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Interventions and Management

1. Upper Limb Movement Measurement Systems for Cerebral Palsy: A Systematic Literature Review

Celia Francisco-Martínez, Juan Prado-Olivarez, José A Padilla-Medina, Javier Díaz-Carmona, Francisco J Pérez-Pinal, Alejandro I Barranco-Gutiérrez, Juan J Martínez-Nolasco

Review Sensors (Basel). 2021 Nov 26;21(23):7884. doi: 10.3390/s21237884.

Quantifying the quality of upper limb movements is fundamental to the therapeutic process of patients with cerebral palsy (CP). Several clinical methods are currently available to assess the upper limb range of motion (ROM) in children with CP. This paper focuses on identifying and describing available techniques for the quantitative assessment of the upper limb active range of motion (AROM) and kinematics in children with CP. Following the screening and exclusion of articles that did not meet the selection criteria, we analyzed 14 studies involving objective upper extremity assessments of the AROM and kinematics using optoelectronic devices, wearable sensors, and low-cost Kinect sensors in children with CP aged 4-18 years. An increase in the motor function of the upper extremity and an improvement in most of the daily tasks reviewed were reported. In the population of this study, the potential of wearable sensors and the Kinect sensor natural user interface as complementary devices for the quantitative evaluation of the upper extremity was evident. The Kinect sensor is a clinical assessment tool with a unique markerless motion capture system. Few authors had described the kinematic models and algorithms used to estimate their kinematic analysis in detail. However, the kinematic models in these studies varied from 4 to 10 segments. In addition, few authors had followed the joint assessment recommendations proposed by the International Society of Biomechanics (ISB). This review showed that three-dimensional analysis systems were used primarily for monitoring and evaluating spatiotemporal variables and kinematic parameters of upper limb movements. The results indicated that optoelectronic devices were the most commonly used systems. The joint assessment recommendations proposed by the ISB should be used because they are approved standards for human kinematic assessments. This review was registered in the PROSPERO database (CRD42021257211).

PMID: [34883885](#)

2. External validity of the Both Hands Assessment for evaluating bimanual performance in children with bilateral cerebral palsy

Ann-Kristin G Elvrum, Gøril Okkenhaug Johansen, Torstein Vik, Lena Krumlinde-Sundholm

Dev Med Child Neurol. 2021 Dec 14. doi: 10.1111/dmcn.15127. Online ahead of print.

Aim: To investigate the external validity of the Both Hands Assessment (BoHA), a new test evaluating bimanual performance in children with bilateral cerebral palsy (CP), by analysing its relationship to established measurements of hand function and self-care skills. **Method:** In this cross-sectional study, we recruited children with bilateral CP and manual ability

corresponding to Manual Ability Classification System (MACS) levels I to III attending three habilitation units in Norway. All participants completed the BoHA. Unimanual capacity was assessed using the Bimanual Fine Motor Function (BFMF) classification, the Box and Block Test (BBT), and the Melbourne Assessment 2 (MA2). Self-care skills were assessed with the Pediatric Evaluation of Disability Inventory (PEDI). Results: Thirty-nine children (19 males, 20 females; mean age 8y 2mo, SD 2y 8mo; age range 2y 8mo-12y 6mo) were included. Spearman's correlation coefficient (ρ) suggested high correlation between the BoHA and MACS ($p=0.89$; 95% confidence interval [CI] 0.79-0.94), BFMF classification ($p=0.84$; 95% CI 0.71-0.91), and BBT for the non-dominant ($p=0.85$; 95% CI 0.68-0.95) and dominant hand ($p=0.72$; 95% CI 0.53-0.85). The Spearman's ρ between the BoHA and the MA2 subscales varied between 0.48 and 0.83, while the PEDI's ρ was 0.51 (95% CI 0.33-0.67). Interpretation: The BoHA provides valid measures of hand use as suggested by its high correlation with other activity-based measures of hand function.

PMID: [34907525](#)

3. 2D Ultrasound Validation to Assess the Accuracy of Hip Displacement Measurement: A Phantom Study

Thanh-Tu Pham, Thanh-Giang La, Lawrence H Le, John Andersen, Edmond Lou

Ann Int Conf IEEE Eng Med Biol Soc. 2021 Nov;2021:3173-3176. doi: 10.1109/EMBC46164.2021.9630476.

Hip displacement is a common orthopedic abnormality in children with cerebral palsy and is assessed on anteroposterior pelvic radiographs during surveillance. Repeated exposure to ionizing radiation is a major concern of cancer risks for children. Ultrasound (US) has been proposed to image the hips. The severity of hip displacement is measured by the Reimers' migration percentage (MP), which is calculated by the ratio of the femoral head distance from the acetabulum to the width of the femoral head. Methods have been published to estimate MP from the US hip images in literature; however, validation for accuracy has not been reported. This study aimed to determine the accuracy of the 2D ultrasound techniques using two 3D printed hip phantoms with known MP values. The MPs estimated from the US images were compared with those measured from the X-ray images. Based on the experimental results, the US measurements had a maximum absolute discrepancy of 2.2% as compared to 9.8% from the X-ray measurements for the MP. The study on phantoms has showed the proposed US approach is promising with better accuracy and without ionizing radiation. Clinical Relevance - If the accuracy is proved to be at least as good as the current X-ray gold standard, the proposed US method will provide a modality of choice to pediatric patients for hip displacement diagnostics and hip surveillance, especially those with cerebral palsy. The method will be free of ionizing radiation and therefore significantly improve the pediatric patient care.

PMID: [34891915](#)

4. Outcome of Gastrocnemius Soleus Facial Lengthening in Ambulatory Patients With Cerebral Palsy

Alan K Stotts, Kristen L Carroll, Emma Natz, Bruce A MacWilliams

J Pediatr Orthop. 2022 Jan 1;42(1):e65-e71. doi: 10.1097/BPO.0000000000001972.

Background: Treatment of equinus contractures in children with cerebral palsy (CP) varies across centers. Existing literature utilizes mixed study populations with a variety of procedures. As such, there is limited knowledge regarding recurrence rates and efficacy of a single procedure performed on a homogenous cohort. Here we retrospectively evaluate outcomes from gastrocnemius soleus fascial lengthenings (GSFL) performed at 2 centers with consistent approaches in both patient selection and operative technique. Methods: Subjects meeting inclusion criteria including CP diagnosis, ambulation status, and minimum follow-up criteria were identified. Revision rate was reported based on need for additional calf lengthening procedures. Functional outcomes were evaluated using physical exam measures and selected variables from computational gait analysis. Outcomes factors were identified by comparing revised subjects to unrevised. Longitudinal outcomes of index surgeries were assessed by comparing preoperative functional data to short-term, mid-term, and long-term data. Results: A total of 64 subjects with 87 limbs met inclusion criteria. In all, 25% of subjects and 21% of limbs went on to revision. Factors influencing revision were age at index surgery and gross motor function classification system (GMFCS) level. More than half of revised limbs had index surgery before age 7. Revision rates for subjects less than 7 were 44% compared with a 17% revision rate for ages 7 to 12, and a 4% revision rate on children older than 12. GMFCSIII subjects had significantly higher revision rates (43%) compared with GMFCSII (18%) and GMFCSI (11%) subjects. Ankle range of motion measures improved significantly with GSFL and most maintained improvements at all time periods. GSFL did not lead to significant calcaneal gait or crouch. Conclusions: This study evaluates long term efficacy of GSFL to address equinus in ambulatory children with CP. Overall revision rates are similar to previous reports for GSFL and other calf lengthening procedures. This information may be useful in setting

expectations and counselling families. Younger subjects and those with more severe involvement are more likely to need revision surgery, with these factors compounding the likelihood in the younger GMFCSIII child. Level of evidence: Level III-retrospective comparative study.

PMID: [34889835](#)

5. Combined effect of hydrotherapy and transcranial direct-current stimulation on children with cerebral palsy: A protocol for a randomized controlled trial

Xiao-Liang Chen, Li-Ping Yu, Ying Zhu, Tie-Yan Wang, Jing Han, Xiao-Yan Chen, Jia-He Zhang, Jia-Li Huang, Xiao-Ling Qian, Bo Wang

Medicine (Baltimore). 2021 Dec 10;100(49):e27962. doi: 10.1097/MD.00000000000027962.

Background: Cerebral palsy (CP) is a neurodevelopmental disorder caused by a brain injury resulting in poor coordination and motor control deficits, which is one of the most common physical disabilities in children. CP brings a heavy burden on families and society and becomes a significant public health issue. In recent years, hydrotherapy, and transcranial direct current stimulation (tDCS) as a physical therapy for CP is developing rapidly. When hydrotherapy and tDCS are used to treat separately, it has positive therapeutic effect in children with CP. The development of new therapies in combination with physical rehabilitation approaches is critical to optimize functional outcomes. tDCS has attracted interest in this context, because of significant functional improvements have been demonstrated in individuals with brain injuries after a short period of cerebral stimulation. Since the onset of this work, tDCS has been used in combination with constraint-induced therapy, virtual reality therapy to potentiate the treatment effect. Up to now, there are no studies on the effect of a combined application of hydrotherapy and tDCS in children with CP. We will conduct a 2-arm parallel clinical trial to investigate the effect of a combined application of tDCS and hydrotherapy. **Methods and analysis:** This study is an outcome assessor and data analyst-blinded, randomized, controlled superiority trial during the period from October 2021 to December 2023. CP patients meeting the inclusion criteria will be allocated in a 1:1 ratio into the treatment group (hydrotherapy plus tDCS), or the control group (treatment as usual). All participants will receive 30 sessions of treatment over 10 weeks. The primary outcomes will be the difference in the Gross Motor Function Assessment and Pediatric Balance Scale during rest and activity. The secondary outcomes will be the difference in adverse effects between the control and treatment groups. **Conclusions:** This study aims to estimate the efficacy of a combined application of tDCS and hydrotherapy in patients with CP. **Trial registration:** This study protocol was registered in Chinese ClinicalTrials.gov, ID: ChiCTR2100047946.

PMID: [34889241](#)

6. Critically appraised paper: A task-specific sit-to-stand training program for children with cerebral palsy improves mobility and self-care function [synopsis]

Alicia Spittle

J Physiother. 2021 Dec 8;S1836-9553(21)00117-X. doi: 10.1016/j.jphys.2021.10.002. Online ahead of print.

PMID: [34895875](#)

7. Critically appraised paper: A task-specific sit-to-stand training program for children with cerebral palsy improves mobility and self-care function [commentary]

Rachel Toovey

J Physiother. 2021 Dec 8;S1836-9553(21)00116-8. doi: 10.1016/j.jphys.2021.10.001. Online ahead of print.

PMID: [34895880](#)

8. Dysphagia rehabilitation following acquired brain injury, including cerebral palsy, across the lifespan: a scoping review protocol

Rhiannon Halfpenny, Alexandra Stewart, Paula Kelly, Eleanor Conway, Christina Smith

Syst Rev. 2021 Dec 13;10(1):312. doi: 10.1186/s13643-021-01861-9.

Background: Swallowing impairment (dysphagia) following brain injury can lead to life-threatening complications such as dehydration, aspiration pneumonia and acute choking episodes. In adult therapeutic practice, there is research and clinical evidence to support the use of swallowing exercises to improve swallowing physiology in dysphagia; however, the use of these exercises in treating children with dysphagia is largely unexplored. Fundamental questions remain regarding the feasibility and effectiveness of using swallowing exercises with children. This review aims to outline the published literature on exercise-based treatment methods used in the rehabilitation of dysphagia secondary to an acquired brain injury across the lifespan. This will allow the range and effects of interventions utilised to be mapped alongside differential practices between adult and child populations to be formally documented, providing the potential for discussions with clinicians about which rehabilitative interventions might be appropriate for further trial in paediatrics. **Methods:** This study will use a scoping review framework to identify and systematically review the existing literature using Joanna Briggs Institute (JBI) and Preferred Reporting Items for Systematic Reviews (PRISMA) scoping review guidelines. Electronic databases (MEDLINE, PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL) and Allied and Complementary Medicine Database (AMED)), grey literature and the reference lists of key texts including systematic reviews will be searched. Information about the rehabilitation design, dosage and intensity of exercise programmes used as well as demographic information such as the age of participants and aetiology of dysphagia will be extracted. The number of articles in each area and the type of data source will be presented in a written and visual format. Comparison between the literature in adult and child populations will be discussed. **Discussion:** This review is unique as it directly compares dysphagia rehabilitation in adults with that of a paediatric population in order to formally identify and discuss the therapeutic gaps in child dysphagia rehabilitation. The results will inform the next stage of research, looking into the current UK-based speech and language therapy practices when working with children with acquired dysphagia. Systematic review registration: Open science framework osf.io/ja4dr.

PMID: [34903269](https://pubmed.ncbi.nlm.nih.gov/34903269/)

9. Orthodontic treatment of an adolescent with cerebral palsy - A case report

Chhatwani Sachin, Johannsen Eva, Möhlhenrich Stephan Christian, Schulte Andreas Gerhard, Danesh Gholamreza, Schmidt Peter

Case Reports Spec Care Dentist. 2021 Dec 16. doi: 10.1111/scd.12688. Online ahead of print.

Cerebral palsy is a common cause of chronic motor neuron impairment. A constant prevalence of 2 to 3/1000 births in industrialized countries has been described. This case report describes the treatment of a 9 year old boy presenting this form of motor neuron impairment and class II malocclusion with an overjet of 14 mm, hyperdivergent growth pattern and various habits. Orthodontic treatment consisted mainly of a two-phase treatment. The first phase was treated with removable appliances and followed by a phase with fixed appliances. Treatment duration with removable appliances was 4 years and 5 months and for the fixed appliance phase, 1 year and 7 months. A class I occlusion could be achieved in this case by removable and fixed orthodontic appliances combined with adjunctive treatment for the hypotonic orofacial musculature.

PMID: [34914122](https://pubmed.ncbi.nlm.nih.gov/34914122/)

10. Gastrostomy feeding in children with severe cerebral palsy in Western Australia

Rachael Marpole, Katherine Langdon, Andrew Wilson

Acta Paediatr. 2021 Dec 14. doi: 10.1111/apa.16214. Online ahead of print.

PMID: [34905225](https://pubmed.ncbi.nlm.nih.gov/34905225/)

11. HeadUp: A Low-Cost Solution for Tracking Head Movement of Children with Cerebral Palsy Using IMU

Sana Sabah Al-Azzawi, Siavash Khaksar, Emad Khedhair Hadi, Himanshu Agrawal, Iain Murray

Sensors (Basel). 2021 Dec 6;21(23):8148. doi: 10.3390/s21238148.

Cerebral palsy (CP) is a common reason for human motor ability limitations caused before birth, through infancy or early childhood. Poor head control is one of the most important problems in children with level IV CP and level V CP, which can affect many aspects of children's lives. The current visual assessment method for measuring head control ability and cervical range of motion (CROM) lacks accuracy and reliability. In this paper, a HeadUp system that is based on a low-cost, 9-axis, inertial measurement unit (IMU) is proposed to capture and evaluate the head control ability for children with CP. The proposed system wirelessly measures CROM in frontal, sagittal, and transverse planes during ordinary life activities. The system is designed to provide real-time, bidirectional communication with an Euler-based, sensor fusion algorithm (SFA) to estimate the head orientation and its control ability tracking. The experimental results for the proposed SFA show high accuracy in noise reduction with faster system response. The system is clinically tested on five typically developing children and five children with CP (age range: 2-5 years). The proposed HeadUp system can be implemented as a head control trainer in an entertaining way to motivate the child with CP to keep their head up.

PMID: [34884148](#)

12. Design and Implementation of an Instrumented Data Glove that measures Kinematics and Dynamics of Human Hand

Martin Burns, Rachel Rosa, Zamin Akmal, Joseph Conway, Dingyi Pei, Emily King, Nilanjan Banerjee, Ramana Vinjamuri

Annu Int Conf IEEE Eng Med Biol Soc. 2021 Nov;2021:7229-7232. doi: 10.1109/EMBC46164.2021.9630204.

Human hands are versatile biomechanical architectures that can perform simple movements such as grasping to complicated movements such as playing a musical instrument. Such extremely dependable and useful parts of the human body can be debilitated due to movement disorders such as Parkinson's disease, stroke, spinal cord injury, multiple sclerosis and cerebral palsy. In such cases, precisely measuring the residual or abnormal hand function becomes a critical assessment to help clinicians and physical therapists in diagnosis, treatment and in prescribing appropriate prosthetics or rehabilitation therapies. The current methodologies used to measure abnormal or residual hand function are either paperbased scales that are prone to human error or expensive motion tracking systems. The cost and complexity restrict the usability of these methods in clinical environments. In this paper we present a low-cost instrumented glove that can measure kinematics and dynamics of human hand, by leveraging the recent advances in 3D printing technologies and flexible sensors.

PMID: [34892767](#)

13. Wearable Lower-Limb Exoskeleton for Children with Cerebral Palsy: A Systematic Review of Mechanical Design, Actuation Type, Control Strategy, and Clinical Evaluation

Mohammadhadi Sarajchi, Mohamad Kenan Al-Hares, Konstantinos Sirlantzis

IEEE Trans Neural Syst Rehabil Eng. 2021 Dec 15;PP. doi: 10.1109/TNSRE.2021.3136088. Online ahead of print.

Children with a neurological disorder such as cerebral palsy (CP) severely suffer from a reduced quality of life because of decreasing independence and mobility. Although there is no cure yet, a lower-limb exoskeleton (LLE) has considerable potential to help these children experience better mobility during overground walking. The research in wearable exoskeletons for children with CP is still at an early stage. This paper shows that the number of published papers on LLEs assisting children with CP has significantly increased in recent years; however, no research has been carried out to review these studies systematically. To fill up this research gap, a systematic review from a technical and clinical perspective has been conducted, based on the PRISMA guidelines, under three extended topics associated with "lower limb", "exoskeleton", and "cerebral palsy" in the databases Scopus and Web of Science. After applying several exclusion criteria, seventeen articles focused on fifteen LLEs were included for careful consideration. These studies address some consistent positive evidence on the efficacy of LLEs in improving gait patterns in children with CP. Statistical findings show that knee exoskeletons, brushless DC motors, the hierarchy control architecture, and CP children with spastic diplegia are, respectively, the most common mechanical design,

actuator type, control strategy, and clinical characteristics for these LLEs. Clinical studies suggest ankle-foot orthosis as the primary medical solution for most CP gait patterns; nevertheless, only one motorized ankle exoskeleton has been developed. This paper shows that more research and contribution are needed to deal with open challenges in these LLEs.

PMID: [34910636](#)

14. ATLAS2030 Pediatric Gait Exoskeleton: Changes on Range of Motion, Strength and Spasticity in Children With Cerebral Palsy. A Case Series Study

Elena Delgado, Carlos Cumplido, Jaime Ramos, Elena Garcés, Gonzalo Puyuelo, Alberto Plaza, Mar Hernández, Alba Gutiérrez, Thomas Taverner, Marie André Destarac, Mercedes Martínez, Elena García

Front Pediatr. 2021 Nov 24;9:753226. doi: 10.3389/fped.2021.753226. eCollection 2021.

Background: Cerebral Palsy (CP), the most common motor disability in childhood, affects individual's motor skills, movement and posture. This results in limited activity and a low social participation. The ATLAS2030 exoskeleton is a pediatric device that enables gait rehabilitation for children with neurological or neuromuscular pathologies with gait pathology. **Purpose:** To study changes in relation to range of motion (ROM), strength and spasticity in children with CP after using the ATLAS2030 gait exoskeleton. **Methods and Participants:** Three children (mean age 8.0 ± 2.0), two girls and one boy, two of them with GMFCS IV and one with GMFCS III, received robot-assisted gait training (RAGT) with ATLAS2030 for one month. **Results:** The average time of exoskeleton use was 54.7 ± 10.4 min in all sessions, and all participants were able to perform all exercises. The strength of all muscle groups was increased after the 10 sessions for the participants assessed and the limited ROM in the sagittal plane (hip and knee extension and ankle dorsiflexion) decreased after the use of the exoskeleton compared to the initial state. Spasticity was reduced at the end of the sessions after the use of the exoskeleton compared to their initial state. **Conclusion:** The ROM, spasticity and strength were improved after RAGT with ATLAS2030 exoskeleton in these children with CP. However, further studies with larger samples should be carried out to confirm our findings.

PMID: [34900862](#)

15. The Effects of Over-Ground Robot-Assisted Gait Training for Children with Ataxic Cerebral Palsy: A Case Report

Myungeun Yoo, Jeong Hyeon Ahn, Eun Sook Park

Case Reports Sensors (Basel). 2021 Nov 26;21(23):7875. doi: 10.3390/s21237875.

Poor balance and ataxic gait are major impediments to independent living in ataxic cerebral palsy (CP). Robot assisted-gait training (RAGT) has been shown to improve the postural balance and gait function in children with CP. However, there is no report on the application of RAGT for children with ataxic CP. Here, we report two cases of children with ataxic CP who underwent over-ground RAGT along with conventional therapy for 4 weeks. Outcome measures including the gross motor function measure (GMFM), pediatric balance scale, pediatric reach scale, one-minute walk test, and Timed Up and Go test were assessed before and after the 4-week intervention. Both cases were well adapted to the RAGT system without any significant adverse event. Improvements in the GMFM after RAGT, compared with that in the GMFM, after intensive conventional therapy have been reported previously. It is noteworthy that over-ground RAGT improved areas of the GMFM that did not improve with conventional therapy. In addition, over-ground RAGT with conventional therapy led to improvements in functional balance and walking capacity. These findings suggest that over-ground RAGT is feasible and may be a potential option for enhancing balance and functional walking capacity in children with ataxic CP.

PMID: [34883877](#)

16. SSVEP based Wheelchair Navigation in Outdoor Environments

M Krana, C Farmaki, M Pediaditis, V Sakkalis

Annu Int Conf IEEE Eng Med Biol Soc. 2021 Nov;2021:6424-6427. doi: 10.1109/EMBC46164.2021.9629516.

A promising application of Brain Computer Interfaces (BCIs), and in particular of Steady-State Visually Evoked Potentials (SSVEP) is wheelchair navigation which can facilitate the daily life of patients suffering from severe paralysis. However, the outdoor performance of such a system is highly affected by uncontrolled environmental factors. In this paper, we present an SSVEP-based wheelchair navigation system and propose incremental learning as a method of adapting the system to changing environmental conditions.

PMID: [34892582](#)

17. Unlocking Independence: Exploring Movement with Brain-Computer Interface for Children with Severe Physical Disabilities

Erica D Floreani, Danette Rowley, Nadia Khan, Dion Kelly, Ion Robu, Adam Kirton, Eli Kinney-Lang

Annu Int Conf IEEE Eng Med Biol Soc. 2021 Nov;2021:5864-5867. doi: 10.1109/EMBC46164.2021.9630578.

Children with severe physical disabilities are often unable to independently explore their environments, further contributing to complex developmental delays. Brain-computer interfaces (BCIs) could be a novel access method to power mobility for children who struggle to use existing alternate access technologies, allowing them to reap the developmental, social, and psychological benefits of independent mobility. In this pilot study we demonstrated that children with quadriplegic cerebral palsy can use a simple BCI system to explore movement with a power mobility device. Four children were able to use the BCI to drive forward at least 7m, although more practice is needed to achieve more efficient driving skills through sustained BCI activations.

PMID: [34892453](#)

18. Differentiating Motor Coordination in Children with Cerebral Palsy and Typically Developing Populations Through Exploratory Factor Analysis of Robotic Assessments

Stephan C D Dobri, Dawa Samdup, Stephen H Scott, T Claire Davies

Annu Int Conf IEEE Eng Med Biol Soc. 2021 Nov;2021:5936-5939. doi: 10.1109/EMBC46164.2021.9630740.

General motor and executive functions are integral for tasks of daily living and are typically assessed when quantifying impairment of an individual. Robotic tasks offer highly repeatable and objective measures of motor and cognitive function. Additionally, robotic tasks and measures have been used successfully to quantify impairment of children with cerebral palsy (CP). Many robotic tasks include multiple performance parameters, so interpretation of results and identification of impairment can be difficult, especially when multiple tasks are completed. This study used exploratory factor analysis to investigate a potential set of quantitative models of motor and cognitive function in children, and compare performance of participants with CP to these models. The three calculated factors achieved strong differentiation between participants with mild CP and the typically developing population. This demonstrates the feasibility of these factors to quantify impairment and track improvements related to therapies. Clinical Relevance- This establishes a method to differentiate atypical motor performance related to CP using a robotic reversed visually guided reaching task.

PMID: [34892470](#)

19. Correction: Incidence of invasive Group B Streptococcal infection and the risk of infant death and cerebral palsy: a Norwegian Cohort Study

Maren Mynarek, Solveig Bjellmo, Stian Lydersen, Jan E Afset, Guro L Andersen, Torstein Vik

Published Erratum *Pediatr Res*. 2021 Dec 9. doi: 10.1038/s41390-021-01887-8. Online ahead of print.

PMID: [34887527](#)

20. Clinical Phenotype of Cerebral Palsy Depends on the Cause: Is It Really Cerebral Palsy? A Retrospective Study

Charlotte Metz, Monika Jaster, Elisabeth Walch, Akosua Sarpong-Bengelsdorf, Angela M Kaindl, Joanna Schneider

J Child Neurol. 2021 Dec 13;8830738211059686. doi: 10.1177/08830738211059686. Online ahead of print.

Cerebral palsy is the most common motor disability in childhood. Still, the precise definition in terms of causes and timing of the brain damage remains controversial. Several studies examine the clinical phenotype of cerebral palsy types. The aim of our study was to determine to what extent the clinical phenotype of cerebral palsy patients depends on the underlying cause. We retrospectively evaluated the clinical phenotype, abnormalities during pregnancy, and cerebral palsy cause of 384 patients, treated at Charité-Medicine University, between 2015 and 2017. The cause of cerebral palsy was identified in 79.9% of cases. Causes prior to the perinatal period were, compared to perinatal brain damage, associated significantly with different comorbidities. The term cerebral palsy does not describe a single disease but is an umbrella term covering many different diseases. Depending on the cause, a varying clinical phenotype can be found, which offers great potential in terms of individual treatment and preventing comorbidities.

PMID: [34898314](#)**21. Clinical analysis of 33 cases with neonatal cerebral infarction**

Ning Yang, Xiaojun He, Cuixia Yin, Lihua Zhao

Pak J Med Sci. Nov-Dec 2021;37(7):1800-1807. doi: 10.12669/pjms.37.7.4720.

Objective: To investigate the etiology, clinical manifestations, diagnosis, treatment and prognosis of neonatal cerebral infarction (NCI) to further improve the understanding of the disease. **Methods:** Clinical data and follow-up results of 33 cases of NCI in neonatal intensive care unit of a first-class hospital from September 2009 to September 2019 were retrospectively analyzed. **Results:** All 33 patients were diagnosed with NCI by MRI. Among them, 31 cases (93.94%) were full-term infants, 25 cases (75.76%) were mother's first birth, and 18 (54.55%) cases were males. Pregnancy complications were reported in 18 cases (54.55%), and 19 cases (57.58%) had perinatal hypoxia history. Seizures were the most common first symptom and clinical manifestation in the course of disease (81.8%). There were 27 cases (81.82%) of patent foramen ovale (PFO) among NCI cohort. Ischemic cerebral infarction occurred in 32 cases (96.97%). The middle cerebral artery and its branches were more frequently involved, mainly on the left side. The acute stage of NCI was managed by symptomatic support treatment, and the recovery stage involved mainly rehabilitation treatment. Among the 33 cases, five cases were lost to follow-up, two patients died, 26 patients survived without complications, one case had cerebral palsy, one case had language retardation, and six cases had dyskinesia. Poor prognosis was associated with the involvement of deep gray matter nuclei or multiple lobes, and intrapartum complications. Vaginal mode of delivery and longer hospital stay were associated with better prognosis. **Conclusions:** Complications leading to placental circulation disorder during pregnancy and perinatal hypoxia are common high-risk factors of NCI. The seizure is the most common clinical manifestation. There is a possible correlation between PFO and NCI. Involvement of deep gray matter or multiple lobes and intrapartum complications may indicate poor prognosis, while vaginal delivery and prolonged hospitalizations are associated with better prognosis of NCI.

PMID: [34912398](#)**22. Probiotics for preventing and treating infant regurgitation: A systematic review and meta-analysis**

Jann P Foster, Hannah G Dahlen, Sabina Fijan, Nadia Badawi, Virginia Schmied, Charlene Thornton, Caroline Smith, Kim Psaila

Review Matern Child Nutr. 2021 Dec 15;e13290. doi: 10.1111/mcn.13290. Online ahead of print.

Infant regurgitation is common during infancy and can cause substantial parental distress. Regurgitation can lead to parental perception that their infant is in pain. Parents often present in general practitioner surgeries, community baby clinics and accident and emergency departments which can lead to financial burden on parents and the health care system. Probiotics are increasingly reported to have therapeutic effects for preventing and treating infant regurgitation. The objective of this systematic review and meta-analysis was to evaluate the efficacy of probiotic supplementation for the prevention and treatment of infant regurgitation. Literature searches were conducted using MEDLINE, CINAHL, and the Cochrane Central Register of

Controlled trials. Only randomised controlled trials (RCTs) were included. A meta-analysis was performed using the Cochrane Collaboration methodology where possible. Six RCTs examined the prevention or treatment with probiotics on infant regurgitation. A meta-analysis of three studies showed a statistically significant reduction in regurgitation episodes for the probiotic group compared to the placebo group (mean difference [MD]: -1.79 episodes/day; 95% confidence interval [CI]: -3.30 to -0.27, N = 560), but there was high heterogeneity (96%). Meta-analysis of two studies found a statistically significant increased number of stools per day in the probiotic group compared to the placebo group at 1 month of age (MD: 1.36, 95% CI: 0.99 to 1.73, N = 488), with moderate heterogeneity (69%). Meta-analysis of two studies showed no statistical difference in body weight between the two groups (MD: -91.88 g, 95% CI: 258.40-74.63; I² = 23%, N = 112) with minimal heterogeneity 23%. Probiotic therapy appears promising for infant regurgitation with some evidence of benefit, but most studies are small and there was relatively high heterogeneity. The use of probiotics could potentially be a noninvasive, safe, cost effective, and preventative positive health strategy for both women and their babies. Further robust, well controlled RCTs examining the effect of probiotics for infant regurgitation are warranted.

PMID: [34908230](#)

23. Parental voice - what outcomes of preterm birth matter most to families?

Thuy Mai Luu, Rebecca Pearce

Semin Perinatol. 2021 Nov 11;151550. doi: 10.1016/j.semperi.2021.151550. Online ahead of print.

Neonatal follow-up studies traditionally report on long-term neurodevelopmental outcomes as a metric of success of neonatal intensive care. Research endpoints are also typically deficit-based, assessing whether disabilities, such as cerebral palsy, cognitive impairment, deafness or blindness, are present or not. These historical approaches have resulted in neonatal follow-up programs that narrowly focus on the early identification of neurodevelopmental problems, possibly to the detriment of other outcomes that matter to parents. This focus on neurodevelopmental disability may also contribute to the negative stereotypes associated with extreme preterm birth. In this article, we discuss parental perspectives regarding important long-term outcomes. We examine limitations with current definitions of outcomes and propose a strength-based approach to generate meaningful findings both for clinicians and families.

PMID: [34887109](#)

24. Life expectancy and its adjustment in cerebral palsy with severe impairment: are we doing this right?

Mark Rosenthal

Review Dev Med Child Neurol. 2021 Dec 12. doi: 10.1111/dmcn.15120. Online ahead of print.

In children with very severe cerebral palsy, an adversarial legal process for medical negligence, when liability is admitted, requires an estimate of life expectancy. Medical experts using the same cohort data and the same clinical facts can produce quite different life expectancies, leading to arguments in legal conferences and courts. The issues that commonly arise include between-country comparisons, projected and therapy-induced advanced life expectancies, and the contribution of epilepsy, scoliosis, and especially cognition to life expectancy. In this review, these factors are discussed from an arithmetic, statistical, and medical viewpoint to initiate debate on the issue, including whether median survival should be advocated.

PMID: [34897672](#)

25. The Effects of tDCS with NDT on the Improvement of Motor Development in Cerebral Palsy

Jhosedyn Carolaym Salazar Fajardo, RockHyun Kim, Chang Gao, JiYeon Hong, JinKyu Yang, DongGil Wang, BumChul Yoon

J Mot Behav. 2021 Dec 16;1-10. doi: 10.1080/00222895.2021.2016572. Online ahead of print.

We investigated the effects of transcranial direct current stimulation (tDCS) over the primary motor cortex (M1) with neurodevelopmental treatment (NDT) on the improvement of motor development and reduction of spasticity in children with cerebral palsy (CP). Twenty-four children with CP were allocated to two groups: the tDCS + NDT group and the only NDT group, done 3 times per week for 5 weeks. The Gross Motor Function Measurement (GMFM-88) and Box and Block Test (BBT) were used to assess changes in motor development, and the Modified Ashworth Scale (MAS) was used to evaluate changes in spasticity. All measurements were carried out at 3 time points: baseline, post-intervention, and 1 month follow-up. We found improvements in the GMFM-88 total scores and in each individual GMFM-88 dimension scores, favoring the tDCS + NDT group over the only NDT group. The BBT scores improved only in the tDCS + NDT group. In addition, the MAS scores reduced in the hemibody with significant motor impairment only in the tDCS + NDT group. The present findings suggest that tDCS combined with NDT can be considered a promising intervention for children with CP, as it can enhance motor development and reduce spasticity in this population.

PMID: [34913842](#)

26. Telerehabilitation during Covid-19 lockdown and gross motor function in cerebral palsy: an observational study

Martina Cristinziano, Carla Assenza, Clementina Antenore, Leonardo Pellicciari, Calogero Foti, Daniela Morelli

Eur J Phys Rehabil Med. 2021 Dec 16. doi: 10.23736/S1973-9087.21.07132-X. Online ahead of print.

Background: COVID-19 (Coronavirus Disease-2019) refers to a mainly respiratory disease, caused by a new SARS-CoV-2 virus predominantly transmitted through direct or indirect contact with mucous membranes of eyes, mouth, or nose. The main control measures are physical distancing, use of specific protective devices, hand hygiene and disinfection of environments and tools. During this health emergency, telemedicine and telerehabilitation guaranteed patients to receive continuity of care through a virtual support while maintaining physical distance. **Aim:** The aim of this study is to evaluate the effects of telerehabilitation on gross motor skills in children with Cerebral Palsy (CP) during Covid-19 lockdown. **Design:** observational study. **Setting:** Pediatric Outpatient Neurorehabilitation Service. **Population:** 53 children with Cerebral Palsy aged between 6 months and 12 years classified according to the Gross Motor Function Classification System (GMFCS). **Methods:** variation on the Gross Motor Function Measure-66 (GMFM-66) score calculated before and after the telerehabilitation period was analyzed. **Results:** after telerehabilitation there was a statistically significant increase in the median value of GMFM scores both on the total sample (from 54.82% to 63.18%, p-value 0.000005) and in the subgroups. Specifically, in children classified as level I and II at the GMFCS, this value increased more after the telerehabilitation period. Only the GMFCS level V group did not show statistically significant changes and only in two cases a decrease in the GMFM score after the telerehabilitation phase occurred. **Conclusions:** telerehabilitation can be considered an efficient tool that can temporarily replace the in person therapy. It can allow the patient or caregiver to acquire skills in performing home exercises and to integrate and implement activity carried out at the rehabilitation center. **Clinical rehabilitation impact:** this study shows a positive effect of telerehabilitation on gross motor function in children with cerebral palsy.

PMID: [34913329](#)

27. Co-Design of a Neurodevelopment Assessment Scale: A Study Protocol

Anne Masi, Syeda Ishra Azim, Christa Lam-Cassettari, Mark Dadds, Antonio Mendoza Diaz, Georgina Henry, Lisa Karlov, Ping-I Lin, Kylie-Ann Mallitt, Alicia Montgomery, Iva Strnadová, Andrew Whitehouse, Valsamma Eapen

Int J Environ Res Public Health. 2021 Dec 6;18(23):12837. doi: 10.3390/ijerph182312837.

Neurodevelopmental disorders are a heterogeneous group of conditions with overlapping symptomatology and fluctuating developmental trajectories that transcend current diagnostic categorisation. There is a need for validated screening instruments which dimensionally assess symptomatology from a holistic, transdiagnostic perspective. The primary aim is to co-design a Neurodevelopment Assessment Scale (NAS), a user-friendly transdiagnostic assessment inventory that systematically screens for all signs and symptoms commonly encountered in neurodevelopmental disorders. Our first objective is to undertake development of this tool, utilising co-design principles in partnership with stakeholders, including both those with lived experience of neurodevelopmental disorders and service providers. Our second objective is to evaluate the face validity, as well as the perceived utility, user-friendliness, suitability, and acceptability (i.e., 'social validity'), of the NAS from the perspective of parents/caregivers and adults with neurodevelopmental disorders, clinicians, and service providers. Our third objective is to ascertain the psychometric properties of the NAS, including content validity and convergent validity. The NAS will provide an efficient transdiagnostic tool for evaluating all relevant signs, symptoms, and the dimensional constructs that underpin

neurodevelopmental presentations. It is anticipated that this will maximise outcomes by enabling the delivery of personalised care tailored to an individual's unique profile in a holistic and efficient manner.

PMID: [34886563](#)

28. Caregiver Burden in Cerebral Palsy: Validity and Reliability of the Turkish Version of Caregiver Difficulties Scale

Emel Atar, Erdal Dilekçi, Tuğba Özsoy Ünübol, Nermin Gündüz, Murat Atar, Ayhan Aşkın

Child Care Health Dev. 2021 Dec 13. doi: 10.1111/cch.12947. Online ahead of print.

Background: This study aims to translate the Caregiver Difficulties Scale (CDS) into Turkish language and to reveal its reliability and validity in Turkish informal family caregivers of children with cerebral palsy (CP). **Methods:** This study included 130 participants (39.9 ± 7.8 years; range 24-58 years; 106 females and 24 males). Demographic properties of participants, relationship with the care recipient, income, caregiving time, CP type, and diseases of the child (e.g., epilepsy, hydrocephalus, and congenital heart disease) and the caregiver were recorded. The Caregiver Difficulties Scale (CDS), Caregiver Well-Being Scale (CWBS), World Health Organization Quality of Life (WHOQOL-BREF), and Beck Depression Inventory (BDI) were used for data collection. The internal consistency of the CDS was assessed using the calculation of Cronbach's alpha coefficient. A test-retest interval of 2-weeks was used to assess the reliability. The intercorrelation of variables was evaluated using the Spearman correlation coefficient. The receiver operating characteristic (ROC) analysis was performed to find the predictive power of CDS scores for depression. **Results:** A total of 130 family caregivers of children with CP completed the test/retest procedures. The Cronbach alpha coefficients were found as 0.878 for the test and 0.852 for the retest. Intraclass correlation coefficient (ICC) value was found between 0.83 and 0.90 for test-retest reliability of the CDS. In addition, the CDS showed a significantly strong correlation with CWBS-activities of living subscale and WHOQOL-BREF psychological, physical, and environment domains, as well as a significantly moderate correlation with CWBS basic needs subscale, BDI, and WHOQOL-BREF general health, and social domains. CDS score that are >46 resulted in a sensitivity of 81.48% and a specificity of 73.79% for moderate-severe depression. **Conclusion:** The Turkish version of the CDS is a valid and reliable measure for caregiver burden of family caregivers of children with CP.

PMID: [34904251](#)

29. Removing a Disabled Person from Her Treasured Independent Living

Katrina Hui, Samuel Law, Harold Braswell

Hastings Cent Rep. 2021 Nov;51(6):13-16. doi: 10.1002/hast.1304.

Ms. X is a person with cerebral palsy and schizophrenia. She has intractable bedsores that are a result of her immobility and to poor wound care related to her delusional thinking. Despite intensive community support, the wounds have worsened to the point that she has needed multiple hospitalizations to prevent systemic sepsis, a life-threatening condition. She is capable of placement decisions and wishes for independence at home but is incapable of making wound care decisions and does not appreciate that immediately returning home from the hospital, instead of going into a special care facility, would likely result in sepsis. The resulting dilemma about discharge planning highlights the complexity involved in weighing concerns around mental illness and capacity for treatment and placement of care. The extent of the care that is required and available in a community or health care system and the slow but relatively certain progression of the symptoms also make the decision challenging. Two commentaries take very different approaches in exploring the question whether Ms. X should be supported to go home or to a special care facility.

PMID: [34904735](#)

Prevention and Cure

30. Effects of delayed versus immediate umbilical cord clamping in reducing death or major disability at 2 years corrected age among very preterm infants (APTS): a multicentre, randomised clinical trial

Kristy P Robledo, William O Tarnow-Mordi, Ingrid Rieger, Preeti Suresh, Andrew Martin, Carbo Yeung, Alpana Ghadge, Helen G Liley, David Osborn, Jonathan Morris, Wendy Hague, Martin Kluckow, Kei Lui, Roger Soll, Melinda Cruz, Anthony Keech, Adrienne Kirby, John Simes

Lancet Child Adolesc Health. 2021 Dec 8;S2352-4642(21)00373-4. doi: 10.1016/S2352-4642(21)00373-4. Online ahead of print.

Background: Very preterm infants are at increased risk of adverse outcomes in early childhood. We assessed whether delayed clamping of the umbilical cord reduces mortality or major disability at 2 years in the APTS Childhood Follow Up Study. **Methods:** In this long-term follow-up analysis of the multicentre, randomised APTS trial in 25 centres in seven countries, infants (<30 weeks gestation) were randomly assigned before birth (1:1) to have clinicians aim to delay clamping for 60 s or more or clamp within 10 s of birth, both without cord milking. The primary outcome was death or major disability (cerebral palsy, severe visual loss, deafness requiring a hearing aid or cochlear implants, major language or speech problems, or cognitive delay) at 2 years corrected age, analysed in the intention-to-treat population. This trial is registered with the Australian and New Zealand Clinical Trials Registry (ACTRN12610000633088). **Findings:** Between Oct 21, 2009, and Jan 6, 2017, consent was obtained for follow-up for 1531 infants, of whom 767 were randomly assigned to delayed clamping and 764 to immediate clamping. 384 (25%) of 1531 infants were multiple births, 862 (56%) infants were male, and 505 (33%) were born before 27 weeks gestation. 564 (74%) of 767 infants assigned to delayed clamping and 726 (96%) of 764 infants assigned to immediate clamping received treatment that fully adhered to the protocol. Death or major disability was determined in 1419 (93%) infants and occurred in 204 (29%) of 709 infants who were assigned to delayed clamping versus 240 (34%) of 710 assigned to immediate clamping, (relative risk [RR]) 0·83, 95% CI 0·72-0·95; p=0·010). 60 (8%) of 725 infants in the delayed clamping group and 81 (11%) of 720 infants in the immediate clamping group died by 2 years of age (RR 0·70, 95% CI 0·52-0·95); among those who survived, major disability at 2 years occurred in 23% (144/627) versus 26% (159/603) of infants, respectively (RR 0·88, 0·74-1·04). **Interpretation:** Clamping the umbilical cord at least 60 s after birth reduced the risk of death or major disability at 2 years by 17%, reflecting a 30% reduction in relative mortality with no difference in major disability. **Funding:** Australian National Health and Medical Research Council.

PMID: [34895510](https://pubmed.ncbi.nlm.nih.gov/34895510/)