.

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DOI: 10.1186/s12883-017-0920-4

PMCID: PMC5530971

PMID: 28750603

### **Exercise Intensity During Power Wheelchair Soccer.**

Barfield JP, Newsome L, Malone LA.

*Arch Phys Med Rehabil.* 2016 Nov;97(11):1938-1944. doi: 10.1016/j.apmr.2016.05.012. Epub 2016 Jun 8.

**OBJECTIVE:** To determine exercise intensity during power wheelchair soccer among a sample of persons with mobility impairments.

**DESIGN:** Cross-sectional descriptive.

**SETTING:** On-site training facilities of multiple power wheelchair soccer teams.

**PARTICIPANTS:** Participants with severe mobility impairments (N=30) (mean  $\pm$  SD, age:  $29.40 \pm 15.51$ y, body mass index:  $24.11 \pm 6.47$ kg/m<sup>2</sup>), power soccer experience:  $7.91 \pm 3.93$ y, disability sport experience:  $12.44 \pm 9.73$ y) were recruited from multiple power wheelchair soccer teams.

**INTERVENTIONS:** Portable metabolic carts were used to collect oxygen consumption ( $\dot{V}O_2$ ) data during resting and game play conditions.

**MAIN OUTCOME MEASURES:** Average  $\dot{V}O_2$  (expressed in metabolic equivalent tasks [METs]) during resting and game play conditions and rating of perceived exertion for game play.

**RESULTS:**  $\dot{V}O_2$  increased from  $1.35 \pm 0.47$  METs at rest to  $1.81 \pm 0.65$  METs during game play. This 34% increase in exercise intensity was significant ( $P < .01$ ) and supported by a mean perceived exertion score of approximately 13 (somewhat hard).

**CONCLUSIONS:** Although not able to sustain an intensity associated with reduced secondary disease risk (ie, 3 METs), the documented light-intensity exercise in the current study surpassed an intensity threshold associated with improved functional capacity and performance of daily living activities (ie, 1.5 METs).

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DOI: 10.1016/j.apmr.2016.05.012

PMID: 27288710 [Indexed for MEDLINE]

### **Feasibility, stability and validity of the four square step test in typically developed children and children with brain damage.**

Leizerowitz G, Katz-Leurer M.

*Brain Inj.* 2017 Jun 30:1-6. doi: 10.1080/02699052.2017.1332384. [Epub ahead of print]

**PURPOSE:** To assess feasibility, test-retest reliability and validity of the Four Square Step Test (FSST) in typically developed children (TD), and children with cerebral palsy (CP) and acquired brain injury (ABI).

**METHODS:** 30 TD children, 20 with CP and 12 with ABI participated in the study. The FSST while sitting and standing, the Timed Up and Go (TUG) and the balance subtest of the Bruininks-Oseretsky Test (BOT-2) were assessed. Each child attempted the FSST twice within 1 week. The scores for the FSST were assigned according to the original test: two successes in four trials, and according to a more lenient test, one success in four trials.

**RESULTS:** The original form of the FSST is not feasible for children with CP or ABI. In TD children the lenient version is feasible (93%) and has moderate stability (Interclass correlation, ICC = 0.723), with a significant, positive correlation with the TUG ( $r_s = 0.56$ ). In children with CP the lenient test is feasible (80%), stable ( $r_s = 0.83$ ) and negatively correlates with the BOT-2 ( $r_s = -0.69$ ). In children with ABI the test is less feasible (67%) and neither stable nor valid.

**CONCLUSIONS:** The lenient form of the FSST is feasible, reliable and valid in TD children and children with CP.

DOI: 10.1080/02699052.2017.1332384

PMID: 28665697

### **Gait analysis in children with cerebral palsy.**

Armand S, Decoulon G, Bonnefoy-Mazure A.

*EFORT Open Rev.* 2016 Dec 22;1(12):448-460. doi: 10.1302/2058-5241.1.000052. eCollection 2016 Dec.

Cerebral palsy (CP) children present complex and heterogeneous motor disorders that cause gait deviations. Clinical gait analysis (CGA) is needed to identify, understand and support the management of gait deviations in CP. CGA assesses a large amount of quantitative data concerning patients' gait characteristics, such as video, kinematics, kinetics, electromyography and plantar pressure data. Common gait deviations in CP can be grouped into the gait patterns of spastic hemiplegia (drop foot, equinus with different knee positions) and spastic diplegia (true equinus, jump, apparent equinus and crouch) to facilitate communication. However, gait deviations in CP tend to be a continuum of deviations rather than well delineated groups. To interpret CGA, it is necessary to link gait deviations to clinical impairments and to distinguish primary gait deviations from compensatory strategies. CGA does not tell us how to treat a CP patient, but can provide objective identification of gait deviations and further the understanding of gait deviations. Numerous treatment options are available to manage gait deviations in CP. Generally, treatments strive to limit secondary deformations, re-establish the lever arm function and preserve muscle strength. Additional roles of CGA are to better understand the effects of treatments on gait deviations. Cite this article: Armand S, Decoulon G, Bonnefoy-Mazure A. Gait analysis in children with cerebral palsy. *EFORT Open Rev* 2016;1:448-460. DOI: 10.1302/2058-5241.1.000052.

### [Free PMC Article](#)

DOI: 10.1302/2058-5241.1.000052

PMCID: PMC5489760

PMID: 28698802

Conflict of interest statement: Conflict of Interest: None declared.

### **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.

OI: 10.1109/EMBC.2016.7591777

PMID: 28269321 [Indexed for MEDLINE]

### **Intra-operatively measured spastic semimembranosus forces of children with cerebral palsy.**

Yucesoy CA , Temelli Y , Ateş F .

*J Electromyogr Kinesiol.* 2017 Jul 12;36:49-55. doi: 10.1016/j.jelekin.2017.07.003. [Epub ahead of print]

The knee kept forcibly in a flexed position is typical in cerebral palsy. Using a benchmark, we investigate intra-operatively if peak spastic hamstring force is measured in flexed knee positions. This tests the assumed shift of optimal length due to adaptation of spastic muscle and a decreasing force trend towards extension. Previously we measured spastic gracilis (GRA) and semitendinosus (ST) forces. Presently, we studied spastic semimembranosus (SM) and tested the following hypotheses: spastic SM forces are (1) high in flexed and (2) low in extended positions. We compared the data to those of GRA and ST to test (3) if percentages of peak force produced in flexed positions are different. During muscle lengthening surgery of 8 CP patients (9years, 4months; GMFCS levels=II-IV; limbs tested=13) isometric SM forces were measured from flexion (120°) to full extension (0°). Spastic SM forces were low in flexed knee positions (only 4.2% (3.4%) and 10.7% (9.7%) of peak force at KA=120° and KA=90° respectively, indicating less force production compared to the GRA or ST) and high in extended knee positions (even 100% of peak force at KA=0°). This indicates an absence of strong evidence for a shift of optimal muscle length of SM towards flexion.

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PMID: 28735102

### **Longitudinal Association Between Gross Motor Capacity and Neuromusculoskeletal Function in Children and Youth With Cerebral Palsy.**

Vos RC , Becher JG , Voorman JM , Gorter JW , van Eck M , van Meeteren J , Smits DW , Twisk JW , Dallmeijer AJ ; PERRIN+ Study Group. Collaborators: van Schie PE, Schuengel C, Ketelaar M, Lindeman E, Jongmans M, Roebroeck ME, Tan SS, Wiegerink DJ, Reinders-Messelink HA, Verheijden J, Bosk.

*Arch Phys Med Rehabil.* 2016 Aug;97(8):1329-37. doi: 10.1016/j.apmr.2016.03.012. Epub 2016 Apr 13.

**OBJECTIVE:** To examine associations over longitudinal measurements between neuromusculoskeletal function and gross motor capacity in children and youth with cerebral palsy (CP).

**DESIGN:** A prospective cohort study.

**SETTING:** Rehabilitation departments of university medical centers and rehabilitations centers.

**PARTICIPANTS:** A sample (N=327) consisting of 148 children (aged 5-9y) and 179 youth (aged 11-20y) with CP, Gross Motor Function Classification System level I (n=180), level II (n=44), level III (n=36), level IV (n=34), and level V (n=33).

**INTERVENTIONS:** Not applicable.

**MAIN OUTCOME MEASURES:** Gross motor capacity was assessed with the Gross Motor Function Measure-66 over a period of 2 to 4 years in different age cohorts. Neuromusculoskeletal function included selective motor control (SMC), muscle strength, spasticity, and range of motion (ROM) of the lower extremities.

**RESULTS:** Multilevel analyses showed that SMC was significantly associated with gross motor capacity in children and youth with CP, showing higher values and a more favorable course of gross motor capacity in those with better SMC. Strength was only associated with gross motor capacity in youth. Reduced ROM of hip (children) and knee extension (youth) and spasticity of the hip adductors (youth) were additionally-but more weakly-associated with lower values and a less favorable course of gross motor capacity.

**CONCLUSIONS:** Results indicate that children and youth with more severely impaired SMC and youth with reduced muscle strength have a less favorable course of gross motor capacity, while spasticity and reduced ROM are less determinative.

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DOI: 10.1016/j.apmr.2016.03.012

PMID: 27085848 [Indexed for MEDLINE]

### **Longitudinal assessment of gait quality in children with bilateral cerebral palsy following repeated lower limb intramuscular Botulinum toxin-A injections.**

Read FA , Boyd RN , Barber LA .

*Res Dev Disabil. 2017 Sep;68:35-41. doi: 10.1016/j.ridd.2017.07.002. Epub 2017 Jul 20.*

**BACKGROUND:** Serial lower limb intramuscular Botulinum toxin-A (BoNT-A) injections are administered to children with bilateral spastic cerebral palsy (BCP) to reduce spasticity, improve walking and functional mobility, and delay the need for orthopaedic surgery. Gait quality is clinically assessed following BoNT-A with 2D video gait assessments (2DVGA) using the Edinburgh Visual Gait Score (EVGS).

**AIM:** To determine the effect of three consecutive treatment cycles of lower limb intramuscular BoNT-A injections on gait quality using the EVGS in children with BCP by retrospectively reviewing repeated 2DVGA measures.

**METHODS AND PROCEDURES:** Seventeen children with BCP and dynamic equinus (8 females and 9 males, age mean (SD), 4.0 (2.2) years, GMFCS I=2 and II=15) were included in the study after a retrospective audit of the records of the Queensland Children's Gait Laboratory (QCGL), Children's Health Queensland, Brisbane. The medical records of children who attended the QCGL between January 2001 and January 2016 were searched for eligibility. Children who had undertaken pre- and post-treatment 2DVGA for the first three lower limb BoNT-A treatment cycles (6 assessments) were reviewed using the EVGS. BoNT-A treatments were administered 7.7 (2.3) months apart and post-BoNT-A reviews occurred 12.6 (6.7) weeks after injection. Mixed-effects linear regression assessed the change from baseline to each subsequent assessment ( $p < 0.05$ ).

**OUTCOMES AND RESULTS:** EVGS reduced significantly by a mean of 2.4 points from pre- to post-BoNT-A in the first treatment cycle ( $p = 0.001$ ). Compared to baseline, mean total EVGS reduced significantly during the second (pre-BoNT-A -1.7 ( $p = 0.020$ ), post BoNT-A -2.8 ( $p < 0.001$ )) and third (pre-BoNT-A -2.6 ( $p = 0.001$ ), post BoNT-A -2.4 ( $p = 0.002$ )) treatment cycles. There was no difference in EVGS between post-BoNT-A in the first treatment cycle and scores for the second and third treatment cycles.

**CONCLUSIONS AND IMPLICATIONS:** Improvements in gait quality were statistically significant, but did not reach the EVGS smallest real difference value of 4 points. Repeated lower limb intramuscular BoNT-A injections to improve gait quality in children with BCP should be reconsidered.

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PMID: 28735160

### **Management of Spinal Deformity in Adult Patients With Neuromuscular Disease.**

Protopsaltis TS, Boniello AJ, Schwab FJ.

*J Am Acad Orthop Surg. 2016 Sep;24(9):634-44. doi: 10.5435/JAAOS-D-15-00421.*

A wide range of neuromuscular diseases, including Parkinson disease, cerebral palsy, multiple sclerosis, and myopathy, are associated with spinal deformities. The most common postural deformities include anterocollis, Pisa syndrome (pleurothotonus), scoliosis, and camptocormia. Nonsurgical management of spinal deformity in patients with neuromuscular disease centers on maximizing the medical management of the underlying neurodegenerative pathology before surgical intervention is contemplated. Surgical management can include decompression alone, or decompression and fusion with short or long fusion constructs. Patients with neuromuscular disease are susceptible to postoperative medical complications, such as delirium, epidural hematomas, pulmonary emboli, and cardiac events. Compared with outcomes in the typical patient with spinal deformity, postoperative outcomes in patients with neuromuscular disease have higher rates of surgical complications, such as instrumentation failure, proximal junctional kyphosis, loss of correction, and the need for revision surgery, regardless of the magnitude of surgical treatment.

DOI: 10.5435/JAAOS-D-15-00421

PMID: 27471900 [Indexed for MEDLINE]

### **Mechanisms contributing to gait speed and metabolic cost in children with unilateral cerebral palsy.**

Pinto TPS , Fonseca ST , Gonçalves RV , Souza TR , Vaz DV , Silva PLP , Mancini MC .

*Braz J Phys Ther. 2017 Jul 5. pii: S1413-3555(17)30254-X. doi: 10.1016/j.bjpt.2017.06.015. [Epub ahead of print]*

**BACKGROUND:** Gait speed and metabolic cost are indicators of functional capacity in children with cerebral palsy. Uncovering their mechanisms helps guide therapeutic actions.

**OBJECTIVES:** To investigate the contributions of energy-generating and energy-conserving mechanisms to gait speed and metabolic cost of children with unilateral cerebral palsy.

**METHODS:** Data on eccentric and concentric muscle work, co-contraction, elastic torque and vertical stiffness of the affected-limb, forcing torque of the non-affected limb, gait speed and metabolic cost were collected from 14 children with unilateral cerebral palsy, aged 6-12 years. Analyses included two groups of multiple regression models. The first group of models tested the association between each dependent variable (i.e., speed and metabolic cost) and the independent variables that met the input criteria. The second group verified the contribution of the non-selected biomechanical variables on the predictors of the first model.

**RESULTS:** Gait speed ( $R(2)=0.80$ ) was predicted by elastic torque ( $\beta=0.62$ ; 95%CI: 0.60, 0.63), vertical stiffness ( $\beta=-0.477$ ; 95%CI: -0.479, -0.474) and knee co-contraction ( $\beta=0.27$ ; 95%CI: -1.96, 2.49). The production of eccentric work by the affected limb proved relevant in adjusting the vertical stiffness ( $R(2)=0.42$ ;  $\beta=-0.64$ ; 95%CI: 0.86, -0.42); elastic torque of the affected-leg was associated with impulsive torque of the non-affected leg ( $R(2)=0.31$ ;  $\beta=0.55$ ; 95%CI: 0.46, 0.64). Metabolic cost of gait ( $R(2)=0.48$ ) was partially predicted by knee co-contraction ( $\beta=0.69$ ; 95%CI: 0.685, 0.694).

**CONCLUSIONS:** The chain of associations revealed by the two steps models helped uncover the mechanisms involved in the locomotion of children with unilateral cerebral palsy. Intervention that changes specific energy conserving and generating mechanisms may improve gait of these children.

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PMID: 28728959

### **Medial gastrocnemius and soleus muscle-tendon unit, fascicle, and tendon interaction during walking in children with cerebral palsy.**

Barber L , Carty C , Modenese L , Walsh J , Boyd R , Lichtwark G .

*Dev Med Child Neurol.* 2017 Aug;59(8):843-851. doi: 10.1111/dmcn.13427. Epub 2017 Apr 1.

**AIM:** This study investigates the in vivo function of the medial gastrocnemius and soleus muscle-tendon units (MTU), fascicles, and tendons during walking in children with cerebral palsy (CP) and an equinus gait pattern.

**METHOD:** Fourteen children with CP (9 males, 5 females; mean age 10y 6mo, standard deviation [SD] 2y 11mo; GMFCS level I=8, II=6), and 10 typically developing (6 males, 4 females; mean age 10y, SD 2y 1mo) undertook full body 3D gait analysis and simultaneous B-mode ultrasound images of the medial gastrocnemius and soleus fascicles during level walking. Fascicle lengths were analysed using a semi-automated tracking algorithm and MTUs using OpenSim. Statistical parametric mapping (two-sample t-test) was used to compare differences between groups ( $p<0.05$ ).

**RESULTS:** In the CP group medial gastrocnemius fascicles lengthened during mid-stance gait and remained longer into late-stance compared to the typically developing group ( $p<0.001$ ). CP medial gastrocnemius fascicles shortened less during stance (1.16mm [SD 1.47mm]) compared to the typically developing group (4.48mm [SD 1.94mm],  $p<0.001$ ). In the CP group the medial gastrocnemius and soleus MTU and tendon were longer during early- and mid-stance ( $p<0.001$ ). Ankle power during push-off ( $p=0.015$ ) and positive work ( $p<0.002$ ) and net work ( $p<0.001$ ) were significantly lower in the CP group.

**INTERPRETATION:** Eccentric action of the CP medial gastrocnemius muscle fascicles during mid-stance walking is consistent with reduced volume and neuromuscular control of impaired muscle. Reduced ankle push-off power and positive work in the children with CP may be attributed to reduced active medial gastrocnemius fascicle shortening. These findings suggest a reliance on passive force generation for forward propulsion during equinus gait.

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PMID: 28369824 [Indexed for MEDLINE]

### **Neuro-musculoskeletal simulation of instrumented contracture and spasticity assessment in children with cerebral palsy.**

van der Krogt MM , Bar-On L , Kindt T , Desloovere K , Harlaar J .

*J Neuroeng Rehabil.* 2016 Jul 16;13(1):64. doi: 10.1186/s12984-016-0170-5.

**BACKGROUND:** Increased resistance in muscles and joints is an important phenomenon in patients with cerebral palsy (CP), and is caused by a combination of neural (e.g. spasticity) and non-neural (e.g. contracture) components. The aim of this study was to simulate instrumented, clinical assessment of the hamstring muscles in CP using a conceptual model of contracture and spasticity, and to determine to what extent contracture can be explained by altered passive muscle stiffness, and spasticity by (purely) velocity-dependent stretch reflex.

**METHODS:** Instrumented hamstrings spasticity assessment was performed on 11 children with CP and 9 typically developing children. In this test, the knee was passively stretched at slow and fast speed, and knee angle, applied forces and EMG were measured. A dedicated OpenSim model was created with motion and muscles around the knee only. Contracture was modeled by optimizing the passive muscle stiffness parameters of vasti and hamstrings, based on slow stretch data. Spasticity was modeled using a velocity-dependent feedback controller, with threshold values derived from experimental data and gain values optimized for individual subjects. Forward dynamic simulations were performed to predict muscle behavior during slow and fast passive stretches.

**RESULTS:** Both slow and fast stretch data could be successfully simulated by including subject-specific levels of contracture and, for CP fast stretches, spasticity. The RMS errors of predicted knee motion in CP were  $1.1 \pm 0.9^\circ$  for slow and  $5.9 \pm 2.1^\circ$  for fast stretches. CP hamstrings were found to be stiffer compared with TD, and both hamstrings and vasti were more compliant than the original generic model, except for the CP hamstrings. The purely velocity-dependent spasticity model could predict response during fast passive stretch in terms of predicted knee angle, muscle activity, and fiber length and velocity. Only sustained muscle activity, independent of velocity, was not predicted by our model.

**CONCLUSION:** The presented individually tunable, conceptual model for contracture and spasticity could explain most of the hamstring muscle behavior during slow and fast passive stretch. Future research should attempt to apply the model to study the effects of spasticity and contracture during dynamic tasks such as gait.

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DOI: 10.1186/s12984-016-0170-5

PMCID: PMC4947289

PMID: 27423898 [Indexed for MEDLINE]

### **Perspectives on Postural Control Dysfunction to Inform Future Research: A Delphi Study for Children With Cerebral Palsy.**

Dewar R, Claus AP, Tucker K, Johnston LM.

*Arch Phys Med Rehabil.* 2017 Mar;98(3):463-479. doi: 10.1016/j.apmr.2016.07.021. Epub 2016 Aug 26.

**OBJECTIVE:** To identify whether consensus can be achieved in how clinicians and researchers define, describe, assess, and treat postural control dysfunction in children with cerebral palsy (CP).

**DESIGN:** Delphi study with 3 iterative rounds.

**SETTING:** Electronic survey.

**PARTICIPANTS:** Researchers and/or clinicians (N=43) from 7 countries with a mean  $\pm$  SD of  $20 \pm 11$  years of experience working with children with CP participated. Participants included authors of published works on postural control in CP (identified from a recent systematic review), members of the Australasian Academy of CP and Developmental Medicine, and 2 major Australian rehabilitation providers.

**INTERVENTIONS:** Not applicable.

**MAIN OUTCOME MEASURES:** The Delphi study consisted of 3 iterative rounds of surveys. In Round 1, respondents answered open-ended questions regarding their views on (1) definition items for postural control, (2) theoretical frameworks, (3) methods for assessment, and (4) interventions for postural control dysfunction in children with CP. Rounds 2 and 3 were made up of items generated by participants in Round 1 and combined with items identified from the literature. Participants indicated their level of agreement for each item on a 7-point Likert scale. Threshold for consensus was  $\geq 85\%$  agreement. **RESULTS:** Of 306 items generated, 174 reached consensus by Round 3. Most postural control definition items (90%) achieved consensus. Two theoretical frameworks (14%) reached consensus. Less than half (42%) of assessment items reached consensus. More individual assessment items (89%) reached consensus than multi-item tools (4%). Just over half (61%) of the items generated for interventions reached consensus.

CONCLUSION: Consensus was achieved for a postural control definition. However, substantial research is needed to establish a comprehensive, postural control-specific framework and suite of assessments. These would provide a foundation to improve intervention selection and dosage.

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DOI: 10.1016/j.apmr.2016.07.021

PMID: 27568884 [Indexed for MEDLINE]

### **Plantar flexor muscle weakness and fatigue in spastic cerebral palsy patients.**

Neyroud D , Armand S , De Coulon G , Sarah R Dias Da Silva , Maffiuletti NA , Kayser B , Place N .  
*Res Dev Disabil. 2017 Feb;61:66-76. doi: 10.1016/j.ridd.2016.12.015. Epub 2017 Jan 5.*

BACKGROUND: Patients with cerebral palsy develop an important muscle weakness which might affect the aetiology and extent of exercise-induced neuromuscular fatigue.

AIM: This study evaluated the aetiology and extent of plantar flexor neuromuscular fatigue in patients with cerebral palsy.

METHODS: Ten patients with cerebral palsy and 10 age- and sex-matched healthy individuals (~20 years old, 6 females) performed four 30-s maximal isometric plantar flexions interspaced by a resting period of 2-3s to elicit a resting twitch. Maximal voluntary contraction force, voluntary activation level and peak twitch were quantified before and immediately after the fatiguing task.

RESULTS: Before fatigue, patients with cerebral palsy were weaker than healthy individuals (341±134N vs. 858±151N, p<0.05) and presented lower voluntary activation (73±19% vs. 90±9%, p<0.05) and peak twitch (100±28N vs. 199±33N, p<0.05). Maximal voluntary contraction force was not significantly reduced in patients with cerebral palsy following the fatiguing task (-10±23%, p>0.05), whereas it decreased by 30±12% (p<0.05) in healthy individuals.

CONCLUSIONS: Plantar flexor muscles of patients with cerebral palsy were weaker than their healthy peers but showed greater fatigue resistance.

WHAT THIS PAPER ADDS: Cerebral palsy is a widely defined pathology that is known to result in muscle weakness. The extent and origin of muscle weakness were the topic of several previous investigations; however some discrepant results were reported in the literature regarding how it might affect the development of exercise-induced neuromuscular fatigue. Importantly, most of the studies interested in the assessment of fatigue in patients with cerebral palsy did so with general questionnaires and reported increased levels of fatigue. Yet, exercise-induced neuromuscular fatigue was quantified in just a few studies and it was found that young patients with cerebral palsy might be more fatigue resistant than their peers. Thus, it appears that (i) conflicting results exist regarding objectively-evaluated fatigue in patients with cerebral palsy and (ii) the mechanisms underlying this muscle fatigue - in comparison to those of healthy peers - remain poorly understood. The present study adds important knowledge to the field as it shows that when young adults with cerebral palsy perform sustained maximal isometric plantar flexions, they appear less fatigable than healthy peers. This difference can be ascribed to a better preservation of the neural drive to the muscle. We suggest that the inability to drive their muscles maximally accounts for the lower extent of exercise-induced neuromuscular fatigue in patients with cerebral palsy.

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DOI: 10.1016/j.ridd.2016.12.015

PMID: 28064025 [Indexed for MEDLINE]

### **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 [Indexed for MEDLINE]

### **Psychometric properties of measures of gait quality and walking performance in young people with Cerebral Palsy: A systematic review.**

Zanudin A , Mercer TH , Jagadamma KC , van der Linden ML .

*Gait Posture*. 2017 Jul 4;58:30-40. doi: 10.1016/j.gaitpost.2017.07.005. [Epub ahead of print]

Availability of outcome measures (OMs) with robust psychometric properties is an essential prerequisite for the evaluation of interventions designed to address gait deterioration in young people with Cerebral Palsy (CP). This review evaluates evidence for the reliability, validity and responsiveness of outcome measures of gait quality and walking performance in young people with CP. A systematic search was performed in MEDLINE, CINAHL, PubMed and Scopus. Articles that met the eligibility criteria were selected. Methodological quality of studies was independently rated by two raters using the modified Consensus-based Standard for the selection of health status Measurement Instruments checklist. Strength of evidence was rated using standardised guidelines. Best evidence synthesis was scored according to Cochrane criteria. Fifty-one articles reporting on 18 distinct OMs were included for review. Best evidence synthesis indicated a moderate to strong evidence for the reliability for OMs of walking performance but conflicting evidence for the reliability of OMs of gait quality. The evidence for responsiveness for all OMs included in this review was rated as 'unknown'. The limitations of using the modified COSMIN scoring for small sample sizes are acknowledged. Future studies of high methodological quality are needed to explore the responsiveness of OMs assessing gait quality and walking performance in young people with CP.

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DOI: 10.1016/j.gaitpost.2017.07.005

PMID: 28711651

### **Reliability of the Brazilian Portuguese version of the Gross Motor Function Measure in children with cerebral palsy.**

Almeida KM , Albuquerque KA , Ferreira ML , Aguiar SK , Mancini MC .

*Braz J Phys Ther*. 2016 Jan-Feb;20(1):73-80. doi: 10.1590/bjpt-rbf.2014.0131. Epub 2016 Jan 19.

OBJECTIVE: To test the intra- and interrater reliability of the Brazilian Portuguese version of the 66-item Gross Motor Function Measure (GMFM-66).

METHOD: The sample included 48 children with cerebral palsy (CP), ranging from 2-17 years old, classified at levels I to IV of the Gross Motor Function Classification System (GMFCS) and four child rehabilitation examiners. A main examiner evaluated all children using the GMFM-66 and video-recorded the assessments. The other examiners watched the video recordings and scored them independently for the assessment of interrater reliability. For the intrarater reliability evaluation, the main examiner watched the video recordings one month after the evaluation and re-scored each child. We calculated reliability by using intraclass correlation coefficients (ICC) with their respective 95% confidence intervals.

RESULTS: Excellent test reliability was documented. The intrarater reliability of the total sample was ICC=0.99 (95% CI 0.98-0.99), and the interrater reliability was ICC=0.97 (95% CI 0.95-0.98). The reliability across GMFCS levels ranged from ICC=0.92 (95% CI 0.72-0.98) to ICC=0.99 (95% CI 0.99-0.99); the lowest value was the interrater reliability for the GMFCS IV group. Reliability in the five GMFM dimensions varied from ICC=0.95 (95% CI 0.93-0.97) to ICC=0.99 (95% CI 0.99-0.99).

CONCLUSION: The Brazilian Portuguese version of the GMFM-66 showed excellent intra- and interrater reliability when used in Brazilian children with CP levels GMFCS I to IV.

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DOI: 10.1590/bjpt-rbf.2014.0131  
PMCID: PMC4835167  
PMID: 26786081 [Indexed for MEDLINE]

### **The criterion validity and intra-rater reliability of the Japanese version of the Functional Mobility Scale in children with cerebral palsy.**

Himuro N, Nishibu H, Abe H, Mori M

*Res Dev Disabil.* 2017 Sep;68:20-26. doi: 10.1016/j.ridd.2017.07.004. Epub 2017 Jul 20.

**OBJECTIVE:** The purpose of this study was to develop a Japanese version of the Functional Mobility Scale (FMS), and examine the criterion validity and intra-rater reliability of the FMS in Japan.

**METHODS:** The translation of the FMS was performed according to international standards for the translation of measurements. For criterion validity, 111 children with cerebral palsy (mean age; 12year 1mo±3year 7mo; range 5-18) were rated the Japanese version of the FMS and Gross Motor Function Classification System (GMFCS). For intra-rater reliability, the Japanese version of the FMS was rated twice by 24 parents of children with cerebral palsy by interview and/or telephone with a one- to two-week interval between assessments.

**RESULTS:** The criterion validity was confirmed with a strong correlation between GMFCS level and FMS scores ( $r(2)=-0.71$  to  $-0.75$ ). For intra-rater reliability, there was a substantial to excellent level of agreement ( $\kappa=0.72-0.87$ ).

**CONCLUSION:** The study provides evidence of the criterion validity and intra-rater reliability of the Japanese version of the FMS as a measurement of mobility in children with cerebral palsy.

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PMID: 28735158

### **The Relationships Between Capacity and Performance in Youths With Cerebral Palsy Differ for GMFCS Levels.**

Ho PC, Chang CH, Granlund M, Hwang AW.

*Pediatr Phys Ther.* 2017 Jan;29(1):23-29.

**PURPOSE:** To examine change in, and longitudinal relationships between motor capacity and activity performance across the Gross Motor Function Classification System (GMFCS).

**METHODS:** Ninety-two youths with cerebral palsy were examined at 2 time points, 1 year apart, using the Gross Motor Function Measure-66 (GMFM-66) for motor capacity, and the Chinese version of the Activities Scale for Kids-Performance Version (ASKp-C) for activity performance. The score changes and capacity-to-performance/performance-to-capacity pathways were explored across GMFCS levels.

**RESULTS:** The GMFM-66 scores declined over time in GMFCS levels IV-V while ASKp-C scores increased in GMFCS level I. The correlations for both pathways in GMFCS levels I, III, and IV-V were significant with a higher correlation for performance-to-capacity pathway in GMFCS levels IV-V.

**CONCLUSIONS:** Longitudinal changes in and relationships between capacity and performance differ between GMFCS levels. The opportunities to perform activities need to be emphasized in GMFCS levels IV-V.

DOI: 10.1097/PEP.0000000000000332

PMID: 27984462 [Indexed for MEDLINE]

### **The Reliability of the Segmental Assessment of Trunk Control (SATCo) in Children with Cerebral Palsy.**

Hansen L, Erhardtsen KT, Bencke J, Magnusson SP, Curtis DJ.

*Phys Occup Ther Pediatr.* 2017 Jul 27:1-14. doi: 10.1080/01942638.2017.1337662. [Epub ahead of print]

**AIMS:** To assess the live-versus-video, intrarater interday and interrater interday reliability of the test Segmental Assessment of Trunk Control (SATCo), which seeks to estimate the degree of sitting trunk control in children with cerebral palsy (CP).

**METHOD:** Thirty-one children with CP between 9 months and 16 years of age (22 males, mean age 8y 10mo [SD 3y 5mo], Gross Motor Function Classification System level I [n = 13], II [n = 4], III [n = 4], IV [n = 3], and V [n = 7]) were included. Children were tested twice by two raters and tests were video recorded. Wilcoxon Signed-Rank Test, ICC [2,1] and a descriptive measure for absolute reliability were applied.

RESULTS: No systematic differences were found between live-versus-video, between raters or days ( $p > 0.05$ ) except for one analysis. All ICC values were excellent ( $ICC \geq 0.9$ ) except for one analysis for which it was good ( $ICC = 0.73$ ). Complete agreement between scores was seen in 75% of all cases while 22% differed by one segmental level. Only 3% showed disagreement above one segmental level.

CONCLUSIONS: SATCo is a clinically applicable assessment tool. Relative reliability is excellent and absolute agreement is good. Modifications regarding testing method could potentially improve the reliability and the value of the test in research and in clinical practice.

DOI: 10.1080/01942638.2017.1337662

PMID: 28749721

### **Toe Walking: When Do We Need to Worry?**

Morozova OM , Chang TF , Brown ME .

*Curr Probl Pediatr Adolesc Health Care.* 2017 Jul 14. pii: S1538-5442(17)30120-7. doi: 10.1016/j.cppeds.2017.06.004. [Epub ahead of print]

Toe walking refers to the lack of heel strike during the stance phase of the gait cycle. It is a common variation of normal gait development in children. Persistent toe walking past 2-3 years of age warrants further evaluation as toe walking can be associated with cerebral palsy, muscular dystrophy, and autism spectrum disorders. The diagnosis of idiopathic toe walking is a diagnosis of exclusion used for children with persistent toe walking and no associated medical condition. Despite variable pathophysiology, the treatment of toe walking has similarities across diagnoses as it is focused on the maintenance of range of motion through the ankle.

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DOI: 10.1016/j.cppeds.2017.06.004

PMID: 28716514

### **Tone-Inhibiting Insoles Enhance the Reciprocal Inhibition of Ankle Plantarflexors of Subjects With Hemiparesis After Stroke: An Electromyographic Study.**

Takahashi N , Takahashi H , Takahashi O , Ushijima R , Umebayashi R , Nishikawa J , Okajima Y .

*PM R.* 2017 Jul 20. pii: S1934-1482(17)30702-5. doi: 10.1016/j.pmrj.2017.07.004. [Epub ahead of print]

BACKGROUND: Spasticity is a common sequela of upper motor neuron pathology, such as cerebrovascular diseases and cerebral palsy. Intervention for spasticity of the ankle plantarflexors in physical therapy may include tone-inhibiting casting and/or orthoses for the ankle and foot. However, the physiological mechanism of tone reduction by such orthoses remains unclarified.

OBJECTIVE: To investigate the electrophysiologic effects of tone-inhibiting insoles in stroke subjects with hemiparesis by measuring changes in reciprocal Ia inhibition (RI) in the ankle plantarflexor.

DESIGN: An interventional before-after study. SETTING: Acute stroke unit or ambulatory rehabilitation clinic of a university hospital in Japan. PARTICIPANTS: Ten subjects (47-84 years) with hemiparesis and 10 healthy male control subjects (31-59 years) were recruited.

METHODS: RI of the spastic soleus in response to the electrical stimulation of the deep peroneal nerve was evaluated by stimulus-locked averaging of rectified electromyography (EMG) of the soleus while subjects were standing.

MAIN OUTCOME MEASUREMENTS: The magnitude of RI, defined as the ratio of the lowest to the baseline amplitude of the rectified EMG at approximately 40 milliseconds after stimulation, was measured while subjects were standing with and without the tone-inhibiting insole on the hemiparesis side.

RESULTS: Enhancement of EMG reduction with the tone-inhibiting insole was significant ( $P < .05$ ) in the subjects with hemiparesis, whereas no significant changes were found in controls.

CONCLUSION: Tone-inhibiting insoles enhanced RI of the soleus in subjects after stroke, which might enhance standing stability by reducing unfavorable ankle plantarflexion tone.

LEVEL OF EVIDENCE: To be determined.

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DOI: 10.1016/j.pmrj.2017.07.004

PMID: 28736326

## Cognition

### **Characterizing Computer Access Using a One-Channel EEG Wireless Sensor.**

Molina-Cantero AJ , Guerrero-Cubero J , Gómez-González IM , Merino-Monge M , Silva-Silva JJ .  
*Sensors (Basel)*. 2017 Jun 29;17(7). pii: E1525. doi: 10.3390/s17071525.

This work studies the feasibility of using mental attention to access a computer. Brain activity was measured with an electrode placed at the Fp1 position and the reference on the left ear; seven normally developed people and three subjects with cerebral palsy (CP) took part in the experimentation. They were asked to keep their attention high and low for as long as possible during several trials. We recorded attention levels and power bands conveyed by the sensor, but only the first was used for feedback purposes. All of the information was statistically analyzed to find the most significant parameters and a classifier based on linear discriminant analysis (LDA) was also set up. In addition, 60% of the participants were potential users of this technology with an accuracy of over 70%. Including power bands in the classifier did not improve the accuracy in discriminating between the two attentional states. For most people, the best results were obtained by using only the attention indicator in classification. Tiredness was higher in the group with disabilities (2.7 in a scale of 3) than in the other (1.5 in the same scale); and modulating the attention to access a communication board requires that it does not contain many pictograms (between 4 and 7) on screen and has a scanning period of a relatively high  $t_s c a n \approx 10$  s. The information transfer rate (ITR) is similar to the one obtained by other brain computer interfaces (BCI), like those based on sensorimotor rhythms (SMR) or slow cortical potentials (SCP), and makes it suitable as an eye-gaze independent BCI.

#### [Free PMC Article](#)

DOI: 10.3390/s17071525

PMCID: PMC5539498

PMID: 28661425

Conflict of interest statement: The authors declare no conflict of interest.

## Traitement - Rééducation motrice et cognitive

### Pharmacologie Efficacite Tolérance

#### **Botulinum Toxin Injections in Musculoskeletal Disorders.**

Godoy IR , Donahue DM , Torriani M .

*Semin Musculoskelet Radiol*. 2016 Nov;20(5):441-452. doi: 10.1055/s-0036-1594284. Epub 2016 Dec 21.

Botulinum toxin (BTX) is used for multiple clinical indications due to its ability to induce temporary chemodenervation and muscle paralysis. This property has supported its application in treating a variety of musculoskeletal conditions, especially those involving muscular hyperactivity and contractures such as cerebral palsy and dystonia. However, off-label use of BTX injection in other musculoskeletal disorders is gaining increased acceptance, such as in neurogenic thoracic outlet syndrome, epicondylitis, and shoulder pain after stroke. This review discusses the mechanism of action, best practices, and current indications of BTX injections in the musculoskeletal system. We also discuss the state of the science regarding BTX injections for musculoskeletal disorders and the available evidence supporting its use.

Thieme Medical Publishers 333 Seventh Avenue, New York, NY 10001, USA.

DOI: 10.1055/s-0036-1594284

PMID: 28002866 [Indexed for MEDLINE]

#### **Can High-Dose Levetiracetam Be Safe? A Case Report of Prolonged Accidental High-Dose Levetiracetam Administration and Review of the Literature.**

Kartal A .

*Clin Neuropharmacol*. 2017 Jul 4. doi: 10.1097/WNF.000000000000229. [Epub ahead of print]

Levetiracetam is an antiepileptic drug that has been used both as adjunctive therapy and monotherapy in pediatric patients with epilepsy. We report a patient with cerebral palsy and epilepsy who took 200 mg/kg per day of levetiracetam for 55 days with no apparent adverse effects. Four other cases of accidental overdose were found in the literature; none of these was associated with any apparent adverse effects. These findings suggest that, in at least some cases, levetiracetam doses much higher than the recommended maximum of 60 mg/kg per day can be administered without apparent adverse effects.

DOI: 10.1097/WNF.0000000000000229

PMID: 28682928

### **Muscle disuse caused by botulinum toxin injection leads to increased central gain of the stretch reflex in the rat.**

Pingel J , Hultborn H , Naslund-Koch L, Jensen DB, Wienecke J , Nielsen JB .

*J Neurophysiol.* 2017 Jul 19;jn.00276.2017. doi: 10.1152/jn.00276.2017. [Epub ahead of print]

Botulinum toxin (Btx) is used in children with cerebral palsy and other neurological patients to diminish spasticity and reduce the risk of development of contractures. Here, we investigated changes in the central gain of the stretch reflex circuitry in response to botulinum toxin injection in the triceps surae muscle in rats. Experiments were performed in 21 rats. 8 rats were in a control group and 13 rats were injected with 6 IU of Btx in the left triceps surae muscle. Two weeks after Btx injection larger monosynaptic reflexes (MSR) were recorded from the left (injected) than the right (non-injected) L4 + L5 ventral roots following stimulation of the corresponding dorsal roots. A similar increase on the left side was observed in response to stimulation of descending motor tracts, suggesting that increased excitability of spinal motor neurones may at least partly explain the increased reflexes. However, significant changes were also observed in post-activation depression of the MSR suggesting that plastic changes in transmission from Ia afferent to the motor neurons may also be involved. The data demonstrate that muscle paralysis induced by Btx injection is accompanied by plastic adaptations in the central stretch reflex circuitry, which counteract the antispastic effect of Btx.

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PMID: 28724781

## **Chirurgie**

### **Changes in hip abductor moment 3 or more years after femoral derotation osteotomy among individuals with cerebral palsy.**

Boyer ER , Novacheck TF , Schwartz MH .

*Dev Med Child Neurol.* 2017 Jun 29. doi: 10.1111/dmcn.13494. [Epub ahead of print]

**AIM:** To examine the effect of femoral derotation osteotomy (FDO) on dimensionless hip abductor moment during gait in children with cerebral palsy.

**METHODS:** We retrospectively analyzed data from independent ambulators within our database. Postoperative visits 1 year (short-term) and at least 3 years (mid-term) were analyzed. We estimated the coronal plane hip abductor moment arm based on musculoskeletal modeling that accounted for anteversion and hip rotation.

**RESULTS:** There were 140 individuals with a short-term analysis (77 males, 63 females; age at surgery 9y 11mo [range 4y 5mo-17y 5mo]) and 29 with mid-term analysis (15 males, 14 females; age at surgery 8y 7mo [range 4y 5mo-13y 1mo]). At short-term, anteversion and internal hip rotation decreased 35° and 13° respectively, which increased median (IQR) moment arms from 20 (23) per cent below normal to 2 (12) per cent above normal. Dimensionless mean hip abductor moment remained unchanged at short-term. Mid-term anteversion did not change but hip rotation increased 8° and hip abductor moment increased to 0.040 (0.029). There was no change in pelvic and trunk obliquity, although hip abductor strength increased and walking velocity decreased at mid-term.

**INTERPRETATION:** The unexpected lack of improvement in hip abductor moment from pre- to short-term may be caused by gait compensations that unload the hip. The increase in hip abductor moment beyond 3 years postoperatively underscores the benefits of an FDO into adolescence for independent ambulating individuals with cerebral palsy.

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PMID: 28660621

### **Comparison of mid-term efficacy of spastic flatfoot in ambulant children with cerebral palsy by 2 different methods.**

Wen J , Liu H, Xiao S, Li X, Fang K, Zeng M, Tang Z, Cao S, Li F.

*Medicine (Baltimore)*. 2017 Jun;96(22):e7044. doi: 10.1097/MD.0000000000007044.

To compare the treatment efficacy of spastic flatfoot surgery by 2 different surgical methods: nonfusion subtalar arthroereisis using subtalar joint stabilizer (SJS) and Dennyson-Fulford subtalar arthrodesis (D-FSA). A total of 26 cases of ambulant children with cerebral palsy diagnosed as spastic flatfoot were surgically treated from January 2011 to December 2014. Preoperative and postoperative American Orthopedic Foot and Ankle Society-Ankle and Hindfoot (AOFAS-AH) scores, anteroposterior-talocalcaneal angles (ATAs), and lateral talar-first metatarsal angles (Meary angles) of the affected foot were recorded. Among 12 children in the SJS group, the AOFAS-AH scores were median preoperative score of 61 (58-64) versus median postoperative score of 83 (75-92), with significant difference ( $P < .05$ ). Of the 20 feet treated, only 1 foot developed occasional pain. Postoperative ATA was decreased from preoperative  $35^\circ$  ( $20^\circ$ - $50^\circ$ ) to  $19^\circ$  ( $12^\circ$ - $25^\circ$ ); lateral X-ray films showed that the Meary angle was decreased from preoperative  $20^\circ$  ( $15^\circ$ - $40^\circ$ ) to postoperative  $0^\circ$  ( $0^\circ$ - $3^\circ$ ). The differences in both findings were statistically significant ( $P < .05$ ). Fourteen children (22 treated feet) formed the D-FSA group; all demonstrated fusion of the talocalcaneal joint; AOFAS-AH scores were median preoperative score of 61 (58-64) versus median postoperative score of 83 (75-92), with significant difference ( $P < .05$ ). Only 1 foot had occasional pain. Postoperative ATA was decreased from preoperative  $35^\circ$  ( $20^\circ$ - $45^\circ$ ) to  $16^\circ$  ( $12^\circ$ - $25^\circ$ ); lateral X-ray films showed that the Meary angle was decreased from preoperative  $19^\circ$  ( $10^\circ$ - $40^\circ$ ) to postoperative  $2^\circ$  ( $0^\circ$ - $5^\circ$ ); the differences in both findings were statistically significant ( $P < .05$ ). Both nonfusion subtalar arthroereisis using SJS and D-FSA were effective for the surgical treatment of spastic flatfoot, with similar clinical outcomes.

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DOI: 10.1097/MD.0000000000007044

PMCID: PMC5459726

PMID: 28562561 [Indexed for MEDLINE]

### **Factors Contributing to Satisfaction with Changes in Physical Function after Orthopedic Surgery for Musculoskeletal Dysfunction in Patients with Cerebral Palsy.**

Kusumoto Y , Nitta O , Matsuo A , Takaki K , Matsuda T .

*PLoS One*. 2016 May 2;11 :e0154749. doi: 10.1371/journal.pone.0154749. eCollection 2016.

**BACKGROUND:** The recognition of required treatments for cerebral palsy (CP) patients, including orthopedic surgery, differs according to region. This study was performed to identify factors associated with satisfactory changes in physical function after orthopedic surgery.

**METHODS:** 358 patients were selected for the questionnaire survey. The following information was collected: gender, primary disease, age of initial surgery, total procedural count, operated sites, satisfaction of postoperative rehabilitation frequency, ideal amount of postoperative rehabilitation sessions per week, frequency of voluntary home training per week, satisfaction of the timing of surgery and the current satisfaction with the changes in physical function after the orthopedic surgery. We classified the patients into the satisfied and dissatisfied group according to satisfactory changes in physical function after the surgery. We performed unpaired t-tests and chi-square tests to determine the variables that differed significantly between the groups. Variables with a p value of  $< 0.2$  were included in the multivariate logistic regression analysis.

**RESULTS:** The logistic model was revised and summed up to two potential predictors of postsurgical satisfaction with physical function: satisfaction with the frequency of postoperative rehabilitation sessions and the orthopedic surgery of the hip (distinction hit ratio, 75.4%).

**CONCLUSIONS:** This study demonstrated that the frequency of postoperative rehabilitation and history of hip surgery seemed to be related to the satisfaction with the changes in physical function after orthopedic surgery.

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PMCID: PMC4852902

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PMID: 27135609 [Indexed for MEDLINE]

### **Spasticity secondary to Leigh syndrome managed with selective dorsal rhizotomy: a case report.**

Mazarakis NK , Vloeberghs MH .

*Childs Nerv Syst.* 2016 Sep;32(9):1745-8. doi: 10.1007/s00381-016-3071-9. Epub 2016 Apr 4.

**PURPOSE:** Selective dorsal rhizotomy (SDR) is a surgical technique used to treat spasticity in children secondary to cerebral palsy (CP).

**METHOD:** We report, to the best of our knowledge for the first time, the case of a child who underwent SDR for the management of spasticity secondary to Leigh syndrome.

**RESULT:** SDR resulted in excellent functional outcome with significant improvement in spasticity. This result contributes to the mounting evidence that SDR could be used to alleviate spasticity secondary not only to CP but also to other pathologies as well.

DOI: 10.1007/s00381-016-3071-9

PMID: 27041374 [Indexed for MEDLINE]

### **Total Wrist Arthrodesis: Indications and Clinical Outcomes.**

Wei DH , Feldon P.

*J Am Acad Orthop Surg.* 2017 Jan;25(1):3-11. doi: 10.5435/JAAOS-D-15-00424.

Total wrist arthrodesis remains an important technique in the surgical armamentarium of upper extremity surgeons. The procedure has evolved over time but continues to provide reliable pain relief at the expense of wrist motion. It is indicated for management of a wide variety of upper extremity conditions, including rheumatoid arthritis, posttraumatic osteoarthritis, cerebral palsy, and brachial plexus injuries, and as a salvage technique after failed implant arthroplasty. Recent studies demonstrate high levels of patient satisfaction and good functional outcomes after bilateral wrist fusion. Compared with total wrist arthroplasty, total wrist arthrodesis provides more reliable pain relief with lower rates of complications, but further studies are needed to compare functional outcomes and cost-effectiveness.

DOI: 10.5435/JAAOS-D-15-00424

PMID: 27893490 [Indexed for MEDLINE]

## **Réadaptation fonctionnelle**

### **A Critical Evaluation of the Updated Evidence for Casting for Equinus Deformity in Children with Cerebral Palsy.**

Tustin K , Patel A .

*Physiother Res Int.* 2017 Jan;22(1). doi: 10.1002/pri.1646. Epub 2015 Sep 9.

**ACKGROUND AND PURPOSE:** Equinus deformity is common in ambulant children with cerebral palsy (CP). Although lower leg casting is frequently used, the physiological basis for casting and effects beyond range of motion (ROM) gains are unclear. This review critically evaluates the updated evidence for casting in the management of ankle equinus in children with CP.

**METHODS:** Comprehensive searches were conducted using electronic databases AMED, MEDLINE, CINAHL, Scopus, PEDro and the Cochrane Database of Systematic Reviews, publication years 2005-2014, in order to identify literature published since an earlier comprehensive systematic review. Only studies evaluating lower leg casting for conservative management of equinus deformity in children with CP were considered. Two independent raters critically appraised studies against the hierarchy of levels of evidence and rigour of study conduct questions proposed by the American Academy of Cerebral Palsy and Developmental Medicine's methodology for systematic review.

**RESULTS:** Four relevant systematic reviews were identified, although these largely concerned earlier literature. Five original studies were included, all demonstrating improvement in dorsiflexion ROM. Combined treatment with botulinum toxin and casting offered greater and/or more sustained ROM gains than botulinum toxin alone in three studies. Effects on gait parameters and motor function were inconsistent. Participation outcomes were not evaluated. Methodological limitations make firm conclusions difficult.

**CONCLUSIONS:** Recent years have offered little progress in the state of evidence for casting in the management of equinus deformity. Casting appears to offer at least short-term improvement in ankle dorsiflexion, although the proposition that this improves function or avoids surgery is not well substantiated. Future research needs to ensure more robust study design and broader evaluation across domains of the International Classification of Functioning, Disability and Health to determine the functional and long-term effect of casting for equinus deformity. Greater knowledge is required of the effect of casting on muscle structure and function in spastic CP.

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DOI: 10.1002/pri.1646

PMID: 26351821 [Indexed for MEDLINE]

### **A device for quantifying physiological and pathological mirror movements in children.**

Jaspers E, Klingels K, Simon-Martinez C, Feys H, Woolley DG, Wenderoth N.

*IEEE Trans Biomed Eng.* 2017 Jul 5. doi: 10.1109/TBME.2017.2723801. [Epub ahead of print] *GriFT:*

**GOAL:** Mirror movements (MM) typically occur during unilateral actions and manifest as involuntary muscle activity of the passive limb, which "mirror" voluntary actions executed by the contralateral homologous body part. They are a normal motor feature in young children and gradually disappear during the first decade of life. In children suffering from neurological disorders, e.g. due to an early brain lesion as in unilateral cerebral palsy, the amplitude and occurrence of MM has been proposed to yield relevant information for diagnosis and therapy. However, in clinical practice MM are typically assessed using an ordinal rating scale, which provides mainly qualitative information. In contrast, there is no validated procedure that allows a quantitative assessment that might offer more objective and detailed information regarding the occurrence and amount of MM. Here we introduce the Grip Force Tracking Device (GriFT Device), a portable system to quantitatively assess MM during repetitive unimanual squeezing whilst playing a computer game. The GriFT Device consists of two identical equally sized handles equipped with two compressive force sensors (range 0-23kg, Fz 1000Hz). Children had to complete three trials of unimanual squeezing, whereby the visual display on the screen determined the rhythm of squeezing (0.67Hz at 15% maximum voluntary contraction, force level adjusted per hand). MM were characterized based on their frequency, strength, and temporal features (synchronization and time lag). These MM characteristics differed significantly between children with different clinical MM scores, and MM frequency and strength were most discriminative. Further categorization of physiological MM based on their frequency and strength proved highly sensitive (89-97%). We demonstrated feasibility and validity of the GriFT Device in a large cohort of typically developing children aged 5 to 15 years, as well as its clinical applicability in children with unilateral cerebral palsy with various levels of hand function. The quantification of MM as proposed in the current study is a promising tool to further investigate and categorize MM in children with unilateral cerebral palsy.

DOI: 10.1109/TBME.2017.2723801

PMID: 28692958

### **Does Corticospinal Tract Connectivity Influence the Response to Intensive Bimanual Therapy in Children With Unilateral Cerebral Palsy?**

Smorenburg AR, Gordon AM, Kuo HC, Ferre CL, Brandao M, Bleyenheuft Y, Carmel JB, Friel KM.

*Neurorehabil Neural Repair.* 2017 Mar;31(3):250-260. doi: 10.1177/1545968316675427. Epub 2016 Nov 17.

**BACKGROUND:** Reorganization of the corticospinal tract (CST) can occur in unilateral spastic cerebral palsy (USCP). The affected hand can be controlled via (1) typical contralateral projections from the lesioned hemisphere, (2) ipsilateral projections from the nonlesioned hemisphere, and (3) a combination of contralateral and ipsilateral projections (ie, bilateral). Intensive bimanual therapy and constraint-induced movement therapy (CIMT) improve hand function of children with USCP. Earlier it was suggested that the CST connectivity pattern may influence the efficacy of CIMT.

**OBJECTIVE:** To examine whether CST projection pattern influences the efficacy of intensive bimanual therapy in children with USCP.

**PARTICIPANTS:** Thirty-three children with USCP (age  $8.9 \pm 2.6$  years, 16 females).

**METHODS:** Bimanual therapy was provided in a day-camp setting (90 hours). Participants were involved in different bimanual play and functional activities actively engaging both hands. Hand function was tested before and after the [Science Infos Paralysie Cérébrale, Juillet 2017, FONDATION PARALYSIE CEREBRALE 67 rue Vergniaud 39 75013 Paris - tel +33 1 45 54 03 03 contact: Christine Doumergue cdoumergue@lafondationmotrice.org](#)

intervention with the Jebsen-Taylor Test of Hand Function, Assisting Hand Assessment, ABILHAND-Kids, and the Canadian Occupational Performance Measure. Single-pulse transcranial magnetic stimulation (TMS) was used to determine each child's CST projection pattern (ie, ipsilateral, contralateral, or bilateral).

**RESULTS:** Children whose affected hand was controlled only by ipsilateral CST projections had worse Jebsen-Taylor Test of Hand Function and Assisting Hand Assessment scores than children in the contralateral group at baseline. Bimanual hand use and functional hand use was independent of CST projection pattern. After bimanual therapy, improvements on all outcome measures were observed, and these improvements were independent of the CST connectivity pattern.

**CONCLUSION:** The efficacy of bimanual therapy on hand function in children with USCP appears to be independent of CST connectivity pattern.

DOI: 10.1177/1545968316675427

PMID: 27856938 [Indexed for MEDLINE]

### **Effects of Combined Exercise Training on Functional Performance in Children With Cerebral Palsy: A Randomized-Controlled Study.**

Peungsuwan P, Parasin P, Siritaratiwat W, Prasertnu J, Yamauchi J.

*Pediatr Phys Ther.* 2017 Jan;29(1):39-46.

**PURPOSE:** The purpose of this study was to investigate the effects of combined exercise training on functional performance in participants with cerebral palsy. **METHODS:** Fifteen participants with spastic cerebral palsy were randomly allocated into either exercise or control groups. Participants in the exercise group participated in a combined strength and endurance training program for 70 minutes per day, 3 days per week, for 8 weeks, whereas those in the control group did not participate in an exercise program. Study participants in both groups continued with their regular physical therapy during the study.

**RESULTS:** After the 8-week training, a 6-minute walk, 30-second sit-to-stand, 10-m walk, and Functional Reach Tests, participants in the exercise group had significant improvement over their baseline values and were significantly higher than those in the control group.

**CONCLUSIONS:** Combined exercise training improved walking ability, functional lower limb strength, and balance in participants with cerebral palsy.

DOI: 10.1097/PEP.0000000000000338

PMID: 27984466 [Indexed for MEDLINE]

### **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 [Indexed for MEDLINE]

### **Imaging Predictors of Improvement From a Motor Learning-Based Intervention for Children With Unilateral Cerebral Palsy.**

Schertz M, Shiran SI, Myers V, Weinstein M, Fattal-Valevski A, Artzi M, Ben Bashat D, Gordon AM, Green D.

*Neurorehabil Neural Repair.* 2016 Aug;30(7):647-60. doi: 10.1177/1545968315613446. Epub 2015 Nov 11.

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Background Motor-learning interventions may improve hand function in children with unilateral cerebral palsy (UCP) but with inconsistent outcomes across participants. Objective To examine if pre-intervention brain imaging predicts benefit from bimanual intervention. Method Twenty children with UCP with Manual Ability Classification System levels I to III, aged 7-16 years, participated in an intensive bimanual intervention. Assessments included the Assisting Hand Assessment (AHA), Jebsen Taylor Test of Hand Function (JTTHF) and Children's Hand Experience Questionnaire (CHEQ) at baseline (T1), completion (T2) and 8-10 weeks post-intervention (T3). Imaging at baseline included conventional structural (radiological score), functional (fMRI) and diffusion tensor imaging (DTI). Results Improvements were seen across assessments; AHA ( $P = 0.04$ ), JTTHF ( $P < .001$ ) and CHEQ ( $P < 0.001$ ). Radiological score significantly correlated with improvement at T2; AHA ( $r = .475$ ) and CHEQ ( $r = .632$ ), but negatively with improvement on unimanual measures at T3 (JTTHF  $r = -.514$ ). fMRI showed negative correlations between contralesional brain activation when moving the affected hand and AHA improvements (T2:  $r = -.562$ , T3:  $r = -.479$ ). Fractional Anisotropy in the affected posterior limb of the internal capsule correlated negatively with increased bimanual use on CHEQ at T2 ( $r = -.547$ ) and AHA at T3 ( $r = -.656$ ). Conclusions Children with greater structural, functional and connective brain damage showed enhanced responses to bimanual intervention. Baseline imaging may identify parameters predicting response to intervention in children with UCP.

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DOI: 10.1177/1545968315613446

PMID: 26564999 [Indexed for MEDLINE]

### **Improvements in Kinematic Performance After Home-Based Bimanual Intensive Training for Children with Unilateral Cerebral Palsy.**

Hung YC, Ferre CL, Gordon AM.

*Phys Occup Ther Pediatr.* 2017 Jul 28;1-12. doi: 10.1080/01942638.2017.1337663. [Epub ahead of print]

AIMS: To evaluate the effects of home-based intensive bimanual training for children with unilateral spastic cerebral palsy (USCP) on bimanual coordination using 3-D kinematic analyses.

METHODS: Seven children with USCP (aged 29-54 months, MACS level: I-III) received 90 hours (2 hrs/day, 5days/week for 9 weeks) of Home Hand-Arm Bimanual Intensive Training (H-HABIT) provided by trained caregivers. A bimanual drawer-opening task was evaluated with eight infrared cameras using VICON workstation4.6 before and after training to assess improvements in bimanual coordination.

RESULTS: H-HABIT training significantly decreased the time between one hand opening the drawer and the other hand manipulating its contents ( $p < 0.05$ ) and increased the percentage of time when both hands were moving simultaneously ( $p = 0.001$ ), which are indicators of improved temporal bimanual coordination. In addition, participants demonstrated a 26% decrease in trunk displacement ( $p < 0.05$ ), a 30% increase in upper arm joint excursion ( $p < 0.01$ ), and a 25% increase in elbow extension ( $p < 0.05$ ) for the affected side. All the improvements were maintained at 6-month posttest.

CONCLUSIONS: H-HABIT improved not only temporal, but also quality of movement during a bimanual task for seven children with USCP. Thus, H-HABIT could be an alternative or adjunctive treatment for children with USCP.

DOI: 10.1080/01942638.2017.1337663

PMID: 28753082

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

Gannotti ME(1), 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

### **Perspectives on rehabilitation of children with cerebral palsy: exploring a cross-cultural view of parents from India and Canada using the international classification of functioning, disability and health.**

Jindal P , MacDermid JC , Rosenbaum P , DiRezze B , Narayan A .

*Disabil Rehabil.* 2017 Jul 26;1-11. doi: 10.1080/09638288.2017.1356383. [Epub ahead of print]

**PURPOSE:** To explore parents' perspectives on rehabilitation of their child with cerebral palsy and their information needs.

**METHODS:** Semistructured interviews were conducted with parents of children with CP from India (n = 11) and Canada (n = 7). Data were analyzed through an interpretive description approach using the International Classification of Functioning, Disability and Health framework.

**RESULTS:** Body Structure and Function: Indian parents were more focused on fixing body structure and function challenges, and independent walking, than Canadian parents. Activity and Participation: All Canadian children were actively involved in school and fun activities in the community. Due to lack of accessible services, Indian children had less school and community participation. Environmental factors: accessible communities, occupational therapy services and greater use of assistive devices enabled Canadian children. Social and cultural beliefs, lack of access to services and inaccessible communities were the barriers experienced by Indian parents. Information needs: both groups needed information to make their child more functional.

**CONCLUSION:** Canadian parents experience a more enabling environment and express a more social view of their child's health, suggesting both education on the International Classification of Functioning, Disability and Health principles and services are needed to better enable and empower Indian parents. There remains a need for healthcare professionals and services in both countries to be more family-centered. Implications for rehabilitation To help parents in rehabilitating their children with cerebral palsy (CP), in India, there is a need to (1) incorporate ICF education into medical curricula and clinical practice; (2) increase the availability of skilled healthcare professionals and centers; (3) make infrastructural and policy reforms to make the society more accessible for the disabled children. Education, counseling and awareness about CP might help both groups of parents, society, and HCPs to change their beliefs and attitudes regarding CP and its rehabilitation. Both countries would benefit from user-friendly and transparent policies. This will help parents to become more aware of them and use them in the rehabilitation process.

DOI: 10.1080/09638288.2017.1356383

PMID: 28747138

### **Standing activity intervention and motor function in a young child with cerebral palsy: A case report.**

Audu O , Daly C .

*Physiother Theory Pract.* 2017 Feb;33(2):162-172. doi: 10.1080/09593985.2016.1265621. Epub 2017 Jan 10.

**PURPOSE:** There is limited evidence to fully justify the use of standing interventions for children with cerebral palsy (CP). This case report describes the impact of an 8-week standing program on motor function in a child with severe CP living in western Africa.

**METHODS:** The subject was diagnosed with ischemic - hypoxic encephalopathy shortly after birth and with CP at 12 months of age. Gross Motor Function Classification of CP was level IV. Early attempts at physical therapy were interrupted by limited access to medical services. At 18 months, a standing program using a locally constructed standing frame was initiated. The standing intervention was completed at home 5 times a week for 8 weeks. Motor skills were assessed at baseline and post-intervention using the Gross Motor Function Measure (GMFM-66).

**RESULTS:** Scores on the GMFM-66 increased from 28 at baseline to 37.4 in 8 weeks. Improvements in motor function included improved head control, improved upper extremity function, and increased sitting ability.

**CONCLUSIONS:** Implementation of a home-based standing program may have contributed to improved motor skills for this child. Further research is needed to determine the effect of standing interventions on functional motor development for children with severe CP.

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PMID: 28071965 [Indexed for MEDLINE]

**Task-Specific and Functional Effects of Speed-Focused Elliptical or Motor-Assisted Cycle Training in Children With Bilateral Cerebral Palsy: Randomized Clinical Trial.**

Damiano DL , Stanley CJ , Ohlrich L , Alter KE .

*Neurorehabil Neural Repair.* 2017 Aug;31(8):736-745. doi: 10.1177/1545968317718631. Epub 2017 Jul 8.

**BACKGROUND:** Locomotor training using treadmills or robotic devices is commonly utilized to improve gait in cerebral palsy (CP); however, effects are inconsistent and fail to exceed those of equally intense alternatives. Possible limitations of existing devices include fixed nonvariable rhythm and too much limb or body weight assistance.

**OBJECTIVE:** To quantify and compare effectiveness of a motor-assisted cycle and a novel alternative, an elliptical, in CP to improve interlimb reciprocal coordination through intensive speed-focused leg training.

**METHODS:** A total of 27 children with bilateral CP, 5 to 17 years old, were randomized to 12 weeks of 20 minutes, 5 days per week home-based training (elliptical = 14; cycle = 13) at a minimum of 40 revolutions per minute, with resistance added when speed target was achieved. Primary outcomes were self-selected and fastest voluntary cadence on the devices and gait speed. Secondary outcomes included knee muscle strength, and selective control and functional mobility measures.

**RESULTS:** Cadence on trained but not nontrained devices increased, demonstrating task specificity of training and increased exercise capability. Mean gait speed did not increase in either group, nor did parent-reported functional mobility. Knee extensor strength increased in both. An interaction between group and time was seen in selective control with scores slightly increasing for the elliptical and decreasing for the cycle, possibly related to tighter limb coupling with cycling.

**CONCLUSIONS:** Task-specific effects were similarly positive across groups, but no transfer was seen to gait or function. Training dose was low ( $\leq 20$  hours) compared with intensive upper-limb training recommendations and may be insufficient to produce appreciable clinical change.

DOI: 10.1177/1545968317718631

PMID: 28691601

**The effect of reflexology upon spasticity and function among children with cerebral palsy who received physiotherapy: Three group randomised trial**

Özkan F , Zincir H .

*Appl Nurs Res.* 2017 Aug;36:128-134. doi: 10.1016/j.apnr.2017.05.011. Epub 2017 May 27.

**PURPOSE:** To assess the effectiveness of reflexology method upon spasticity and function among children with cerebral palsy who received physiotherapy.

**METHODS:** A three group, randomised trial with blinded evaluator. Randomization was made sealed and opaque envelopes. 45 children with cerebral palsy who were trained at a Special Education and Rehabilitation Centre. In the reflexology and placebo group; a 20min reflexology was performed twice a week in a total 24 sessions. In the control group; no intervention was done. Before and after the implementation; measurements of the participants were obtained. The data were collected using Gross Motor Function Measure, Modified Ashworth Scale (MAS), Modified Tardieu Scale, Pediatric Functional Independence Scale, Pediatric Quality of Life Scale (PedsQL) and demographic data.

**RESULTS:** A total of 45 children completed the study. The groups were homogeneous at baseline. Between right MAS Gastrocnemius muscle was a difference and right and left Soleus muscles was significant among the groups ( $p < 0.05$ ). Also; there was significant difference in between right and left Tardieu value in the legs; right M. Gastrocnemius V1, V3 and M. Soleus V1, V3 values;  $p < 0.001$  and left Gastrocnemius V1 and M. Soleus V1, V3 values;  $p < 0.001$ . In Gross Motor Function Measure total scores and sitting position; in Pediatric Functional Independence Scale total scores, self-care and communication subscales ( $p < 0.05$ ). But in terms of PedsQL was no statistically significant difference among the groups ( $p > 0.05$ ).

**CONCLUSIONS:** Reflexology with physiotherapy reduced spasticity in legs, improved gross motor functions, decreased dependency but led to no change in quality of life.

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PMID: 28720233

### **The Mirror Illusion Increases Motor Cortex Excitability in Children With and Without Hemiparesis.**

Grunt S , Newman CJ , Saxer S , Steinlin M , Weisstanner C ,Kaelin-Lang A .

*Neurorehabil Neural Repair.* 2017 Mar;31(3):280-289. doi:10.1177/1545968316680483. Epub 2016 Dec 13.

**BACKGROUND:** Mirror therapy provides a visual illusion of a normal moving limb by using the mirror reflection of the unaffected arm instead of viewing the paretic limb and is used in rehabilitation to improve hand function. Little is known about the mechanism underlying its effect in children with hemiparesis.

**OBJECTIVE:** To investigate the effect of the mirror illusion (MI) on the excitability of the primary motor cortex (M1) in children and adolescents.

**METHODS:** Twelve patients with hemiparesis (10-20 years) and 8 typically developing subjects (8-17 years) participated. Corticospinal reorganization was classified as contralateral (projection from contralateral hemisphere to affected hand) or ipsilateral (projection from ipsilateral hemisphere to affected hand). M1 excitability of the hemisphere projecting to the affected (nondominant in typically developing subjects) hand was obtained during 2 different conditions using single-pulse transcranial magnetic stimulation (TMS). Each condition (without/with mirror) consisted of a unimanual and a bimanual task. Motor-evoked potentials (MEPs) were recorded from the abductor pollicis brevis and flexor digitorum superficialis muscles.

**RESULTS:** MEP amplitudes were significantly increased during the mirror condition ( $P = .005$ ) in typically developing subjects and in patients with contralateral reorganization. No significant effect of MI was found in subjects with ipsilateral reorganization. MI increased M1 excitability during active movements only. This increase was not correlated to hand function.

**CONCLUSION:** MI increases the excitability of M1 in hemiparetic patients with contralateral corticospinal organization and in typically developing subjects. This finding provides neurophysiological evidence supporting the application of mirror therapy in selected children and adolescents with hemiparesis.

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### **Treadmill interventions in children under six years of age at risk of neuromotor delay.**

Valentín-Gudiol M , Mattern-Baxter K, Girabent-Farrés M, Bagur-Calafat C, Hadders-Algra M, Angulo-Barroso RM.

*Cochrane Database Syst Rev.* 2017 Jul 29;7:CD009242. doi: 10.1002/14651858.CD009242.pub3.

**BACKGROUND:** Delayed motor development may occur in children with Down syndrome, cerebral palsy, general developmental delay or children born preterm. It limits the child's exploration of the environment and can hinder cognitive and social-emotional development. Literature suggests that task-specific training, such as locomotor treadmill training, facilitates motor development.

**OBJECTIVES:** To assess the effectiveness of treadmill interventions on locomotor development in children with delayed ambulation or in pre-ambulatory children (or both), who are under six years of age and who are at risk for neuromotor delay.

**SEARCH METHODS:** In May 2017, we searched CENTRAL, MEDLINE, Embase, six other databases and a number of trials registers. We also searched the reference lists of relevant studies and systematic reviews.

**SELECTION CRITERIA:** We included randomised controlled trials (RCTs) and quasi-RCTs that evaluated the effect of treadmill intervention in the target population.

**DATA COLLECTION AND ANALYSIS:** Four authors independently extracted the data. Outcome parameters were structured according to the International Classification of Functioning, Disability and Health model.

**MAIN RESULTS:** This is an update of a Cochrane review from 2011, which included five trials. This update includes seven studies on treadmill intervention in 175 children: 104 were allocated to treadmill groups, and 71 were controls. The studies varied in population (children with Down syndrome, cerebral palsy, developmental delay or at moderate risk for neuromotor delay); comparison type (treadmill versus no treadmill; treadmill with versus without orthoses; high- versus low-intensity training); study duration, and assessed outcomes. Due to the diversity of the studies, only data from five studies were used in meta-analyses for five outcomes: age of independent walking onset, overall gross motor function, gross motor function related to standing and walking, and gait velocity. GRADE assessments of quality of the evidence ranged from high to very low. The effects of treadmill intervention on independent walking onset compared to no treadmill intervention was population dependent, but showed no

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overall effect (mean difference (MD) -2.08, 95% confidence intervals (CI) -5.38 to 1.22, 2 studies, 58 children; moderate-quality evidence): 30 children with Down syndrome benefited from treadmill training (MD -4.00, 95% CI -6.96 to -1.04), but 28 children at moderate risk of developmental delay did not (MD -0.60, 95% CI -2.34 to 1.14). We found no evidence regarding walking onset in two studies that compared treadmill intervention with and without orthotics in 17 children (MD 0.10, 95% CI -5.96 to 6.16), and high- versus low-intensity treadmill interventions in 30 children with Down syndrome (MD -2.13, 95% CI -4.96 to 0.70). Treadmill intervention did not improve overall gross motor function (MD 0.88, 95% CI -4.54 to 6.30, 2 studies, 36 children; moderate-quality evidence) or gross motor skills related to standing (MD 5.41, 95% CI -1.64 to 12.43, 2 studies, 32 children; low-quality evidence), and had a negligible improvement in gross motor skills related to walking (MD 4.51, 95% CI 0.29 to 8.73, 2 studies, 32 children; low-quality evidence). It led to improved walking skills in 20 ambulatory children with developmental delay (MD 7.60, 95% CI 0.88 to 14.32, 1 study) and favourable gross motor skills in 12 children with cerebral palsy (MD 8.00, 95% CI 3.18 to 12.82). A study which compared treadmill intervention with and without orthotics in 17 children with Down syndrome suggested that adding orthotics might hinder overall gross motor progress (MD -8.40, 95% CI -14.55 to -2.25). Overall, treadmill intervention showed a very small increase in walking speed compared to no treadmill intervention (MD 0.23, 95% CI 0.08 to 0.37, 2 studies, 32 children; high-quality evidence). Treadmill intervention increased walking speed in 20 ambulatory children with developmental delay (MD 0.25, 95% CI 0.08 to 0.42), but not in 12 children with cerebral palsy (MD 0.18, 95% CI -0.09 to 0.45).

**AUTHORS' CONCLUSIONS:** This update of the review from 2011 provides additional evidence of the efficacy of treadmill intervention for certain groups of children up to six years of age, but power to find significant results still remains limited. The current findings indicate that treadmill intervention may accelerate the development of independent walking in children with Down syndrome and may accelerate motor skill attainment in children with cerebral palsy and general developmental delay. Future research should first confirm these findings with larger and better designed studies, especially for infants with cerebral palsy and developmental delay. Once efficacy is established, research should examine the optimal dosage of treadmill intervention in these populations.

DOI: 10.1002/14651858.CD009242.pub3

PMID: 28755534

## Orthèses

### **Effect of floor reaction ankle-foot orthosis on crouch gait in patients with cerebral palsy: What can be expected?**

Böhm H , Matthias H , Braatz F , Döderlein L .

*Prosthet Orthot Int.* 2017 Jul 1:309364617716240. doi: 10.1177/0309364617716240. [Epub ahead of print]

**BACKGROUND:** Floor reaction ankle-foot orthoses are commonly prescribed to improve knee extension of children with cerebral palsy having crouch gait. Their effectiveness is debated. Therefore, the objective of this study is to optimize current prescription criteria for the improvement of crouch gait.

**STUDY DESIGN:** Cross-sectional interventional study. **METHODS:** A total of 22 patients with bilateral spastic cerebral palsy, between 6 and 17 years, Gross Motor Function Classification System II-IV participated in this study. Instrumented gait analysis was done under three conditions: barefoot, shoed, and with orthotics. Patients were divided into two groups: good and non-responders with more and less than 8.8° improvement of knee extension during walking, respectively. A multiple predictor analysis was done on parameters that were different between groups.

**RESULTS:** In total, 12 of 22 patients showed good response in knee extension with a mean change of 17° (standard deviation = 5°). Good responders showed a significantly smaller walking velocity, knee extension strength, ankle plantarflexion strength, and greater external foot progression angle compared to non-responders. Foot progression angle together with ankle plantarflexion strength explained 37% of the variance in improvement of knee extension.

**CONCLUSION:** With appropriate patient selection, an improvement of crouch gait by ankle-foot orthoses of 17° (standard deviation = 5°) can be expected. Patients with slow velocity, weak plantarflexors, and external foot progression benefit most. Joint contractures were no contraindications. Clinical relevance This study showed that gait in patients with low functional level benefit most from ankle-foot orthoses. Unlike in patients with higher functional status, contractures of hip, knee, and ankle did not reduce the positive effects on gait. The suggested prescription criteria may help to better select appropriate patients for orthotics.

DOI: 10.1177/0309364617716240

## **Efficacy of ankle foot orthoses types on walking in children with cerebral palsy: A systematic review. A mettre dans Orthèses**

Aboutorabi A , Arazpour M , Ahmadi Bani M , Saeedi H , Head JS .

*Ann Phys Rehabil Med.* 2017 Jul 13. pii: S1877-0657(17)30079-9. doi: 10.1016/j.rehab.2017.05.004. [Epub ahead of print]

**BACKGROUND:** Ankle foot orthoses (AFOs) are orthotic devices that can be used to normalize the walking pattern of children with cerebral palsy (CP). One of the aims of orthotic management is to produce a more normal gait pattern by positioning joints in the proper position to reduce pathological reflex or spasticity.

**OBJECTIVE:** To conduct a systematic review of the literature and establish the effect of treatment with various types of AFOs on gait patterns of children with CP.

**METHODS:** PubMed, Scopus, ISI Web of knowledge, Cochrane Library, EMBASE and Google Scholar were searched for articles published between 2007 and 2015 of studies of children with CP wearing the following AFOs: hinged (HAFO), solid (SAFO), floor reaction (FRO), posterior leaf spring (PLS) and dynamic (DAFO). Studies that combined treatment options were excluded. Outcomes investigated were a change in gait pattern and subsequent walking ability. The PEDro scale used to assess the methodological quality of relevant studies.

**RESULTS:** We included 17 studies investigating a total of 1139 children with CP. The PEDro score was poor for most studies (3/10). Only 4 studies, of 209 children in total, were randomized controlled trials, for a good PEDro score (5, 7, 9/10) and an appropriate level of evidence. One study used a case-based series and the remainder a cross-sectional design. In general, the use of AFOs improved speed and stride length. The HAFO was effective for improving gait parameters and decreasing energy expenditure with hemiplegic CP as compared with the barefoot condition. It also improved stride length, speed of walking, single limb support and gait symmetry with hemiplegic CP. The plastic SAFO and FRO were effective in reducing energy expenditure with diplegic CP. With diplegic CP, the HAFO and SAFO improved gross motor function.

**CONCLUSION:** For children with CP, use of specific types of AFOs improved gait parameters, including ankle and knee range of motion, walking speed and stride length. AFOs reduced energy expenditure in children with spastic CP. However, further studies with good PEDro scores are required for more conclusive evidence regarding the effectiveness of AFOs in children with CP.

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PMID: 28713039

## **Simulated impacts of ankle foot orthoses on muscle demand and recruitment in typically-developing children and children with cerebral palsy and crouch gait.**

Rosenberg M , Steele KM .

*PLoS One.* 2017 Jul 13;12(7):e0180219. doi: 10.1371/journal.pone.0180219. eCollection 2017.

Passive ankle foot orthoses (AFOs) are often prescribed for children with cerebral palsy (CP) to assist locomotion, but predicting how specific device designs will impact energetic demand during gait remains challenging. Powered AFOs have been shown to reduce energy costs of walking in unimpaired adults more than passive AFOs, but have not been tested in children with CP. The goal of this study was to investigate the potential impact of powered and passive AFOs on muscle demand and recruitment in children with CP and crouch gait. We simulated gait for nine children with crouch gait and three typically-developing children with powered and passive AFOs. For each AFO design, we computed reductions in muscle demand compared to unassisted gait. Powered AFOs reduced muscle demand 15-44% compared to unassisted walking, 1-14% more than passive AFOs. A slower walking speed was associated with smaller reductions in absolute muscle demand for all AFOs ( $r^2 = 0.60-0.70$ ). However, reductions in muscle demand were only moderately correlated with crouch severity ( $r^2 = 0.40-0.43$ ). The ankle plantarflexor muscles were most heavily impacted by the AFOs, with gastrocnemius recruitment decreasing 13-73% and correlating with increasing knee flexor moments ( $r^2 = 0.29-0.91$ ). These findings support the potential use of powered AFOs for children with crouch gait, and highlight how subject-specific kinematics and kinetics may influence muscle demand and recruitment to inform AFO design.

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DOI: 10.1371/journal.pone.0180219

PMCID: PMC5509139

PMID: 28704464

### **Robots – Exosquelette**

#### **A robotic exoskeleton to treat crouch gait from cerebral palsy: Initial kinematic and neuromuscular evaluation.**

Lerner ZF, Damiano DL, Bulea TC.

*Conf Proc IEEE Eng Med Biol Soc. 2016 Aug;2016:2214-2217. doi: 10.1109/EMBC.2016.7591169.*

A robotic exoskeleton was designed for individuals with crouch gait caused by cerebral palsy with the intent to supplement existing muscle function during walking. The aim of this study was to evaluate how powered knee extension assistance provided during stance and swing phases of the gait cycle affect knee kinematics, and knee flexor and extensor muscle activity. Muscle activity and kinematic data were collected from four individuals with crouch gait from cerebral palsy during their normal walking condition and while walking with the exoskeleton under stance, swing, and stance & swing assistance. The exoskeleton was effective in reducing crouch by an average of 13.8° in three of the four participants when assistance was provided during the stance phase; assistance during the swing phase alone was ineffective. Peak knee extensor activity was maintained for all of the conditions during the stance and swing phases. Integrated (i.e. area under the curve) knee extensor activity decreased in two of the subjects indicating a more well-modulated activation pattern. Modest increases in peak and integrated antagonist knee flexor activity were exhibited in all participants; the subject without kinematic improvement had the greatest increase. While the exoskeleton was well tolerated, additional training with a focus on reducing knee flexor activity may lead to further improvements in crouch gait reduction.

DOI: 10.1109/EMBC.2016.7591169

PMID: 28324959 [Indexed for MEDLINE]

#### **Can Lokomat therapy with children and adolescents be improved? An adaptive clinical pilot trial comparing Guidance force, Path control, and FreeD.**

Aurich-Schuler T, Grob F, van Hedel HJA, Labruyère R.

*J Neuroeng Rehabil. 2017 Jul 14;14(1):76. doi: 10.1186/s12984-017-0287-1.*

**BACKGROUND:** Robot-assisted gait therapy is increasingly being used in pediatric neurorehabilitation to complement conventional physical therapy. The robotic device applied in this study, the Lokomat (Hocoma AG, Switzerland), uses a position control mode (Guidance Force), where exact positions of the knee and hip joints throughout the gait cycle are stipulated. Such a mode has two disadvantages: Movement variability is restricted, and patients tend to walk passively. Kinematic variability and active participation, however, are crucial for motor learning. Recently, two new control modes were introduced. The Path Control mode allows the patient to walk within a virtual tunnel surrounding the ideal movement trajectory. The FreeD was developed to support weight shifting through mediolaterally moveable pelvis and leg cuffs. The aims of this study were twofold: 1) To present an overview of the currently available control modes of the Lokomat. 2) To evaluate if an increase in kinematic variability as provided by the new control modes influenced leg muscle activation patterns and intensity, as well as heart rate while walking in the Lokomat.

**METHODS:** In 15 adolescents with neurological gait disorders who walked in the Lokomat, 3 conditions were compared: Guidance Force, Path Control, and FreeD. We analyzed surface electromyographic (sEMG) activity from 5 leg muscles of the more affected leg and heart rate. Muscle activation patterns were compared with norm curves. **RESULTS:** Several muscles, as well as heart rate, demonstrated tendencies towards a higher activation during conditions with more kinematic freedom. sEMG activation patterns of the M.rectus femoris and M.vastus medialis showed the highest similarity to over-ground walking under Path Control, whereas walking under FreeD led to unphysiological muscle activation in the tested sample. **CONCLUSIONS:** Results indicate that especially Path Control seems promising for adolescent patients undergoing neurorehabilitation, as it increases proximal leg muscle activity while facilitating a physiological muscle activation. Therefore, this may be a solution to increase kinematic variability and patients' active participation in robot-assisted gait training.

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PMCID: PMC5513325

PMID: 28705170

### **Effects of Robot-Assisted Training for the Unaffected Arm in Patients with Hemiparetic Cerebral Palsy: A Proof-of-Concept Pilot Study.**

Picelli A , La Marchina E , Vangelista A , Chemello E , Modenese A , Gandolfi M , Ciceri EFM , Bucci A , Zoccatelli G , Saltuari L , Waldner A (7), Baricich A , Santamato A , Smania N .

*Behav Neurol.* 2017;2017:8349242. doi: 10.1155/2017/8349242. Epub 2017 Jul 6.

On a voluntary basis, 10 adolescents with hemiparesis due to cerebral palsy and 11 neurologically healthy control subjects participated in this proof-of-concept pilot study. The aim was to examine the effects of robot-assisted training for the unaffected arm in patients with hemiparetic cerebral palsy. Baseline comparison between the unaffected arm of the hemiparetic patients with cerebral palsy and the dominant arm of healthy control subjects showed significant differences on the Jebsen-Taylor Hand Function test and action planning ability tests. Within-group comparison after ten 30-minute sessions (five days a week for two consecutive weeks) of robot-assisted training for the unaffected arm showed significant improvements in patients with cerebral palsy on the Jebsen-Taylor Hand Function test (performed at both hands) and action planning ability test (evaluated at the unaffected arm). Our findings are in line with previous evidences of action planning deficits at the unaffected arm in patients with hemiparetic cerebral palsy and support the hypothesis that robot-assisted training for the unaffected arm may be useful to improve manual dexterity and action planning in patients with hemiparesis due to cerebral palsy.

[Free PMC Article](#)

DOI: 10.1155/2017/8349242

PMCID: PMC5518504

PMID: 28744066

### **Home-Based Versus Laboratory-Based Robotic Ankle Training for Children With Cerebral Palsy: A Pilot Randomized Comparative Trial.**

Chen K , Wu YN , Ren Y , Liu L , Gaebler-Spira D , Tankard K , Lee J , Song W , Wang M , Zhang LQ .

*Arch Phys Med Rehabil.* 2016 Aug;97(8):1237-43. doi: 10.1016/j.apmr.2016.01.029. Epub 2016 Feb 20.

**OBJECTIVE:** To examine the outcomes of home-based robot-guided therapy and compare it to laboratory-based robot-guided therapy for the treatment of impaired ankles in children with cerebral palsy.

**DESIGN:** A randomized comparative trial design comparing a home-based training group and a laboratory-based training group.

**SETTING:** Home versus laboratory within a research hospital.

**PARTICIPANTS:** Children (N=41) with cerebral palsy who were at Gross Motor Function Classification System level I, II, or III were randomly assigned to 2 groups. Children in home-based and laboratory-based groups were 8.7±2.8 (n=23) and 10.7±6.0 (n=18) years old, respectively.

**INTERVENTIONS:** Six-week combined passive stretching and active movement intervention of impaired ankle in a laboratory or home environment using a portable rehabilitation robot.

**MAIN OUTCOME MEASURES:** Active dorsiflexion range of motion (as the primary outcome), mobility (6-minute walk test and timed Up and Go test), balance (Pediatric Balance Scale), Selective Motor Control Assessment of the Lower Extremity, Modified Ashworth Scale (MAS) for spasticity, passive range of motion (PROM), strength, and joint stiffness.

**RESULTS:** Significant improvements were found for the home-based group in all biomechanical outcome measures except for PROM and all clinical outcome measures except the MAS. The laboratory-based group also showed significant improvements in all the biomechanical outcome measures and all clinical outcome measures except the MAS. There were no significant differences in the outcome measures between the 2 groups.

**CONCLUSIONS:** These findings suggest that the translation of repetitive, goal-directed, biofeedback training through motivating games from the laboratory to the home environment is feasible. The benefits of home-based robot-guided therapy were similar to those of laboratory-based robot-guided therapy.

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PMID: 26903143 [Indexed for MEDLINE]

### **MIT-Skywalker: A Novel Gait Neurorehabilitation Robot for Stroke and Cerebral Palsy.**

Susko T, Swaminathan K, Krebs HI.

*IEEE Trans Neural Syst Rehabil Eng.* 2016 Oct;24(10):1089-1099. Epub 2016 Feb 25.

The MIT-Skywalker is a novel robotic device developed for the rehabilitation or habilitation of gait and balance after a neurological injury. It represents an embodiment of the concept exhibited by passive walkers for rehabilitation training. Its novelty extends beyond the passive walker quintessence to the unparalleled versatility among lower extremity devices. For example, it affords the potential to implement a novel training approach built upon our working model of movement primitives based on submovements, oscillations, and mechanical impedances. This translates into three distinct training modes: discrete, rhythmic, and balance. The system offers freedom of motion that forces self-directed movement for each of the three modes. This paper will present the technical details of the robotic system as well as a feasibility study done with one adult with stroke and two adults with cerebral palsy. Results of the one-month feasibility study demonstrated that the device is safe and suggested the potential advantages of the three modular training modes that can be added or subtracted to tailor therapy to a particular patient's need. Each participant demonstrated improvement in common clinical and kinematic measurements that must be confirmed in larger randomized control clinical trials.

DOI: 10.1109/TNSRE.2016.2533492

PMCID: PMC5552172 [Available on 2017-10-01]

PMID: 26929056 [Indexed for MEDLINE]

### **Preliminary testing by adults of a haptics-assisted robot platform designed for children with physical impairments to access play.**

Sakamaki I , Adams K , Medina MFG , Cruz JLC , Jafari N , Tavakoli M , Janz H .

*Assist Technol.* 2017 Jul 11:1-9. doi: 10.1080/10400435.2017.1318974. [Epub ahead of print]

Development of children's cognitive and perceptual skills depends heavily on object exploration and experience in their physical world. For children who have severe physical impairments, one of the biggest concerns is the loss of opportunities for meaningful play with objects, including physical contact and manipulation. Assistive robots can enable children to perform object manipulation through the control of simple interfaces. Touch sensations conveyed through haptic interfaces in the form of force reflection or force assistance can help a child to sense the environment and to control a robot. A robotic system with forbidden region virtual fixtures (VFs) was tested in an object sorting task. Three sorting tasks-by color, by shape, and by both color and shape-were performed by 10 adults without disability and one adult with cerebral palsy. Tasks performed with VFs were accomplished faster than tasks performed without VFs, and deviations of the motion area were smaller with VFs than without VFs. For the participant with physical impairments, two out of three tasks were slower with the VFs. This implies that forbidden region VFs are not always able to improve user task performance. Alignment with an individual's unique motion characteristics can improve VF assistance.

DOI: 10.1080/10400435.2017.1318974

PMID: 28696831

### **Robotic Gait Training For Individuals With Cerebral Palsy: A Systematic Review And Meta-Analysis.**

da Silveira Carvalho I , Pinto SM , Chagas DDV , Praxedes Dos Santos JL , de Sousa Oliveira T , Batista LA .

*Arch Phys Med Rehabil.* 2017 Jul 24. pii: S0003-9993(17)30474-4. doi: 10.1016/j.apmr.2017.06.018. [Epub ahead of print]

OBJECTIVE: To identify the effects of robotic gait training practices in individuals with cerebral palsy.

DATA SOURCES: The search was performed in the following electronic databases: PubMed, EMBASE (Excerpta Medical), MEDLINE (OvidSP), CDSR (Cochrane database of systematic reviews), Web of Science, Scopus, Compendex, IEEE Xplore, ScienceDirect, Academic Search Premier, and PEDro.

STUDY SELECTION: Studies were included if they fulfilled the following criteria: (1) they investigated the effects of robotic gait training, (2) they involved patients with cerebral palsy, and (3) they enrolled patients classified between levels I and IV using the Gross Motor Function Classification System.

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**DATA EXTRACTION:** The information was extracted from the selected articles using the descriptive-analytical method. The "Critical Review Form for Quantitative Studies" was used to quantitate the presence of critical components in the articles. To perform the meta-analysis, the effects of the intervention were quantified by effect size (Cohen's d).

**DATA SYNTHESIS:** Of the 133 identified studies, 10 met the inclusion criteria. The meta-analysis showed positive effects on gait speed (0.21 [-0.09, 0.51]), endurance (0.21 [-0.06, 0.49]), and gross motor function in dimension D (0.18 [-0.10, 0.45]) and dimension E (0.12 [-0.15, 0.40]).

**CONCLUSION:** The results obtained suggest that this training benefits people with cerebral palsy, specifically by increasing walking speed and endurance and improving gross motor functions. For future studies, we suggest investigating device configuration parameters and conducting a large number of randomized controlled trials with larger sample sizes and individuals with homogeneous impairment. Copyright © 2017 American Congress of Rehabilitation Medicine.

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DOI: 10.1016/j.apmr.2017.06.018

PMID: 28751254

### **Usability testing of a developed assistive robotic system with virtual assistance for individuals with cerebral palsy: a case study.**

Jafari N , Adams K , Tavakoli M , Wiebe S , Janz H .

*Disabil Rehabil Assist Technol.* 2017 Jul 4:1-6. doi: 10.1080/17483107.2017.1344884. [Epub ahead of print]

This paper presents a novel application of an assistive robotic system with virtual assistance to enhance manual performance of individuals with cerebral palsy. Cerebral palsy affects one's voluntary motor movements resulting in limited opportunities to actively engage in physical manipulative activities that require fine motor movements and coordination. Lack of object manipulation and environmental exploration can result in further impairments such as cognitive and social delays. The proposed assistive robotic system has been developed to enhance hand movements of people with disabilities when performing a functional task colouring. This paper presents the usability testing of the effectiveness of the developed system with an individual with cerebral palsy in a set of colouring tasks. Assisted and unassisted approaches were compared and analysed through quantitative and qualitative measures. The robotic-based approach was further compared with the participant's typical alternate access method to perform the same proposed tasks. The robotic system with virtual assistance was clinically validated to be significantly more effective, compared to both unassisted and typical approaches, by increasing the hand controllability, reducing the physical load and increasing the easiness of maintaining movements within the lines. Future studies will inform the use of the system for children with disabilities to provide them with assisted play for functional and playful activities. Implications for rehabilitation Robotic system can enhance manual performance in individuals with disabilities. Participating in a robot-mediated play activity could increase children's motivation and engagement. The developed robotic system can contribute to a basis for clinical and home-based implementation of the technology to promote manual play activities for children with disabilities.

DOI: 10.1080/17483107.2017.1344884

PMID: 28673115

### **Thérapies cellulaires**

#### **Accelerated generation of oligodendrocyte progenitor cells from human induced pluripotent stem cells by forced expression of Sox10 and Olig2.**

Li P , Li M , Tang X , Wang S , Zhang YA , Chen Z .

*Sci China Life Sci.* 2016 Nov;59(11):1131-1138. Epub 2016 Oct 25.

Oligodendrocyte progenitor cells (OPCs) hold great promise for treatment of dysmyelinating disorders, such as multiple sclerosis and cerebral palsy. Recent studies on generation of human OPCs mainly use human embryonic stem cells (hESCs) or neural stem cells (NSCs) as starter cell sources for the differentiation process. However, NSCs are restricted in availability and the present method for generation of oligodendrocytes (OLs) from ESCs often requires a lengthy period of time. Here, we demonstrated a protocol to efficiently derive OPCs from human induced

pluripotent stem cells (hiPSCs) by forced expression of two transcription factors (2TFs), Sox10 and Olig2. With this method, PDGFR $\alpha$ (+) OPCs can be obtained in 14 days and O4(+) OPCs in 56 days. Furthermore, OPCs may be able to differentiate to mature OLs that could ensheath axons when co-cultured with rat cortical neurons. The results have implications in the development of autologous cell therapies.

DOI: 10.1007/s11427-016-0165-3

PMID: 27785726 [Indexed for MEDLINE]

### **Modèles animaux Réhabilitation**

#### **Histological and functional assessment of the efficacy of constraint-induced movement therapy in rats following neonatal hypoxic-ischemic brain injury.**

Kim H , Kim MJ , Koo YS , Lee HI , Lee SW , Shin MJ , Kim SY , Shin YB , Shin YI , Choi BT , Yun YJ , Shin HK .  
*Exp Ther Med.* 2017 Jun;13 :2775-2782. doi: 10.3892/etm.2017.4371. Epub 2017 Apr 21.

Constraint-induced movement therapy (CIMT) is used in stroke rehabilitation to promote recovery of upper limb motor function. However, its efficacy in improving functional outcomes in children with hemiplegic cerebral palsy has not been clearly determined in clinical or experimental research. The aim of our study was to assess the efficacy of a new experimental model of CIMT, evaluated in terms of mortality, stress, motor and cognitive function in rats having undergone a neonatal hypoxic-ischemic (HI) brain injury. Neonatal HI injury was induced at post-natal day 7 through unilateral ligation of the common carotid artery followed by exposure to hypoxia for 2 h. CIMT was implemented at 3 weeks, post-HI injury, using a pouch to constrain the unimpaired forelimb and forcing use of the affected forelimb using a motorized treadmill. After HI injury, animals demonstrated motor and cognitive deficits, as well as volumetric decreases in the ipsilateral hemisphere to arterial occlusion. CIMT yielded a modest recovery of motor and cognitive function, with no effect in reducing the size of the HI lesion or post-HI volumetric decreases in brain tissue. Therefore, although animal models of stroke have identified benefits of CIMT, CIMT was not sufficient to enhance brain tissue development and functional outcomes in an animal model of hemiplegic cerebral palsy. Based on our outcomes, we suggest that CIMT can be used as an adjunct treatment to further enhance the efficacy of a program of rehabilitation in children with hemiplegic cerebral palsy.

[Free PMC Article](#)

DOI: 10.3892/etm.2017.4371

PMCID: PMC5450637

PMID: 28587341

### **Méthodes alternatives – Autres**

#### **Beneficial effects of Jiawei Shenqi-wan and treadmill training on deficits associated with neonatal hypoxic-ischemia in rats.**

Kim HN , Pak ME , Shin MJ , Kim SY , Shin YB , Yun YJ , Shin HK , Choi BT .

*Exp Ther Med.* 2017 May;13(5):2134-2142. doi: 10.3892/etm.2017.4286. Epub 2017 Mar30.

Jiawei Shenqi-wan (JSQW), which comprises Shenqi-wan and two additional medicinal herbs, has been widely used for the treatment of various growth impairments, including cerebral palsy. In the present study, JSQW was administered to hypoxic-ischemic Sprague-Dawley rats that underwent treadmill training from 4-7 weeks of age to examine the beneficial effects of combined JSQW and treadmill therapy. Behavioral examinations were performed and a significant improvement in cylinder test performance was observed in rats treated with treadmill training compared with hypoxic-ischemia rats ( $P < 0.05$ ), as well as a significant improvement in passive avoidance test performance for rats treated with JSQW ( $P < 0.05$ ). The thickness of the corpus callosum and the integrated optical density (IOD) of myelin basic protein (MBP) were significantly increased by treatment with treadmill therapy alone ( $P < 0.01$  and  $P < 0.001$ , respectively) and treatment with both JSQW and treadmill significantly increased the IOD of MBP compared with hypoxic-ischemia rats ( $P < 0.001$ ). Western blot analysis revealed that the expression of neuronal nuclei (NeuN) and doublecortin (Dcx) significantly decreased ( $P < 0.001$  and  $P < 0.05$ , respectively) and MBP expression markedly decreased in the ipsilateral subventricular zone of hypoxic-ischemic rats compared with the control group; however, the expression of NeuN was significantly recovered by treatment with both JSQW and treadmill training ( $P < 0.05$ ). Furthermore, Dcx expression was significantly recovered by treatment with JSQW ( $P < 0.05$ ), and MBP

expression was significantly restored by treatment with treadmill training ( $P < 0.01$ ). In the immunohistochemical analyses, a significant increase in the number of bromodeoxyuridine (BrdU) positive cells in this region was observed in treadmill-treated rats ( $P < 0.05$ ), whereas significant increases in the number of BrdU/Dcx or NeuN or glial fibrillary acidic protein double-positive cells were observed only in the group co-treated with JSQW and treadmill ( $P < 0.01$ ,  $P < 0.05$  and  $P < 0.001$ , respectively). These results suggest that JSQW and treadmill training may contribute to behavior recovery following hypoxic-ischemia, and JSQW treatment was particularly effective in promoting memory function via enhancing the differentiation of neuronal progenitor cells. The results of the present study therefore suggest that JSQW may provide an additional treatment option for functional recovery with treadmill training in cerebral palsy.

[Free PMC Article](#)

DOI: 10.3892/etm.2017.4286

PMCID: PMC5443215

PMID: 28565820

### **Influence of Hippotherapy on Body Balance in the Sitting Position Among Children with Cerebral Palsy.**

Matusiak-Wieczorek E , Małachowska-Sobieska M , Synder M .

*Ortop Traumatol Rehabil.* 2016 Mar 23;18(2):165-175. doi:10.5604/15093492.1205024.

**BACKGROUND:** Cerebrally palsied children demonstrated limited independence while performing various activities of daily living, which is due to disorders of postural control. The best solution to improve postural control is the use of therapies that simultaneously focus on the sense of balance and motor skills. Such possibilities for patients with cerebral palsy are offered, for example, by hippotherapy.

**OBJECTIVE:** To assess the influence of hippotherapy on body balance in the sitting position among children with cerebral palsy.

**MATERIAL AND METHODS:** The study enrolled thirty-nine children aged 6-12 years with GMFCS level 1 or 2 spastic diplegia or spastic hemiplegia. The participants were divided into an intervention group ( $n=19$ ) and a control group ( $n=20$ ). Children from the intervention group attended 30 minutes of hippotherapy once weekly for 12 consecutive weeks. The Sitting Assessment Scale (SAS) was used to assess the patients' posture and balance.

**RESULTS:** Some children improved their posture and balance during the study. Generally, control of trunk and head position and function of arms were getting better, while footwork was the weakest.

**CONCLUSION:** Hippotherapy has positive effects on the position and function of individual parts of the body, thus making it possible for cerebrally palsied children to improve posture and the ability to maintain balance in the sitting position.

DOI: 10.5604/15093492.1205024

PMID: 28155825 [Indexed for MEDLINE]

### **MiYoga: a randomised controlled trial of a mindfulness movement programme based on hatha yoga principles for children with cerebral palsy: a study protocol.**

Mak C , Whittingham K , Cunnington R , Boyd RN .

*BMJ Open.* 2017 Jul 10;7(7):e015191. doi: 10.1136/bmjopen-2016-015191.

**INTRODUCTION:** Cerebral palsy (CP) is the most common childhood physical disability, with life-long impacts for 1.77 in 1000 children. Although CP is primarily a physical disability, children with CP have an increased risk of experiencing cognitive difficulties, particularly attention and executive function deficits. Impairment in cognitive abilities can lead to subsequent impairment in independent functioning, education, employment and interpersonal relationships. This paper reports the protocol of a randomised controlled trial of a novel family-centred lifestyle intervention based on mindfulness and hatha yoga principles (MiYoga). MiYoga aims to enhance child and parent outcomes for children with CP.

**METHODS AND ANALYSIS:** The aim is to recruit 36 child-parent dyads (children aged 6-16 years; bilateral or unilateral CP; Gross Motor Function Classification System I-III), who will be randomly assigned to two groups: MiYoga and waitlist control. The MiYoga programme will be facilitated in a group format for 8 weeks. Assessments will be administered at baseline, prior to MiYoga, following completion of MiYoga, and at 6-month follow-up (retention). The primary outcome will be the child's sustained attentional ability as measured by the Conner's Continuous Performance Test II. Other outcomes of interest for children with CP consists of attentional control, physical

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functioning, behavioural and well-being. For parents, the outcomes of interest are mindfulness, psychological flexibility and well-being. Data will be analysed using general linear models, specifically analysis of covariance and analysis of variance.

**ETHICS AND DISSEMINATION:** Full ethical approval for this study has been obtained by the Children's Health Queensland Hospital and Health Service Research Ethics Committee (HREC/12/QRCH/120) and The University of Queensland (2012000993). If MiYoga is proven effective, its dissemination would assist children with CP and complement their ongoing therapy by improving the ability of the child to pay attention at school and in therapy, and alleviating environmental stressors for both the child and his/her parents.

**TRIAL REGISTRATION NUMBER:** ACTRN12613000729729; Pre-results. <http://www.ANZCTR.org.au/ACTRN12613000729729.aspx> **DATE OF TRIAL REGISTRATION:** Prospectively registered on 2 July 2013-present (ongoing).

**FINDINGS TO DATE:** Recruitment is complete. Data are still being collected at present. We aim to complete data collection by February 2017.

### [Free Article](#)

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PMID: 28698326

Conflict of interest statement: Competing interests: MiYoga was developed by first author.

## **Douleur**

### **Assessments of pain in children and adolescents with cerebral palsy: a retrospective population-based registry study.**

Westbom L , Rimstedt A , Nordmark E .

*Dev Med Child Neurol.* 2017 Aug;59(8):858-863. doi: 10.1111/dmcn.13459. Epub 2017 May 16.

**AIM:** To explore pain screening in CPUP, a follow-up surveillance programme for people with cerebral palsy (CP), specifically to describe reported pain prevalence, localizations, patterns of distribution; to compare with studies using psychometrically sound assessment instruments; and to assess agreement between pain documented in CPUP and medical records.

**METHOD:** Registry study of a population with CP, born 1993 to 2008, living in Skåne, Sweden in 2013. Descriptive data, cross-tabulations, and chi-square tests to characterize and compare the study groups. Kappa analysis to test the concordance between register and medical record reports on pain.

**RESULTS:** Pain was reported by 185 out of 497 children (37%; females 40%, males 35%). Level V in both Gross Motor Function Classification System (GMFCS) and Manual Ability Classification System (MACS) was associated with highest prevalence of pain (50% and 54%), and level I with lowest prevalence of pain (30% and 32%). Pain was most frequent in dyskinetic CP (46%) and least frequent in unilateral spastic CP (33%). Feet and knees were the dominant localizations. Fair-moderate agreement (kappa 0.37, prevalence-adjusted bias-adjusted kappa [PABAK] 0.44) was found between documented pain in CPUP and medical records, although more seldom recognized in medical records.

**INTERPRETATION:** The distribution of pain between CP subtypes, functional levels, sex, and age in CPUP is concordant with previous population-based studies, indicating the validity of the CPUP pain screening. Despite this, further clinical evaluation with extended pain assessments and pain management were largely neglected in children reporting chronic pain.

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PMID: 28509356 [Indexed for MEDLINE]

### **Equimolar mixture of nitrous oxide and oxygen during post-operative physiotherapy in patients with cerebral palsy: A randomized, double-blind, placebo-controlled study.**

Delafontaine A , Presedo A , Mohamed D , Lopes D , Wood C , Alberti C .

*Eur J Pain.* 2017 Jul 20. doi: 10.1002/ejp.1071. [Epub ahead of print]

**BACKGROUND:** The administration of an equimolar mixture of nitrous oxide and oxygen (N<sub>2</sub>O) is recommended during painful procedures. However, the evaluation of its use during physiotherapy after surgery has not been reported, although pain may hamper physiotherapy efficiency. This study investigated whether the use of N<sub>2</sub>O improves the efficacy of post-operative physiotherapy after multilevel surgery in patients with cerebral palsy. **METHOD:** It was a randomized 1:1, double-blind, placebo-controlled study. All patients had post-operative physiotherapy starting the day after surgery. Patients received either N<sub>2</sub>O or placebo gas during the rehabilitation sessions. All patients had post-operative pain management protocol, including pain medication as needed for acute pain. The primary objective was to reach angles of knee flexion of 110° combined with hip extension of 10°, with the patient lying prone, within six or less physiotherapy sessions. Secondary evaluation criteria were the number of sessions required to reach the targeted angles, the session-related pain intensity and the analgesics consumption for managing post-operative pain.

**RESULTS:** Sixty-four patients were enrolled. Targeted angles were achieved more often in the N<sub>2</sub>O group (23 of 32, 72%, vs. Placebo: 13/ of 32, 41%; p = 0.01).

**CONCLUSION:** The administration of N<sub>2</sub>O during post-operative physiotherapy can help to achieve more quickly an improved range of motion, and, although not significant in our study, to alleviate the need for pain medication. Further studies evaluating the administration of N<sub>2</sub>O in various settings are warranted. **SIGNIFICANCE:** During this randomized placebo-controlled double-blind study, children receiving nitrous oxide and oxygen (N<sub>2</sub>O) achieved more often the targeted range of motion during physiotherapy sessions after multilevel surgery. Compared to placebo, nitrous oxide and oxygen (N<sub>2</sub>O) enabled a better management of acute pain related to physiotherapy procedures.

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DOI: 10.1002/ejp.1071

PMID: 28726270

#### **Prevalence of pain in 240 non-ambulatory children with severe cerebral palsy.**

Poirot I , Laudy V , Rabilloud M , Roche S , Ginhoux T , Kassai B , Vuillerot C .

*Ann Phys Rehabil Med.* 2017 Jul 6. pii: S1877-0657(17)30056-8. doi: 10.1016/j.rehab.2017.03.011. [Epub ahead of print]

**BACKGROUND:** Several studies have given frequencies of pain in children with cerebral palsy, but comparing the findings is difficult. We aimed to estimate the prevalence of pain in non-ambulatory children with cerebral palsy and describe their characteristics by presence or absence of pain.

**METHODS:** Data were extracted from an ongoing longitudinal national cohort following non-ambulatory children with severe cerebral palsy aged 3 to 10years over 10years. We described and compared data for the first 240 children at inclusion by presence or absence of pain. Pain was assessed by a visual analog scale and the Douleur Enfant San Salvador scales and by investigator interview.

**RESULTS:** Overall, 65 children experienced pain, for a prevalence of 27.1% (95% confidence interval 22-33%). All children experiencing pain had orthopaedic pain and 45.6% had pain from another origin. The main pain sites were hips (43.4%) and feet (26.9%). Joint mobilisation was the source of pain for 58.3% of children experiencing pain, and sitting was identified as painful for 10.3%. Pain was greater with scoliosis (43.1% vs 24.1% with and without pain; P=0.006) and spasticity treatment (32.3% vs 17.2%; P=0.020).

**CONCLUSION:** Children with cerebral palsy frequently experience pain and also early pain, mostly articular and orthopedic. The assessment of pain should be systematic because of its high prevalence. Interventions to prevent scoliosis, hip luxation, and foot deformities and to reduce spasticity, such as the use of analgesics before joint mobilization exercises, may reduce the prevalence of this pain.

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DOI: 10.1016/j.rehab.2017.03.011

PMID: 28690031

#### **Strategies to decrease injection site pain in botulinum toxin therapy.**

Paracka L , Kollwe K , Wegner F , Dressler D .

*J Neural Transm (Vienna).* 2017 Jul 24. doi: 10.1007/s00702-017-1764-1. [Epub ahead of print]

Botulinum toxin is now used for numerous indications including dystonias, spasticity, cerebral palsy, hyperhidrosis, cosmetics and chronic migraine. It has to be injected into its target tissues thus causing injection site pain. We wanted to compare the efficacy of various analgesic interventions suggested for reduction of injection site pain. In 13 healthy controls, pain thresholds in the fingertips II and III bilaterally were determined by the Mechanical Pain Threshold Test and the Repetitive Pain Stimulation Test at baseline and under nitrous oxide/oxygen, ice spray, local anaesthetic cream and forearm ischaemia. All interventions studied produce statistically significant and robust elevations of the pain threshold in both tests. Nitrous oxide/oxygen had stronger effects than the other interventions, although this superiority was statistically significant only in the Repetitive Pain Stimulation Test and not against ice spray. Also considering duration, localisation and penetration depth of analgesic effects, hyperhidrosis treatment may benefit from nitrous oxide/oxygen, ice spray and local anaesthetic cream. In palmar hyperhidrosis, forearm ischaemia is possible and also reduces botulinum toxin washout. Cosmetic indications may also benefit from nitrous oxide/oxygen and local anaesthetic cream. For botulinum toxin therapy of spasticity, dystonia and tremor, only nitrous oxide/oxygen may offer intramuscular analgesic effect. Its systemic and prolonged effect is also an advantage in injections in several body parts. Future studies are necessary to test the influence of penetration depth and combinations of analgesic interventions.

DOI: 10.1007/s00702-017-1764-1

PMID: 28741118

## Language -Communication

### **Acoustic changes in the speech of children with cerebral palsy following an intensive program of dysarthria therapy.**

Pennington L , Lombardo E , Steen N , Miller N .

*Int J Lang Commun Disord.* 2017 Jul 17. doi: 10.1111/1460-6984.12336. [Epub ahead of print]

**BACKGROUND:** The speech intelligibility of children with dysarthria and cerebral palsy has been observed to increase following therapy focusing on respiration and phonation.

**AIMS:** To determine if speech intelligibility change following intervention is associated with change in acoustic measures of voice.

**METHODS & PROCEDURES:** We recorded 16 young people with cerebral palsy and dysarthria (nine girls; mean age 14 years, SD = 2; nine spastic type, two dyskinetic, four mixed; one Worster-Drought) producing speech in two conditions (single words, connected speech) twice before and twice after therapy focusing on respiration, phonation and rate. In both single-word and connected speech we measured vocal intensity (root mean square-RMS), period-to-period variability (Shimmer APQ, Jitter RAP and PPQ) and harmonics-to-noise ratio (HNR). In connected speech we also measured mean fundamental frequency, utterance duration in seconds and speech and articulation rate (syllables/s with and without pauses respectively). All acoustic measures were made using Praat. Intelligibility was calculated in previous research.

**OUTCOMES & RESULTS:** In single words statistically significant but very small reductions were observed in period-to-period variability following therapy: Shimmer APQ -0.15 (95% CI = -0.21 to -0.09); Jitter RAP -0.08 (95% CI = -0.14 to -0.01); Jitter PPQ -0.08 (95% CI = -0.15 to -0.01). No changes in period-to-period perturbation across phrases in connected speech were detected. However, changes in connected speech were observed in phrase length, rate and intensity. Following therapy, mean utterance duration increased by 1.11 s (95% CI = 0.37-1.86) when measured with pauses and by 1.13 s (95% CI = 0.40-1.85) when measured without pauses. Articulation rate increased by 0.07 syllables/s (95% CI = 0.02-0.13); speech rate increased by 0.06 syllables/s (95% CI = < 0.01-0.12); and intensity increased by 0.03 Pascals (95% CI = 0.02-0.04). There was a gradual reduction in mean fundamental frequency across all time points (-11.85 Hz, 95% CI = -19.84 to -3.86). Only increases in the intensity of single words (0.37 Pascals, 95% CI = 0.10-0.65) and reductions in fundamental frequency (-0.11 Hz, 95% CI = -0.21 to -0.02) in connected speech were associated with gains in intelligibility.

**CONCLUSIONS & IMPLICATIONS:** Mean reductions in impairment in vocal function following therapy observed were small and most are unlikely to be clinically significant. Changes in vocal control did not explain improved intelligibility.

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DOI: 10.1111/1460-6984.12336

PMID: 28714530

### **Changes in White Matter Integrity following Intensive Voice Treatment (LSVT LOUD®) in Children with Cerebral Palsy and Motor Speech Disorders.**

Reed A , Cummine J, Bakhtiari R, Fox CM, Boliek CA.

*Dev Neurosci.* 2017 Jul 28. doi: 10.1159/000478724. [Epub ahead of print]

Preliminary evidence suggests that intensive voice and speech treatment based on activity-dependent neuroplasticity principles holds promise for affecting positive change in children with cerebral palsy (CP) and motor speech disorders. Diffusion tensor imaging (DTI) allows researchers to make inferences about the integrity of white matter tracks and provides a sensitive measure of neuroplasticity. Previous treatment studies looking at the effects of training on white matter integrity have shown positive results, but these studies have been limited to gross motor function. Eight children with motor speech disorders and CP (3 females; age 8-16 years) and an age- and sex-matched group of typically developing (TD) children participated. Each child with CP completed a full dose of LSVT LOUD® and a 12-week maintenance program. Participants attended 3 recording sessions: before and after treatment, and after the maintenance period. TD children were tested at the same 3 time points. Recording sessions for both groups of children included measures of white matter integrity using DTI and acoustic measures of voice and speech. Fractional anisotropy (FA) was measured for 2 motor tracts and 5 association tracts. In children with CP, we observed an increase in FA in several motor and association tracts immediately following treatment and 12 weeks after treatment. Acoustic data on untrained tasks were correlated with changes in FA detected immediately following treatment and after the 12-week maintenance program. These findings suggest that long-term practice of skills attained during the treatment phase enhances white matter tract integrity in speech production networks.

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PMID: 28750368

## **Autres Troubles / Troubles concomitants**

### **✚ Troubles musculosquelettiques, des tissus conjonctifs et osseux**

#### **Patients with non-ambulatory cerebral palsy have higher sclerostin levels and lower bone mineral density than patients with ambulatory cerebral palsy.**

Shin YK , Yoon YK , Chung KB , Rhee Y , Cho SR .

*Bone.* 2017 Jul 15;103:302-307. doi: 10.1016/j.bone.2017.07.015. [Epub ahead of print]

Bone loss is a serious clinical issue in patients with cerebral palsy (CP). Sclerostin has garnered interest as a key mechanosensor in osteocytes, leading to considerations of the therapeutic utilization of anti-sclerostin medications. This study was undertaken to determine associations among mechanical unloading, sclerostin levels, and bone imbalance in patients with CP. A total of 28 patients with CP participated in this cross-sectional study. The following measurements were taken: anthropometrics, clinical diagnosis of CP subtype and ambulatory status, bone mineral density (BMD) z-scores at the lumbar spine and hip, and blood biochemical markers, including sclerostin, parathyroid hormone (PTH), osteocalcin, C-terminal telopeptide, 25-hydroxyvitamin D, 1,25-dihydroxyvitamin D, creatinine, calcium, and phosphorus. In analysis according to CP subtype, patients with spastic CP showed significantly lower BMD z-scores at the lumbar spine and femur neck regions than patients with dyskinetic CP. In analysis according to ambulatory status, patients with non-ambulatory CP showed significantly lower BMD z-scores at all lumbar spine and femoral sites, lower PTH and creatinine levels, and higher plasma sclerostin levels than patients with ambulatory CP. In regression analysis, ambulatory status was a significant determinant of plasma sclerostin levels. This study is the first to report on sclerostin levels and BMD in patients with CP, based on the hypothesis that patients who lack sufficient weight-bearing activities would show increased sclerostin levels and decreased BMD scores, compared with patients who sustain relatively sufficient physical activity. Therefore, this report may provide clinical insights for clinicians considering ambulatory status, sclerostin levels, and bone loss in patients with CP.

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DOI: 10.1016/j.bone.2017.07.015

PMID: 28720522

**Site-Specific Bone Mineral Density Is Unaltered Despite Differences in Fat-Free Soft Tissue Mass Between Affected and Nonaffected Sides in Hemiplegic Paralympic Athletes with Cerebral Palsy: Preliminary Findings.**

Runciman P , Tucker R, Ferreira S, Albertus-Kajee Y, Micklesfield L, Derman W.

*Am J Phys Med Rehabil.* 2016 Oct;95(10):771-8. doi: 10.1097/PHM.0000000000000532.

**OBJECTIVE:** This study investigated bone mineral density (BMD, g/cm), fat mass (FM, kg), and fat-free soft tissue mass (FFSTM, kg) in Paralympic athletes with cerebral palsy (CP) using dual-energy x-ray absorptiometry.

**METHODS:** Bone mineral density, BMD Z scores (standard deviations), FM, and FFSTM were measured for the whole body and at the lumbar spine, femoral neck, and total hip sites on both nonaffected and affected sides of 6 athletes with hemiplegic CP.

**RESULTS:** There were no differences between nonaffected and affected sides with respect to site-specific BMD and BMD Z scores and FM. Fat-free soft tissue mass was significantly lower on the affected side in both upper and lower limbs (15% lower;  $P < 0.05$ ).

**CONCLUSION:** The present study is the first to describe similar BMD between sides, symmetry in FM, and asymmetry in FFSTM in Paralympic athletes with CP. These findings have important consequences for rehabilitation, as they indicate the potential for positive physiological adaptation as a result of exercise training over long periods of time.

DOI: 10.1097/PHM.0000000000000532

PMID: 27149600 [Indexed for MEDLINE]

**Skeletal muscle fiber-type specific succinate dehydrogenase activity in cerebral palsy.**

Zogby AM , Dayanidhi S , Chambers HG , Schenk S , Lieber RL .

*Muscle Nerve.* 2017 Jan;55(1):122-124. doi: 10.1002/mus.25379. Epub 2016 Sep 26.

**INTRODUCTION:** Children with cerebral palsy (CP) exhibit increased energy expenditure during movement, but whether this is due in part to decrements in skeletal muscle mitochondrial oxidative capacity is unknown. Accordingly, we compared fiber-type specific succinate dehydrogenase (SDH) activity in children with CP with typically developing (TD) children.

**METHODS:** SDH activity and myofiber areas of type 1 and 2A fibers were measured in semitendinosus biopsies of both groups ( $n = 5/\text{group}$ ).

**RESULTS:** SDH activity was ~35% higher in type 1 compared with type 2A fibers, but there were no differences between groups. Average myofiber area was 45% smaller in CP versus TD ( $P < 0.05$ ), and type 2A fibers were 32% larger than type 1 fibers ( $P < 0.05$ ) only in TD children.

**CONCLUSIONS:** Fiber-type specific SDH activity is similar between TD children and children with CP. This suggests that increased energy expenditure in children with CP is not related to impaired mitochondrial oxidative capacity. *Muscle Nerve*, 2016 *Muscle Nerve* 55: 122-124, 2017.

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DOI: 10.1002/mus.25379

PMCID: PMC5173443 [Available on 2018-01-01]

PMID: 27515237 [Indexed for MEDLINE]

**The effect of anticonvulsant use on bone mineral density in non-ambulatory children with cerebral palsy.**

Cheng SW , Ko CH , Lee CY .

*Hong Kong Med J.* 2016 Jun;22(3):242-8. doi: 10.12809/hkmj154588. Epub 2016 May 6.

**INTRODUCTION:** Studies showed that use of anticonvulsants (antiepileptic drugs) might be associated with reduced bone mineral density. The primary objective of this study was to evaluate the effect of anticonvulsants on bone mineral density in non-ambulatory children with cerebral palsy. The secondary objective was to identify their risk factors for low bone mineral density.

**METHODS:** This case series with internal comparisons was conducted in a paediatric residential rehabilitation centre in Hong Kong. Overall, 32 patients were enrolled. The study group comprised 18 patients (6 males, 12 females) aged 5.0 to 19.5 years (mean  $\pm$  standard deviation,  $13.8 \pm 4.7$  years); all were prescribed anticonvulsant therapy for more

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than 2 years. The comparison group comprised 14 patients (6 males, 8 females) aged 7.0 to 19.1 years (mean, 16.4 ± 3.0 years) who were concomitant non-ambulatory residents with cerebral palsy and were not prescribed any anticonvulsant therapy prior to study recruitment. Patients underwent a physical examination, blood tests, nutritional assessment, and dual-energy X-ray absorptiometry scan of the total body less head. Z-scores were calculated.

**RESULTS:** There was no significant difference in Z-scores of total body less head between groups. Among children with low bone mineral density (Z-scores ≤ -2.0) and normal bone mineral density, multivariate analysis revealed that higher weight-for-age Z-score (adjusted odds ratio=0.015) and presence of puberty (adjusted odds ratio=0.027) were independent factors for bone mineral density improvement. Hosmer-Lemeshow goodness of fit test (P=0.315) was not significant. Nagelkerke R was 0.677, signifying a relatively well-fitting model.

**CONCLUSION:** There was no evidence that anticonvulsant therapy has any detrimental effect on bone mineral density in non-ambulatory children with cerebral palsy. A low weight-for-age Z-score was associated with low bone mineral density. Early nutritional intervention to optimise body weight may help to increase bone mineral density.

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DOI: 10.12809/hkmj154588

PMID: 27149974 [Indexed for MEDLINE]

### **Ultrasonographic Assessment of Femoral Cartilage Thickness in Patients with Cerebral Palsy.**

Adıgüzel E , Tok F , Ata E , Yaşar E , Yılmaz B .

*PM R. 2017 Jul 17. pii: S1934-1482(17)30699-8. doi: 10.1016/j.pmrj.2017.07.002. [Epub ahead of print]*

**BACKGROUND:** Cerebral palsy (CP) is one of the most disabling syndromes in children. To our knowledge, there has not yet been any reported evaluation by ultrasonography of the effect of CP on distal femoral cartilage. The value of understanding this effect on cartilage is that sonographic evaluation of cartilage thickness may help physicians to predict the joint health of these children.

**OBJECTIVE:** To determine whether femoral cartilage thickness in patients with CP is different from that in healthy control subjects.

**DESIGN:** Cross-sectional study.

**SETTING:** National tertiary rehabilitation center.

**PATIENTS:** The study included 40 patients with diplegic CP (23 male and 17 female) and 51 healthy control subjects (29 male and 22 female).

**METHODS:** Demographic and clinical characteristics were recorded. Cartilage thicknesses were measured.

**MAIN OUTCOME MEASURE:** Cartilage thickness measurements were taken from the medial and lateral condyles, and intercondylar areas of both knees.

**RESULTS:** Both groups were similar in terms of age, gender, and weight (P > .05). The mean cartilage thickness measurements of the medial condyle and intercondylar area of knees in the CP group were significantly less than those in the healthy control group (all P < .05). There was moderate negative correlation between age and all femoral cartilage thickness measurements in the CP group. There was no correlation between age and femoral cartilage thickness measurements in the healthy group. There was a negative correlation between Gross Motor Functional Classification System levels and cartilage thickness in the CP group. The highest cartilage thickness measurements were detected in level 1 patients, and the lowest measurements were detected in level 5 patients.

**CONCLUSION:** This study showed that patients with CP have a thinner femoral cartilage than healthy control subjects. Management of patients with CP should include close surveillance.

**LEVEL OF EVIDENCE:** To be determined.

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PMID: 28729059

## **Nutrition - Métabolisme -Composition corporelle**

### **Assessment of nutritional status of children and adolescents with spastic quadriplegic cerebral palsy.**

Caselli tb , lomazi EA , Montenegro MAS , Bellomo-Brandão MA .

*Arq Gastroenterol. 2017 Jul 6:0. doi: 10.1590/S0004-2803.201700000-32. [Epub ahead of print]*

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75013 Paris - tel +33 1 45 54 03 03 contact: Christine Doumergue [cdoumergue@lafondationmotrice.org](mailto:cdoumergue@lafondationmotrice.org)

**BACKGROUND:** : Due to several factors, such as gastrointestinal's diseases and difficulty in feeding, children with Spastic Quadriplegic Cerebral Palsy tend to present nutritional deficits.

**OBJECTIVE:** : To assess the nutritional status of pediatric patients with Spastic Quadriplegic Cerebral Palsy according to reference curves for this population and with the measures of folds and circumferences, obtained by the upper arm circumference and triceps skin fold.

**METHODS:** : The data were obtained from: knee-height, estimated height, weight, upper arm circumference, and triceps skin fold. Values of folds and circumferences were compared with Frisancho, and specific curves for these patients were used as reference. The relationship between the values in the growth curve for healthy children, Z-Score, and comparison with the reference curve were verified by Fisher's exact test. We adopted the significance level of 5%.

**RESULTS:** : We evaluated 54 patients. The mean age was 10.2 years, and 34 were male, 25 fed by gastrostomy and 29, orally. The frequency of low weight by the reference curve was 22.22%. More than half of the patients presented the parameters indicating lean mass below the 5th percentile. The height of all patients was classified as adequate for the age by the reference curve.

**CONCLUSION:** Low weight was found in 22% of patients, and there is a greater tendency to present reduced muscle mass and increased fat mass, showing the need for evaluation and appropriate interventions for patients with Spastic Quadriplegic Cerebral Palsy.

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DOI: 10.1590/S0004-2803.201700000-32

PMID: 28723982

### **Cardiac Autonomic System Response to Submaximal Test in Children With Cerebral Palsy. Je l'aurais mis dans métabolisme mais ça se discute**

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 [Indexed for MEDLINE]

## **Sphère bucco-dentaire – Troubles de la déglutition**

### **Effect of Functional Chewing Training on tongue thrust and drooling in children with cerebral palsy: a randomised controlled trial.**

Inal Ö , Serel Arslan S , Demir N , Tunca Yilmaz Ö , Karaduman AA .

*J Oral Rehabil.* 2017 Jul 6. doi: 10.1111/joor.12544. [Epub ahead of print]

Tongue thrust, which is an oral reflex associated with sucking behaviour, may cause problems in swallowing, speech, oro-facial development and also drooling. We aimed to examine the effect of Functional Chewing Training (FuCT) on tongue thrust and drooling in children with cerebral palsy. The study included 32 children with a mean age of 58.25 ± 9.58 months who had tongue thrust. Children were divided into two groups: the FuCT group and control group receiving classical oral motor exercises. Each group received training for 12 weeks. Oral motor assessment was performed. Chewing performance level was determined with the Karaduman Chewing Performance Scale. Tongue

thrust severity was evaluated with the Tongue Thrust Rating Scale. The Drooling Severity and Frequency Scale was used to evaluate drooling severity and frequency. The evaluations were performed before and after treatment. Groups were well matched in age, gender and oral motor assessment. No significant difference was found between groups in terms of pre-treatment chewing function, tongue thrust severity, drooling severity and frequency ( $P > 0.05$ ). The FuCT group showed improvement in chewing performance ( $P = 0.001$ ), tongue thrust severity ( $P = 0.046$ ) and drooling severity ( $P = 0.002$ ), but no improvement was found in terms of drooling frequency ( $P = 0.082$ ) after treatment. There was no improvement in chewing performance, tongue thrust, drooling severity and frequency in the control group. A significant difference was found between groups in favour of FuCT group in tongue thrust severity ( $P = 0.043$ ). This study showed that the FuCT is an effective approach on the severity of tongue thrust and drooling in children with CP.

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PMID: 28681387

### **Factors associated with mouth breathing in children with -developmental -disabilities.**

de Castilho LS , Abreu MH , de Oliveira RB , Souza E Silva ME , Resende VL .

*Spec Care Dentist. 2016 Mar-Apr;36 :75-9. doi: 10.1111/scd.12157. Epub 2016 Jan 13.*

**OBJECTIVE:** To investigate the prevalence and factors associated with mouth breathing among patients with developmental disabilities of a dental service. **METHODS:** We analyzed 408 dental records. Mouth breathing was reported by the patients' parents and from direct observation. Other variables were as follows: history of asthma, bronchitis, palate shape, pacifier use, thumb -sucking, nail biting, use of medications, gastroesophageal reflux, bruxism, gender, age, and diagnosis of the patient. Statistical analysis included descriptive analysis with ratio calculation and multiple logistic regression. Variables with  $p < 0.25$  were included in the model to estimate the adjusted OR (95% CI), calculated by the forward stepwise method. Variables with  $p < 0.05$  were kept in the model. **RESULTS:** Being male ( $p = 0.016$ ) and use of centrally acting drugs ( $p = 0.001$ ) were the variables that remained in the model.

**CONCLUSION:** Among patients with -developmental disabilities, boys and psychotropic drug users had a greater chance of being mouth breathers.

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DOI: 10.1111/scd.12157

PMID: 26763202 [Indexed for MEDLINE]

### **Oral sucking habits among children with Down syndrome and cerebral palsy.**

Carneiro NCR , Monteiro LR , Pordeus IA , Borges-Oliveira AC .

*Spec Care Dentist. 2017 Jul;37(4):176-180. doi: 10.1111/scd.12231.*

**AIMS:** Identify factors associated with the presence of oral sucking habits among children with Down syndrome (DS) and cerebral palsy (CP).

**METHODS:** The sample consisted of 181 children with DS or CP from two public healthcare institutions that treat children with special needs in the city of Rio de Janeiro, Brazil. The children's mothers answered a questionnaire about the individual and behavioral characteristics and the medical history of their children. The study was approved by the Research Ethics Committee of Universidade Federal de Minas Gerais.

**RESULTS:** The presence of oral sucking habits (bottle feeding and pacifier/finger sucking) was observed in 83.0% of children. Children with artificial sucking habits had a 3.42 times greater chance of having a history of throat infection during the previous 6 months (5.61 to 48). A mother in the group of children with oral sucking habits had a 10.28 chance of not having breastfed her child (2.86 to 36.93).

**CONCLUSION:** The history of throat infections in the preceding 6 months and the lack of breastfeeding were associated with the presence of oral sucking habits in children with DS and CP.

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PMID: 28677883

### **Orthodontic treatment and follow-up of a patient with cerebral palsy and spastic quadriplegia.**

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Çifter M , Cura N .

*Am J Orthod Dentofacial Orthop.* 2016 Oct;150(4):670-678. doi:10.1016/j.ajodo.2015.10.031.

**INTRODUCTION:** This report describes the clinical orthodontic management of a patient with spastic quadriplegia and cerebral palsy. Guidelines to overcome difficulties encountered during the treatment period are suggested.

**METHODS:** A 13-year-old boy with cerebral palsy and spastic quadriplegia complained of an undesirable oral appearance because of his malocclusion. He had a Class II molar relationship, with severe maxillary and moderate mandibular anterior crowding. Enamel hypoplasia was apparent on all teeth. He had losses of body function and upper extremity function of 70% and 39%, respectively. His physical limitations necessitated a treatment approach that did not rely on patient-dependent appliances. The treatment plan called for maxillary first premolar extractions, mandibular incisor protrusion, and air rotor stripping.

**RESULTS:** The patient's oral function and esthetic appearance were significantly improved. Aligned dental arches with good occlusion were obtained. The patient's self-confidence improved during the treatment period.

**CONCLUSIONS:** Physical appearance can influence personality and social acceptability. Corrective orthodontic treatment for patients with physical handicaps can improve not only oral function, but also self-confidence and self-esteem.

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DOI: 10.1016/j.ajodo.2015.10.031

PMID: 27692425 [Indexed for MEDLINE]

### **Perinatal undernutrition associated to experimental model of cerebral palsy increases adverse effects on chewing in young rats.**

Lacerda DC , Ferraz-Pereira KN , Visco DB , Pontes PB , Chaves WF , Guzman-Quevedo O , Manhães-de-Castro R , Toscano AE .

*Physiol Behav.* 2017 May 1;173:69-78. doi: 10.1016/j.physbeh.2017.01.043. Epub 2017 Jan 30.

The aim of the present study was to investigate the effect of perinatal undernutrition on the sensorimotor pattern of chewing in rats submitted to cerebral palsy experimental model. A total of 60 male Wistar rats were randomly distributed into four groups: Nourished/Control (NC, n=15), Nourished/Cerebral Palsy (NCP, n=15); Undernourished/Control (UC, n=15) and Undernourished/Cerebral Palsy (UCP, n=15). Animals of cerebral palsy (CP) group were subjected to an experimental model based on the combination of perinatal anoxia associated with sensorimotor restriction of the hindlimb. In the rats were evaluated body weight gain, intake of breast milk, feed post-weaning consumption, parameters of the chewing, intra-oral sensitivity and muscle properties (muscle weight and distribution of types of fibers) of the masseter and digastric. Animals from undernourished CP group showed greater reduction in most data evaluated including body weight (P<0.05), food intake post-weaning (P<0.05), frequency of chewing cycles (P<0.05), duration of the reactions of "taste" (P<0.05), muscle weight and decrease of the proportion of type IIB fibers in the masseter muscle (P<0.05). These results demonstrated in rats submitted a cerebral palsy that perinatal undernutrition intensifies the damage in morphological and functional parameters of chewing.

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DOI: 10.1016/j.physbeh.2017.01.043

PMID: 28153456 [Indexed for MEDLINE]

### **Safety of Ultrasound-Guided Botulinum Toxin Injections for Sialorrhea as Performed by Pediatric Otolaryngologists.**

Shariat-Madar B , Chun RH , Sulman CG , Conley SF .

*Otolaryngol Head Neck Surg.* 2016 May;154 :924-7. doi: 10.1177/0194599816629612. Epub 2016 Feb 23.

**OBJECTIVE:** To evaluate incidence of complications and hospital readmission as a result of ultrasound-guided botulinum toxin injections to manage sialorrhea.

**STUDY DESIGN:** Case series with chart review.

**SETTING:** Children's Hospital of Wisconsin.

**SUBJECTS AND METHODS:** A case series with chart review was performed of all cases of ultrasound-guided injection of botulinum toxin by pediatric otolaryngologists from March 5, 2010, to September 26, 2014. Primary outcomes included complications such as dysphagia, aspiration pneumonia, and motor paralysis. Secondary outcomes included hospitalization, intubation, and nasogastric tube placement.

**RESULTS:** There were 48 patients, 111 interventions, and 306 intraglandular injections identified. Botulinum toxin type A and type B were utilized in 4 and 107 operative interventions, respectively. Type A was injected into 4 parotid and 4 submandibular glands, utilizing doses of 20 U per parotid and 30 U per submandibular gland. Type B was injected into 98 parotid and 200 submandibular glands, with average dosing of 923 U per parotid and 1170 U per submandibular gland, respectively. There were 2 instances of subjectively worsening of baseline dysphagia that self-resolved. No cases were complicated by aspiration pneumonia or motor paralysis. No patients required hospital readmission, intubation, or nasogastric tube placement.

**CONCLUSION:** Prior published data indicated 16% complication incidence with ultrasound-guided injection of botulinum toxin. Our study found a low complication rate (0.6%) with ultrasound-guided injections of botulinum toxin to manage sialorrhea, without cases of aspiration pneumonia or motor paralysis. Of 306 intraglandular injections, there were 2 cases of worsening baseline subjective dysphagia that self-resolved.

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DOI: 10.1177/0194599816629612

PMID: 26908558 [Indexed for MEDLINE]

### **Treatment of drooling with sublingual atropine sulfate in children and adolescents with cerebral palsy.**

Dias BLS, Fernandes AR, Maia HS Filho.

*Arq Neuropsiquiatr.* 2017 May;75 :282-287. doi: 10.1590/0004-282X20170033.

**Objective:** To report the effect of sublingual atropine sulfate to treat drooling in children with cerebral palsy by comparing the results of the Drooling Impact Scale in a non-controlled open clinical trial.

**Results:** Twenty-five children were assessed. The difference in the mean scores of the pre- and post-treatment scales reached statistical significance. There was a low frequency of side effects compared to studies with other anticholinergics. **Conclusion:** The use of sublingual atropine sulfate seems to be safe and there is a reduction in the Drooling Impact Scale score, which suggests efficacy in the treatment of drooling in children and adolescents with cerebral palsy. Our results should be replicated in randomized, placebo-controlled studies with larger numbers of participants.

[Free Article](#)

DOI: 10.1590/0004-282X20170033

PMID: 28591387 [Indexed for MEDLINE]

## **Troubles du sommeil**

### **Sleep: An underemphasized aspect of health and development in neurorehabilitation.**

Verschuren O, Gorter JW, Pritchard-Wiart L.

*Early Hum Dev.* 2017 Jul 12. pii: S0378-3782(17)30328-6. doi: 10.1016/j.earlhumdev.2017.07.006. [Epub ahead of print]

Sleep deficiency has unique causes and implications for children with neonatal brain injury; contributing to the development or exacerbation of neurodevelopmental impairments and yet it is an underemphasized aspect of health and development. There is very little research evidence to guide the management of sleep disorders in children with cerebral palsy, a common neurodevelopmental disability of childhood. This paper is a comprehensive review and analysis of the literature regarding what is known about sleep quantity and quality in children with cerebral palsy. The specific implications for children with cerebral palsy are explored including the adverse effects of sleep deficiency on general child development, physical health and growth, and mental functioning. The consequences for the family are also discussed. Finally, the assessment and management of sleep problems are summarized to provide guidance to clinicians who work in neurodevelopmental medicine.

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DOI: 10.1016/j.earlhumdev.2017.07.006

PMID: 28711232

## Epilepsie

### **Seizures in Children With Cerebral Palsy and White Matter Injury.**

Cooper MS , Mackay MT , Fahey M , Reddihough D , Reid SM , Williams K , Harvey AS .  
*Pediatrics*. 2017 Mar;139 . pii: e20162975. doi: 10.1542/peds.2016-2975. Epub 2017 Feb 16.

**OBJECTIVE:** The goal of this study was to describe the prevalence, syndromes, and evolution of seizure disorders in children with cerebral palsy (CP) due to white matter injury (WMI).

**METHODS:** For this population-based cohort study, brain MRI scans and medical records were reviewed in children in the Victorian Cerebral Palsy Register born between 1999 and 2006 recorded as having WMI. Children were excluded if they had features of an undiagnosed syndrome, associated cortical malformation or injury, or no medical contact in the preceding year. Included were 166 children with CP and isolated WMI due to presumed vascular insufficiency or hemorrhage; 87 were born preterm. Seizure and CP details were obtained from medical records and interviews, and EEG recordings were reviewed.

**RESULTS:** Forty-one children (25%) had seizures beyond the neonatal period. Four children had West syndrome, which resolved with treatment. Thirteen children had febrile seizures that they outgrew. Thirty children had focal epilepsy with seizure manifestations and EEG discharges typical of early-onset childhood occipital epilepsy or childhood epilepsy with centrotemporal spikes; 23 have outgrown these seizures. Two children had idiopathic generalized epilepsy; it was ongoing in 1 child. Fourteen children had evolution from 1 epileptic syndrome to another. At last follow-up (median age, 12.7 years; minimum age, 9.7 years), 80% had not had a seizure for >2 years.

**CONCLUSIONS:** The electroclinical features of seizure disorders associated with CP and WMI are those of the age-limited, epileptic syndromes of childhood, with favorable outcome in the majority. The findings have important implications for counseling and drug treatment.

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DOI: 10.1542/peds.2016-2975

PMID: 28209769 [Indexed for MEDLINE]

## **Qualité de vie et rapport au monde**

### **Qualité de vie – Retentissement dans la vie quotidienne**

#### **Exploring quality of life of children with cerebral palsy and intellectual disability: What are the important domains of life?**

Davis E , Reddihough D , Murphy N , Epstein A , Reid SM , Whitehouse A , Williams K , Leonard H , Downs J .  
*Child Care Health Dev*. 2017 Jul 26. doi: 10.1111/cch.12501. [Epub ahead of print]

**BACKGROUND:** Although it is estimated that half of all children with cerebral palsy also have comorbid intellectual disability, the domains of quality of life (QOL) important for these children are not well understood. The aim of this study was to identify important domains of QOL for these children and adolescents.

**METHODS:** Due to the children's communication impairments, qualitative semi-structured interviews were conducted with 18 parents. The children (9 males) had a median age of 12 (range 7 to 17) years at interview and nearly two thirds were classified as Gross Motor Function Classification System IV or V. A grounded theory approach was used to identify domains of QOL.

**RESULTS:** The 11 domains identified as important to QOL were physical health, body comfort, behaviour and emotion, communication, predictability and routine, movement and physical activity, nature and outdoors, variety of activity, independence and autonomy, social connectedness, and access to services.

**CONCLUSIONS:** The domains of QOL that emerged from this study will be useful for professionals who support children with cerebral palsy and their families. They will also be important for developing a QOL instrument essential for informing the development of interventions and their monitoring and evaluation.

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DOI: 10.1111/cch.12501

PMID: 28748578

## **Longitudinal changes in health-related quality of life in preschool children with cerebral palsy of different levels of motor severity.**

Lai CJ , Chen CY , Chen CL , Chan PS , Shen IH , Wu CY .

*Res Dev Disabil.* 2017 Feb;61:11-18. doi: 10.1016/j.ridd.2016.11.013. Epub 2016 Dec 29.

**BACKGROUND:** When setting goals for cerebral palsy (CP) interventions, health-related quality of life (HRQoL) is an important outcome.

**AIMS:** To compare longitudinal changes in HRQoL in children with CP of different levels of motor severity.

**METHODS AND PROCEDURES:** Seventy-three children with CP were collected and classified into three groups based on Gross Motor Function Classification System (GMFCS) levels. HRQoL was assessed by parent's proxy of the TNO-AZL Preschool Quality of Life (TAPQOL) at baseline and 6 months later.

**OUTCOMES AND RESULTS:** Children with GMFCS level V had a lower total TAPQOL score and scores in all domains than those with level I-IV ( $p < 0.01$ ), except for the non-motor subdomain of physical functioning at follow-up. With regards to longitudinal changes, the children with GMFCS level V had greater improvements in physical ( $p = 0.016$ ) and cognitive functioning ( $p = 0.042$ ), but greater deterioration in emotional functioning ( $p = 0.008$ ) than those with levels I-II at 6 months of follow-up.

**CONCLUSIONS AND IMPLICATIONS:** Motor severity was associated with TAPQOL scores in all domains and changes in some domains in children with CP. Clinicians should early identify children at risk of a poor HRQoL and plan timely treatment strategies to enhance the HRQoL of children with CP.

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PMID: 28040642 [Indexed for MEDLINE]

## **Reliability and Validity of The Cerebral Palsy Quality of Life Questionnaire in The Turkish Population.**

Atasavun Uysal S , Düger T , Elbasan B , Karabulut E , Toylan İ .

*Percept Mot Skills.* 2016 Feb;122 :150-64. doi: 10.1177/0031512515625388. Epub 2016 Feb 1.

This study examined the psychometric properties of the Turkish version of the Cerebral Palsy Quality of Life Questionnaire (CP QOL). A total of 149 primary caregivers completed the final version of the CP QOL-Primary Caregivers and the Children Health Questionnaire (CHQ) for children 4-12 years old (M age = 7.6 yr., SD = 2.5); 58 children with CP ages 9 to 12 years completed the CP QOL-Child and Health-Related Quality of Life Questionnaire for Children (Kid-KINDL) questionnaire. The Gross Motor Function Classification System was also used for the classification of the children with CP. Internal consistency (Cronbach's  $\alpha$ ) ranged between .63 and .93 for primary caregivers and .61 to .92 for the children's self-reports. Intra-class correlation coefficients ranged between .88 and .97 for primary caregivers and .91 to .98 for children. It was concluded that the Turkish version of CP QOL questionnaire is a reliable and valid tool for assessing QOL in children with CP.

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## **Activité physique -Sport**

### **Developing a Clinical Protocol for Habitual Physical Activity Monitoring in Youth With Cerebral Palsy.**

Nicholson K , Weaver A, George A, Hulbert R, Church C, Lennon N.

*Pediatr Phys Ther.* 2017 Jan;29(1):2-7.

**PURPOSE:** The StepWatch (SW) has been used to monitor physical activity (PA) in youth with cerebral palsy; however, there is no standard collection protocol. The goal was to develop such a protocol.

**METHODS:** Data were examined from patients who wore the SW for 8 to 14 days. The Spearman-Brown prediction formula determined the minimum number of days for reliable PA. Weekdays were compared to weekends and 10- and 60-second collection intervals were examined.



RESULTS: The PA data were collected from 98 youth with cerebral palsy. Results showed 3 days would provide reliable representation of PA, participants took significantly more steps during school days compared with weekends, and there were no differences between collection intervals.

CONCLUSIONS: We recommend setting the SW for 7 days at 10-second collection rate. Data should be analyzed if at least 3 days of data are present. Weekdays and weekend days should be noted, and both included when possible.

DOI: 10.1097/PEP.0000000000000320

PMID: 27984456 [Indexed for MEDLINE]

### **Habitual Physical Activity in Children With Cerebral Palsy Aged 4 to 5 Years Across All Functional Abilities.**

Keawutan P , Bell KL, Oftedal S, Davies PS, Ware RS, Boyd RN.

*Pediatr Phys Ther.* 2017 Jan;29(1):8-14.

PURPOSE: To compare ambulatory status in children with cerebral palsy aged 4 to 5 years with their habitual physical activity and time spent sedentary, and to compare their activity with physical activity guidelines.

METHODS: Sixty-seven participants-independently ambulant, marginally ambulant, and nonambulant-wore accelerometers for 3 days. Time spent sedentary as a percentage of wear time and activity counts were compared between groups.

RESULTS: There were significant differences in time spent sedentary and activity counts between groups. Children who were independently ambulant were more likely to meet physical activity guidelines.

CONCLUSION: Children with cerebral palsy spent more than half of their waking hours in sedentary time. Interventions to reduce sedentary behavior and increase habitual physical activity are needed in children with cerebral palsy at age 4 to 5 years.

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PMID: 27984458 [Indexed for MEDLINE]

### **Longitudinal physical activity and sedentary behaviour in preschool-aged children with cerebral palsy across all functional levels.**

Keawutan P , Bell KL , Oftedal S , Ware RS , Stevenson RD , Davies PSW , Boyd RN .

*Dev Med Child Neurol.* 2017 Aug;59(8):852-857. doi: 10.1111/dmcn.13439. Epub 2017 Apr 22.

AIM: To investigate longitudinal changes of habitual physical activity (HPA) and sedentary time in children with cerebral palsy (CP) aged 1 year 6 months to 5 years across all functional abilities.

METHOD: At study entry, 95 children (62 males, 33 females) were classified using the Gross Motor Function Classification System (GMFCS) at levels I (50), II (9), III (16), IV (6), and V (14). Physical activity was recorded on a total of 159 occasions at four possible time points: 1 year 6 months to 2 years; 2 years 6 months to 3 years; 4 years; and 5 years using ActiGraph for 3 days. Mixed-effects regression models were used for analyses.

RESULTS: Participants classified at GMFCS levels I and II had stable HPA as they aged. HPA significantly decreased at 5 years in children classified at GMFCS levels III to V. Sedentary time significantly increased at 4 years and 5 years in all participants. Annual HPA significantly reduced in children classified at GMFCS levels III to V (-123 counts/min, 95% confidence interval [CI] -206 to -40) while annual sedentary time significantly increased in all participants (GMFCS levels I-II: 2.4%, 95% CI 0.7-4.1; GMFCS levels III-V: 6.9%, 95% CI 4.6-9.2).

INTERPRETATION: Children with CP at all GMFCS levels should be encouraged to be physically active from early childhood as HPA levels start to decline from 4 years. Breaks in sedentary time are required for all children with CP from the age of 3 years.

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### **Self-efficacy of physical education teachers in including students with cerebral palsy in their classes.**

Hutzler Y , Barak S .

*Res Dev Disabil.* 2017 Sep;68:52-65. doi: 10.1016/j.ridd.2017.07.005. Epub 2017 Jul 21.

Children with cerebral palsy (CP) are often mainstreamed into the general education system, but are likely to be excluded from physical education (PE) classes. A questionnaire was constructed and utilized to measure PE teachers'

Science Infos Paralyse Cérébrale, Juillet 2017, FONDATION PARALYSIE CEREBRALE 67 rue Vergniaud 65 75013 Paris - tel +33 1 45 54 03 03 contact: Christine Doumergue cdoumergue@lafondationmotrice.org

self-efficacy (SE) toward inclusion of students with CP in each of three mobility categories (independent, using assistive devices, using wheelchair mobility) and the impact of experience and training on teachers' SE. Participants in the study were 121 PE teachers from different parts of Israel (mean age: 41.02±9.33 years; range: 25.00-59.00 years). Exploratory factor analysis was used to determine the structure of the sub-scales' factors' structure and Cronbach's Alpha reliability was satisfactory (range 0.872-0.941). Independent t-tests were calculated in order to compare the SE of teachers with and without adapted PE experience. Repeated Analysis of Variance was performed to measure within-group differences in SE. Results revealed that the PE teachers' SE in teaching students who use mobility assistive devices or wheelchairs was significantly lower compared to teaching those who walk and run unaided ( $F=19.11$ ;  $p<0.001$ ). The teachers' SE towards including CP children who independently ambulate was influenced ( $p<0.05$ ;  $d=0.94$ ) by the teacher's experience (elementary school practicum). SE in the mobility with assistive device group was also significantly influenced ( $p<0.05$ ;  $d=0.1$ ) by teaching experience (previous experience and having a specialization in adapted PE). Finally, SE when teaching the wheelchair mobility group was influenced by having an adapted PE specialization ( $p<0.05$ ;  $d=0.82$ ). Specialized training in this particular area should be enhanced to increase teachers' SE and enable greater participation of children with CP in general physical education classes.

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PMID: 28738221

## **Prise en charge et Accompagnant/Accompagnement**

### **Coaction of individual and environmental factors: a review of intensive therapy paradigms for children with unilateral spastic cerebral palsy.**

Ferre CL , Gordon AM .

*Dev Med Child Neurol.* 2017 Jul 27. doi: 10.1111/dmcn.13497. [Epub ahead of print]

Evidence-based treatment approaches for children with unilateral spastic cerebral palsy are expanding and being modified to fit the constraints of families and the child receiving treatment. In this review, we first provide an overview of a theoretical framework that considers the intricate interactions between the individual child and the environment in which treatment is provided. Next, we describe intensive interventions that have strong support for their efficacy. We also highlight the heterogeneity with which children respond to these approaches. Individual characteristics that might affect responsiveness are summarized. We propose that a one-size-fits-all approach may not be as efficacious as approaches based on the specific brain damage and resulting development of the corticospinal tract. Finally, we review evidence suggesting that the environment can be structured to promote opportunities for intensive practice and self-generated movement—two important aspects of efficacious treatments. Emphasis is placed on intensive home programs delivered by caregivers.

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### **Family adaptation to cerebral palsy in adolescents: A European multicenter study.**

Guyard A , Michelsen SI , Arnaud C , Fauconnier J .

*Res Dev Disabil.* 2017 Feb;61:138-150. doi: 10.1016/j.ridd.2016.11.010. Epub 2017 Jan 10.

**BACKGROUND AND AIM:** Factors promoting family adaptation to child's disability are poorly studied together. The aim of the study was to describe the family adaptation to disability and to identify determinants associated with using a global theoretical model.

**MATERIALS AND METHODS:** 286 families of teenagers [13-17 years] with cerebral palsy (CP) from 4 European disability registers were included and visited at home. Face to face interviews were performed in order to measure parental distress, perceived impact in various dimensions of family life, family resources and stressors. Relationships were modelled with structural equations.

**RESULTS:** 31.8% of parents living with an adolescent with CP showed clinically significant high stress requiring professional assistance. The main stressors were the level of motor impairment and behavioural disorders in

adolescent. A good family functioning was the best protective factor. Respite in care and a parents' positive attitude were significantly related to less parental distress. Material support, socioeconomical level, marital status or parental qualifications did not appear to be significant protector factors.

**CONCLUSIONS:** Particular attention must be paid not only on physical condition but also on adolescent psychological problems to improve family adaptation. Families at risk of experiencing severe distress should be targeted early and proactive caregiver interventions on the whole family should be performed.

**WHAT THIS PAPER ADDS:** Family is a dynamic system: facing disability, it tries to recover its balance with available resources and its perception of the situation. Literature highlights potential stressors and protecting factors that could affect the disabled child's family adaptation but few papers study a global model including most of these factors. This study validated a global theoretical model of family adaptation to disability at adolescence. It identified behaviour disorders and motor impairment level as main stressors, family functioning as the largest protecting factors, and equipment and financial support as non significant protective factors.

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PMID: 28087202 [Indexed for MEDLINE]

### **Parents' Assessments of Disability in Their Children Using World Health Organization International Classification of Functioning, Disability and Health, Child and Youth Version Joined Body Functions and Activity Codes Related to Everyday Life.**

Illum NO, Gradel KO.

*Clin Med Insights Pediatr.* 2017 Jun 19;11:1179556517715037. doi: 10.1177/1179556517715037. eCollection 2017.

**AIM:** To help parents assess disability in their own children using World Health Organization (WHO) International Classification of Functioning, Disability and Health, Child and Youth Version (ICF-CY) code qualifier scoring and to assess the validity and reliability of the data sets obtained.

**METHOD:** Parents of 162 children with spina bifida, spinal muscular atrophy, muscular disorders, cerebral palsy, visual impairment, hearing impairment, mental disability, or disability following brain tumours performed scoring for 26 body functions qualifiers (b codes) and activities and participation qualifiers (d codes). Scoring was repeated after 6 months. Psychometric and Rasch data analysis was undertaken.

**RESULTS:** The initial and repeated data had Cronbach  $\alpha$  of 0.96 and 0.97, respectively. Inter-code correlation was 0.54 (range: 0.23-0.91) and 0.76 (range: 0.20-0.92). The corrected code-total correlations were 0.72 (range: 0.49-0.83) and 0.75 (range: 0.50-0.87). When repeated, the ICF-CY code qualifier scoring showed a correlation R of 0.90. Rasch analysis of the selected ICF-CY code data demonstrated a mean measure of 0.00 and 0.00, respectively. Code qualifier infit mean square (MNSQ) had a mean of 1.01 and 1.00. The mean corresponding outfit MNSQ was 1.05 and 1.01. The ICF-CY code  $\tau$  thresholds and category measures were continuous when assessed and reassessed by parents. Participating children had a mean of 56 codes scores (range: 26-130) before and a mean of 55.9 scores (range: 25-125) after repeat. Corresponding measures were -1.10 (range: -5.31 to 5.25) and -1.11 (range: -5.42 to 5.36), respectively. Based on measures obtained at the 2 occasions, the correlation coefficient R was 0.84. The child code map showed coherence of ICF-CY codes at each level. There was continuity in covering the range across disabilities. And, first and foremost, the distribution of codes reflexed a true continuity in disability with codes for motor functions activated first, then codes for cognitive functions, and, finally, codes for more complex functions.

**CONCLUSIONS:** Parents can assess their own children in a valid and reliable way, and if the WHO ICF-CY second-level code data set is functioning in a clinically sound way, it can be employed as a tool for identifying the severity of disabilities and for monitoring changes in those disabilities over time. The ICF-CY codes selected in this study might be one cornerstone in forming a national or even international generic set of ICF-CY codes for the benefit of children with disabilities, their parents, and caregivers and for the whole community supporting with children with disabilities on a daily and perpetual basis.

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**Parent-child interactions and children with cerebral palsy: An exploratory study investigating emotional availability, functional ability, and parent distress.**

Barfoot J , Meredith P , Ziviani J , Whittingham K .

*Child Care Health Dev.* 2017 Jul 23. doi: 10.1111/cch.12493. [Epub ahead of print]

**BACKGROUND:** Emotionally available parent-child relationships are supportive of child health and development. When a child has cerebral palsy, a range of child and parent factors can potentially impact the parent-child relationship; however, little research has specifically addressed this question. The aim of this study is to investigate links between parent-child emotional availability and both child functional abilities and parent distress in a sample of parents and children with cerebral palsy.

**METHODS:** Twenty-three mothers (mean age 37.3+/-5.7 years) and their children (mean age 4.9+/-3.3 years) with cerebral palsy completed a 20 min videoed parent-child interaction, scored using the Emotional Availability Scales. Parents also completed the Depression Anxiety Stress Scale, the Paediatric Evaluation of Disability Inventory, and the Strengths and Difficulties Questionnaire. Correlational analyses were conducted, and qualitative observations were made.

**RESULTS:** Parent-child dyads in which the parent reported depressive symptoms scored poorer on all aspects of parent-child emotional availability. Where parents reported experiencing anxiety or stress, increased parent hostility and decreased child responsiveness was found. There was no relationship between child functional abilities and either parent distress or parent-child emotional availability. Parent sensitivity, structuring, and nonintrusiveness were negatively associated with child peer problems. Both child responsiveness and child involvement were negatively associated with hyperactivity/inattention. Observations of video footage suggested that parent implementation of therapy strategies impacted negatively on parent-child emotional availability for some dyads.

**CONCLUSION:** Findings from this study are consistent with the wider literature showing a link between parental depression and the parent-child relationship and extend this link to the cerebral palsy population. The importance of routine screening for parental mental health problems in early childhood intervention is highlighted by these findings. In addition, this study emphasizes the need to better understand how therapists support parents to implement therapeutic strategies to minimize negative impact on the developing parent-child relationship.

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**Parents' Perception of Receiving Family-Centered Care for Their Children with Physical Disabilities: A Meta-Analysis.**

Almasri NA , An M , Palisano RJ .

*Phys Occup Ther Pediatr.* 2017 Jul 28:1-17. doi: 10.1080/01942638.2017.1337664. [Epub ahead of print]

**AIMS:** Understanding parent perceptions of family-centered care (FCC) is important to improve processes and outcomes of children's services.

**OBJECTIVE:** A systematic review and meta-analysis of research on the Measures of Processes of Care (MPOC-20) were performed to determine the extent parents of children with physical disabilities perceive they received FCC.

**METHODS:** A comprehensive literature search was conducted using four databases. A total of 129 studies were retrieved; 15 met the criteria for the synthesis. Meta-analysis involving 2,582 mothers and fathers of children with physical disabilities mainly cerebral palsy was conducted for the five scales of the MPOC-20.

**RESULTS:** Aggregated mean ratings varied from 5.0 to 5.5 for Providing Specific Information about the Child; Coordinated and Comprehensive Care; and Respectful and Supportive Care (relational behaviors) and Enabling and Partnership (participatory behaviors) indicating that, on average, parents rated FCC as having been provided to "a fairly great extent." The aggregated mean rating was 4.1 for Providing General Information, indicating FCC was provided "to a moderate extent."

**CONCLUSIONS:** Service providers are encouraged to focus on child and family needs for general information. Research is needed to better understand parent perspectives of service provider participatory behaviors which are important for engaging families in intervention processes.

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## Aspects économiques - Coûts –

### Impact of Non-medical Out-of-pocket Expenses on Families of Children With Cerebral Palsy Following Orthopaedic Surgery.

Vessey JA , DiFazio RL , Strout TD , Snyder BD .

*J Pediatr Nurs.* 2017 Jul 24. pii: S0882-5963(17)30117-3. doi: 10.1016/j.pedn.2017.07.006. [Epub ahead of print]

**PURPOSE:** Limited research has been conducted on the non-medical out-of-pocket expenses (NOOPEs) incurred by families of children with chronic health conditions. The study objectives were to: 1) calculate the estimated NOOPEs incurred by families during hospitalization of their child, 2) identify predictors of high NOOPEs, and 3) assess the impact of the child's chronic health condition on the family's finances.

**DESIGN AND METHODS:** Prospective observational study. Parents were included if their child was 3-20 years old, had severe, non-ambulatory cerebral palsy (CP), and scheduled for hip or spine surgery. Parents reported all NOOPEs incurred during their child's hospitalization using the Family Expense Diary. Families completed the subscales of the Impact on Family Scale and the Assessment of Caregivers Experience with Neuromuscular Disease. Descriptive and univariate and multiple hierarchical regression models were used in the analysis.

**RESULTS:** Fifty two parents participated. The total NOOPEs ranged from \$193.00 to \$7192.71 (M=\$2001.92) per hospitalization representing an average of 4% of the family's annual earned income. Caregiver age (F=8.393, p<0.001), income (F=7.535, p<0.001), and distance traveled to the hospital (F=4.497, p=0.039) were significant predictors of high NOOPEs. The subscale scores indicated that a child's chronic health condition had a significant impact on family finances.

**CONCLUSIONS AND PRACTICE IMPLICATIONS:** Hospitalization is associated with numerous NOOPEs that create additional financial demands for families caring for a child with severe CP. NOOPEs should be addressed when preparing families for their children's planned hospital admissions, especially those families of CSHCN who experience significant financial impacts secondary to their children's care.

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### Therapy Use for Children With Developmental Conditions: Analysis of Colorado Medicaid Data.

McManus BM, Rapport MJ, Richardson Z, Lindrooth R.

*Pediatr Phys Ther.* 2017 Jul;29(3):192-198. doi: 10.1097/PEP.0000000000000425.

**STUDY PURPOSE:** To examine therapy use and spending for Medicaid-enrolled infants and toddlers with developmental conditions.

**METHODS:** Sample infants and toddlers had a diagnosis (eg, cerebral palsy) or developmental delay (DD). Colorado Children's Medicaid administrative outpatient therapy claims (2006-2008) were used to estimate differences, by condition type and number of comorbid chronic conditions (CCCs), of any physical therapy (PT)/occupational therapy (OT) and Medicaid PT/OT spending.

**RESULTS:** The sample included 20 959 children. Children with at least 2 CCCs had higher odds of PT/OT than children with no CCC. Children with DD had 12-fold higher odds of having any PT/OT compared with children with diagnosis. Children with a DD and 2 CCCs had the highest PT/OT spending.

**CONCLUSIONS:** Medicaid PT/OT use and spending are higher for children with more CCCs and those with DD because children with DD receive more specialized PT/OT.

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