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Interventions and Management

1. Constraint-induced movement therapy in children with unilateral cerebral palsy.

Hoare BJ, Wallen MA, Thorley MN, Jackman ML, Carey LM, Imms C.

Cochrane Database Syst Rev. 2019 Apr 1;4:CD004149. doi: 10.1002/14651858.CD004149.pub3. [Epub ahead of print]

BACKGROUND: Unilateral cerebral palsy (CP) is a condition that affects muscle control and function on one side of the body. Children with unilateral CP experience difficulties using their hands together secondary to disturbances that occur in the developing fetal or infant brain. Often, the more affected limb is disregarded. Constraint-induced movement therapy (CIMT) aims to increase use of the more affected upper limb and improve bimanual performance. CIMT is based on two principles: restraining the use of the less affected limb (for example, using a splint, mitt or sling) and intensive therapeutic practice of the more affected limb. **OBJECTIVES:** To evaluate the effect of constraint-induced movement therapy (CIMT) in the treatment of the more affected upper limb in children with unilateral CP. **SEARCH METHODS:** In March 2018 we searched CENTRAL, MEDLINE, Embase, CINAHL, PEDro, OTseeker, five other databases and three trials registers. We also ran citation searches, checked reference lists, contacted experts, handsearched key journals and searched using Google Scholar. **SELECTION CRITERIA:** Randomised controlled trials (RCTs), cluster-RCTs or clinically controlled trials implemented with children with unilateral CP, aged between 0 and 19 years, where CIMT was compared with a different form of CIMT, or a low dose, high-dose or dose-matched alternative form of upper-limb intervention such as bimanual intervention. Primarily, outcomes were bimanual performance, unimanual capacity and manual ability. Secondary outcomes included measures of self-care, body function, participation and quality of life. **DATA COLLECTION AND ANALYSIS:** Two review authors independently screened titles and abstracts to eliminate ineligible studies. Five review authors were paired to extract data and assess risk of bias in each included study. GRADE assessments were undertaken by two review authors. **MAIN RESULTS:** We included 36 trials (1264 participants), published between 2004 and 2018. Sample sizes ranged from 11 to 105 (mean 35). Mean age was 5.96 years (standard deviation (SD) 1.82), range three months to 19.8 years; 53% male and 47% participants had left hemiplegia. Fifty-seven outcome measures were used across studies. Average length of CIMT programs was four weeks (range one to 10 weeks). Frequency of sessions ranged from twice weekly to seven days per week. Duration of intervention sessions ranged from 0.5 to eight hours per day. The mean total number of hours of CIMT provided was 137 hours (range 20 to 504 hours). The most common constraint devices were a mitt/glove or a sling (11 studies each). We judged the risk of bias as moderate to high across the studies. **KEY RESULTS:** Primary outcomes at primary endpoint (immediately after intervention) CIMT versus low-dose comparison (e.g. occupational therapy) We found low-quality evidence that CIMT was more effective than a low-dose comparison for improving bimanual performance (mean difference (MD) 5.44 Assisting Hand Assessment (AHA) units, 95% confidence interval (CI) 2.37 to 8.51). CIMT was more effective than a low-dose comparison for improving unimanual capacity (Quality of upper extremity skills test (QUEST) - Dissociated movement MD 5.95, 95% CI 2.02 to 9.87; Grasps; MD 7.57, 95% CI 2.10 to 13.05; Weight bearing MD 5.92, 95% CI 2.21 to 9.6; Protective extension MD 12.54, 95% CI 8.60 to 16.47). Three studies reported adverse events, including frustration, constraint refusal and reversible skin irritations from casting. CIMT versus high-dose comparison (e.g. individualised occupational therapy, bimanual therapy) When compared with a high-dose comparison, CIMT was not more effective for improving bimanual performance (MD -0.39 AHA Units, 95% CI -3.14 to 2.36). There was no evidence that CIMT was more effective than a high-dose comparison for improving unimanual capacity in a single study using QUEST (Dissociated movement MD 0.49, 95% CI -10.71 to 11.69; Grasp MD -0.20, 95% CI -11.84 to 11.44). Two studies reported that some children experienced

frustration participating in CIMT. CIMT versus dose-matched comparison (e.g. Hand Arm Bimanual Intensive Therapy, bimanual therapy, occupational therapy) There was no evidence of differences in bimanual performance between groups receiving CIMT or a dose-matched comparison (MD 0.80 AHA units, 95% CI -0.78 to 2.38). There was no evidence that CIMT was more effective than a dose-matched comparison for improving unimanual capacity (Box and Blocks Test MD 1.11, 95% CI -0.06 to 2.28; Melbourne Assessment MD 1.48, 95% CI -0.49 to 3.44; QUEST Dissociated movement MD 6.51, 95% CI -0.74 to 13.76; Grasp, MD 6.63, 95% CI -2.38 to 15.65; Weightbearing MD -2.31, 95% CI -8.02 to 3.40) except for the Protective extension domain (MD 6.86, 95% CI 0.14 to 13.58). There was no evidence of differences in manual ability between groups receiving CIMT or a dose-matched comparison (ABILHAND-Kids MD 0.74, 95% CI 0.31 to 1.18). From 15 studies, two children did not tolerate CIMT and three experienced difficulty. **AUTHORS' CONCLUSIONS:** The quality of evidence for all conclusions was low to very low. For children with unilateral CP, there was some evidence that CIMT resulted in improved bimanual performance and unimanual capacity when compared to a low-dose comparison, but not when compared to a high-dose or dose-matched comparison. Based on the evidence available, CIMT appears to be safe for children with CP.

PMID: [30932166](#)

2. Bimanual Skill Learning after Transcranial Direct Current Stimulation in Children with Unilateral Cerebral Palsy: A Brief Report.

Nemanich ST, Rich TL, Gordon AM, Friel KM, Gillick BT.

Dev Neurorehabil. 2019 Apr 3:1-5. doi: 10.1080/17518423.2019.1600065. [Epub ahead of print]

Bimanual skills are important for goal-oriented activities. Children with unilateral cerebral palsy (UCP) have deficits in unimanual and bimanual motor control and learning. The application of non-invasive brain stimulation with existing motor training may further promote motor learning; however, the effects of stimulation on bimanual learning have not been examined. Here, we assessed the performance of a novel bimanual skill (modified Speed Stacks task) in eight children with UCP before, during, and after a combined motor training and brain stimulation intervention. Participants received 10 days (120 min/day) of goal-oriented bimanual therapy combined initially with transcranial direct current stimulation (tDCS, 20 min/day). Results showed task improvement tapered ($p < 0.001$) during and after the intervention and task variability decreased in 6/8 participants, indicating the potential impact of novel rehabilitation to improve skill learning in children with UCP. Future work is required to understand how both tDCS and bimanual training contribute to learning bimanual tasks.

PMID: [30943373](#)

3. Current concepts in neuromuscular scoliosis.

Murphy RF, Mooney JF 3rd.

Curr Rev Musculoskelet Med. 2019 Apr 2. doi: 10.1007/s12178-019-09552-8. [Epub ahead of print]

PURPOSE OF REVIEW: Spinal deformity is a common issue in pediatric patients with an underlying neurological diagnosis or syndrome. Management of neuromuscular scoliosis (NMS) is a major part of the orthopedic care of such patients, as the deformity is often progressive, and may affect gait, seating and positioning. In addition, untreated large spinal deformities may be associated with pain and/or cardiopulmonary issues over time. **RECENT FINDINGS:** Recent changes in medical management of the underlying disease process appears to alter the natural history of certain neuromuscular conditions, and in the case of patients with Duchenne's muscular dystrophy significantly diminish the incidence of spinal deformity. In the most common diagnosis associated with NMS, cerebral palsy, there is evidence that despite a high complication rate, surgical management of spinal deformity is associated with measurable improvements in validated health-related quality-of-life measures. Spinal deformity is a common finding in patients with neurological diagnoses. It is important for those involved in the care of these patients to understand the natural history of NMS, as well as the potential risks and benefits to the patient and caregivers, of surgical and non-surgical interventions.

PMID: [30941730](#)

4. Pharmacological management of abnormal tone and movement in cerebral palsy.

Lumsden DE, Crowe B, Basu A, Amin S, Devlin A, DeAlwis Y, Kumar R, Lodh R, Lundy CT, Mordekar SR, Smith M, Cadwgan J.

Arch Dis Child. 2019 Apr 4. pii: archdischild-2018-316309. doi: 10.1136/archdischild-2018-316309. [Epub ahead of print]
BACKGROUND: The evidence base to guide the pharmacological management of tone and abnormal movements in cerebral palsy (CP) is limited, as is an understanding of routine clinical practice in the UK. We aimed to establish details of motor phenotype and current pharmacological management of a representative cohort across a network of UK tertiary centres.
METHODS: Prospective multicentre review of specialist motor disorder clinics at nine UK centres, collecting data on clinical features and pharmacological management of children and young people (CYP) with CP over a single calendar month.
RESULTS: Data were collected from 275 CYP with CP reviewed over the calendar month of October 2017. Isolated dystonia or spasticity was infrequently seen, with a mixed picture of dystonia and spasticity \pm choreoathetosis identified in 194/275 (70.5%) of CYP. A comorbid diagnosis of epilepsy was present in 103/275 (37.4%). The most commonly used medications for abnormal tone/movement were baclofen, trihexyphenidyl, gabapentin, diazepam and clonidine. Medication use appeared to be influenced separately by the presence of dystonia or spasticity. Botulinum toxin use was common (62.2%). A smaller proportion of children (12.4%) had undergone a previous neurosurgical procedure for tone/movement management.
CONCLUSIONS: CYP with CP frequently present with a complex movement phenotype and comorbid epilepsy. They have multiple therapy, medical and surgical management regimens. Future trials of therapeutic, pharmacological or surgical interventions in this population must adequately encompass this complexity in order to be translatable to clinical practice.

PMID: [30948360](#)

5. Muscle synergies demonstrate only minimal changes after treatment in cerebral palsy.

Shuman BR, Goudriaan M, Desloovere K, Schwartz MH, Steele KM.

J Neuroeng Rehabil. 2019 Mar 29;16(1):46. doi: 10.1186/s12984-019-0502-3.

BACKGROUND: Children with cerebral palsy (CP) have altered synergies compared to typically-developing peers, reflecting different neuromuscular control strategies used to move. While these children receive a variety of treatments to improve gait, whether synergies change after treatment, or are associated with treatment outcomes, remains unknown. **METHODS:** We evaluated synergies for 147 children with CP before and after three common treatments: botulinum toxin type-A injection (n = 52), selective dorsal rhizotomy (n = 38), and multi-level orthopaedic surgery (n = 57). Changes in synergy complexity were measured by the number of synergies required to explain > 90% of the total variance in electromyography data and total variance accounted for by one synergy. Synergy weights and activations before and after treatment were compared using the cosine similarity relative to average synergies of 31 typically-developing (TD) peers. **RESULTS:** There were minimal changes in synergies after treatment despite changes in walking patterns. Number of synergies did not change significantly for any treatment group. Total variance accounted for by one synergy increased (i.e., moved further from TD peers) after botulinum toxin type-A injection (1.3%) and selective dorsal rhizotomy (1.9%), but the change was small. Synergy weights did not change for any treatment group (average 0.001 ± 0.10), but synergy activations after selective dorsal rhizotomy did change and were less similar to TD peers (-0.03 ± 0.07). Only changes in synergy activations were associated with changes in gait kinematics or walking speed after treatment. Children with synergy activations more similar to TD peers after treatment had greater improvements in gait. **CONCLUSIONS:** While many of these children received significant surgical procedures and prolonged rehabilitation, the minimal changes in synergies after treatment highlight the challenges in altering neuromuscular control in CP. Development of treatment strategies that directly target impaired control or are optimized to an individual's unique control may be required to improve walking function.

PMID: [30925882](#)

6. Stander use for an adolescent with cerebral palsy at GMFCS level V with hip and knee contractures.

Capati V, Covert SY, Paleg G.

Assist Technol. 2019 Apr 4:1-7. doi: 10.1080/10400435.2019.1579268. [Epub ahead of print]

AIMS: Adolescents with cerebral palsy (CP) report high rates of pain and contractures. Standing may positively affect these outcomes, yet there are no published studies on how to accommodate contractures or when a stander is no longer beneficial. This is the first study that answers the question: Can an adolescent with CP and 40-degree knee and/or hip flexion contractures benefit from a standing program, after being non-weight bearing for many years? **METHODS:** A 16-year-old male with spastic tetraplegic CP, Gross Motor Function Classification System (GMFCS) level V, used a stander with a "knee and hip contracture system." Knee and hip extension, as well as upright inclination, were increased weekly. Knee and hip passive range of motion (PROM) measurements, pain scale, and a parent survey were completed at baseline, 7 and 15 months. **RESULTS:** After 15 months of stander use, both hips and left knee PROM improved. The subject's activity and participation increased, while pain, suppository use, and time spent on bowel care decreased. **CONCLUSION:** An adolescent with 40-degree knee and hip flexion contractures may be positioned well in a stander with a specialized contracture system. PROM, bowel function, pain, activity, and participation may improve for some adolescents at GMFCS level V, through use of a stander.

PMID: [30945990](#)

7. Relationship between walking efficiency and muscular strength of the lower limbs in children with cerebral palsy.

Kimoto M, Okada K, Sakamoto H, Kondou T, Kawanobe U.

J Phys Ther Sci. 2019 Mar;31(3):232-235. doi: 10.1589/jpts.31.232. Epub 2019 Mar 19.

[Purpose] In children with cerebral palsy, despite increases in muscle strength after strengthening, improvements in walking efficiency are inconsistent in previous studies. The purpose of this study was to analyze the relationship between walking efficiency and muscle strength in children with cerebral palsy. [Participants and Methods] Twenty-six children with cerebral palsy participated in this study. Isometric muscle strength in the lower extremities and the Total Heart Beat Index were measured. Participants were divided into the high and low walking efficiency groups based on the median Total Heart Beat Index value (2.06 beats/m). [Results] For all participants, all isometric muscle strength values were significantly correlated with the Total Heart Beat Index. In the high walking efficiency group, there was no significant correlation. All isometric muscle strength values in the low walking efficiency group were significantly correlated with the Total Heart Beat Index, except for that of the hip extensors. [Conclusion] The influence of muscular strength on walking efficiency in children with cerebral palsy varied. Significant correlations were observed only for those in the low walking efficiency group. The walking efficiency level should be confirmed before planning muscle strength training to improve walking efficiency.

PMID: [30936637](#)

8. Gait Pattern Differences Among Children With Bilateral Cerebral Palsy.

Domagalska-Szopa M, Szopa A.

Front Neurol. 2019 Mar 12;10:183. doi: 10.3389/fneur.2019.00183. eCollection 2019.

Background: The positive findings from our previous studies, which revealed the link between postural and gait patterns in children with unilateral cerebral palsy (CP) were very encouraging for recognition this relationship in children with bilateral cerebral palsy (CP). Therefore, the objective of this study was to evaluate whether different gait patterns corresponding to postural patterns in children with bilateral CP could be statistically significant according to a cluster analysis. Methods: Fifty-eight participants with bilateral CP and 45 matched children with typical growth and development. The participants walked barefoot along a treadmill at their own pace. Three-dimensional kinematic data were collected using the Measuring System for Motion Analysis. To characterize gait patterns, the Gillette Gait Index (GGI) and its 16 distinct gait parameters were used. The participants were divided into four subgroups according to their postural patterns. Results: A cluster analysis revealed 4 gait patterns corresponding to postural patterns: (1) normal gait pattern corresponded to neutral posture; (2) balanced gait pattern corresponded to balanced posture; (3) lordotic gait pattern corresponded to lordotic postural pattern; (4) swayback gait pattern corresponded to backward-leaning posture. There were significant differences in mean GGI and various clusters in the 8 GGI gait parameters: cadence, mean pelvic tilt; mean pelvic rotation, minimum hip flexion, peak hip abduction in swing; knee flexion at initial contact, and peak dorsiflexion in stance. Conclusion: Our results showed that gait discrepancies among children with bilateral CP were not simply a result of lower limb kinematic deviations in the sagittal plane. Information on different gait patterns could improve early therapy in children with bilateral CP before abnormal gait patterns are fully established.

PMID: [30930827](#)

9. The effect of combined functional anaerobic and strength training on treadmill gait kinematics and kinetics in ambulatory young adults with cerebral palsy.

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

Gait Posture. 2019 Mar 25;70:323-329. doi: 10.1016/j.gaitpost.2019.03.023. [Epub ahead of print]

BACKGROUND: Leg muscle weakness is a major impairment for individuals with cerebral palsy (CP) and is related to reduced functional capacity. Evidence is limited regarding the translation of strength improvements following conventional resistance training to improved gait outcomes. RESEARCH QUESTION: Does a combined functional anaerobic and lower limb strength training intervention improve gait kinematics and kinetics in individuals with CP aged 15-30 years? 17 young adults (21 ± 4 years, 9 males, GMFCS I = 11, II = 6) were randomized to 12 weeks, 3 sessions per week, of high intensity functional anaerobic and progressive resistance training of the lower limbs ($n = 8$), or a waitlist control group ($n = 9$). Pre- and post-training outcomes included maximum ankle dorsiflexion angle at foot contact and during stance, gait profile score, ankle and hip power generation during late stance, and the ratio of ankle to hip power generation. RESULTS: There were no between

-group differences after the intervention for any kinematic or kinetic gait outcome variable. Within-group analysis revealed an increase in peak ankle power during late stance ($0.31 \pm 0.28 \text{ W}\cdot\text{kg}^{-1}$, $p = 0.043$) and ankle to hip power ratio (0.43 ± 0.37 , $p = 0.034$) following training in the intervention group. SIGNIFICANCE: We have previously reported increased overground walking capacity, agility and sprint power, in the training group compared to the control group at 12-weeks. These changes in overground measures of functional capacity occurred in the absence of changes in treadmill gait kinematics and kinetics reported here. ANZCTR: 12614001217695.

PMID: [30947107](#)

10. Propulsion strategy in running in children and adolescents with cerebral palsy.

Chappell A, Gibson N, Williams G, Allison GT, Morris S.

Gait Posture. 2019 Mar 18;70:305-310. doi: 10.1016/j.gaitpost.2019.02.018. [Epub ahead of print]

BACKGROUND: Running is a fundamental movement skill important for participation in physical activity. Children with cerebral palsy (CP) who are classified at Gross Motor Function Classification Scale (GMFCS) level I and II are able to run but may be limited by neuromuscular impairments. **RESEARCH QUESTION:** To describe the propulsion strategy (PS) during running of children and adolescents with CP. **METHODS:** This cross-sectional study used kinematic and kinetic data collected during running from 40 children and adolescents with unilateral or bilateral CP and 21 typically developing (TD) children. Maximum speed, peak ankle power generation (A2), peak hip flexor power generation in swing (H3) and PS ($PS = A2 / (A2 + H3)$) were calculated. Linear mixed models were developed to analyze differences between groups. **RESULTS:** Maximum speed, A2 and PS were significantly less in children with CP GMFCS level I than in TD children and significantly less in children in GMFCS level II than level I. For children with CP, A2 and PS were significantly smaller in affected legs than non-affected legs. In affected legs, H3 was significantly larger in children in GMFCS level II than GMFCS level I but not different between TD children and children in GMFCS level II. **SIGNIFICANCE:** The contribution of ankle plantarflexor power to forward propulsion in running is reduced in young people with CP and is related to GMFCS level. This deficit appears to be compensated in part by increased hip flexor power generation but limits maximum sprinting speed.

PMID: [30927640](#)

11. Validity and reliability of the 20-m run, horizontal leap, and four-bound tests measuring high-level mobility in neurologically impaired patients.

Gorski M, Scroggie G, Haines T.

Hong Kong Physiother J. 2015 Dec;33(2):59-66. doi: 10.1016/j.hkpj.2015.03.003. Epub 2015 May 27.

BACKGROUND: High-level mobility (HLM) training including running forms an integral part of physical rehabilitation for neurologically impaired patients. **OBJECTIVE:** This study examines the validity and reliability of three quickly administrable measures of HLM, namely, the 20-m run, horizontal leap, and four-bound tests in patients with neurological disorders. **METHODS:** This is a retrospective data audit of 62 patients (23 women, 37.1%; 39 men, 62.9%) participating in the HLM (running retraining) task. All participants were recovering from neurological conditions such as stroke, brain injury, brain/spinal tumour, Guillain-Barré syndrome, and cerebral palsy complications. **RESULTS:** High levels of test-retest reliability of the investigated tests (interclass correlation coefficient > 0.95) were obtained. The 95% minimum detectable changes were as follows: 20-m run, 1.9 seconds; horizontal leap, 0.20 m; four-bound test, 0.57 m. The area under the receiver-operated characteristic curve was 0.96 for the 20-m run, 0.90 for the horizontal leap, and 0.91 for the four-bound test, which suggests high validity of the tests to discriminate between participants who were classified as "running" and those as "not running". Participants performing at < 7.2 seconds for the 20-m run test or ≥ 0.75 m for the horizontal leap test or 4.0 m for the four-bound test were most likely classified as running. **CONCLUSION:** The 20-m run, horizontal leap, and four-bound tests are valid and reliable objective measures of HLM when administered in people with neurological conditions.

PMID: [30930569](#)

12. Efficacy of cycling interventions to improve function in children and adolescents with cerebral palsy: a systematic review and meta-analysis.

Armstrong EL, Spencer S, Kentish MJ, Horan SA, Carty CP, Boyd RN.

Clin Rehabil. 2019 Apr 2:269215519837582. doi: 10.1177/0269215519837582. [Epub ahead of print]

OBJECTIVES: The aim of this study was to determine the efficacy of cycling to improve function and reduce activity limitations in children with cerebral palsy; the optimal training parameters for improved function; and whether improvements in function can be retained. **METHOD:** Six databases were searched (until February 2019) and articles were screened in duplicate. Randomized or quasi-randomized controlled trials and pre-post studies were included. Methodological quality was assessed using the Downs and Black scale. Outcomes were reported under the International Classification of Functioning, Disability and Health domains of body functions and activity limitations. Quantitative analyses were completed using RevMan V5.3. **RESULTS:** A total of 533 articles were identified and 9 studies containing data on 282 participants met full inclusion criteria. Methodological quality ranged from low (14 of 32) to high (28 of 32). Significant improvements were reported for hamstring strength (effect size = 0.77-0.93), cardiorespiratory fitness (effect size = 1.13-1.77), balance (effect size = 1.03-1.29), 3-minute walk test distance (effect size = 1.14) and gross motor function (effect size = 0.91). Meta-analysis suggested that cycling can improve gross motor function (standardized mean difference = 0.35; 95% confidence interval = (-0.01, 0.70); $P = 0.05$); however, the effect was insignificant when a poor-quality study was omitted. **CONCLUSION:** Cycling can improve muscle strength, balance and gross motor function in children with cerebral palsy; however, optimal training doses are yet to be determined. There was insufficient data to determine whether functional improvements can be retained. Conclusions were limited by small sample sizes, inconsistent outcome measures and a lack of follow-up testing.

PMID: [30935240](#)

13. A pilot study of children and parents experiences of the use of a new assistive device, the electro suit Mollii.

Nordstrom B PhD, Prellwitz M PhD.

Assist Technol. 2019 Apr 4:1-8. doi: 10.1080/10400435.2019.1579267. [Epub ahead of print]

Electrical stimulation has been used for many years to treat spasticity in children with cerebral palsy and some improvements have been noted. Building on the benefits of electrical stimulation, a new assistive device, a suit with imbedded electrodes designed to reduce spasticity through electrical stimulation of the antagonistic muscles, has been tested. **AIM:** The aim of this study was to describe experiences from children with cerebral palsy and their parents regarding the use of the suit. **METHODS:** Individual interviews were conducted with six children 5 to 10 years of age and their parents. The interviews were transcribed and analyzed using a qualitative content analysis. **RESULTS:** The analysis resulted in three themes: (1) the suit's impact on image, (2) changes that make a difference and (3) dealing with a desire for change. Each of the themes included subthemes. **CONCLUSION:** All children reported some impact on their body and self and/or in some activities after the use of the suit. The parents also saw improvements during the trial period. However, the results are inconclusive and a larger study is needed to determine if the suit is useful from a longer perspective and whether it can affect activity and participation in daily activities for children with spasticity.

PMID: [30945989](#)

14. Effects of combined Adeli suit and neurodevelopmental treatment in children with spastic cerebral palsy with gross motor function classification system levels I and II.

Kim MR, Lee BH, Park DS.

Hong Kong Physiother J. 2015 Nov 7;34:10-18. doi: 10.1016/j.hkpj.2015.09.036. eCollection 2016 Jun.

BACKGROUND: Children with cerebral palsy (CP) exhibit diverse gait patterns depending on their neurological deficits and musculoskeletal problems. The Adeli suit treatment (AST) has been proposed as an intensive exercise protocol in the management of CP. **OBJECTIVES:** The aim of this study was to compare the effects of a 6-week programme of combined AST and neurodevelopment treatment (NDT) with those of NDT alone on Gross Motor Function Measure (GMFM), balance, and gait in children with CP. **METHODS:** Twenty children with CP of Gross Motor Function Classification System levels I and II were randomly assigned to one of the following two groups: (1) NDT or (2) AST/NDT. The participants were assessed using the GMFM, Pediatric Balance Scale (PBS), Timed Up and Go (TUG) test, and spatiotemporal gait parameters. **RESULTS:** The GMFM, PBS, and TUG test for both groups showed a statistically significant increase ($p < 0.05$). Three children were excluded. Compared to the NDT group ($n = 9$), the AST/NDT group ($n = 8$) demonstrated a significant increase in spatiotemporal gait parameters ($p < 0.05$). **CONCLUSION:** These results provide evidence for the greater effectiveness of combined AST/NDT than NDT alone in improving spatiotemporal gait parameters but not GMFM, PBS, and TUG test.

PMID: [30931022](#)

15. LETTER TO THE EDITOR.

Fiss AL, Westcott McCoy S, Jeffries L, Bartlett D, Chiarello LA, Palisano R, Hanna S, Avery L, Bjornson K.

Pediatr Phys Ther. 2019 Apr;31(2):132-133. doi: 10.1097/PEP.0000000000000612.

Comment on Developmental Trajectories and Reference Percentiles for the 6-Minute Walk Test for Children With Cerebral Palsy. [Pediatr Phys Ther. 2019]

PMID: [30907827](#)

16. Children with dyskinetic cerebral palsy are severely affected as compared to bilateral spastic cerebral palsy.

Préel M, Rackauskaite G, Larsen ML, Laursen B, Lorentzen J, Born AP, Langhoff-Roos J, Uldall P, Hoei-Hansen CE.

Acta Paediatr. 2019 Apr 1. doi: 10.1111/apa.14806. [Epub ahead of print]

AIM: We aimed at describing clinical findings in children with dyskinetic as compared to bilateral spastic cerebral palsy (CP). METHODS: Data was extracted from the Danish nationwide CP register. Participants were born in 1999-2007 and were 5-6 years at ascertainment. RESULTS: The total number of CP cases was 1,165 of which 92 had dyskinetic and 540 bilateral spastic CP. Prevalence of dyskinetic CP was 0.16 per 1000 live-births. In participants with dyskinetic compared to bilateral spastic CP, there was more frequently an Apgar level less than five at five minutes (22.7% versus 11.2%) and neonatal seizures (43.5% versus 28.5%), but less respiratory deficiency, hyperbilirubinaemia, and sepsis. Impairment based on gross motor function classification was more severe in dyskinetic CP (level III-V 90.0% versus 66.0%). In dyskinetic CP there was a high rate of reduced developmental quotient (68.1%), visual impairment (39.3%), and epilepsy (51.6%). Basal ganglia lesions were more prevalent in dyskinetic compared to bilateral spastic CP (27.7% vs. 12.8%). CONCLUSION: Cases of dyskinetic CP had overlapping clinical features with cases of bilateral spastic CP, but differed significantly in several perinatal risk factors. The children with dyskinetic CP had experienced more peri- or neonatal adverse events, and neurodevelopmental impairment was severe. This article is protected by copyright. All rights reserved.

PMID: [30933377](#)

17. A Randomized Control Trial of Botulinum Toxin A Administration under Ultrasound Guidance against Manual Palpation in Spastic Cerebral Palsy.

Kaushik PS, Gowda VK, Shivappa SK, Mannapur R, Jaysheel A.

J Pediatr Neurosci. 2018 Oct-Dec;13(4):443-447. doi: 10.4103/JPN.JPN_60_18.

BACKGROUND: Botulinum toxin A is established as an effective treatment to reduce spasticity in cerebral palsy (CP). But very little data are available regarding the techniques of administration. Hence, this study was conducted to compare administration of botulinum toxin with and without ultrasound. MATERIALS AND METHODS: This is a randomized trial conducted for 2 years at a tertiary care hospital in children aged up to 6 years with CP. Children were assessed with range of ankle dorsiflexion, Modified Ashworth Scale (MAS), and Gross Motor Function Measure 66 (GMFM 66) before and after administration. They were followed up for 6 months. RESULTS: Of the 180 children screened, 30 who met the criteria were included. Those enrolled in the study were categorized into group I and group II, children who were given botulinum toxin with ultrasound (n = 14) and without ultrasound (n = 16), respectively. Results showed a significant increase in ankle dorsiflexion in both groups ($P \leq 0.005$) but no significant difference was reported between the groups ($P = 0.4$). A statistically significant increase in GMFM scores ($P \leq 0.005$) during sequential assessment was observed in both groups, but no significant difference was observed in the GMFM scores between the groups ($P = 0.45$). Majority of children improved by a scale of 2 (MAS) from baseline in groups after 12 weeks, 50% in group I and 57.9% in group II. CONCLUSION: No significant difference was observed in the outcome with regard to technique of administration of botulinum toxin with ultrasound and without ultrasound into gastrocnemius muscle.

PMID: [30937086](#)

18. Development and validation of a screening tool for feeding/swallowing difficulties and undernutrition in children with cerebral palsy.

Bell KL2, Benfer KA, Ware RS, Patrao TA, Garvey JJ, Arvedson JC, Boyd RN, Davies PS, Weir KA.

Dev Med Child Neurol. 2019 Apr 1. doi: 10.1111/dmcn.14220. [Epub ahead of print]

AIM: To develop and validate a screening tool for feeding/swallowing difficulties and/or undernutrition in children with cerebral palsy (CP). **METHOD:** This cross-sectional, observational study included 89 children with CP (63 males, 26 females; median age 6y 0mo; interquartile range 4y 0mo-8y 11mo), across all Gross Motor Function Classification System levels. Children with feeding tubes were excluded. Children were classified as well-nourished or moderately to severely undernourished, using the paediatric Subjective Global Nutrition Assessment. Eating and drinking abilities were classified using the Eating and Drinking Ability Classification System (EDACS) from mealtime observation and videofluoroscopic swallow studies when indicated. Parents/caregivers answered 33 screening questions regarding their child's feeding/swallowing abilities and nutritional status. The diagnostic ability of each question for identifying children with feeding/swallowing difficulties and undernutrition was calculated and the combination of questions with the highest sensitivity and specificity identified. **RESULTS:** Feeding difficulties impacted on swallow safety in 26 children (29%) and 26 children (29%) were moderately or severely undernourished. The 4-item final tool had high sensitivity and specificity for identifying children with feeding/swallowing difficulties (81% and 79% respectively) and undernutrition (72% and 75% respectively). The tool successfully identified 100 per cent of children with severe undernutrition and 100 per cent of those classified as EDACS level IV or V. **INTERPRETATION:** Screening for feeding/swallowing difficulties and undernutrition will enable early identification, assessment, and management for those children in need. **WHAT THIS PAPER ADDS:** A screening tool with high sensitivities and specificities for identifying children with feeding/swallowing difficulties and undernutrition. The tool identified 100 per cent of children with severe undernutrition. The tool identified 100 per cent of children in Eating and Drinking Ability Classification System levels IV or V.

PMID: [30937885](#)

19. Anthropometric measurements to identify undernutrition in children with cerebral palsy.

Duran I, Martakis K, Rehberg M, Semler O, Schoenau E.

Dev Med Child Neurol. 2019 Mar 29. doi: 10.1111/dmcn.14225. [Epub ahead of print]

AIM: To evaluate the diagnostic performance of anthropometric indicators to identify undernutrition in children with cerebral palsy (CP). **METHOD:** The present study was a monocentric retrospective analysis of prospectively collected data among children and adolescents with CP participating in a rehabilitation program. Undernutrition was defined as a z-score for dual-energy X-ray absorptiometry (DXA) determined body fat percentage less or equal to -2.0. The cut-off values for body mass index (BMI) of the World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC), and the cut-off values for BMI and height for age of the Robert Koch Institut (RKI) were evaluated. **RESULTS:** In total, 329 children with CP (181 males, 148 females, Gross Motor Function Classification System levels I-V) were eligible for analysis. The mean age was 12 years 4 months (SD 2y 9mo). The BMI cut-off values showed the following sensitivities and specificities: WHO, sensitivity of 0.474 (95% confidence interval [CI] 0.244-0.711), specificity of 0.897 (95% CI: 0.857-0.928); CDC, sensitivity of 0.632 (95% CI: 0.384-0.837), specificity of 0.819 (95% CI: 0.772-0.861); RKI, sensitivity of 0.789 (95% CI: 0.544-0.939), specificity of 0.732 (95% CI: 0.679-0.781); and for height for age, sensitivity of 0.263 (95% CI: 0.091-0.512), specificity of 0.668 (95% CI: 0.612-0.720). **INTERPRETATION:** BMI had a high specificity but very low sensitivity in identifying undernutrition in children with CP. Z-scores for height for age had even lower specificity and sensitivity and seemed not to be appropriate for predicting undernutrition in children with CP. **WHAT THIS PAPER ADDS:** Body mass index (BMI) z-scores had a high specificity but very low sensitivity in identifying undernutrition in children with cerebral palsy (CP). Height z-scores were not appropriate for predicting undernutrition in children with CP. Undernutrition assessed by BMI was overestimated in children with CP versus when assessed by dual-energy X-ray absorptiometry (DXA).

PMID: [30927269](#)

20. Prediction of adverse motor outcome for neonates with punctate white matter lesions by MRI images using radiomics strategy: protocol for a prospective cohort multicentre study.

Wang M, Liu H, Liu C, Li X, Jin C, Sun Q, Liu Z, Zheng J, Yang J.

BMJ Open. 2019 Apr 3;9(4):e023157. doi: 10.1136/bmjopen-2018-023157.

INTRODUCTION: Punctate white matter lesions (PWML) are prevalent white matter disease in preterm neonates, and may cause motor disorders and even cerebral palsy. However, precise individual-based diagnosis of lesions that result in an adverse motor outcome remains unclear, and an effective method is urgently needed to guide clinical diagnosis and treatment. Advanced radiomics for multiple modalities data can provide a possible look for biomarkers and determine prognosis

quantitatively. The study aims to develop and validate a model for prediction of adverse motor outcomes at a corrected age (CA) of 24 months in neonates with PWML. **METHODS AND ANALYSIS:** A prospective cohort multicentre study will be conducted in 11 Chinese hospitals. A total of 394 neonates with PWML confirmed by MRI will undergo a clinical assessment (modified Neonatal Behavioural Assessment Scale). At a CA of 18 months, the motor function will be assessed by Bayley Scales of Infant and Toddler Development-III (Bayley-III). Mild-to-severe motor impairments will be confirmed using the Bayley-III and Gross Motor Function Classification System at a CA of 24 months. During the data collection, the perinatal and clinical information will also be recorded. According to the radiomics strategy, the extracted imaging features and clinical information will be combined for exploratory analysis. After using multiple-modelling methodology, the accuracy, sensitivity and specificity will be computed. Internal and external validations will be used to evaluate the performance of the radiomics model. **ETHICS AND DISSEMINATION:** This study has been approved by the institutional review board of The First Affiliated Hospital of Xi'an Jiaotong University (XJTU1AF2015LSK-172). All parents of eligible participants will be provided with a detailed explanation of the study and written consent will be obtained. The results of this study will be published in peer-reviewed journals and presented at local, national and international conferences. **TRIAL REGISTRATION NUMBER:** NCT02637817; Pre-results.

PMID: [30948562](#)

21. Cerebral palsy prevalence, subtypes, and associated impairments: a population-based comparison study of adults and children.

Jonsson U, Eek MN, Sunnerhagen KS, Himmelmann K.

Dev Med Child Neurol. 2019 Apr 5. doi: 10.1111/dmcn.14229. [Epub ahead of print]

AIM: To describe the prevalence of cerebral palsy (CP), subtype distribution, motor and intellectual impairment, and epilepsy in adults with CP compared with children with CP. **METHOD:** CP subtype and impairment data from the population-based CP register of western Sweden and population data from Statistics Sweden were used to compare surviving adults (n=581; 244 females, 337 males) born between 1959 and 1978, with the same cohort as children (n=723; 307 females, 416 males), and with the most recent cohort, born from 2007 to 2010 (n=205; 84 females, 121 males). **RESULTS:** Prevalence of CP in adults born between 1959 and 1978 was 1.14 per 1000. The occurrence of impairments differed between CP subtypes. Motor and intellectual impairment were closely related, regardless of subtype. Subtype distribution among survivors differed significantly from the original cohorts (p=0.002), and the most recent cohort (p<0.01), tetraplegia and dyskinetic CP being less common in survivors. Severe motor impairment, intellectual disability, and epilepsy were less common among survivors than in the original cohorts (p=0.004, p=0.002, p=0.037) and the most recent cohort (p=0.004, p=0.008, p<0.01). **INTERPRETATION:** Data on prevalence, subtype distribution, and impairments in children with CP are not applicable to adults with CP. Population-based studies of adults with CP are needed. **WHAT THIS PAPER ADDS:** Cerebral palsy (CP) subtypes are differently distributed in adults compared to children. The prevalence of impairments in adults with CP is related to CP subtype. Spastic tetraplegia and dyskinetic CP are less common in adults than children. Severe motor impairment, intellectual disability, and epilepsy are less common in adults.

PMID: [30950519](#)

22. Adults with cerebral palsy: findings from a population-based register.

Goldsmith S.

Dev Med Child Neurol. 2019 Apr 5. doi: 10.1111/dmcn.14238. [Epub ahead of print]

PMID: [30950510](#)

23. A special issue on childhood-onset movement disorders.

Ebrahimi-Fakhari D, Münchau A, Stamelou M.

Mov Disord. 2019 Apr 2. doi: 10.1002/mds.27663. [Epub ahead of print]

PMID: [30938852](#)

24. Timing of delivery in women with prior uterine rupture: A decision analysis.

Frank ZC, Lee VR, Hersh AR, Pilliod RA, Caughey AB.

J Matern Fetal Neonatal Med. 2019 Apr 1:1-291. doi: 10.1080/14767058.2019.1602825. [Epub ahead of print]

BACKGROUND: Uterine rupture is an obstetric complication with high rates of associated maternal and neonatal morbidity and mortality. However, limited guidance for the timing of delivery in women with a history of prior uterine rupture exists. **OBJECTIVE:** To determine the optimal gestational age of delivery in women with prior uterine rupture. **STUDY DESIGN:** A decision-analytic model was built using TreeAge software to compare the outcomes of repeat cesarean delivery when performed at 32, 33, 34, 35, or 36 weeks' gestation in a theoretical cohort of 1000 women with prior uterine rupture. Strategies involved expectant management until a later gestational age accounting for the risks of spontaneous uterine rupture, spontaneous labor, uterine rupture following spontaneous labor, and stillbirth during each successive week that a woman was still pregnant. Maternal outcomes included uterine rupture, hysterectomy, and death. Neonatal outcomes included hypoxic ischemic encephalopathy, cerebral palsy, and death. Probabilities were derived from the literature and total quality-adjusted life years (QALYs) were calculated. Sensitivity analyses were used to vary model inputs to investigate the robustness of our baseline assumptions. **RESULTS:** In our theoretical cohort of 1000 pregnant women with history of prior uterine rupture, cesarean delivery at 34 weeks maximized maternal and neonatal QALYs. Compared to delivery at 36 weeks, delivery at 34 weeks would prevent 38.6 uterine ruptures, 0.079 maternal deaths, 6.10 hysterectomies, and 12.1 neonatal deaths, but result in 4.70 more cases of cerebral palsy. Univariate sensitivity analysis found that repeat cesarean at 34 weeks remained the optimal strategy until the probability of spontaneous repeat uterine rupture (baseline estimate: 0.68%) fell below 0.2% or rose above 0.9%, at which point a strategy of delivery at 35 or 32 weeks became optimal, respectively. However, Monte Carlo simulation demonstrated that delivery at 35 weeks was the optimal strategy 37% of the time, whereas 34 weeks was the optimal strategy 17% of the time.

PMID: [30935266](#)**25. Consensus outcome rating for international neonatal resuscitation guidelines.**

Strand ML, Simon WM, Wyllie J, Wyckoff MH, Weiner G.

Arch Dis Child Fetal Neonatal Ed. 2019 Mar 29. pii: fetalneonatal-2019-316942. doi: 10.1136/archdischild-2019-316942. [Epub ahead of print]

The International Liaison Committee on Resuscitation uses the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) working group method to evaluate the quality of evidence and the strength of treatment recommendations. This method requires guideline developers to use a numerical rating of the importance of each specified outcome. There are currently no uniform reporting guidelines or outcome measures for neonatal resuscitation science. We describe consensus outcome ratings from a survey of 64 neonatal resuscitation guideline developers representing seven international resuscitation councils. Among 25 specified outcomes, 10 were considered critical for decision-making. The five most critically rated outcomes were death, moderate-severe neurodevelopmental impairment, blindness, cerebral palsy and deafness. These data inform outcome rankings for systematic reviews of neonatal resuscitation science and international guideline development using the GRADE methodology.

PMID: [30926715](#)**26. Can Neonatal Systemic Inflammation and Hypoxia Yield a Cerebral Palsy-Like Phenotype in Periadolescent Mice?**

Fragopoulou AF, Qian Y, Heijtz RD, Forssberg H.

Mol Neurobiol. 2019 Apr 2. doi: 10.1007/s12035-019-1548-8. [Epub ahead of print]

Cerebral palsy (CP) is one of the most common childhood-onset motor disabilities, attributed to injuries of the immature brain in the foetal or early postnatal period. The underlying mechanisms are poorly understood, rendering prevention and treatment strategies challenging. The aim of the present study was to establish a mouse model of CP for preclinical assessment of new interventions. For this purpose, we explored the impact of a double neonatal insult (i.e. systemic inflammation combined with hypoxia) on behavioural and cellular outcomes relevant to CP during the prepubertal to adolescent period of mice. Pups were subjected to intraperitoneal lipopolysaccharide (LPS) injections from postnatal day (P) 3 to P6 followed by hypoxia at P7. Gene expression analysis at P6 revealed a strong inflammatory response in a brain region-dependent manner. A comprehensive battery of behavioural assessments performed between P24 and P47 showed impaired limb placement and coordination when

walking on a horizontal ladder in both males and females. Exposed males also displayed impaired performance on a forelimb skilled reaching task, altered gait pattern and increased exploratory activity. Exposed females showed a reduction in grip strength and traits of anxiety-like behaviour. These behavioural alterations were not associated with gross morphological changes, white matter lesions or chronic inflammation in the brain. Our results indicate that the neonatal double-hit with LPS and hypoxia can induce subtle long-lasting deficits in motor learning and fine motor skills, which partly reflect the symptoms of children with CP who have mild gross and fine motor impairments.

PMID: [30941732](#)

27. Cerebrospinal Fluid Neopterin in Children With Enterovirus-Related Brainstem Encephalitis.

Casas-Alba D, Valero-Rello A, Muchart J, Armangué T, Jordan I, Cabrerizo M, Molero-Luís M, Artuch R, Fortuny C, Muñoz-Almagro C, Launes C.

Pediatr Neurol. 2019 Feb 7. pii: S0887-8994(18)30986-X. doi: 10.1016/j.pediatrneurol.2019.01.024. [Epub ahead of print]

BACKGROUND: Enterovirus-A71 causes outbreaks of brainstem encephalitis, ranging from self-limited disease to acute flaccid paralysis. The aim of this study was to assess the role of cerebrospinal fluid (CSF) neopterin as a biomarker of disease severity in children with enterovirus-related brainstem encephalitis. **METHODS:** A descriptive, prospective cohort study was conducted from April 2016 to March 2017 in a tertiary hospital. Pediatric patients with a diagnosis of brainstem encephalitis with or without myelitis due to enterovirus infection were enrolled. The final study group comprised a convenience sample including all patients with sufficient CSF volume for neopterin determination. The major variables considered in estimating the severity were the diagnosis of encephalomyelitis, the presence of lesions and extensive lesions on brain and spinal magnetic resonance imaging (MRI), hospital stay length greater than seven days, and sequelae at day 30. **RESULTS:** Of 60 patients, CSF neopterin could be measured in 36. Median age was 26 months (interquartile range: 19 to 32). Thirty-three were diagnosed with brainstem encephalitis and three with encephalomyelitis. Enterovirus-A71 was the only identified genotype (25 of 25). CSF neopterin levels were elevated (>61 nmol/L) in 33 of 36 (92%), with a median of 347 nmol/L (interquartile range: 204 to 525). CSF neopterin was useful to distinguish patients with lesions on MRI (area under the receiver operating characteristic curve = 0.76; $P = 0.02$) and extensive lesions (area under the receiver operating characteristic curve = 0.76; $P = 0.04$). **CONCLUSIONS:** This study suggests an association between CSF neopterin levels and the presence of inflammatory lesions on MRI.

PMID: [30935719](#)