

Monday 14 December 2015

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Interventions and Management

1. **BMJ Open. 2015 Dec 7;5(12):e010212. doi: 10.1136/bmjopen-2015-010212.**

Early childhood constraint therapy for sensory/motor impairment in cerebral palsy: a randomised clinical trial protocol.

Chorna O, Heathcock J, Key A, Noritz G, Carey H, Hamm E, Nelin MA, Murray M, Needham A, Slaughter JC, Maitre NL.

INTRODUCTION: Cerebral palsy (CP) is the most common physical disability in childhood. It is a disorder resulting from sensory and motor impairments due to perinatal brain injury, with lifetime consequences that range from poor adaptive and social function to communication and emotional disturbances. Infants with CP have a fundamental disadvantage in recovering motor function: they do not receive accurate sensory feedback from their movements, leading to developmental disregard. Constraint-induced movement therapy (CIMT) is one of the few effective neurorehabilitative strategies shown to improve upper extremity motor function in adults and older children with CP, potentially overcoming developmental disregard. **METHODS AND ANALYSIS:** This study is a randomised controlled trial of children 12-24 months corrected age studying the effectiveness of CIMT combined with motor and sensory-motor interventions. The study population will comprise 72 children with CP and 144 typically developing children for a total of N=216 children. All children with CP, regardless of group allocation will continue with their standard of care occupational and physical therapy throughout the study. The research material collected will be in the form of data from high-density array event-related potential scan, standardised assessment scores and motion analysis scores.

ETHICS AND DISSEMINATION: The study protocol was approved by the Institutional Review Board. The findings of the trial will be disseminated through peer-reviewed journals and scientific conferences. **TRIAL REGISTRATION NUMBER:** NCT02567630.

[PMID: 26644127](#)

2. **Phys Occup Ther Pediatr. 2015 Dec 7:1-14. [Epub ahead of print]**

Younger Children with Cerebral Palsy Respond Better Than Older Ones to Therapist-Based Constraint-Induced Therapy at Home on Functional Outcomes and Motor Control.

Chen HC, Kang LJ, Chen CL, Lin KC, Chen FC, Wu KP.

AIMS: To examine the differences in efficacy of home-based constraint-induced therapy (CIT) on functional

outcomes and motor control in two age groups of children with cerebral palsy (CP). **METHODS:** Twenty-three children with spastic unilateral CP receiving 4-week home-based CIT by a therapist were divided into younger (6-8 years; n = 11) and older (9-12 years; n = 12) groups. The home-based CIT involved intensive functional training of the more affected upper-limb while restraining the less affected upper-limb. The outcome measures were Peabody Developmental Motor Scale-2nd edition (PDMS-2) that was being used in a modified way, Functional Independence Measure for Children (WeeFIM), and reach-to-grasp kinematic parameters, including reaction time (RT), normalized movement time (MT), normalized movement units (MUs), peak velocity (PV), and maximum grip aperture (MGA). The outcome measures were assessed at baseline, 4-weeks (post-treatment), 3- and 6-months (follow-up). **RESULTS:** The younger group showed greater changes in visual motor integration skills and RT at all post-tests after intervention than the older group. Groups had comparable changes on any other measures. **CONCLUSIONS:** Younger children with CP responded better to home-based CIT on some areas of upper-limb functions and reach-to-grasp motor control strategies than older children.

[PMID: 26643052](#)

3. *Dev Med Child Neurol.* 2015 Dec 8. doi: 10.1111/dmcn.12977. [Epub ahead of print]

Do mirror movements relate to hand function and timing of the brain lesion in children with unilateral cerebral palsy?

Klingels K, Jaspers E, Staudt M, Guzzetta A, Mailleux L, Ortibus E, Feys H.

AIM: This study aimed to systematically map the severity of mirror movements in both hands in a prospective cohort of children with unilateral cerebral palsy, and to explore the relationship with hand function and brain lesion type. **METHOD:** Seventy-eight children were included (41 males, 37 females; age 9y 4mo, SD 3y 1mo, range 5-15y). Mirror movements were scored during three repetitive tasks following Woods and Teuber criteria. Strength, tone, Melbourne Assessment, Jebsen-Taylor test, and Assisting Hand Assessment were evaluated. Lesions were classified into malformations (n=5), periventricular (n=43), cortico-subcortical (n=22), and postnatally acquired lesions (n=8). **RESULTS:** Significantly more mirror movements were observed in the non-paretic versus the paretic hand ($p \leq 0.003$). Higher mirror movement scores in the non-paretic hand significantly correlated with lower distal strength and lower scores on unimanual and bimanual assessments ($r=0.29-0.41$). In the paretic hand, significant differences were found between lesion types ($p=0.03$). **INTERPRETATION:** The occurrence of mirror movements in the non-paretic hand seems related to hand function while mirror movements in the paretic hand seem more related to the lesion timing, whereby children with earlier lesions present with more mirror movements.

[PMID: 26645574](#)

4. *J Phys Ther Sci.* 2015 Oct;27(10):3255-8. doi: 10.1589/jpts.27.3255. Epub 2015 Oct 30.

The effect of physician experience on the measurement reliability of the Reimers' hip migration percentage in children with cerebral palsy.

Analan PD, Yilmaz EE, Adam M, Leblebici B.

[Purpose] Reimers' hip migration percentage (MP) is commonly used to document the extent of hip displacement in children with cerebral palsy (CP). However, factors such as poor administration of pelvic radiographs, a lack of concentration, inexperience, or a busy clinical environment may result in variations in the MP measurements. The aim of this study was to compare the differences in the MP results of two physiatrists with varying levels of experience to determine the role of experience in the measurement's accuracy. [Subjects and Methods] This retrospective study included 62 hip radiographs of 31 children with spastic CP. Two physiatrists with different experience levels calculated the baseline MP on two occasions six weeks apart. Correlations, intra- and inter-rater reliabilities, and differences in the MPs were compared. [Results] Correlations and inter- and intra-rater reliabilities of the measurements were excellent. There were no statistically significant intra- or inter-rater differences for either of the two measurement points. Inter-rater correlations for each session were 0.94. [Conclusion] Experience does not appear to be a factor in the evaluation of MP, and inter-rater differences do not cause problems regarding patient follow-up.

Therefore, repeated pelvic radiographs are not necessary in the evaluation of MP in children with CP unless indicated.

[PMID: 26644686](#)

5. Biomed Res Int. 2015;2015:813942. doi: 10.1155/2015/813942. Epub 2015 Nov 10.

Changes of Plantar Pressure and Gait Parameters in Children with Mild Cerebral Palsy Who Used a Customized External Strap Orthosis: A Crossover Study.

Chang WD, Chang NJ, Lin HY, Lai PT.

Toe-in gait and crouch gait can make children with mild cerebral palsy fall and suffer improper balance during walking or ambulation training. A customized external strap orthosis for correcting leg alignment was used to resolve this problem. The purpose of this study was to research the immediate effects while wearing the customized external strap orthosis. Pressure platform was used to assess the plantar pressure through static and dynamic assessments and to record the changes in path of pressure trajectory. Motion image analysis system was used to record the gait parameters, which included gait speed, stride length, and cadence. The influence of both wearing and removing the orthosis on the dominant leg of children with mild cerebral palsy was analyzed. Nine children with mild cerebral palsy, who all had a dominant right leg, were recruited. After wearing the orthosis, all gait parameters improved, and foot motion changed in the stance phase of the gait cycle. The path of pressure trajectory closing to the midline was also observed during dynamic assessment. Changes in plantar pressure and path of pressure trajectory were observed and the orthosis device could provide immediate assistance to correct the leg alignment and improve the gait performance in children with mild cerebral palsy.

[PMID: 26640796](#)

6. BMC Pediatr. 2015 Dec 7;15(1):202. doi: 10.1186/s12887-015-0520-7.

The use of instrumented gait analysis for individually tailored interdisciplinary interventions in children with cerebral palsy: a randomised controlled trial protocol.

Rasmussen HM, Pedersen NW, Overgaard S, Hansen L, Dunkhase-Heinl U, Petkov Y, Engell V, Baker R, Holsgaard-Larsen A.

BACKGROUND: Children with cerebral palsy (CP) often have an altered gait. Orthopaedic surgery, spasticity management, physical therapy and orthotics are used to improve the gait. Interventions are individually tailored and are planned on the basis of clinical examinations and standardised measurements to assess walking ('care as usual'). However, these measurements do not describe features in the gait that reflect underlying neuro-musculoskeletal impairments. This can be done with 3-dimensional instrumented gait analysis (IGA). The aim of this study is to test the hypothesis that improvements in gait following individually tailored interventions when IGA is used are superior to those following 'care as usual'. **METHODS/DESIGN:** A prospective, single blind, randomised, parallel group study will be conducted. Children aged 5 to 8 years with spastic CP, classified at Gross Motor Function Classification System levels I or II, will be included. The interventions under investigation are: 1) individually tailored interdisciplinary interventions based on the use of IGA, and 2) 'care as usual'. The primary outcome is gait measured by the Gait Deviation Index. Secondary outcome measures are: walking performance (1-min walk test) and patient-reported outcomes of functional mobility (Pediatric Evaluation of Disability Inventory), health-related quality of life (The Pediatric Quality of Life Inventory Cerebral Palsy Module) and overall health, pain and participation (The Pediatric Outcome Data Collection Instrument). The primary endpoint for assessing the outcome of the two interventions will be 52 weeks after start of intervention. A follow up will also be performed at 26 weeks; however, exclusively for the patient-reported outcomes. **DISCUSSION:** To our knowledge, this is the first randomised controlled trial comparing the effects of an individually tailored interdisciplinary intervention based on the use of IGA versus 'care as usual' in children with CP. Consequently, the study will provide novel evidence for the use of IGA. **TRIAL REGISTRATION:** ClinicalTrials.gov NCT02160457 . Registered June 2, 2014.

[PMID: 26643822](#)

7. Dev Med Child Neurol. 2015 Dec 9. doi: 10.1111/dmcn.12983. [Epub ahead of print]

Effectiveness of neuromuscular electrical stimulation during gait in children with cerebral palsy.

Dayanidhi S.

This commentary is on the original article by Pool et al.

[PMID: 26647909](#)

8. J Phys Ther Sci. 2015 Oct;27(10):3211-4. doi: 10.1589/jpts.27.3211. Epub 2015 Oct 30.

Rehabilitation outcomes in children with cerebral palsy during a 2 year period.

İçağasıoğlu A, Mesci E, Yumusakhuylu Y, Turgut ST, Murat S.

[Purpose] To observe motor and functional progress of children with cerebral palsy during 2 years. [Subjects and Methods] Pediatric cerebral palsy patients aged 3-15 years (n = 35/69) with 24-month follow-up at our outpatient cerebral palsy clinic were evaluated retrospectively. The distribution of cerebral palsy types was as follows: diplegia (n = 19), hemiplegia (n = 4), and quadriplegia (n = 12). Participants were divided into 3 groups according to their Gross Motor Functional Classification System scores (i.e., mild, moderate, and severe). All participants were evaluated initially and at the final assessment 2 years later. During this time, patients were treated 3 times/week. Changes in motor and functional abilities were assessed based on Gross Motor Function Measure-88 and Wee Functional Independence Measure. [Results] Significant improvements were observed in Gross Motor Function Measure-88 and Wee Functional Independence Measure results in all 35 patients at the end of 2 years. The Gross Motor Function Measure-88 scores correlated with Wee Functional Independence Measure Scores. Marked increases in motor and functional capabilities in mild and moderate cerebral palsy patients were observed in the subgroup assessments, but not in those with severe cerebral palsy. [Conclusion] Rehabilitation may greatly help mild and moderate cerebral palsy patients achieve their full potential.

[PMID: 26644677](#)

9. Dev Med Child Neurol. 2015 Dec 9. doi: 10.1111/dmcn.12980. [Epub ahead of print]

Growing muscles in children with cerebral palsy.

This commentary is on the original article by Herskind et al.

Barber LA, Boyd RN.

[PMID: 26648578](#)

10.Dev Med Child Neurol. 2015 Dec 8. doi: 10.1111/dmcn.12990. [Epub ahead of print]

Differentiating between language domains, cognition, and communication in children with cerebral palsy.

Geytenbeek J.

This commentary is on the original article by Mei et al.

[PMID: 26645699](#)

11. Dev Med Child Neurol. 2015 Dec 9. doi: 10.1111/dmcn.12981. [Epub ahead of print]

Pain hurts worldwide: non-verbal children and adolescents with cerebral palsy.

Ramstad K.

This commentary is on the original article by Jayanath et al.

[PMID: 26647738](#)

12. Eur J Paediatr Neurol. 2015 Nov 27. pii: S1090-3798(15)00192-0. doi: 10.1016/j.ejpn.2015.11.009. [Epub ahead of print]

Ketamine-based procedural sedation and analgesia for botulinum toxin A injections in children with cerebral palsy.

Chow C, Choong CT.

INTRODUCTION: Adequate procedural sedation and analgesia (PSA) is essential to reduce pain and distress for children undergoing intramuscular botulinum toxin (BoNT-A) injections. This study describes our institution's experience with ketamine-based PSA in terms of safety and efficacy in children with cerebral palsy receiving BoNT-A injections. **MATERIAL AND METHODS:** This is an analysis of ketamine-based PSA for children undergoing BoNT-A injections between January 2000 and October 2014. All patients received PSA according to our institution's sedation protocol. From 2000 to 2012, intravenous ketamine and midazolam PSA was administered. From 2013 onwards, intravenous ketamine was used as a sole agent for PSA. **RESULTS:** A total of 152 BoNT-A procedures were performed successfully on 87 children. The median age of the children was 5 years 5 months with 9 children younger than 36 months. Ten procedures (6.6%) were associated with acute transient self-limiting side effects: Four developed rashes, three had nausea and vomiting, one child had limb tremors and another child complained of mild headache. One child reported nightmares on the evening of the procedure during the two-week post-procedure review. No child experienced serious adverse events. **CONCLUSION:** Administration of ketamine-based PSA for intramuscular BoNT-A procedures in children can be both safe and efficacious.

[PMID: 26640079](#)

13. Dev Med Child Neurol. 2015 Dec 9. doi: 10.1111/dmcn.12989. [Epub ahead of print]

Pain as a root of the problem: health-related quality of life in children with cerebral palsy.

Vargus-Adams JN.

This commentary is on the original article by Findlay et al.

[PMID: 26648350](#)

14. Methods Inf Med. 2015 Dec 7;55(1). [Epub ahead of print]

Quantitative Evaluation of Performance during Robot-assisted Treatment.

Peri E, Biffi E, Maghini C, Servodio Iammarrone F, Gagliardi C, Germiniasi C, Pedrocchi A, Turconi AC, Reni G.

INTRODUCTION: This article is part of the Focus Theme of Methods of Information in Medicine on "Methodologies, Models and Algorithms for Patients Rehabilitation". **OBJECTIVES:** The great potential of robots in extracting quantitative and meaningful data is not always exploited in clinical practice. The aim of the present work is to describe a simple parameter to assess the performance of subjects during upper limb robotic training exploiting

data automatically recorded by the robot, with no additional effort for patients and clinicians. METHODS: Fourteen children affected by cerebral palsy (CP) performed a training with Armeo@Spring. Each session was evaluated with P, a simple parameter that depends on the overall performance recorded, and median and interquartile values were computed to perform a group analysis. RESULTS: Median (interquartile) values of P significantly increased from 0.27 (0.21) at T0 to 0.55 (0.27) at T1. This improvement was functionally validated by a significant increase of the Melbourne Assessment of Unilateral Upper Limb Function. CONCLUSIONS: The parameter described here was able to show variations in performance over time and enabled a quantitative evaluation of motion abilities in a way that is reliable with respect to a well-known clinical scale.

[PMID: 26640835](#)

15. Dev Med Child Neurol. 2015 Dec 9. doi: 10.1111/dmcn.12973. [Epub ahead of print]

A systematic review of evidence-based assessment practices by allied health practitioners for children with cerebral palsy.

O'Connor B, Kerr C, Shields N, Imms C.

AIM: The routine use of psychometrically robust assessment tools is integral to best practice. This systematic review aims to determine the extent to which evidence-based assessment tools were used by allied health practitioners for children with cerebral palsy (CP). METHOD: The Preferred Reporting Items for Systematic Reviews and Meta-Analysis protocols 2015 was employed. A search strategy applied the free text terms: 'allied health practitioner', 'assessment', and 'cerebral palsy', and related subject headings to seven databases. Included articles reported assessment practices of occupational therapists, physiotherapists, or speech pathologists working with children with CP aged 0 to 18 years, published from the year 2000. RESULTS: Fourteen articles met the inclusion criteria. Eighty-eight assessment tools were reported, of which 23 were in high use. Of these, three tools focused on gross motor function and had acceptable validity for use with children with CP: Gross Motor Function Measure, Gross Motor Function Classification System, and goniometry. Validated tools to assess other activity components, participation, quality of life, and pain were used infrequently or not at all. INTERPRETATION: Allied health practitioners used only a few of the available evidence-based assessment tools. Assessment findings in many areas considered important by children and families were rarely documented using validated assessment tools.

[PMID: 26645152](#)

16. J Phys Ther Sci. 2015 Oct;27(10):3059-62. doi: 10.1589/jpts.27.3059. Epub 2015 Oct 30.

Mediating effects of the ICF domain of function and the gross motor function measure on the ICF domains of activity, and participation in children with cerebral palsy.

Lee BH, Kim YM, Jeong GC.

[Purpose] This study aimed to evaluate the mediating effect of gross motor function, measured using the Gross Motor Function Measure (GMFM) and of general function, measured using the International Classification of Functioning, Disability and Health-Child and Youth Check List (ICF-CY), on the ICF domains of activity and participation in children with cerebral palsy (CP). [Subjects] Ninety-five children with CP, from Seoul, Korea, participated in the study. [Methods] The GMFM was administered in its entirety to patients without orthoses or mobility aids. The ICF-CY was used to evaluate the degree of disability and health of subjects. [Results] GMFM score and ICF-CY function were negatively correlated to ICF-CY activity and participation. ICF-CY partially mediated the effects of the GMFM on activity and participation. [Conclusion] When establishing a treatment plan for a child with CP, limitations in activity and participation, as described by the ICF-CY, should be considered in addition to the child's physical abilities and development. In addition, the treatment plan should focus on increasing the child's activity and participation level, as well as his/her physical level.

[PMID: 26644643](#)

17. Phys Occup Ther Pediatr. 2015 Dec 7:1-13. [Epub ahead of print]**Parents' Experiences of Health and Needs When Supporting Their Adolescents With Cerebral Palsy During Transition to Adulthood.**

Björquist E, Nordmark E, Hallström I.

AIMS: Parents are the primary support providers for adolescents with disabilities, their health and wellbeing is therefore of great importance when planning for youths' transition into adulthood. The aim of this study was to gain a deeper understanding of how parents of adolescents with cerebral palsy (CP) experience their own health and wellbeing and their needs for support during the adolescent's transition to adulthood. **METHODS:** An inductive qualitative approach was used, including interviews with 15 mothers and fathers to 10 adolescents with CP aged 17-18 years. Latent content analysis was used for analyzing the data. **RESULTS:** The main theme "Friction blisters chafing and healing during transition" illustrates the parents' experiences. Five sub-themes formed the parents' experiences of concerns along with sorrow and stress in life, worries about what was to come, their need for support, strategies for coping, and experiences of cohesion. **CONCLUSIONS:** Knowledge of parents' experiences of their health, wellbeing, and needs provide valuable information for the planning of transition for adolescents with disabilities. Help with parents' sorrow, stress, and worry in daily life might be facilitated and parental health safeguarded by a navigator who can both guide and give hands-on support.

[PMID: 26642865](#)

Prevention and Cure

18. Dev Med Child Neurol. 2015 Dec 9. doi: 10.1111/dmcn.12986. [Epub ahead of print]**Causes and pathways of cerebral palsy following neonatal encephalopathy in children born at term.**

Marret S.

This commentary is on the original article by Garfinkle et al.

[PMID: 26648052](#)

19. Mol Neurobiol. 2015 Dec 8. [Epub ahead of print]**TNF- α and MTHFR Polymorphisms Associated with Cerebral Palsy in Chinese Infants.**

Hou R, Ren X, Wang J, Guan X.

This study aims to examine whether the presence of polymorphisms in TNF- α (rs361525 and rs1799724) and MTHFR (rs1476413 and rs9651118) genes is associated with the pathogenesis of cerebral palsy (CP). A total of 105 CP patients and 114 age-, gender-, and ethnicity-matched healthy controls were genotyped for the selected polymorphisms, using TaqMan allelic discrimination assay. Odds ratios (OR) and 95 % confidence intervals (CI) were determined to measure the strength of associations of TNF- α and MTHFR polymorphisms with CP. The proportion of subjects with the gestational age more than 37 weeks or asphyxia was much larger in cases compared with controls (gestational age 63.8 vs. 34.2 %; asphyxia 25.7 vs. 7.9 %). The genotype frequencies of TNF- α rs1799724 were similar between groups ($P > 0.05$), yet the allele distributions were significantly different ($P < 0.05$). Both the allele and genotype distributions of MTHFR rs9651118 polymorphism varied significantly between the groups ($P < 0.05$). Subgroup analysis based on gestational age indicated a significant association between rs361525 and rs9651118 and CP with or without premature. TNF- α protein concentrations were significantly increased among patients with rs361525 GG genotype compared with controls. Also, a significant increase in the risk of CP was observed to be associated with the interactions of TNF- α rs1799724 and MTHFR rs9651118 (OR

2.75, 95 % CI 1.23-6.13). These data suggest that polymorphisms in TNF- α and MTHFR genes might be involved in the pathogenesis of CP in Chinese infants.

[PMID: 26646537](#)

20. Neuroimage Clin. 2015 Sep 30;9:498-505. doi: 10.1016/j.nicl.2015.09.014. eCollection 2015.

Structural connectivity of the anterior cingulate in children with unilateral cerebral palsy due to white matter lesions.

Scheck SM, Pannek K, Raffelt DA, Fiori S, Boyd RN, Rose SE.

In this work we investigate the structural connectivity of the anterior cingulate cortex (ACC) and its link with impaired executive function in children with unilateral cerebral palsy (UCP) due to periventricular white matter lesions. Fifty two children with UCP and 17 children with typical development participated in the study, and underwent diffusion and structural MRI. Five brain regions were identified for their high connectivity with the ACC using diffusion MRI fibre tractography: the superior frontal gyrus, medial orbitofrontal cortex, rostral middle frontal gyrus, precuneus and isthmus cingulate. Structural connectivity was assessed in pathways connecting these regions to the ACC using three diffusion MRI derived measures: fractional anisotropy (FA), mean diffusivity (MD) and apparent fibre density (AFD), and compared between participant groups. Furthermore we investigated correlations of these measures with executive function as assessed by the Flanker task. The ACC-precuneus tract had significantly different MD ($p < 0.0001$) and AFD ($p = 0.0072$) between groups, with post-hoc analysis showing significantly increased MD in the right hemisphere of children with left hemiparesis compared with controls. The ACC-superior frontal gyrus tract had significantly different FA ($p = 0.0049$) and MD ($p = 0.0031$) between groups. AFD in this tract (contralateral to side of hemiparesis; right hemisphere in controls) showed a significant relationship with Flanker task performance ($p = 0.0045$, $\beta = -0.5856$), suggesting that reduced connectivity correlates with executive dysfunction. Reduced structural integrity of ACC tracts appears to be important in UCP, in particular the connection to the superior frontal gyrus. Although damage to this area is heterogeneous it may be important in early identification of children with impaired executive function.

[PMID: 26640762](#)