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## Interventions and Management

### 1. Characterization of Atypical Corticospinal Tract Microstructure and Hand Impairments in Early-Onset Hemiplegic Cerebral Palsy: Preliminary Findings

Alexandra Hruby, Divya Joshi, Julius P A Dewald, Carson Ingo

Annu Int Conf IEEE Eng Med Biol Soc. 2023 Jul:2023:1-4. doi: 10.1109/EMBC40787.2023.10340084.

Unilateral brain injuries occurring before at or shortly after full-term can result in hemiplegic cerebral palsy (HCP). HCP affects one side of the body and can be characterized in the hand with measures of weakness and a loss of independent hand control resulting in mirror movements. Hand impairment severity is extremely heterogeneous across individuals with HCP and the neural basis for this variability is unclear. We used diffusion MRI and tractography to investigate the relationship between structural morphology of the supraspinal corticospinal tract (CST) and the severity of two typical hand impairments experienced by individuals with HCP, grasp weakness and mirror movements. Results from nine children with HCP and eight children with typical development show that there is a significant hemispheric association between CST microstructure and hand impairment severity that may be explained by atypical development and fiber distribution of motor pathways. Further analysis in the non-lesioned (dominant) hemisphere shows significant differences for CST termination in the cortex between participants with HCP and those with typical development. These findings suggest that structural disparities at the cellular level in the seemingly unaffected hemisphere after early unilateral brain injury may be the cause of heterogeneous hand impairments seen in this population. Clinical Relevance- Quantitative measurement of the variability in hand function in individuals with HCP is necessary to represent the distinct impairments experienced by each person. Further understanding of the structural neural morphology underlying distal upper extremity motor deficits after early unilateral brain injury will help lead to the development of more specific targeted interventions that increase functional outcomes.

PMID: [38083210](#)

### 2. Clocks Are Ticking! Early Diagnosis, Early Interventions: A Commentary on Detecting Asymmetry of Upper Limb Activity with Accelerometry in Infants at Risk for Unilateral Spastic Cerebral Palsy

Isabelle Poitras

Phys Occup Ther Pediatr. 2023 Dec 11:1-3. doi: 10.1080/01942638.2024.2284071. Online ahead of print.

No abstract available

PMID: [38083845](#)

### 3. Self-care and hand function in preschool children with unilateral or bilateral cerebral palsy: A cross-sectional study

Hilde Bonden, Reidun Birgitta Jahnsen, Gunvor Lilleholt Klevberg

Child Care Health Dev. 2023 Dec 11. doi: 10.1111/cch.13208. Online ahead of print.

**Aims:** To describe self-care capabilities among children with cerebral palsy (CP) and explore associations between self-care and hand function for children with unilateral cerebral palsy (UCP) and children with bilateral cerebral palsy (BCP) separately. **Method:** Cross-sectional data on self-care capabilities (Pediatric Evaluation of Disability Inventory, PEDI), manual abilities (Manual Ability Classification System, MACS) and hand use during bimanual performance (Assisting Hand Assessment, AHA; Both Hands Assessment, BoHA) were retrieved from the Norwegian Quality and Surveillance Registry for Cerebral Palsy (NorCP). Eighty-seven children with CP (UCP,  $n = 61$ , mean age 4 years 1 month, SD 1 year 3 months, range 56) or BCP ( $n = 26$ , mean age 4 years 4 months, SD 1 year, range 41), classified at MACS level I ( $n = 26$ ), II ( $n = 40$ ) or III ( $n = 21$ ), were included. **Results:** No significant differences in self-care capabilities were found between children with UCP and children with BCP. Analysis of variance showed significant differences in self-care between MACS levels for the whole group. No significant differences in self-care between MACS levels were observed for children with UCP ( $p = 0.36$ ), but significant differences were found for those with BCP ( $p < 0.001$ ). Whereas a small correlation ( $r = 0.3$ ) between PEDI and AHA scores was found for children with UCP, a large correlation ( $r = 0.6$ ) was found for those with BCP. Children with BCP with symmetric hand use during bimanual performance (BoHA) had higher PEDI scores than children with asymmetric hand use. **Conclusion:** Though children with UCP and children with BCP who were classified at MACS I-III exhibited similar self-care capabilities, the limited hand use seems to contribute differently between the two groups. The two different measures of hand use exhibit different associations with self-care capabilities for young children with UCP and BCP, respectively, and illustrate the need to treat UCP and BCP as two distinct groups, each requiring tailored interventions according to their specific needs.

PMID: [38083836](#)

#### 4. Estimation of Height Using Body Weight and Segmental Measurements in Children with Cerebral Palsy

Samuel Olufemi Akodu FMCPaed, Tinuade Adetutu Ogunlesi Fmacp, Abiodun Folashade Adekanmbi

Iran J Child Neurol. 2023 Fall;17(4):71-81. doi: 10.22037/ijcn.v17i4.33321. Epub 2023 Oct 26.

**Objectives:** The current study aimed to determine the proxy measurements for height in children with Cerebral Palsy (CP). **Materials & methods:** In a cross-sectional descriptive study, the length/height of Nigerian children with CP was studied over eighteen months using descriptive statistics. The study subjects comprised children aged 15 months to 17 years with CP. Height/length, weight, arm span, forearm length, mid-upper arm circumference, foot length, head circumference, hip circumference, leg length, and tibia length were measured to the nearest 0.1 cm using standard procedures. The relations between segmental measurements and weight with height were investigated using linear regression. **Results:** A total of 31 children were studied. The correlation between height/length and other linear measurements has a significantly strong positive relationship. Regression analysis showed that when used singly, the weight and thigh length offered a high explanation for the height variability with little estimation error. On the other hand, weight had a lower mean difference between observed and predicted height (0.21 and -0.76, respectively), with thigh length overestimating the height. **Conclusion:** Weight measurement may be the preferred proxy for height in children with CP.

PMID: [38074938](#)

#### 5. Selective dorsal rhizotomy: Analysis of two rootlet sectioning techniques

Beatriz Mantese, Christian G Pirozzi Chiusa, Yamila Basilotta Marquez, María Pía Gotter Campo, Ricardo Nazar, Marcos Crespo, Alfredo Toledo, Emiliano Ravera

Childs Nerv Syst. 2023 Dec 13. doi: 10.1007/s00381-023-06247-x. Online ahead of print.

**Objective:** To analyze and compare the efficacy of two selective dorsal rhizotomy (SDR) techniques with intraoperative neurophysiological monitoring, using instrumented three-dimensional gait analysis. **Introduction:** SDR is a common, irreversible surgical treatment increasingly used to address gait disturbances in children with chronic non-progressive encephalopathy by reducing spasticity. Various techniques have been used, which mainly differ in the percentage of rootlets selected for sectioning. A greater proportion of rootlets sectioned leads to a more effective reduction of spasticity; however, there is a potential risk of unwanted neurological effects resulting from excessive deafferentation. While there is evidence of the short- and long-term benefits and complications of SDR, no studies have compared the effectiveness of each technique regarding gait function and preservation of the force-generating capacity of the muscles. **Materials and methods:** Instrumented three-dimensional gait analysis was used to evaluate two groups of patients with spastic cerebral palsy treated by the same neurosurgeon in different time periods, initially using a classic technique (cutting 50% of the nerve rootlets) and subsequently a conservative technique (cutting no more than 33% the nerve rootlets). **Results:** In addition to an increase in knee joint range of motion (ROM), in children who underwent SDR with the conservative technique, a statistically significant increase ( $p = 0.04$ ) in the net joint power developed by the ankle was observed. Patients who underwent SDR with the conservative technique developed a maximum net ankle joint power of  $1.37 \pm 0.61$  (unit: W/BW), whereas those who were operated with the classic technique developed a maximum net ankle joint power of  $0.98 \pm 0.18$  (unit: W/BW). The conservative group not only showed greater improvement in net ankle joint power but also demonstrated more significant enhancements in minimum knee flexion during the stance phase and knee extension at initial contact. **Conclusion:** Our results show that both techniques led to a reduction in spasticity with a positive impact on the gait pattern. In addition, patients treated with the conservative technique

were able to develop greater net ankle joint power, leading to a better scenario for rehabilitation and subsequent gait.

PMID: [38092980](#)

## **6. Design and Implementation of a Portable Knee Actuator for the Improvement of Crouch Gait in Children with Cerebral Palsy**

Jack Snodgrass, Shijun Yan, Hyosok Lim, Iram Hameeduddin, Ming Wu

Ann Int Conf IEEE Eng Med Biol Soc. 2023 Jul;2023:1-4. doi: 10.1109/EMBC40787.2023.10341076.

Common manifestation of spastic Cerebral Palsy (CP) are abnormal gait pathologies. These conditions require greater energy expenditure to successfully ambulate and are linked with significant deterioration in joint health and childhood musculoskeletal development. Crouch gait presents with knee hyperflexion throughout stance due to extensor muscle weakness and spasticity in flexor muscles stemming from neurological damage. The goal of this study was to develop a wearable cable-driven robotic system that applies controlled perturbation to the knee joint during overground walking in children with CP. Two children with spastic CP were recruited in this pilot study. They were tested in two conditions, i.e., applying knee resistance vs. knee assistance during overground walking. Kinematic and EMG data were recorded during overground walking. Data indicated that it was feasible to apply controlled knee perturbation torque during overground walking in children with crouch and preliminary results showed an improvement in crouch gait pattern in children with CP after one session of walking with the robotic system. Clinical Relevance- This study might have a potential clinical significance modifying neuromuscular control of CP patients with Crouch Gait.

PMID: [38082689](#)

## **7. Retracted: Effect of Hospital-Family Rehabilitation Intervention on Walking Function and Lower Limb Surface Electromyography in Children with Cerebral Palsy**

Computational And Mathematical Methods In Medicine

Retraction of Publication Comput Math Methods Med. 2023 Dec 6;2023:9786314. doi: 10.1155/2023/9786314. eCollection 2023.

[This retracts the article DOI: 10.1155/2022/7034670.].

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Retraction of

Effect of Hospital-Family Rehabilitation Intervention on Walking Function and Lower Limb Surface Electromyography in Children with Cerebral Palsy.

Wang J, Yue L, Chen Z, Bai B, Chen C.

Comput Math Methods Med. 2022 Jun 8;2022:7034670. doi: 10.1155/2022/7034670. eCollection 2022.

PMID: 35720026 Free PMC article. Retracted. Clinical Trial.

PMID: [38094409](#)

## **8. Patellar Tendon Rupture During Postoperative Physiotherapy for Crouch Gait: A Case Report**

Maulin M Shah, Santosh Raibagkar, Sheenam Bansal, Meet Jain, Godhasiri Ponugoti

Case Reports JBJS Case Connect. 2023 Dec 14;13(4). doi: 10.2106/JBJS.CC.23.00157. eCollection 2023 Oct 1.

Introduction: A 14-year-old adolescent girl with spastic diplegic cerebral palsy underwent bilateral distal femur extension osteotomy and patellar tendon plication. Two and a half months after surgery, during physiotherapy, she sustained mid-substance tear of the left patellar tendon. The girl was successfully managed with patellar tendon repair and augmentation with tensor fascia lata autograft. Conclusion: Patellar tendon rupture during rehabilitative physiotherapy after patellar tendon plication surgery is rare. Postoperative protocols in patients with cerebral palsy are crucial and should progress gradually to improve knee range of motion. This report highlights that patellar tendon repair with fascia lata augmentation yields good outcome.

PMID: [38096336](#)

## **9. Gait and sEMG characteristics of lower limbs in children with unilateral spastic cerebral palsy during walking**

Longfei Li, Lina Zhang, Hongxing Cui, Yixuan Zhao, Chuanhua Zhu, Qianqian Fan, Wei Li

Gait Posture. 2023 Dec 10;108:177-182. doi: 10.1016/j.gaitpost.2023.12.007. Online ahead of print.

**Background:** Children with unilateral spastic cerebral palsy (USCP) have muscle hypertonia, balance, and coordination defects that affect gross motor skills, especially walking. Understanding the gait characteristics and lower limb muscle activation patterns of USCP children can provide an objective and quantitative basis for patient assessment and treatment plan formulation. **Objective:** This study compared the gait and lower limb muscle activation characteristics of children with USCP and with typical development (TD) during walking. **Methods:** We recorded gait and sEMG data of 20 children with USCP, and 20 with typical development. sEMG signals were acquired from the bilateral tibialis anterior (TA) and lateral gastrocnemius muscles (LG) during walking. The root mean square (RMS) value, integrated electromyographic (iEMG) value and co-contraction ratio (CR) were used to evaluate muscle activity. Student's t Test and non-parametric rank sum Test were used to compare the differences between the data groups (significance level of 0.05). **Results:** The stance time, step length, speed, single leg support time ratio, ground impact, pre-swing angle, and muscle strength of the affected side were significantly decreased compared to those of the unaffected side in children with USCP ( $P < 0.05$ ), while the swing phase, muscle tonus of LG were significantly prolonged ( $P < 0.05$ ). Compared with TD children, children with USCP exhibited reduced bilateral walking ability, particularly noticeable in their smaller pre-swing angle ( $P < 0.05$ ), diminished muscle strength of the TA and LG, as well as LG spasms ( $P < 0.05$ ). **Significance:** Children with USCP have decreased ambulatory gait stability. Step length, pull acceleration, pre-swing angle, and CR can be used as sensitive indicators for gait assessment. Strengthening the TA muscle and reducing ankle spasm may help improve gait and postural stability in children with USCP.

PMID: [38100956](#)

## 10. Effect of psychostimulant medications on physical function in children with cerebral palsy: scoping review

Anwar B Almutairi, Naif Z Alrashdi, Laura Vogtle, Mansour M Alotaibi

Review Pediatr Res. 2023 Dec 9. doi: 10.1038/s41390-023-02933-3. Online ahead of print.

The aim of this scoping review is to examine the extent and depth of the literature on effects of central nervous system (CNS) stimulant medications on physical function in children with cerebral palsy (CP). A systematic search for relevant peer-reviewed studies was conducted of PubMed, CINAHL, Cochrane, SPORTDiscus, Embase, & Scopus (January 2002 & August 2022). We included studies that examined the effects of CNS stimulants on physical function in children with CP. Four studies met our selection criteria. All studies explored the effect of Modafinil on physical function outcomes. Three studies of the four included studies reported positive effects of Modafinil on spasticity, motor performance, and gait, whereas one study reported no significant effects of Modafinil. Our findings suggest that there is very low-quality evidence that suggests that Modafinil may enhance physical improvements in body structure and function, including reduction in spasticity and improvements in gait parameters. **IMPACT:** Central nervous system stimulants were examined for efficacy on physical function and spasticity in children with cerebral palsy. The evidence on the effects of central nervous system stimulants on physical function in children with CP is limited and inconsistent.

PMID: [38071277](#)

## 11. The Effectiveness of Physical Therapy Intervention in a Seven-Year-Old Child With Congenital Talipes Equinovarus: A Case Report

Spandan Munjewar, Kamyia J Somaiya, Manali A Boob, Pratik Phansopkar

Case Reports Cureus. 2023 Nov 7;15(11):e48423. doi: 10.7759/cureus.48423. eCollection 2023 Nov.

Congenital talipes equinovarus (CTEV), a prevalent congenital anomaly, is characterized by the backward bending of the hindfoot, the inward turning of the midfoot, and the turning or tilting of the front foot. The likelihood of experiencing clubfoot is higher in males and among firstborn offspring. Both genetic and environmental elements are recognized as factors that play a role in the occurrence of this developmental irregularity. It is diagnosed clinically because the abnormality has been visible since childhood, where one or both feet point downward and inward. If the deformity is not addressed, tarsal bones and joints will stiffen over time, further causing an inability to walk and stand, causing additional limb deformities. Late presentations are typical in less developed nations because of a lack of awareness, access to care, or a holdup in referral. We have a case of a seven-year-old spastic cerebral palsy (CP) male child with congenital talipes equinovarus. While assessing, we found visible deformities at the knee and ankle joints. Wedge osteotomy and Achilles tendon lengthening surgery were performed. Probably, extensive soft tissue surgery is the best option for treating clubfoot. A physical therapist may use stretching, proprioceptive neuromuscular facilitation (PNF), joint mobilization, and joint compression to enhance the foot's alignment, mobility, and range of motion (ROM) to keep the joint in the correct position. Physical therapy greatly reduced stiffness. The physiotherapy treatment plan we used was highly beneficial in enhancing the patient's quality of life, increasing his level of independence, and enhancing his participation in his activities of daily living (ADLs).

PMID: [38074009](#)

## 12. Bone health in children with severe cerebral palsy

Vincent Barbier, Vincent Goeb, Richard Gouron, Severine Fritot, Romuald Mentaverri, Céline Klein

Front Pediatr. 2023 Nov 29;11:1264111. doi: 10.3389/fped.2023.1264111. eCollection 2023.

**Aim:** To describe bone health and associated factors in children with severe cerebral palsy. **Method:** In a retrospective, single-centre study, we performed a comprehensive bone evaluation (including clinical, densitometric and bone biomarker assessments) of children with severe cerebral palsy. **Results:** None of the 19 included children had a normal BMCTBLH Z score, and only one had a BMDTBLH Z score greater than -2. Six children had a BMDLS Z score greater than -2. The bone biomarker data were suggestive of excessive bone remodelling. Levels of bone remodelling markers factors and densitometric variables were not significantly related. Age, weight and pubertal stage were significantly related to bone mass. **Discussion:** Our results highlights the insufficient increase in bone mass with age (probably due to excessive bone remodelling) and confirms the high prevalence of low bone mineral density in children with severe cerebral palsy. Possible preventive measures might include calcium + vitamin D supplementation and the systematic management of underweight and delayed puberty. Bone remodelling markers might be of value for follow-up.

PMID: [38094189](#)

## 13. Predictive value of General Movements Assessment for developmental delay at 18 months in children with complex congenital heart disease

Darlene C Huisenga, Sacha la Bastide-van Gemert, Andrew H Van Bergen, Jane K Sweeney, Mijna Hadders-Algra

Early Hum Dev. 2023 Dec 8;188:105916. doi: 10.1016/j.earlhumdev.2023.105916. Online ahead of print.

**Background:** Infants with complex congenital heart disease are at increased risk of impaired fetal brain growth, brain injury, and developmental impairments. The General Movement Assessment (GMA) is a valid and reliable tool to predict cerebral palsy (CP), especially in preterm infants. Predictive properties of the GMA in infants with complex congenital heart disease (CCHD) are unknown. **Aim:** To evaluate predictive properties of the GMA to predict developmental outcomes, including cerebral palsy (CP), at 18-months corrected age (CA) in children with CCHD undergoing heart surgery in the first month of life. **Methods:** A prospective cohort of 56 infants with CCHD (35 males, 21 females) was assessed with GMA at writhing age (0-6 weeks CA) and fidgety age (7-17 weeks CA) and the Bayley Scales of Infant Development at 18 months. GMA focused on markedly reduced GM-variation and complexity (definitely abnormal (DA) GM-complexity) and fidgety movements. Predictive values of GMA for specific cognitive, language and motor delay (composite scores <85th percentile) and general developmental delay (delay in all domains) were calculated at 18 months. **Results:** At fidgety age, all infants had fidgety movements and no child was diagnosed with CP. DA GM-complexity at fidgety age predicted general developmental delay at 18 months (71 % sensitivity, 90 % specificity), but predicted specific developmental delay less robustly. DA GM-complexity at writhing age did not predict developmental delay, nor did it improve prediction based on DA GM-complexity at fidgety age. **Conclusions:** In infants with CCHD and fidgety movements, DA GM-complexity at fidgety age predicted general developmental delay.

PMID: [38091843](#)

## 14. "Pain is one piece of a complex jigsaw puzzle" - experiences of raising a child with cerebral palsy who has pain

Elisabeth Rønning Rinde, Agneta Anderzén-Carlsson, Reidun Birgitta Jahnsen, Randi Dovland Andersen

Disabil Rehabil. 2023 Dec 9;1-9. doi: 10.1080/09638288.2023.2290199. Online ahead of print.

**Purpose:** To explore experiences of parenting a child with CP and pain. **Method:** Fourteen mothers and one father of children (9 -16) with CP were included. All children had pain regularly, but the frequency and intensity of their pain experiences varied. Their motor function varied from GMFCS level I to V. Cognitive abilities varied from normal to moderate cognitive deficits. All children could express themselves verbally. Semi structured individual interviews were carried out, and results were developed using inductive thematic analysis. **Results:** The analysis resulted in the main theme "My child's pain is just one piece of a complex jigsaw puzzle". The main theme was developed by four mutually exclusive, but related themes: "My child's struggle burdens me", "Pain and CP direct our everyday life", "I want to be in control, but cannot always be" and "We are the only ones who understand the complexity". **Conclusion:** Parents of children with CP experience pain as one aspect of a bigger picture. They need help and support to cope with their child's pain, and professional helpers need to address the complexity pain is a part of. **IMPLICATIONS FOR REHABILITATION** Parents of children with cerebral palsy (CP) experience their child's pain as one piece in a jigsaw puzzle, and counseling needs to address the complexity rather than the separate parts of the picture. Health professionals should support parents in evaluation and management of their child's pain, as a feeling of competence in pain management is important to reduce parental stress. Health professionals should inform themselves about the life situation of parents whose child with CP has pain, and encourage them to seek practical support and apply for relevant support schemes that can make their everyday life easier. Parents of children with CP should be encouraged to take part in a

diagnosis-specific support group, where they can meet with others in a similar situation, in order to reduce their feeling of being alone with their challenges.

PMID: [38069685](#)

### **15. Self-reported Vocal symptoms among speech language pathologists dealing with children with hearing impairment and cerebral palsy**

Shamsa Kanwal, Nazia Mumtaz

J Pak Med Assoc. 2023 Dec;73(12):2434-2437. doi: 10.47391/JPMA.8127.

A cross-sectional study was conducted at the Ripah International University, Lahore, Pakistan from January to April, 2022 to evaluate and compare the Self-Reported Vocal symptoms among Speech Language Pathologists (SLP) practicing with children having Hearing Impairment (HI) and Cerebral Palsy (CP). The sample included 141 participants of both genders, aged 25 to 60 years, practicing with children with hearing impairment and cerebral palsy for at least one year. Vocal Tract Discomfort Scale (VTDS) and Voice Activity Participation Profile (VAPP) were utilised for data collection which was analysed using SPSS Ver-23. The study revealed no significant association of self-perceived vocal symptoms for SLPs catering to CP and HI children with  $p=0.303$  and  $p=0.412$  for VTDS and VAPP scores respectively and with higher mean scores for SLPs catering to CP children. Results revealed a total VTDS score of  $40.26\pm 13.10$  with highest score for dryness, while highest VAPP mean score was noted for daily communication ( $53.82\pm 23.20$ ). Hence, there is no significant association of the speciality being catered to, while dryness is the commonest self-perceived symptom.

PMID: [38083926](#)

### **16. Data linkage and pain medication in people with cerebral palsy: A cross-sectional study**

No authors listed

Dev Med Child Neurol. 2023 Dec 14. doi: 10.1111/dmcn.15831. Online ahead of print.

No abstract available

PMID: [38098151](#)

### **17. Upper Limb Movement Execution Classification using Electroencephalography for Brain Computer Interface**

Saadat Ullah Khan, Muhammad Majid, Marius George Linguraru, Syed Muhammad Anwar

Annu Int Conf IEEE Eng Med Biol Soc. 2023 Jul:2023:1-4. doi: 10.1109/EMBC40787.2023.10341008.

An accurate classification of upper limb movements using electroencephalogram (EEG) signals is gaining significant importance in recent years due to the prevalence of brain-computer interfaces. The upper limbs in the human body are crucial since different skeletal segments combine to make a range of motions that helps us in our trivial daily tasks. Decoding EEG-based upper limb movements can be of great help to people with spinal cord injury (SCI) or other neuro-muscular diseases such as amyotrophic lateral sclerosis (ALS), primary lateral sclerosis, and periodic paralysis. This can manifest in a loss of sensory and motor function, which could make a person reliant on others to provide care in day-to-day activities. We can detect and classify upper limb movement activities, whether they be executed or imagined using an EEG-based brain-computer interface (BCI). Toward this goal, we focus our attention on decoding movement execution (ME) of the upper limb in this study. For this purpose, we utilize a publicly available EEG dataset that contains EEG signal recordings from fifteen subjects acquired using a 61-channel EEG device. We propose a method to classify four ME classes for different subjects using spectrograms of the EEG data through pre-trained deep learning (DL) models. Our proposed method of using EEG spectrograms for the classification of ME has shown significant results, where the highest average classification accuracy (for four ME classes) obtained is 87.36%, with one subject achieving the best classification accuracy of 97.03%. Clinical relevance- This research shows that movement execution of upper limbs is classified with significant accuracy by employing a spectrogram of the EEG signals and a pre-trained deep learning model which is fine-tuned for the downstream task.

PMID: [38082727](#)

### **18. Automated structuring of gait data for analysis purposes - A deep learning pilot example**

Eirik G Homlong, Rahul P Kumar, Ole Jakob Elle, Ola Wiig

Annu Int Conf IEEE Eng Med Biol Soc. 2023 Jul:2023:1-5. doi: 10.1109/EMBC40787.2023.10340938.

Clinical gait analysis can help diagnose ambulatory children with cerebral palsy and provide treatment recommendations. This group represents the largest group of children with gait problems. Currently, the workflow for 3D gait analysis involves a complex process of collecting motion capture data and other types of data, analyzing the collected data, and creating an expert knowledge-based assessment. With this in mind, a data pipeline is essential for efficiently and effectively structuring data and reducing the time and effort required for data annotation and organization. A novel data pipeline has been developed to help structure, anonymize and automate parts of the annotation process of the data. In this sense, a pilot experiment was conducted using a simple convolutional neural network to classify between hemi-plegic and diplegic gait. This experiment included preprocessing the data, training the model and testing it. The data pipeline was used to create a semi-automated annotated data set. The neural network was trained on the data set and achieved an accuracy of 0.78 and a median of 1.0 on a holdout test set.

PMID: [38083029](#)

### **19. Deep-Learning Markerless Tracking of Infant General Movements using Standard Video Recordings**

Hamid Abbasi, Sarah R Mollet, Sian A Williams, Lilian Lim, Malcolm R Battin, Thor F Besier, Angus J C McMorland

Annu Int Conf IEEE Eng Med Biol Soc. 2023 Jul:2023:1-4. doi: 10.1109/EMBC40787.2023.10340116.

Monitoring spontaneous General Movements (GM) of infants 6-20 weeks post-term age is a reliable tool to assess the quality of neurodevelopment in early infancy. Abnormal or absent GMs are reliable prognostic indicators of whether an infant is at risk of developing neurological impairments and disorders such as cerebral palsy (CP). Therapeutic interventions are most effective at improving neuromuscular outcomes if administered in early infancy. Current clinical protocols require trained assessors to rate videos of infant movements, a time-intensive task. This work proposes a simple, inexpensive, and broadly applicable markerless pose-estimation approach for automatic infant movement tracking using conventional video recordings from handheld devices (e.g., tablets and mobile phones). We leverage the enhanced capabilities of deep-learning technology in image processing to identify 12 anatomical locations (3 per limb) in each video frame, tracking a baby's natural movement throughout the recordings. We validate the capability of resnet152 and a mobile-net-v2-1 to identify body-parts in unseen frames from a full-term male infant, using a novel automatic unsupervised approach that fuses likelihood outputs of a Kalman filter and the deep-nets. Both deep-net models were found to perform very well in the identification of anatomical locations in the unseen data with high average Percentage of Correct Keypoints (aPCK) performances of >99.65% across all locations. Clinical relevance-Results of this research confirm the feasibility of a low-cost and publicly accessible technology to automatically track infants' GMs and diagnose those at higher risk of developing neurological conditions early, when clinical interventions are most effective.

PMID: [38083202](#)

### **20. Machine Learning to Classify Cardiotocography for Fetal Hypoxia Detection**

Farah Francis, Saturnino Luz, Honghan Wu, Rosemary Townsend, Sarah S Stock

Annu Int Conf IEEE Eng Med Biol Soc. 2023 Jul:2023:1-4. doi: 10.1109/EMBC40787.2023.10340803.

Fetal hypoxia can cause damaging consequences on babies' such as stillbirth and cerebral palsy. Cardiotocography (CTG) has been used to detect intrapartum fetal hypoxia during labor. It is a non-invasive machine that measures the fetal heart rate and uterine contractions. Visual CTG suffers inconsistencies in interpretations among clinicians that can delay interventions. Machine learning (ML) showed potential in classifying abnormal CTG, allowing automatic interpretation. In the absence of a gold standard, researchers used various surrogate biomarkers to classify CTG, where some were clinically irrelevant. We proposed using Apgar scores as the surrogate benchmark of babies' ability to recover from birth. Apgar scores measure newborns' ability to recover from active uterine contraction, which measures appearance, pulse, grimace, activity and respiration. The higher the Apgar score, the healthier the baby is. We employ signal processing methods to pre-process and extract validated features of 552 raw CTG. We also included CTG-specific characteristics as outlined in the NICE guidelines. We employed ML techniques using 22 features and measured performances between ML classifiers. While we found that ML can distinguish CTG with low Apgar scores, results for the lowest Apgar scores, which are rare in the dataset we used, would benefit from more CTG data for better performance. We need an external dataset to validate our model for generalizability to ensure that it does not overfit a specific population. Clinical Relevance- This study demonstrated the potential of using a clinically relevant benchmark for classifying CTG to allow automatic early detection of hypoxia to reduce decision-making time in maternity units.

PMID: [38083272](#)

### **21. Comparison of Sub-Scalp EEG and Endovascular Stent-Electrode Array for Visual Evoked Potential Brain-Computer Interface**

Timothy B Mahoney, Po-Chen Liu, David B Grayden, Sam E John

Annu Int Conf IEEE Eng Med Biol Soc. 2023 Jul;2023:1-4. doi: 10.1109/EMBC40787.2023.10340834.

Brain-computer interfaces (BCI) have the potential to improve the quality of life for persons with paralysis. Sub-scalp EEG provides an alternative BCI signal acquisition method that compromises between the limitations of traditional EEG systems and the risks associated with intracranial electrodes, and has shown promise in long-term seizure monitoring. However, sub-scalp EEG has not yet been assessed for suitability in BCI applications. This study presents a preliminary comparison of visual evoked potentials (VEPs) recorded using sub-scalp and endovascular stent electrodes in a sheep. Sub-scalp electrodes recorded comparable VEP amplitude, signal-to-noise ratio and bandwidth to the stent electrodes. Clinical relevance-This is the first study to report a comparison between sub-scalp and stent electrode array signals. The use of sub-scalp EEG electrodes may aid in the long-term use of brain-computer interfaces.

PMID: [38083531](#)

## **22. Retracted: Computer-Aided Diagnosis of Children with Cerebral Palsy under Deep Learning Convolutional Neural Network Image Segmentation Model Combined with Three-Dimensional Cranial Magnetic Resonance Imaging**

Journal Of Healthcare Engineering

Retraction of Publication J Healthc Eng. 2023 Dec 6;2023:9848293. doi: 10.1155/2023/9848293. eCollection 2023. [This retracts the article DOI: 10.1155/2021/1822776].

Retraction of

Computer-Aided Diagnosis of Children with Cerebral Palsy under Deep Learning Convolutional Neural Network Image Segmentation Model Combined with Three-Dimensional Cranial Magnetic Resonance Imaging.

Yang R, Zuo H, Han S, Zhang X, Zhang Q.

J Healthc Eng. 2021 Nov 10;2021:1822776. doi: 10.1155/2021/1822776. eCollection 2021.

PMID: 34804446 Free PMC article. Retracted.

PMID: [38094766](#)

## **23. Automating General Movements Assessment with quantitative deep learning to facilitate early screening of cerebral palsy**

Qiang Gao, Siqiong Yao, Yuan Tian, Chuncao Zhang, Tingting Zhao, Dan Wu, Guangjun Yu, Hui Lu

Nat Commun. 2023 Dec 14;14(1):8294. doi: 10.1038/s41467-023-44141-x.

The Prechtl General Movements Assessment (GMA) is increasingly recognized for its role in evaluating the integrity of the developing nervous system and predicting motor dysfunctions, particularly in conditions such as cerebral palsy (CP). However, the necessity for highly trained professionals has hindered the adoption of GMA as an early screening tool in some countries. In this study, we propose a deep learning-based motor assessment model (MAM) that combines infant videos and basic characteristics, with the aim of automating GMA at the fidgety movements (FMs) stage. MAM demonstrates strong performance, achieving an Area Under the Curve (AUC) of 0.967 during external validation. Importantly, it adheres closely to the principles of GMA and exhibits robust interpretability, as it can accurately identify FMs within videos, showing substantial agreement with expert assessments. Leveraging the predicted FMs frequency, a quantitative GMA method is introduced, which achieves an AUC of 0.956 and enhances the diagnostic accuracy of GMA beginners by 11.0%. The development of MAM holds the potential to significantly streamline early CP screening and revolutionize the field of video-based quantitative medical diagnostics.

PMID: [38097602](#)

## **24. Latin American Cerebral Palsy Register (LATAM-CPR): study protocol to develop a collaborative register with surveillance of children with cerebral palsy in Latin American countries**

Maria de Las Mercedes Ruiz Brunner, Israt Jahan, Eduardo Cuestas, Maria Elisabeth Cieri, Johana Escobar Zuluaga, Ana Laura Condanzi, Federico Sanchez, Sarah McIntyre, Hayley Smithers-Sheedy, Mohammad Muhit, Nadia Badawi, Raul Díaz, Agripina Diaz, Jorge Carranza, Claudia Durán, Carlos Alberto Quintero Valencia, Mariana Melaragno, Gulam Khandaker

BMJ Open. 2023 Dec 9;13(12):e071315. doi: 10.1136/bmjopen-2022-071315.

Introduction: Cerebral palsy (CP) is one of the leading causes of childhood disability globally with a high burden in low-income and middle-income countries (LMICs). Preliminary findings from the global LMIC CP Register (GLM CPR) suggest that the majority of CP in LMICs are due to potentially preventable causes. Such data are lacking in the Latin American region. Generating comparable epidemiological data on CP from this region could enable translational research and services towards early diagnosis and early intervention. We aim to establish a Latin American multicountry network and online data repository



of CP called Latin American Cerebral Palsy Register (LATAM-CPR). Methods and analysis: The LATAM-CPR will be modelled after the GLM CPR and will support new and emerging Latin American CP registers following a harmonised protocol adapted from the GLM CPR and piloted in Argentina (ie, Argentine Register of Cerebral Palsy). Both population-based and institution-based surveillance mechanisms will be adopted for registration of children with CP aged less than 18 years to the participating CP registers. The data collection form of the LATAM-CPR will include risk factors, clinical profile, rehabilitation, socioeconomic status of children with CP. Descriptive data on the epidemiology of CP from each participating country will be reported, country-specific and regional data will be compared. Ethics and dissemination: Individual CP registers have applied ethics approval from respective national human research ethics committees (HREC) and/or institutional review boards prior to the establishment and inclusion into the LATAM-CPR. Ethical approval for LATAM-CPR has already been obtained from the HREC in the two countries that started (Argentina and Mexico).

PMID: [38070889](#)

## **25. Enhancing nursing documentation in Kazakhstan: assessing utilization and standardization for improving patient care**

Bibinur Sydykova, Dariga Smailova, Zaituna Khismetova, Marzhan Brimzhanova, Zaure Baigozhina, Hengameh Hosseini, Natalya Latypova, Marina Izmailovich

Front Public Health. 2023 Nov 23;11:1267809. doi: 10.3389/fpubh.2023.1267809. eCollection 2023.

**Background and aim:** This article stresses the importance of comprehensive nursing documentation in scientific medicine and discusses the adoption of standardized terminologies in Europe. The study also presents findings from a cross-sectional study conducted in Kazakhstan, assessing the utilization of standard operating procedures and nursing documentation in various clinical scenarios. The aim was evaluate the level of use of the form of nursing documentation and Standard Operating Procedure within the framework of reforming the Republic of Kazakhstan. **Materials and methods:** During the period from December 2021 to February 2022, a cross-sectional study was conducted in Kazakhstan, involving a randomly selected sample of nurses with technical and vocational education as well as those with applied/academic baccalaureate degrees in nursing. **Results:** In this cross-sectional study of 2,263 female nurses, 75.3% were nurse practitioners, and 44% held the highest qualification category. Awareness levels varied, with around 64.7% aware of the pilot program for care services, 65.8% aware of the deputy head position, and 73.8% familiar with the "extended practice nurse" role. Only 55.2% knew about the International Clinical Nursing Classification, and 54.5% observed changes in their nursing approach due to education. The limb edema measurement checklist was not used by the majority (88.4%) of respondents, and 68% did not utilize the antibiotic susceptibility testing checklist. Various other checklists and algorithms had limited utilization, with percentages ranging from 9.1 to 69.3%, indicating varying levels of adoption among participants. For assisting children with cerebral palsy, the "Assessment of hand use capacity according to the MACS classification system" was utilized by 9.1%, while 90.9% did not employ it. In the context of communication, 30.7% of the respondents utilized the "Algorithm of actions of a medical registrar when communicating with a patient," while 69.3% did not use it. These findings highlight variable adoption rates among participants for these medical procedures and protocols. **Conclusion:** In Kazakhstan, nursing documentation forms and Standard Operating Procedures face challenges and limited utilization, but their implementation has shown positive impacts on patient care and healthcare outcomes. Overcoming resistance to change, increasing awareness, and addressing resource constraints are essential for further improvement.

PMID: [38074771](#)

## **26. Stem Cell Therapy in Neonatal Hypoxic-Ischemic Encephalopathy and Cerebral Palsy: a Bibliometric Analysis and New Strategy**

Qiu-Xia Xiao, Min-Jian Geng, Yi-Fei Sun, Yu Pi, Liu-Lin Xiong

Review Mol Neurobiol. 2023 Dec 16. doi: 10.1007/s12035-023-03848-0. Online ahead of print.

The aim of this study was to identify related scientific outputs and emerging topics of stem cells in neonatal hypoxic-ischemic encephalopathy (NHIE) and cerebral palsy (CP) through bibliometrics and literature review. All relevant publications on stem cell therapy for NHIE and CP were screened from websites and analyzed research trends. VOSviewer and CiteSpace were applied to visualize and quantitatively analyze the published literature to provide objective presentation and prediction. In addition, the clinical trials, published articles, and projects of the National Natural Science Foundation of China associated with stem cell therapy for NHIE and CP were summarized. A total of 294 publications were associated with stem cell therapy for NHIE and CP. Most publications and citations came from the USA and China. Monash University and University Medical Center Utrecht produced the most publications. Pediatric research published the most studies on stem cell therapy for NHIE and CP. Heijnen C and Kavelaars A published the most articles. Cluster analyses show that current research trend is more inclined toward the repair mechanism and clinical translation of stem cell therapy for NHIE and CP. By summarizing various studies of stem cells in NHIE and CP, it is indicated that this research direction is a hot topic at present. Furthermore, organoid transplantation, as an emerging and new therapeutic approach, brings new hope for the treatment of NHIE and CP. This study comprehensively summarized and analyzed the research trend of global stem cell therapy for NHIE and CP. It has shown a

marked increase in stem cell therapy for NHIE and CP research. In the future, more efforts will be made on exploring stem cell or organoid therapy for NHIE and CP and more valuable related mechanisms of action to achieve clinical translation as soon as possible.

PMID: [38102517](#)

### **27. Informal caregivers of children with cerebral palsy ways of coping with the uncertainty of illness [Article in English, Portuguese] [Abstract in English, Portuguese, Spanish]**

Isabella Joyce Silva de Almeida Carvalho, Inácia Sátiro Xavier de França, Francisco Stélio de Sousa, Francisca Márcia Pereira Linhares, Ana Luisa Brandão de Carvalho Lira, Alexsandro Silva Coura

Rev Esc Enferm USP. 2023 Dec 15:57:e20230115. doi: 10.1590/1980-220X-REEUSP-2023-0115en. eCollection 2023.

**Objective:** To unveil the process of collective construction of interventions for coping by informal caregivers of children with cerebral palsy using the Theory of Uncertainty in Illness. **Method:** Qualitative action-research in a hybrid format with informal caregivers of children with cerebral palsy registered with the Raros group in Petrolina, Pernambuco. The research followed the planned intervention cycle, going through four phases. The analysis was carried out using the IRAMUTEQ software and content analysis. **Results:** Interventions were designed collectively, both virtually and in person, which resulted in improvements for informal caregivers in coping with the conditions associated with the disability, promotion of self-care, empowerment and the construction of a sense of belonging to the group. There were 12 participants, all of whom were mothers. **Conclusion:** There was a facilitation of the process of coping with uncertainty in the disease on the part of the informal caregiver of children with cerebral palsy and it was evidenced that for this a prismatic perspective is necessary, which understands that the uncertainties are not only related to the conditions associated with cerebral palsy, but involve subjective aspects of the caregivers.

PMID: [38100602](#)

### **28. Huge primary vaginal stone in cerebral palsy patient**

Linda Chamma, Ibrahim Ballout, Bachar Al Ali, Rabih Awad, Hussein Issa, Mohamad Moussa

Case Reports Urol Case Rep. 2023 Nov 17:51:102621. doi: 10.1016/j.eucr.2023.102621. eCollection 2023 Nov.

Vaginal stones are rarely encountered in practice, often misdiagnosed as bladder stone on plain radiography. The clinical manifestation can be unspecific ranging from asymptomatic stones to acute onset of fever or abdominal discomfort, rendering the diagnosis challenging. They are classified into primary stones resulting from urine stasis, and more commonly secondary stones formed around a nidus. Cerebral palsy is frequently associated with urinary incontinence and leads to constant leakage of urine into the vagina. In addition, the prolonged recumbent position results in urinary stasis, thus promoting stone formation.

PMID: [38089558](#)

### **29. Factors Affecting the Independence Level of 4-6-Year-Old Children with Cerebral Palsy in Activities of Daily Living**

Faeze Alvandi, Malek Amini, Narges Ghafarzadeh Namazi

Iran J Child Neurol. 2023 Fall;17(4):93-104. doi: 10.22037/ijcn.v17i2.37401. Epub 2023 Oct 26.

**Objectives:** Enhancing the independence of children with cerebral palsy in their daily activities can significantly alleviate caregiver stress and challenges, thereby improving the quality of life for caregivers. This study aimed to identify the influential factors in the independence level of children with CP in Activities of Daily Living (ADL) (self-care) and Instrumental Activities of Daily Living (IADL) (home participation). **Materials & methods:** In this cross-sectional study, 116 children with different types of CP (61 boys and 55 girls) in the 4-6 age range and their parents were non-randomly selected through convenience sampling. The Iranian-Children Participation Questionnaire was used to measure the children's independence level in self-care activities and home participation. Several instruments, along with a demographic questionnaire, were used to assess personal factors, such as the Gross Motor Function Classification System, Manual Ability Classification System, Communication Function Classification System, SPARCLE (for determining children's cognitive level), and Eating and Drinking Ability Classification System. Eventually, the collected data were analyzed using stepwise linear regression. **Results:** The results showed that the level of Gross Motor Function Classification System (GMFCS) and Communication Function Classification System (CFCS) and the child's age had the most correlation with the independence level in self-care activities. Moreover, GMFCS, Manual Ability Classification System (MACS), cognitive level, and child's age were most associated with home participation. **Conclusion:** Personal factors are more effective than environmental factors in determining the independence of children with CP.

PMID: [38074928](#)

## Prevention and Cure

### 30. Maintenance of the synergistic effects of cord blood cells and erythropoietin combination therapy after additional cord blood infusion in children with cerebral palsy: 1-year open-label extension study of randomized placebo-controlled trial

Mi Ri Suh, Kyunghoon Min, Kye Hee Cho, Jongwook Kim, Ikhyun Lim, Mijin Park, Eun-Min Noh, Min Young Kim

Randomized Controlled Trial Stem Cell Res Ther. 2023 Dec 12;14(1):362. doi: 10.1186/s13287-023-03600-4.

Background: This 1-year open-label extension study aimed to identify the persistent synergistic effects of allogeneic umbilical cord blood (UCB) cells and erythropoietin (EPO) in children with cerebral palsy (CP) for up to 2 years. Methods: This open-label extension study followed children with CP who were enrolled in the previous randomized, double blind, placebo-controlled trial. The following groups from the first trial were maintained: (A) UCB + EPO, (B) UCB, (C) EPO, and (D) only placebo, and all the participants had continued active rehabilitation. This extended study started 3 months after termination of the first trial, which had a 1-year follow-up duration. All subjects received single additional UCB intravenous infusion at the extension baseline regardless of their initial allocation. Outcome measures were the gross motor performance measure (GMPM), gross motor function measure-66 (GMFM-66), and Bayley scales of infant development-II (BSID-II), which were followed at 3, 6, and 12 months after the extension baseline. Changes in the outcome scores from the baseline values of the previous trial and this study were analysed. Results: Sixty-nine children ( $4.29 \pm 1.28$  years, M:F = 34:35) were included in this study. Each group showed improvements in the outcome measures at 12 months after additional UCB infusion compared to the baseline scores, except for GMFM and GMPM in Group C which were elevated at 3 and 6 months post-therapy. Total subject analyses did not show significant differences in the outcome measures between the four different groups at 3, 6 and 12 months after additional UCB therapy. However, patients with severe dysfunction, whose GMFCS levels were IV and V, revealed a larger improvement of the GMPM score in Group A than in Group D ( $P_s < 0.05$ ) from the baseline value of the previous trial. The changes in BSID-II mental scale scores were positively correlated with the number of administered total nucleated cells per unit body weight during this one-year extension study period ( $r = 0.536$ ,  $P = 0.001$ ). Conclusions: These results suggest that when administering UCB to treat patients with CP, combination therapy with EPO is more effective, and the effect might last as long as 2 years, especially in patients with severe impairments.

PMID: [38087394](#)

### 31. Effects of riboflavin in the treatment of brain damage caused by oxygen deprivation: an integrative systematic review

Eulália Rebeca da Silva-Araújo, Raul Manhães-de-Castro, Paula Brielle Pontes, Diego Bulcão Visco, Diego Cabral Lacerda, Henrique José Cavalcanti Bezerra Gouveia, Ana Elisa Toscano

Review Nutr Neurosci. 2023 Dec 14:1-19. doi: 10.1080/1028415X.2023.2288387. Online ahead of print.

Brain oxygen deprivation causes morphological damage involved in the formation of serious pathological conditions such as stroke and cerebral palsy. Therapeutic methods for post-hypoxia/anoxia injuries are limited and still have deficiencies in terms of safety and efficacy. Recently, clinical studies of stroke have reported the use of drugs containing riboflavin for post-injury clinical rehabilitation, however, the effects of vitamin B2 on exposure to cerebral oxygen deprivation are not completely elucidated. This review aimed to investigate the potential antioxidant, anti-inflammatory and neuroprotective effects of riboflavin in cerebral hypoxia/anoxia. After a systematic search, 21 articles were selected, 8 preclinical and 12 clinical studies, and 1 translational study. Most preclinical studies used B2 alone in models of hypoxia in rodents, with doses of 1-20 mg/kg (in vivo) and 0.5-5  $\mu$ M (in vitro). Together, these works suggested greater regulation of lipid peroxidation and apoptosis and an increase in neurotrophins, locomotion, and cognition after treatment. In contrast, several human studies have administered riboflavin (5 mg) in combination with other Krebs cycle metabolites, except one study, which used only B2 (20 mg). A reduction in lactic acidosis and recovery of sensorimotor functions was observed in children after treatment with B2, while adults and the elderly showed a reduction in infarct volume and cognitive rehabilitation. Based on findings from preclinical and clinical studies, we conclude that the use of riboflavin alone or in combination acts beneficially in correcting the underlying brain damage caused by hypoxia/anoxia and its inflammatory, oxidative, and behavioral impairments.

PMID: [38095869](#)