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Interventions and Management

1. Upper Extremity Strengthening for an Individual With Dyskinetic Cerebral Palsy: A Case Report

Laura Graber, Claudia Senesac

Pediatr Phys Ther. 2021 Feb 23. doi: 10.1097/PEP.0000000000000785. Online ahead of print.

Purpose: The purpose of this case is to describe an exercise program designed for an individual with athetoid cerebral palsy who had difficulties with fine motor control and shoulder girdle stability. **Summary of key points:** ET is a 19-year-old man with dyskinetic-type cerebral palsy with rapidly fluctuating muscle tone and movements that preclude trunk and extremity control necessary for the effective performance of functional activities. The participant underwent a 6-week intense physical therapy program aimed at strength and stability at the shoulder girdle and fine motor movements of the hand. **Conclusions:** ET had improvements on the Performance of Upper Limb Scale, myometry, and from family report after 6 weeks.

Recommendations: A progressive exercise program aimed at improving proximal stability and fine motor function might be an appropriate intervention for persons with athetoid cerebral palsy (see Supplemental Digital Content 1, available at: <http://links.lww.com/PPT/A315>).

PMID: [33653985](https://pubmed.ncbi.nlm.nih.gov/33653985/)

2. Preschool HABIT-ILE: study protocol for a randomised controlled trial to determine efficacy of intensive rehabilitation compared with usual care to improve motor skills of children, aged 2-5 years, with bilateral cerebral palsy

Leanne Sakzewski, Sarah Reedman, Kate McLeod, Megan Thorley, Andrea Burgess, Stewart Trost, Matthew Ahmadi, David Rowell, Mark Chatfield, Yannick Bleyenheuft, Roslyn N Boyd

BMJ Open. 2021 Mar 2;11(3):e041542. doi: 10.1136/bmjopen-2020-041542.

Introduction: Young children with bilateral cerebral palsy (BCP) often experience difficulties with gross motor function, manual ability and posture, impacting developing independence in daily life activities, participation and quality of life. Hand Arm Bimanual Intensive Training Including Lower Extremity (HABIT-ILE) is a novel intensive motor intervention integrating upper and lower extremity training that has been developed and tested in older school-aged children with unilateral and BCP. This study aims to compare an adapted preschool version of HABIT-ILE to usual care in a randomised controlled trial. **Methods and analysis:** 60 children with BCP aged 2-5 years, Gross Motor Function Classification System (GMFCS) II-IV will be recruited. Children will be stratified by GMFCS and randomised using concealed allocation to either receive Preschool HABIT-ILE or usual care. Preschool HABIT-ILE will be delivered in groups of four to six children, for 3 hours/day for 10 days (total 30 hours). Children receiving Preschool HABIT-ILE be provided a written home programme with the aim of achieving an additional 10 hours of home practice (total dose 40 hours). Outcomes will be assessed at baseline, immediately following intervention and then retention of effects will be tested at 26 weeks. The primary outcome will be the Peabody

Developmental Motors Scales-Second Edition to evaluate gross and fine motor skills. Secondary outcomes will be gross motor function (Gross Motor Function Measure-66), bimanual hand performance (Both Hands Assessment), self-care and mobility (Pediatric Evaluation of Disability Inventory-Computer Adapted Test), goal attainment (Canadian Occupational Performance Measure), global performance of daily activities (ACTIVLIM-CP), cognition and adaptive function (Behavior Rating Inventory of Executive Function-Preschool Version), habitual physical activity (ActiGraph GT3X+) and quality of life (Infant Toddler Quality of Life Questionnaire and Child Health Utility Index-9). Analyses will follow standard principles for RCTs using two-group comparisons on all participants on an intention-to-treat basis. Comparisons between groups for primary and secondary outcomes will be conducted using regression models. Ethics and dissemination: Ethics approval has been granted by the Medical Research Ethics Committee Children's Health Queensland Hospital and Health Service Human Research Ethics Committee (HREC/19/QCHQ/59444) and The University of Queensland (2020000336/HREC/19/QCHQ/59444). Trial registration number: ACTRN126200000719.

PMID: [33653745](#)

3. Evaluating validity of the Kids-Balance Evaluation Systems Test (Kids-BESTest) Clinical Test of Sensory Integration of Balance (CTSIB) criteria to categorise stance postural control of ambulant children with CP

Rosalee M Dewar, Kylie Tucker, Andrew P Claus, Wolbert van den Hoorn, Robert S Ware, Leanne M Johnston

Disabil Rehabil. 2021 Feb 28;1-8. doi: 10.1080/09638288.2021.1887374. Online ahead of print.

Purpose: Evaluate the validity of the Clinical Test of Sensory Integration of Balance (CTSIB) scored using Kids-Balance Evaluation Systems Test (Kids-BESTest) criteria compared to laboratory measures of postural control. Method: Participants were 58 children, 7-18 years, 17 with ambulant cerebral palsy (CP) (GMFCS I-II), and 41 typically developing (TD). Postural control in standing was assessed using CTSIB items firm and foam surfaces, eyes open (EO) then closed (EC). Face validity was evaluated comparing clinical Kids-BESTest scores between groups. Correlating force plate centre-of-pressure (CoP) data and clinical scores allowed evaluation of concurrent and content validity. Results: Face validity: TD children scored higher for all CTSIB conditions when compared to children with CP. Concurrent validity: the agreement between clinical and CoP derived scores was poor to excellent (Firm-EO = 76%, Firm-EC = 76%, Foam-EO = 59%, Foam-EC = 94%). Clinical scores of "2-unstable" and "3-stable" were not distinguished reliably by force plate measures. Content validity: significant correlations were found between clinical scores and CoP data for the two intermediate conditions (Firm-EC: rs -0.40 to -0.72; Foam-EO: rs -0.12 to -0.50), but not the easier (Firm-EO: rs -0.41 to -0.36) or harder conditions (Foam-EC: rs -0.25 to -0.27). Conclusion: Face validity of Kids-BESTest CTSIB criteria was supported. Content and concurrent validity were partially supported. Improved Kids-BESTest scoring terms were recommended to describe postural characteristics of "2-unstable." IMPLICATIONS FOR REHABILITATION Face validity of the Kids-BESTest criteria for the CTSIB was confirmed. The Kids-BESTest criteria for the CTSIB can identify children with atypical postural control. Concurrent validity and content validity were partially supported, since children with CP resorted to a range of different balance strategies when "unstable." To improve CTSIB Kids-BESTest criteria, new terms were recommended to better describe postural characteristics of "2-unstable."

PMID: [33645385](#)

4. Applying Stretch to Evoke Hyperreflexia in Spasticity Testing: Velocity vs. Acceleration

Lizeth H Sloot, Guido Weide, Marjolein M van der Krogt, Kaat Desloovere, Jaap Harlaar, Annemieke I Buizer, Lynn Bar-On

Front Bioeng Biotechnol. 2021 Feb 16;8:591004. doi: 10.3389/fbioe.2020.591004. eCollection 2020.

In neurological diseases, muscles often become hyper-resistant to stretch due to hyperreflexia, an exaggerated stretch reflex response that is considered to primarily depend on the muscle's stretch velocity. However, there is still limited understanding of how different biomechanical triggers applied during clinical tests evoke these reflex responses. We examined the effect of imposing a rotation with increasing velocity vs. increasing acceleration on triceps surae muscle response in children with spastic paresis (SP) and compared the responses to those measured in typically developing (TD) children. A motor-operated ankle manipulator was used to apply different bell-shaped movement profiles, with three levels of maximum velocity (70, 110, and 150°/s) and three levels of maximum acceleration (500, 750, and 1,000°/s²). For each profile and both groups, we evaluated the amount of evoked triceps surae muscle activation. In SP, we evaluated two additional characteristics: the intensity of the response (peak EMG burst) and the time from movement initiation to onset of the EMG burst. As expected, the amount of evoked muscle activation was larger in SP compared to TD (all muscles: $p < 0.001$) and only sensitive to biomechanical triggers in SP. Further investigation of the responses in SP showed that peak EMG bursts increased in profiles

with higher peak velocity (lateral gastrocnemius: $p = 0.04$), which was emphasized by fair correlations with increased velocity at EMG burst onset (all muscles: $r > 0.33-0.36$, $p \leq 0.008$), but showed no significant effect for acceleration. However, the EMG burst was evoked faster with higher peak acceleration (all muscles $p < 0.001$) whereas it was delayed in profiles with higher peak velocity (medial gastrocnemius and soleus: $p < 0.006$). We conclude that while exaggerated response intensity (peak EMG burst) seems linked to stretch velocity, higher accelerations seem to evoke faster responses (time to EMG burst onset) in triceps surae muscles in SP. Understanding and controlling for the distinct effects of different biological triggers, including velocity, acceleration but also length and force of the applied movement, will contribute to the development of more precise clinical measurement tools. This is especially important when aiming to understand the role of hyperreflexia during functional movements where the biomechanical inputs are multiple and changing.

PMID: [33665186](#)

5. Brain activation changes following motor training in children with unilateral cerebral palsy: an fMRI study

R Araneda, L Dricot, D Ebner-Karestinos, J Paradis, A M Gordon, K M Friel, Y Bleyenheuft

Ann Phys Rehabil Med. 2021 Feb 26;101502. doi: 10.1016/j.rehab.2021.101502. Online ahead of print.

Background: Intensive motor-learning-based interventions have demonstrated efficacy for improving motor function in children with unilateral spastic cerebral palsy (USCP). Although this improvement has been associated mainly with neuroplastic changes in the primary sensori-motor cortices, this plasticity may also involve a wider fronto-parietal network for motor learning. Objective: To determine whether Hand-Arm Bimanual Intensive Therapy Including Lower Extremities (HABIT-ILE) induces brain activation changes in an extensive network for motor skill learning and whether these changes are related to functional changes observed after HABIT-ILE. Methods: In total, 25 children with USCP were behaviorally assessed in manual dexterity and everyday activities before and after HABIT-ILE. Functional imagery monitored brain activity while participants manipulated objects using their less-affected, more-affected or both hands. Two random-effects-group analyses performed at the whole-brain level assessed the brain activity network before and after therapy. Three other random-effects-group analyses assessed brain activity changes after therapy. Spearman's correlations were used to evaluate the correlation between behavioral and brain activity changes. Results: The same fronto-parietal network was identified before and after therapy. After the intervention, the more-affected hand manipulation elicited a decrease in activity on the motor cortex of the non-lesional hemisphere and an increase in activity on motor areas of the lesional hemisphere. The less-affected hand manipulation generated a decrease in activity of sensorimotor areas in the non-lesional hemisphere. Both-hands manipulation elicited an increase in activity of both hemispheres. Furthermore, we observed an association between brain activity changes and changes in everyday activity assessments. Conclusion: Brain activation changes were observed in a fronto-parietal network underlying motor skill learning with HABIT-ILE in children with USCP. Two different patterns were observed, probably related to different phases of motor skill learning, representing an increased practice-dependent brain recruitment or a brain activation refinement by more efficient means.

PMID: [33647530](#)

6. Exercise intervention protocol in children and young adults with cerebral palsy: the effects of strength, flexibility and gait training on physical performance, neuromuscular mechanisms and cardiometabolic risk factors (EXECP)

Pedro Valadão, Harri Piitulainen, Eero A Haapala, Tiina Parviainen, Janne Avela, Taija Finni

BMC Sports Sci Med Rehabil. 2021 Feb 26;13(1):17. doi: 10.1186/s13102-021-00242-y.

Background: Individuals with cerebral palsy (CP) have problems in everyday tasks such as walking and climbing stairs due to a combination of neuromuscular impairments such as spasticity, muscle weakness, reduced joint flexibility and poor coordination. Development of evidence-based interventions are in pivotal role in the development of better targeted rehabilitation of CP, and thus in maintaining their motor function and wellbeing. Our aim is to investigate the efficacy of an individually tailored, multifaceted exercise intervention (EXECP) in children and young adults with CP. EXECP is composed of strength, flexibility and gait training. Furthermore, this study aims to verify the short-term retention of the adaptations three months after the end of the EXECP intervention. Methods: Twenty-four children and young adults with spastic CP will be recruited to participate in a 9-month research project with a 3-month training intervention, consisting of two to three 90-min sessions per week. In each session, strength training for the lower limbs and trunk muscles, flexibility training for the lower limbs and inclined treadmill gait training will be performed. We will evaluate muscle strength, joint flexibility, neuromuscular and cardiometabolic parameters. A nonconcurrent multiple baseline design with two pre-tests and two post-tests all interspaced

by three months is used. In addition to the CP participants, 24 typically developing age and sex-matched participants will perform the two pre-tests (i.e. no intervention) to provide normative data. Discussion: This study has a comprehensive approach examining longitudinal effects of wide variety of variables ranging from physical activity and gross motor function to sensorimotor functions of the brain and neuromuscular and cardiometabolic parameters, providing novel information about the adaptation mechanisms in cerebral palsy. To the best of our knowledge, this is the first intervention study providing supervised combined strength, flexibility and gait training for young individuals with CP. Trial registration number: ISRCTN69044459, prospectively registered (21/04/2017).

PMID: [33637124](#)

7. Physical therapist-led swimming lessons for children with cerebral palsy: a report of 2 cases

Tadashi Matsuda, Yoshiteru Akezaki, Yoko Tsuji, Kazunori Hamada, Mitsuhiro Ookura

Case Reports J Phys Ther Sci. 2021 Feb;33(2):175-178. doi: 10.1589/jpts.33.175. Epub 2021 Feb 13.

[Purpose] The purpose of this study was to report that a physical therapist qualified for swimming instruction can provide swimming instruction to children with spastic paraplegia due to cerebral palsy. We examined the role of the physical therapist in the support. [Participants and Methods] Two elementary school children with cerebral palsy participated in this study. The swimming program consisting of 6 sessions was performed over 6 months in an indoor swimming pool. Each session lasted for 30 minutes and was instructed by a trained physical therapist. The 5 categories for evaluation were motor function, muscle tone, activities of daily living, swimming skill, and satisfaction level. [Results] Case A showed improvement in streamline floating distance and 15-m time. Case B could not swim 15 m in the first session but completed 15 m within 102 s in the last session. The 3 other categories besides swimming skills did not improve. [Conclusion] With a skilled physical therapist's instruction, children with cerebral palsy may improve their swimming skills over a limited number of sessions without any adverse events.

PMID: [33642695](#)

8. Performance Analysis in Football-Specific Tests by Para-Footballers With Cerebral Palsy: Implications for Evidence-Based Classification

Javier Yanci, Daniel Castillo, Aitor Iturricastillo, Astrid Aracama, Alba Roldan, Raúl Reina

Int J Sports Physiol Perform. 2021 Mar 3;1-7. doi: 10.1123/ijsp.2020-0370. Online ahead of print.

Purpose: The objectives of this study were to analyze whether there were differences among para-footballers with different types and degrees of brain impairment (ie, bilateral spasticity, athetosis/ataxia, unilateral spasticity, minimum impairment criteria, or no impairment) in performing 3 football-specific tests requiring ball dribbling, to analyze whether there was an association among the results obtained in the 3 tests, and to determine whether the performance in the tests was associated with competitive level, level of training, or years' experience in para-footballers with cerebral palsy (CP). Methods: A total of 123 footballers took part in the study, 87 of whom were footballers with CP and 36 who were without impairment. Both groups were assessed in 3 football-specific tests (Stop and Go, Turning and Dribbling, and the Illinois Agility Test). Results: The results showed that the footballers without impairment recorded a better performance in all tests ($P < .01$) in comparison with the CP players. No significant differences in test performance were observed among the CP players from different competitive levels. However, significant differences ($P < .01$) were observed between players with diplegia or athetosis/ataxia compared with players with hemiplegia or minimum impairment level. Performance in the tests did not correlate with years of football experience, weekly strength training sessions, or specific football training in the footballers with CP ($P = .12-.95$). Conclusions: These findings suggest the possible inclusion of these tests in the classification process for footballers with CP because they discriminate among functional classes and are resistant to training and competitive level.

PMID: [33662930](#)

9. Pain in adults with cerebral palsy after single-event multilevel surgery

M Götzte, A Geisbüsch, M Thielen, L Döderlein, S I Wolf, T Dreher, C Putz

Am J Phys Med Rehabil. 2021 Feb 27. doi: 10.1097/PHM.0000000000001741. Online ahead of print.

Objective: Aim of the investigation was to assess the contribution of pain to functional, social, and health-related quality of life (QoL) outcomes in adults with cerebral palsy. **Design:** This monocentric, prospective study included long-term data for ambulant adults with cerebral palsy and at level I to III in the Gross Motor Function Classification System who had received orthopedic multilevel surgery in adulthood and in whom pre- and postoperative three-dimensional gait analysis was conducted, including the Gait Profile Score. A questionnaire including the Visual Analogue Scale, Oswestry Disability Index, and Euro Qol (EQ)-5D-3L was analyzed. **Results:** Twenty-four adults at a mean age of 38.0 years were included. Sixteen (66.7%) patients indicated that they experienced pain and 10 (41.7%) patients had pain for more than 6 months. Overall, 13 (54%) patients experienced both pain and anxiety. There was no correlation of the Gait Profile Score with pain, Gross Motor Function Classification System, and Oswestry Disability Index. The Oswestry Disability Index showed a positive correlation with the Gross Motor Function Classification System ($cc=0.39$, $p=0.05$) and pain ($cc=0.57$, $p=0.004$). **Conclusions:** Pain and anxiety represent relevant comorbidities in adults with cerebral palsy. The occurrence of pain correlates with the Oswestry Disability Index and is higher than in children with cerebral palsy.

PMID: [33657030](#)

10. Reproducibility and validity of the Functional Communication Classification System for young children with cerebral palsy

Katy Caynes, Tanya A Rose, Debbie Burmester, Robert S Ware, Leanne M Johnston

Dev Med Child Neurol. 2021 Feb 26. doi: 10.1111/dmcn.14844. Online ahead of print.

Aim: To examine interrater agreement and validity of the Functional Communication Classification System (FCCS) for young children with cerebral palsy (CP) aged 2 or 3 years. **Method:** Speech-language pathologist (SLP) and parent FCCS ratings for 31 children with CP (aged 2y, $n=16$; aged 3y, $n=15$; 18 males, 13 females) were examined for interrater agreement using a weighted Cohen's kappa statistic. Relationships between FCCS (SLP) ratings and: (1) concurrent validity with the Language Use Inventory, a standardized pragmatic assessment for children aged 18 to 47 months, (2) gross motor and fine motor function, (3) associated impairments (visual and intellectual), and (4) primary expressive communication mode were examined using Spearman's correlation coefficients. **Results:** Almost perfect interrater agreement between SLP and parent FCCS ratings were found ($kw=0.94$). Correlations with FCCS (SLP) were excellent for pragmatic function ($rs=-0.83$, $p<0.001$), intellectual function ($rs=0.89$, $p<0.001$), and primary expressive communication mode ($rs=0.92$, $p<0.001$). Correlations were good for gross motor function ($rs=0.72$, $p<0.001$) and visual impairment ($rs=0.70$, $p<0.001$) and fair for fine motor function ($rs=0.53$, $p<0.002$). Analysis was unwarranted for epilepsy ($n=1$ out of 31) and hearing-associated impairments ($n=0$ out of 31). **Interpretation:** The FCCS has excellent interrater agreement and validity for communication classification of children with CP aged 2 or 3 years and is highly suitable for surveillance and research purposes.

PMID: [33638178](#)

11. Perceptual and Acoustic Effects of Dual-Focus Speech Treatment in Children With Dysarthria

Erika S Levy, Younghwa M Chang, KyungHae Hwang, Megan J McAuliffe

J Speech Lang Hear Res. 2021 Mar 3;1-16. doi: 10.1044/2020_JSLHR-20-00301. Online ahead of print.

Purpose Children with dysarthria secondary to cerebral palsy may experience reduced speech intelligibility and diminished communicative participation. However, minimal research has been conducted examining the outcomes of behavioral speech treatments in this population. This study examined the effect of Speech Intelligibility Treatment (SIT), a dual-focus speech treatment targeting increased articulatory excursion and vocal intensity, on intelligibility of narrative speech, speech acoustics, and communicative participation in children with dysarthria. **Method** American English-speaking children with dysarthria ($n=17$) received SIT in a 3-week summer camplike setting at Columbia University. SIT follows motor-learning principles to train the child-friendly, dual-focus strategy, "Speak with your big mouth and strong voice." Children produced a story narrative at baseline, immediate posttreatment (POST), and at 6-week follow-up (FUP). Outcomes were examined via blinded listener ratings of ease of understanding ($n=108$ adult listeners), acoustic analyses, and questionnaires focused on communicative

participation. Results SIT resulted in significant increases in ease of understanding at POST, that were maintained at FUP. There were no significant changes to vocal intensity, speech rate, or vowel spectral characteristics, with the exception of an increase in second formant difference between vowels following SIT. Significantly enhanced communicative participation was evident at POST and FUP. Considerable variability in response to SIT was observed between children. Conclusions Dual-focus treatment shows promise for improving intelligibility and communicative participation in children with dysarthria, although responses to treatment vary considerably across children. Possible mechanisms underlying the intelligibility gains, enhanced communicative participation, and variability in treatment effects are discussed.

PMID: [33656916](#)

12. Measure of early vision use: initial validation with parents of children with cerebral palsy

Belinda Deramore Denver, Elspeth Froude, Peter Rosenbaum, Christine Imms

Disabil Rehabil. 2021 Mar 2;1-9. doi: 10.1080/09638288.2021.1890243. Online ahead of print.

Purpose: To report initial psychometric evidence on the Measure of Early Vision Use. **Method:** Data on performance of the Measure of Early Vision Use scale were collected from 100 parents of children with cerebral palsy aged 0-12 years via online survey. Psychometric evaluation included assessment of scale dimensionality using Classical Test Theory and hypothesis testing for evidence of construct validity. **Results:** Principal components analysis of the 14-item parent-rated Measure of Early Vision Use revealed one component with an eigenvalue of 9.343, explaining 66.7% of variance; internal consistency was high (Cronbach's $\alpha = 0.96$). Total scores ranged from 15-56 (Mean 42.8, standard deviation = 10.6). The results support seven pre-defined hypotheses including statistically significant differences in MEVU-total scores between children with and without parent-reported cerebral visual impairment. **Conclusions:** Measure of Early Vision Use is the first assessment tool to describe 'how vision is used' in children with cerebral palsy. Results provide preliminary evidence that the measure comprises a unidimensional construct, sufficient construct validity, and feasibility as a parent-completed online assessment. Findings on internal structure provide foundational evidence and require further testing with Confirmatory Factor Analysis or Rasch Analysis. **IMPLICATIONS FOR REHABILITATION**The Measure of Early Vision Use is a new instrument to describe the use of basic visual abilities and is feasible to use as a parent-completed online questionnaire. The Measure of Early Vision Use is a unidimensional scale with sufficient construct validity to support its use as a measure of 'how vision is used' without confounding visual ability with the reason why it might be impaired (e.g., cerebral vision impairment, motor limitations, or cognition). There is potential for the Measure of Early Vision Use to support early intervention planning for children with (or at high risk of) cerebral palsy.

PMID: [33651960](#)

13. Sleep, cognition and executive functioning in young children with cerebral palsy

Andrea F Duncan, Nathalie L Maitre

Adv Child Dev Behav. 2021;60:285-314. doi: 10.1016/bs.acdb.2020.11.002. Epub 2021 Feb 16.

Children with cerebral palsy (CP) are at higher risk for sleep disturbances than their typically developing peers. In typically developing young children, lack of sufficient sleep results in deficits in cognition, behavior and executive functioning. Unfortunately, research on sleep in infancy rarely focuses on children with neurodevelopmental disabilities. Studies of older children with CP demonstrate that roughly half of children with CP have a sleep disorder, though screening for sleep disorders in children with CP is not routinely performed. Given the high prevalence of sleep abnormalities in older children with CP and the resulting adverse effects on functioning, understanding sleep derangements and how they affect cognition and executive functioning in these children at earlier ages is critical. In this chapter, we present the state of the evidence for sleep characteristics, cognition and executive functions for infants and toddlers 0-3years old with CP.

PMID: [33641797](#)

14. Suit therapy versus whole-body vibration on bone mineral density in children with spastic diplegia

Amira E El-Bagalaty, Marwa M I Ismaeel

J Musculoskelet Neuronal Interact. 2021 Mar 1;21(1):79-84.

Objectives: Osteoporosis because of physical inactivity is one of the major complications associated with neuromuscular disorders. The study aimed to compare using Suit therapy and whole-body vibration in addition to selected physical therapy program to improve Bone Mineral Density in children with cerebral palsy of spastic diplegia. **Methods:** Forty-six patients were classified randomly into two equal groups. Patients in the group (A) engaged in a selected physical therapy program, also besides, suit therapy training program while those in the group (B) received the same selected physical therapy program received by group (A) in addition to the whole-body vibration training program. The treatment programs were conducted three times per week for twelve successive weeks. Measurements obtained included bone mineral density at the lumbar spine as well as at the femoral neck. These measures were recorded pre- and post-treatment. **Results:** There was a significant improvement in favor of the whole-body Vibration group. Bone mineral density improved significantly at both the lumbar spine ($P=.038$) and the femoral neck ($P=.005$) in the WBV group as compared to the Suit therapy group. **Conclusions:** Whole-body vibration is effective in improving Bone Mineral Density rather than Suit therapy in children with cerebral palsy of spastic diplegia.

PMID: [33657757](#)

15. Randomised trial of virtual reality gaming and physiotherapy on balance, gross motor performance and daily functions among children with bilateral spastic cerebral palsy

Krishna Kumari Jha, Gandhi Balaji Karunanithi, A Sahana, Suruliraj Karthikbabu

Somatosens Mot Res. 2021 Mar 3;1-10. doi: 10.1080/08990220.2021.1876016. Online ahead of print.

Background: Balance issues and poor gross motor function affect the daily needs of children with cerebral palsy. **Purpose:** The study objective was to examine the effects of virtual reality gaming and physiotherapy on balance, gross motor performance and daily functioning among children with bilateral spastic cerebral palsy. **Method:** Thirty-eight children with bilateral spastic cerebral palsy aged 6-12 years with GMFCS- level II-III, Manual Ability Classification System level I-III participated in this randomized controlled trial. The experimental group performed virtual reality games and physiotherapy, while the control group underwent physiotherapy alone. The exercise intensity was 60 minutes session a day, 4-days a week for 6-weeks. Paediatric Balance Scale (PBS), Kids-Mini-Balance Evaluation System Test (Kids-Mini-BESTest), Gross Motor Function Measure-88 (GMFM-88), and Wee-Functional Independence Measure (WeeFIM) were the outcome measures collected at baseline, 6-week post-training and 2-months follow-up. **Results:** The time by group interaction of repeated measures ANOVA revealed no statistical significance for all the outcome measures except Kids-Mini-BESTest ($p < 0.05$). The PBS and, Kids-Mini-BESTest improved by a mean (standard deviation) score of 5.1(1.7) and 8.7(2.8) points, respectively in the experimental group as compared to control group [3.4(1.6) and 5.8(2.5) points]. These gains remained at follow-up ($p < 0.001$). **Conclusion:** Combined virtual reality gaming and physiotherapy is not superior over physiotherapy alone in improving the gross motor performance and daily functioning among children with bilateral spastic cerebral palsy. Virtual gaming, along with physiotherapy, appears to be beneficial in their balance capacity, warranting further trials to investigate the same in children with GMFCS level-III.

PMID: [33655813](#)

16. National surveillance of oral medication prescription for children with dystonic cerebral palsy

Adrienne Harvey, Natasha Bear, James Rice, Giuliana Antolovich, Mary-Clare Waugh

J Paediatr Child Health. 2021 Mar 3. doi: 10.1111/jpc.15429. Online ahead of print.

Aim: Oral medications are often first-line medical management for children with cerebral palsy who have generalised dystonia; however, evidence for their effectiveness is limited and dosing practices are inconsistent. As a first step to improve consistency, this study aimed to examine current clinical practice of expert doctors for prescribing medications for children with dystonic cerebral palsy including prescribing patterns and combinations of medications used. **Methods:** This was a prospective surveillance study of medical doctors working in major Australian centres who manage children with cerebral palsy. Each week over a continuous 6-month period, doctors completed a custom developed online survey for children seen that week with dystonic cerebral palsy for whom they prescribed a new medication to treat dystonia. **Results:** Twenty-five

doctors consented to participate, 16 of whom prescribed new medications for dystonia in children with cerebral palsy over the study period. There were 77 children who were prescribed new medications. Baclofen and gabapentin were prescribed most, followed by levodopa, trihexyphenidyl and diazepam. The most common combinations of medications were baclofen and diazepam or baclofen and gabapentin. Dosage regimens were variable, particularly for trihexyphenidyl and diazepam. Conclusion: Inconsistencies in dosing regimens remain for oral medication prescription by Australian doctors when managing dystonia in cerebral palsy. Future studies using the consensus of expert clinicians will be conducted to develop guidelines in an area where the evidence for individual medications is extremely limited.

PMID: [33655652](#)

17. Trends observed in bilateral cerebral palsy during a thirty-year period: A cohort study with an ICF-based overview Silvia Pizzighello, Marinela Vavla, Nadia Minicuci, Alda Pellegrini, Andrea Martinuzzi

Pediatr Neonatol. 2021 Feb 5;S1875-9572(21)00018-8. doi: 10.1016/j.pedneo.2021.01.016. Online ahead of print.

Background: To describe trends observed across thirty years in demographic and clinical characteristics and rehabilitation of patients with bilateral cerebral palsy. Methods: This retrospective study includes 464 (261 M and 203 F) inpatients with bilateral cerebral palsy, born from 1967 to 1997 and discharged from an outpatient rehabilitative facility from 1985 to 2015. Data concerning the health profile were collected from medical reports and organized in the domains of Body Functions and Structure; Activity and participation and Personal and Environmental factors as proposed in the International Classification of Functioning Disability and Health (ICF). The trend observed over the three birth decades was discussed. Results: The duration of the rehabilitative treatment decreased across decades approximately by two years per decade (from an initial 16.2 yrs to 12.3 yrs). Across the decades the rate of quadriplegia decreased, whereas rates of diplegia increased; spasticity was the prevalent observed motor type for all decades. The most frequent musculoskeletal disorder involved the middle inferior part of the body, among comorbidities a steady decrease in psychiatric disorders was found. With respect to the first decade a slight improvement was observed in the gross motor functioning and in the hand dexterity. No particular trend was observed concerning communication abilities. An increase in the use of pharmacological and surgical treatments for motor symptoms was observed. Conclusion: This study presents and describes the functioning of a large sample of Italian patients with bilateral CP on the basis of the ICF framework and it discussed the trend observed across decades.

PMID: [33663988](#)

18. The Changing Face of Cerebral Palsy

Ann H Tilton, Jessica Solomon Sanders

Ann Neurol. 2021 Mar 1. doi: 10.1002/ana.26057. Online ahead of print.

PMID: [33650158](#)

19. "Help Me to Improve my Own Priorities!": A Feasibility Study of an Individualized Intensive Goal Training for Adolescents with Cerebral Palsy

Aline M Feitosa, Marisa C Mancini, Ana Paula M Silvério, Andrew M Gordon, Marina B Brandão

Phys Occup Ther Pediatr. 2021 Mar 2;1-18. doi: 10.1080/01942638.2021.1891186. Online ahead of print.

Aim: To investigate the feasibility and the preliminary effects of an individualized intensive goal training for adolescents with cerebral palsy (CP). Methods: Twelve adolescents with CP (12-17 years old, MACS II-III, GMFCS I-IV) identified functional goals to be practiced three hours/day, five days/week, for two weeks. The feasibility aspects included the participant's adherence (i.e., daily logs), the adequacy of the instruments used, and the participant's satisfaction with the intervention (i.e., structured questionnaire). Outcome measures included the Canadian Occupational Performance Measure (COPM), Pediatric Evaluation of Disability Inventory (PEDI) (self-care; mobility), Children Helping Out: Responsibilities, Expectations and Supports (CHORES), Participation and Environment Measure-Children and Youth (PEM-CY) (home) and Box and Blocks Test (BBT). Assessments were conducted one month and two days before the intervention, immediately and three months after

the intervention. Friedman tests were used to test time-related differences in the outcome measures. Results: All adolescents completed and reported satisfaction with the proposed intervention. Significant improvements were observed in performance and satisfaction (COPM), in functional skills and caregiver assistance in self-care and in the performance of household tasks. There were no significant differences in mobility skills, independence in mobility or household tasks, home participation, or manual dexterity. Conclusion: The intensive training was feasible and promoted improvements in functional goals and daily functioning of adolescents with CP.

PMID: [33653225](#)

20. [The challenge of comprehensive care for patients with cerebral palsy][Article in Spanish]

Dorleta López de Suso Martínez de Aguirre, Ricardo Martino-Alba

An Pediatr (Barc). 2021 Mar 1;S1695-4033(21)00129-6. doi: 10.1016/j.anpedi.2021.02.002. Online ahead of print.

PMID: [33663965](#)

21. FETAL HEART RATE PATTERN IN TERM OR NEAR-TERM CEREBRAL PALSY: LOOKING AT THE DATA IN THE RIGHT PERSPECTIVE

Salvatore Politi, Edwin Chandraharan, Tullio Ghi

Am J Obstet Gynecol. 2021 Mar 1;S0002-9378(21)00124-1. doi: 10.1016/j.ajog.2021.02.031. Online ahead of print.

PMID: [33662360](#)

22. Hard to Swallow: Dysphagia and Feeding After Ischemic Stroke in Children and Neonates

Lori C Jordan, Lauren A Beslow

Editorial Stroke. 2021 Mar 1;STROKEAHA120033524. doi: 10.1161/STROKEAHA.120.033524. Online ahead of print.

PMID: [33641381](#)

23. Baclofen Toxicity Mimicking Brain Death: A Case Report of a Pediatric Patient

Rachel P Pearson, LeAnn K Hoang, John Roufail, Michael G Muhonen, Anjalee W Galion

Pediatr Emerg Care. 2021 Mar 1;37(3):e141-e146. doi: 10.1097/PEC.0000000000002361.

Background: Baclofen is commonly used in both pediatric and adult patients to treat spasticity secondary to spinal cord and cerebral pathology. A broad range of symptoms and severity of baclofen toxicity have been described. However, to our knowledge, there are no reports to date of baclofen toxicity mimicking brain death in pediatric patients. Objective: We reviewed the presentation, clinical course, diagnostic studies including imaging and electroencephalography, and outcome of a patient with transient coma and loss of brainstem reflexes mimicking brain death secondary to baclofen toxicity. Methods: During a baclofen pump refill, a 12-year-old boy with cerebral palsy had inadvertent injection of 12,000 µg of baclofen into the pocket around his pump. Within an hour, he presented with acute altered mental status that rapidly progressed to a comatose state with absent brainstem reflexes. Results: After appropriate management, the patient returned to his neurological baseline by hospital day 3. Discussion: We reviewed the literature for varying presentations of baclofen toxicity and associated electroencephalography findings, mechanism of overdose, and different management options. In this case, the mechanism of baclofen toxicity was suspected to be secondary to extravasation from the pump pocket and subsequent systemic absorption. Conclusions: Patients with baclofen toxicity may have a dramatic presentation and an initial examination mimicking brain death. Given its rarity, this clinical entity may not be readily recognized, and there is potential for misinterpretation of

diagnosis and prognosis. It is important for physicians to be familiar with this clinical scenario to avoid false declaration of brain death.

PMID: [33651765](#)

24. Antenatal prediction models for short- and medium-term outcomes in preterm infants

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Acta Obstet Gynecol Scand. 2021 Mar 3. doi: 10.1111/aogs.14136. Online ahead of print.

Introduction: In extremely and very preterm infants, predicting individual risks for adverse outcomes antenatally is challenging but necessary for risk-stratified perinatal management and parents' participation in decision making about treatment. Our aim was to develop and validate prediction models for short-term (neonatal period) and medium-term (3 years of age) outcomes based on antenatal maternal and fetal factors alone. **Material and methods:** A population-based study was conducted on 31,157 neonates weighing $\leq 1,500$ g and born between 22 and 31 weeks of gestation registered in the Neonatal Research Network of Japan during 2006-2015. Short-term outcomes were assessed in 31,157 infants and medium-term outcomes were assessed in 13,751 infants among the 31,157 infants. The clinical data were randomly divided into training and validation datasets in a ratio of 2:1. The prediction models were developed by factors selected using stepwise logistic regression from 12 antenatal maternal and fetal factors with the training dataset. The number of factors incorporated into the model varied from 3 to 10, on the basis of each outcome. To evaluate predictive performance, the area under the receiver operating characteristic curve (AUROC) was calculated for each outcome with the validation dataset. **Results:** Among short-term outcomes, AUROCs for in-hospital death, chronic lung disease, intraventricular hemorrhage (grade III or IV) and periventricular leukomalacia were 0.85 [95% confidence interval (0.83-0.86)], 0.80 (0.79-0.81), 0.78 (0.75-0.80) and 0.58 (0.55-0.61), respectively. Among medium-term outcomes, AUROCs for cerebral palsy and developmental quotient of <70 at 3 years of age were 0.66 (0.63-0.69) and 0.72 (0.70-0.74), respectively. **Conclusions:** Although the predictive performance of these models varied for each outcome, their discriminative ability for in-hospital death, chronic lung disease, and intraventricular hemorrhage (grade III or IV) was relatively good. We provided a bedside prediction tool for calculating the likelihood of various infant complications for clinical use. To develop these prediction models would be valuable in each country, and these risk assessment tools could facilitate risk-stratified perinatal management and parents' shared understanding of their offspring's subsequent risks.

PMID: [33656762](#)

25. Moderately and Late Preterm Infants: Short- and Long-Term Outcomes From a Registry-Based Cohort

Nikoletta Smyrni, Maria Koutsaki, Marianna Petra, Eirini Nikaina, Maria Gontika, Helen Strataki, Fotini Davora, Helen Bouza, George Damianos, Helen Skouteli, Sotiria Mastroianni, Zoi Dalivigka, Argyris Dinopoulos, Margarita Tzaki, Antigone Papavasiliou

Front Neurol. 2021 Feb 12;12:628066. doi: 10.3389/fneur.2021.628066. eCollection 2021.

Background: While most studies on the association of preterm birth and cerebral palsy (CP) have focused on very preterm infants, lately, attention has been paid to moderately preterm [32 to <34 weeks gestational age (GA)] and late preterm infants (34 to <37 weeks GA). **Methods:** In order to report on the outcomes of a cohort of moderately and late preterm infants, derived from a population-based CP Registry, a comparative analysis of data on 95 moderately preterm infants and 96 late preterm infants out of 1,016 with CP, was performed. **Results:** Moderately preterm neonates with CP were more likely to have a history of N-ICU admission ($p = 0.001$) and require respiratory support ($p < 0.001$) than late preterm neonates. Birth weight was significantly related to early neonatal outcome with children with lower birth weight being more likely to have a history of N-ICU admission [moderately preterm infants ($p = 0.006$)/late preterm infants ($p < 0.001$)], to require ventilator support [moderately preterm infants ($p = 0.025$)/late preterm infants ($p = 0.014$)] and not to have neonatal seizures [moderately preterm infants ($p = 0.044$)/late preterm infants ($p = 0.263$)]. In both subgroups, the majority of children had bilateral spastic CP with moderately preterm infants being more likely to have bilateral spastic CP and less likely to have ataxic CP as compared to late preterm infants ($p = 0.006$). The prevailing imaging findings were white matter lesions in both subgroups, with statistically significant difference between moderately preterm infants who required ventilator support and mainly presented with this type of lesion vs. those who did not and presented with gray matter lesions, maldevelopments or miscellaneous findings. Gross motor function was also assessed in both subgroups without significant difference. Among late preterm infants, those who needed N-ICU admission and ventilator support as neonates achieved worse fine motor outcomes than those who did not.

Conclusions: Low birth weight is associated with early neonatal problems in both moderately and late preterm infants with CP. The majority of children had bilateral spastic CP and white matter lesions in neuroimaging. GMFCS levels were comparable in both subgroups while BFMF was worse in late preterm infants with a history of N-ICU admission and ventilator support.

PMID: [33643206](#)

26. Perinatal Stroke: A Practical Approach to Diagnosis and Management

Ratika Srivastava, Adam Kirton

Neoreviews. 2021 Mar;22(3):e163-e176. doi: 10.1542/neo.22-3-e163.

Perinatal stroke is a focal vascular brain injury that occurs from the fetal period to 28 days of postnatal age. With an overall incidence of up to 1 in 1,000 live births, the most focused lifetime risk for stroke occurs near birth. Perinatal stroke can be classified by the timing of diagnosis, vessel involvement, and type of injury. Timing of diagnosis may be in the acute neonatal period or retrospectively after a period of normal development, followed by abnormal neurologic findings, with the injury presumed to have occurred around the time of birth. Strokes may be arterial or venous, ischemic, and/or hemorrhagic. Within these classifications, 6 perinatal stroke diseases are recognizable, based on clinical and radiographic features. Morbidity is high in perinatal stroke, because it accounts for most cases of hemiparetic cerebral palsy, with disability lasting a lifetime. Additional complications include disorders of sensation and vision, language delays, cognitive and learning deficits, epilepsy, and mental health consequences that affect the entire family. Advances in neonatal neurocritical care may afford opportunity to minimize brain injury and improve outcomes. In the chronic timeframe, progress made in neuroimaging and brain mapping is revealing the developmental plasticity that occurs, informing new avenues for neurorehabilitation. This review will summarize the diagnosis and management of each perinatal stroke disease, highlighting their similarities and distinctions and emphasizing a patient- and family-centered approach to management.

PMID: [33649089](#)

27. Conclusions and implications for early intervention

Regina T Harbourne

Adv Child Dev Behav. 2021;60:317-327. doi: 10.1016/bs.acdb.2020.10.001. Epub 2021 Jan 11.

Each chapter in this volume supports the assumption that the quantity and quality of sleep is an essential building block for the architecture of learning in early life. Diverse areas affected by sleep include language, motor skills, problem solving, and memory, which show greater improvements when adequate and healthy sleep pervades a child's routine. Studies described in this volume expand our understanding of the impact of sleep both for short term skill improvement and for long-term developmental gains. The interdisciplinary content of this volume brings practical and translational information regarding sleep and learning in young children, including those with special challenges, such as children with Down syndrome, Williams syndrome, attention deficits, or cerebral palsy. In this concluding chapter, key knowledge gaps will be described with an eye toward areas of study that could further build strategies that support early learning and suggest attention to the role of sleep to enhance the effects of early intervention for children with developmental challenges.

PMID: [33641799](#)

28. Experimental cerebral palsy causes microstructural brain damage in areas associated to motor deficits but no spatial memory impairments in the developing rat

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Brain Res. 2021 Feb 24;147389. doi: 10.1016/j.brainres.2021.147389. Online ahead of print.

Introduction: Cerebral palsy (CP) is the major cause of motor and cognitive impairments during childhood. CP can result from

direct or indirect structural injury to the developing brain. In this study, we aimed to describe brain damage and behavioural alterations during early adult life in a CP model using the combination of maternal inflammation, perinatal anoxia and postnatal sensorimotor restriction. Methods: Pregnant Wistar rats were injected intraperitoneally with 200µg/kg LPS at embryonic days E18 and E19. Between 3 to 6h after birth (postnatal day 0 - PND0), pups of both sexes were exposed to anoxia for 20min. From postnatal day 2 to 21, hindlimbs of animals were immobilized for 16h daily during their active phase. From PND40, locomotor and cognitive tests were performed using Rota-Rod, Ladder Walking and Morris water Maze. Ex-vivo MRI Diffusion Tensor Imaging (DTI) and Neurite Orientation Dispersion and Density Imaging (NODDI) were used to assess macro and microstructural damage and brain volume alterations induced by the model. Myelination and expression of neuronal, astroglial and microglial markers, as well as apoptotic cell death were evaluated by immunofluorescence. Results: CP animals showed decreased body weight, deficits in gross (rota-rod) and fine (ladder walking) motor tasks compared to Controls. No cognitive impairments were observed. Ex-vivo MRI showed decreased brain volumes and impaired microstructure in the cingulate gyrus and sensory cortex in CP brains. Histological analysis showed increased cell death, astrocytic reactivity and decreased thickness of the corpus callosum and altered myelination in CP animals. Hindlimb primary motor cortex analysis showed increased apoptosis in CP animals. Despite the increase in NeuN and GFAP, no differences between groups were observed as well as no co-localization with the apoptotic marker. However, an increase in Iba-1+ microglia with co-localization to cleaved caspase 3 was observed. Conclusion: Our results suggest that experimental CP induces long-term brain microstructural alterations in myelinated structures, cell death in the hindlimb primary motor cortex and locomotor impairments. Such new evidence of brain damage could help to better understand CP pathophysiological mechanisms and guide further research for neuroprotective and neurorehabilitative strategies for CP patients.

PMID: [33639200](#)