

Monday 20 January 2020

Cerebral Palsy Alliance is delighted to bring you this free weekly bulletin of the latest published research into cerebral palsy. Our organisation is committed to supporting cerebral palsy research worldwide - through information, education, collaboration and funding. Find out more at cerebralpalsy.org.au/our-research

Professor Nadia Badawi AM

Macquarie Group Foundation Chair of Cerebral Palsy

[Subscribe to CP Research News](#)

Interventions and Management

1. Intensive Unimanual Training Leads to Better Reaching and Head Control than Bimanual Training in Children with Unilateral Cerebral Palsy.

Hung YC, Spingarn A, Friel KM, Gordon AM.

Phys Occup Ther Pediatr. 2020 Jan 16:1-15. doi: 10.1080/01942638.2020.1712513. [Epub ahead of print]

Aims: To quantify the changes in joint movement control and motor planning of the more-affected upper extremity (UE) during a reach-grasp-eat task in children with Unilateral Spastic Cerebral Palsy (USCP) after either constraint-induced movement therapy (CIMT) or hand-arm bimanual intensive therapy (HABIT). **Methods:** Twenty children with USCP (average age 7.7; MACS levels I-II) were randomized into either a CIMT or HABIT group. Both groups received intensive training 6 h a day for 15 days. Children performed a reach-grasp-eat task before and after training with their more-affected hand using 3D kinematic analysis. **Results:** Both groups illustrated shorter movement time during reaching, grasping, and eating phases after training ($p < 0.05$). Additionally, both intensive training approaches improved joint control with decreased trunk involvement, greater elbow, and wrist excursions during the reaching phase, and greater elbow excursion during the eating phase ($p < 0.05$). However, only the CIMT group decreased hand curvature during reaching, lowered hand position at grasp, and decreased head rotation during the eating phase ($p < 0.05$). **Conclusions:** The current findings showed that both CIMT and HABIT improved UE joint control, but there were greater effects of CIMT on the more-affected UE motor planning and head control for children with USCP.

PMID: [31942818](#)

2. Robotic-assisted hand therapy for improvement of hand function in children with cerebral palsy: a case series study.

Kuo FL, Lee HC, Hsiao HY, Lin JC.

Eur J Phys Rehabil Med. 2020 Jan 14. doi: 10.23736/S1973-9087.20.05926-2. [Epub ahead of print]

BACKGROUND: Most types of robot-assisted training (RT) have been used in Cerebral Palsy (CP) patients only focus on proximal upper extremity. Few of study investigated the effect of distal upper extremity training. **CASE REPORT:** Pediatric CP patients (N = 7) participated the RT sessions for 6 weeks (12 60-min sessions 2 times a week). Performance was assessed at 3 time points (pretest, posttest, and 1-month follow-up). RT significantly improved in body structure and function domains: FMA-UE scores ($P = .002$). On electromyography, significant improvements in the mean brachioradialis muscle amplitude ($P = .015$) and electrical agonist-antagonist muscle ratio ($P = .041$) in the 1-inch cube-grasping task. The effects were maintained after 1 month. **CLINICAL REHABILITATION IMPACT:** RT using a Gloreha device which focuses on the distal part of the upper limb benefit on body structure and function, including upper- extremity motor function, brachioradialis muscle recruitment, and coordination in children with cerebral palsy.

PMID: [31939267](#)

3. Development and Evaluation of a Customized Wrist-Hand Orthosis using 3D Technology for a Child with Cerebral Palsy - A Case Study.

Schmitz C, Mori YT, Remigio Gamba H, Nohama P, de Souza MA.

Conf Proc IEEE Eng Med Biol Soc. 2019 Jul;2019:1476-1479. doi: 10.1109/EMBC.2019.8857327.

Cerebral Palsy (CP) is a disability that affects more than 100 million children. More than 60% of these children have significant difficulties within their hand abilities, affected by involuntary movements and spasticity. So, to overcome this issue, orthoses are being employed as therapeutic intervention and can allow children with CP to have an opportunity to better use their hands. Three-dimensional (3D) technologies provide the generation of high-quality orthopedic products. Although, there are limited studies related to the evaluation of such assistive devices, especially for children. Therefore, the purpose of this research was to design, develop and evaluate a customized wrist-hand orthosis using 3D technologies for a child with CP. So, it was used a high-level 3D scanning to acquire the wrist-hand anatomy, a free software for 3D modelling and a low-cost 3D printer for manufacturing the orthosis. The Jebsen-Taylor Test of Hand Function (JTTHF) was used to evaluate unilateral hand abilities. We noticed improvements while wearing the orthosis at the affected hand, in the following subtests: writing (13 s), lifting small objects (0.9 s) and simulated feeding (69.3 s). The customized orthosis was able not only to improve some functional hand skills, but also to provide comfort, better fitting and with an appealing aesthetic design.

PMID: [31946172](#)

4. Experimental Validation of the Multiphysics Modelling of Radiofrequency Ablation using Physical Phantom.

Thipayawat T, Minh DN, Prinable J, McEwan A, Barry T.

Conf Proc IEEE Eng Med Biol Soc. 2019 Jul;2019:154-157. doi: 10.1109/EMBC.2019.8856962.

Spastic Cerebral Palsy is the most common type of Cerebral Palsy (CP) that affects muscle coordination and control. Using Radiofrequency Ablation (RFA) to target the motor branches of the median and ulnar nerve may provide an additional treatment to Botulinum Toxin for spasticity in the hand. However, there are a limited number of studies that report the use of RFA in treating upper-limb spasticity. This prompts the need to establish a simulation model that has been tested against physical phantom to help determine the efficacy of RFA as a treatment for spasticity. In this study, a 3D COMSOL Multiphysics model of a commercial RF probe was validated against a Thermochromic Liquid Crystal (TLC) homogeneous gel phantom. The results of the COMSOL model were compared to the TLC phantom in terms of temperature ($0.42 \pm 1.06^\circ\text{C}$ for the TLC high temperature range and $-1.90 \pm 0.88^\circ\text{C}$ for the TLC low temperature range), lesion shape ($14.5 \pm 5.0\%$) and lesion size (0.18 ± 0.06 mm). These results show that COMSOL Multiphysics may be feasible as a tool to characterise RF lesions if the reported errors are accounted for. Further work is required to develop a more complex COMSOL model that incorporates different tissue aspects. However, this is a first step to establishing a validated COMSOL model of a RF probe in homogeneous muscle tissue.

PMID: [31945867](#)

5. Development of a risk score for scoliosis in children with cerebral palsy.

Pettersson K, Wagner P, Rodby-Bousquet E.

Acta Orthop. 2020 Jan 13:1-6. doi: 10.1080/17453674.2020.1711621. [Epub ahead of print]

Background and purpose - Children and young adults with cerebral palsy (CP) have an increased risk of developing scoliosis, with a prevalence ranging from 11% to 29%. Information on risk factors for the emergence and progression of scoliosis is inconclusive. This study aimed to develop a risk score based on 5-year-old children with CP to predict the risk of scoliosis before the age of 16. **Patients and methods** - This prospective registry study included 654 children with CP in Sweden born in 2000 to 2003 and registered with the Swedish CP follow-up program (CPUP) at the age of 5 years, including all Gross Motor Function Classification System (GMFCS) levels. 92 children developed a scoliosis before the age of 16 years. Univariable and multivariable logistic regressions were used to analyze 8 potential predictors for scoliosis: GMFCS, sex, spastic subtype,

epilepsy, hip surgery, migration percentage, and limited hip or knee extension. Results - 4 predictors for scoliosis remained significant after analyses: female sex, GMFCS levels IV and V, epilepsy, and limited knee extension, and a risk score was constructed based on these factors. The predictive ability of the risk score was high, with an area under the receiver operating characteristics curve of 0.87 (95% CI 0.84-0.91). Interpretation - The risk score shows high discriminatory ability for differentiating between individuals at high and low risk for development of scoliosis before the age of 16. It may be useful when considering interventions to prevent or predict severe scoliosis in young children with CP.

PMID: [31928285](#)

6. Does repetitive Transcranial Magnetic Stimulation (rTMS) have therapeutic effects on Dynamic Balance of Children with Cerebral Palsy?

Dadashi F, Lotfian M, Rafieenazari Z, Shahroki A, Irani A, Mirbagheri A, Mirbagheri MM.

Conf Proc IEEE Eng Med Biol Soc. 2019 Jul;2019:425-428. doi: 10.1109/EMBC.2019.8857947.

Our big goal in this research was to evaluate the therapeutic effects of repetitive Transcranial Magnetic Stimulation (rTMS) on cerebral palsy (CP) children with balance deficits. Four spastic hemiplegic CP children were participated; the experimental group received rTMS training 4 days a week for 3 weeks and then for the next 3 weeks they received typical occupational therapy just after rTMS therapy. The control group received placebo rTMS instead of real one accordingly. Their dynamic balance was evaluated before the start of the treatment and 6 weeks after it. Center of pressure (COP) and center of mass (COM) features were regarded as dynamic balance parameters. Our results showed that the peak to peak of COP, COM, COM-COP, COM-COP inclination angles all improved for both experimental (15-86%) and control group patients, though there was less improvement about 8-46% in features of the control patients. Our results demonstrate that intensive sessions of the rTMS training could have the potential to enhance the therapeutic effects of typical occupational therapy that can produce dynamic balance improvements in CP children compared to using the occupational therapy by itself.

PMID: [31945929](#)

7. The Effects of Repetitive Transcranial Magnetic Stimulation (rTMS) on Balance Control in Children with Cerebral Palsy.

Dadashi F, Shahroki A, Nourian R, Irani A, Molavi M, Rafieenazari Z, Mirbagheri MM, Mirbagheri A.

Conf Proc IEEE Eng Med Biol Soc. 2019 Jul;2019:5241-5244. doi: 10.1109/EMBC.2019.8857361.

Cerebral palsy (CP) is a neurological disorder which can result in balance and mobility impairments. Four children with spastic CP participated and randomly assigned to experimental and control groups. The experimental group received 1-Hz repetitive Transcranial Magnetic Stimulation (rTMS) four times a week for 3 weeks, and the control group received sham rTMS using the similar experimental protocol. Each rTMS session lasted for 20 minutes. Postural balance was quantified by analyzing the center of pressure (COP) signal of a force plate according to the Romberg test. The balance was also evaluated using the Berg Balance Scale (BBS). The evaluations were done before and after the treatment. COP signal features showed up to 70% improvement following rTMS treatment, whereas there was no notable improvements in the control group. Similarly the BBS assessment presented balance enhancement only in the experimental group. These results, particularly under closed eye foam condition may imply an improvement in proprioception system. Our findings suggested that rTMS has a potential to be used as a therapeutic method to improve postural balance in children with CP.

PMID: [31947040](#)

8. Preferential deficit of fat-free soft tissue in the appendicular region of children with cerebral palsy and proposed statistical models to capture the deficit.

Zhang C, Colquitt G, Miller F, Shen Y, Modlesky CM.

Clin Nutr. 2019 Jul 2. pii: S0261-5614(19)30276-6. doi: 10.1016/j.clnu.2019.06.020. [Epub ahead of print]

BACKGROUND: Cerebral palsy (CP) is a neurological disorder characterized by a profound skeletal muscle deficit. However, whether there is a regional-specific skeletal muscle deficit in children with CP is unknown. The purpose of this study was to determine whether fat-free soft tissue mass (FFST), a commonly used surrogate for skeletal muscle mass, is more compromised in the limbs than in the trunk in children with CP. A second purpose was to determine whether physical characteristics can be used to accurately estimate appendicular FFST (AFFST) in children with CP. **METHODS:** Forty-two children with CP (4-13 y) and 42 typically developing children matched to children with CP for sex, age and race were studied. Whole body FFST (FFST_{whole}), FFST in the upper limbs (FFST_{upper}), FFST in the lower limbs (FFST_{lower}), the ratio of AFFST to height (AFFST/ht), the ratio of AFFST to height² (AFFST/ht²) and non-appendicular FFST were estimated from dual-energy X-ray absorptiometry. Statistical models were developed to estimate AFFST, AFFST/ht and AFFST/ht² in both groups of children, and the leave-one-out method was used to validate the models. **RESULTS:** Children with CP had 21% lower FFST_{whole}, 30% lower AFFST, 34% lower FFST_{lower}, 14% lower non-appendicular FFST, 23% lower AFFST/ht, 19% lower AFFST/ht² and 9% lower AFFST/FFST_{whole} (all $p < 0.05$). Statistical models developed using data from typically developing children overestimated AFFST, AFFST/ht and AFFST/ht² by 35%, 30% and 21% (all $p < 0.05$), respectively, in children with CP. Separate models developed using data from children with CP yielded better accuracy, with the estimated results highly correlated ($r^2 = 0.78, 0.66$ and 0.50 , respectively; all $p < 0.001$) and not different from calculated AFFST, AFFST/ht and AFFST/ht² (all $p > 0.99$). However, when the difference in estimated values and measured values of AFFST, AFFST/ht and AFFST/ht² were plotted against measured values, there was an inverse relationship ($r = -0.38, -0.47$ and -0.61 , respectively, all $p < 0.05$). **CONCLUSION:** Children with CP have a remarkable deficit in FFST that is more pronounced in the appendicular than in the non-appendicular region and more pronounced in the lower than in the upper limbs. Preliminary models developed using data from children with CP can provide reasonable estimates of AFFST and indexes of AFFST relative to height, but further development of the models may be needed.

PMID: [31924383](#)

9. A Method to Quantify Multi-Degree-of-Freedom Lower Limb Isometric Joint Torques in Children with Hemiplegia. Goyal V, Sukal-Moulton T, Dewald JPA.

Conf Proc IEEE Eng Med Biol Soc. 2019 Jul;2019:1521-1524. doi: 10.1109/EMBC.2019.8856444.

Pediatric hemiplegia, caused by a unilateral brain injury during childhood, can lead to motor deficits such as weakness and abnormal joint torque coupling patterns which may result in a loss of independent joint control. It is hypothesized that these motor impairments are present in the paretic lower extremity, especially at the hip joint where extension may be abnormally coupled with adduction. Previous studies investigating lower extremity isometric joint torques in children with spastic cerebral palsy used tools that limited data collection to one degree of freedom, making it impossible to quantify these coupling patterns. We describe the adaptation of a multi-joint lower extremity isometric torque measurement device to allow for quantification of weakness and abnormal joint torque coupling patterns at the hip in the pediatric population. We also present preliminary data in three children without hemiplegia to highlight how the presence of atypical femoral bony geometry, often observed in childhood hemiplegia, can be accounted for in the Jacobian transformations and affect joint torque measurements at the hip.

PMID: [31946183](#)

10. The effect of mono- versus multi-segment musculoskeletal models of the foot on simulated triceps surae lengths in pathological and healthy gait.

Zandbergen MA, Schallig W, Stebbins JA, Harlaar J, van der Krogt MM.

Gait Posture. 2020 Jan 8;77:14-19. doi: 10.1016/j.gaitpost.2020.01.010. [Epub ahead of print]

BACKGROUND: Estimating muscle-tendon complex (MTC) lengths is important for planning of soft tissue surgery and evaluating outcomes, e.g. in children with cerebral palsy (CP). Conventional musculoskeletal models often represent the foot as one rigid segment, called a mono-segment foot model (mono-SFM). However, a multi-segment foot model (multi-SFM) might provide better estimates of triceps surae MTC lengths, especially in patients with foot deformities. **RESEARCH QUESTION:** What is the effect of a mono- versus a multi-SFM on simulated ankle angles and triceps surae MTC lengths during gait in typically developing subjects and in children with CP with equinus, cavovarus or planovalgus foot deformities? **METHODS:** 50 subjects were included, 10 non-affected adults, 10 typically developing children, and 30 children with spastic CP and foot

deformities. During walking trials, marker trajectories were collected for two marker models, including a mono- and multi-segment foot; respectively Newington gait model and Oxford foot model. Two musculoskeletal lower body models were constructed in OpenSim with either a mono- or multi-SFM based on the corresponding marker models. Normalized triceps surae MTC lengths (soleus, gastrocnemius medialis and lateralis) and ankle angles were calculated and compared between models using statistical parametric mapping RM-ANOVAs. Root mean square error values between simulated MTC lengths were compared using Wilcoxon signed-rank and rank-sum tests. RESULTS: Mono-SFM simulated significantly more ankle dorsiflexion ($7.5 \pm 1.2^\circ$) and longer triceps surae lengths (difference; soleus: $2.6 \pm 0.29\%$, gastrocnemius medialis: $1.7 \pm 0.2\%$, gastrocnemius lateralis: $1.8 \pm 0.2\%$) than a multi-SFM. Differences between models were larger in children with CP compared to typically developing children and larger in the stance compared to the swing phase of gait. Largest differences were found in children with CP presenting with planovalgus (4.8 %) or cavovarus (3.8 %) foot deformities. SIGNIFICANCE: It is advisable to use a multi-SFM in musculoskeletal models when simulating triceps surae MTC lengths, especially in individuals with planovalgus or cavovarus foot deformities.

PMID: [31951914](#)

11. Impact of anti-gravity locomotion (AlterG) training on structure and function of corticospinal tract and gait in children with cerebral palsy.

Azizi S, Birgani PM, Irani A, Shahrokhi A, Nourian R, Mirbagheri MM.

Conf Proc IEEE Eng Med Biol Soc. 2019 Jul;2019:126-129. doi: 10.1109/EMBC.2019.8857784.

We aimed to characterize the impact of anti-gravity locomotion training on the structure and function of the corticospinal tract (CST) in cerebral palsy (CP). Fourteen CP children participated. Nine children were trained with an antigravity treadmill (Alter-G) and five children received occupational therapy (OT). Treatments were provided for 45 min each session, 3 sessions per week for 8 weeks. Diffusion tensor imaging (DTI) was used, and fractional anisotropy (FA), mean diffusivity (MD), radial (RD) and axial (AD) diffusivity was extracted to characterize the structure of the CST. Transcranial magnetic stimulation (TMS) was used and threshold, latency, and peak-peak amplitude of the MEP signal, elicited by the TMS, were used to quantify the function of the CST. Walking ability was evaluated by measuring gait speed, endurance, balance, and mobility. The evaluations were performed before and after the interventions. The results showed that FA improved in both sides of the brain for the AlterG group, but enhanced only in the less affected side of the OT group. MD, RD, and AD mostly improved in the more affected side of the AlterG group. The enhancement of the CST function was similar in both groups. Walking speed and endurance also enhanced in both groups, but the improvement was greater in the AlterG group. Our findings demonstrate that AlterG training can improve gait ability, and simultaneously result in brain neuroplasticity. The clinical implication is that AlterG training can be used as an effective rehabilitation approach to improve gait persistently.

PMID: [31945860](#)

12. Adaptive Ankle Resistance from a Wearable Robotic Device to Improve Muscle Recruitment in Cerebral Palsy.

Conner BC, Luque J, Lerner ZF.

Ann Biomed Eng. 2020 Jan 16. doi: 10.1007/s10439-020-02454-8. [Epub ahead of print]

Individuals with cerebral palsy can have weak and poorly coordinated ankle plantar flexor muscles that contribute to inefficient walking patterns. Previous studies attempting to improve plantar flexor function have had inconsistent effects on mobility, likely due to a lack of task-specificity. The goal of this study was to develop, validate, and test the feasibility and neuromuscular response of a novel wearable adaptive resistance platform to increase activity of the plantar flexors during the propulsive phase of gait. We recruited eight individuals with spastic cerebral palsy to walk with adaptive plantar flexor resistance provided from an untethered exoskeleton. The resistance system and protocol was safe and feasible for all of our participants. Controller validation demonstrated our ability to provide resistance that proportionally- and instantaneously-adapted to the biological ankle moment ($R = 0.92 \pm 0.04$). Following acclimation to resistance (0.16 ± 0.02 Nm/kg), more-affected limbs exhibited a $45 \pm 35\%$ increase in plantar flexor activity ($p = 0.02$), a $26 \pm 24\%$ decrease in dorsiflexor activity ($p < 0.05$), and a $46 \pm 25\%$ decrease in co-contraction (tibialis anterior and soleus) ($p = 0.02$) during the stance phase. This adaptive resistance system warrants further investigation for use in a longitudinal intervention study.

PMID: [31950309](#)

13. The Effects of Anti-gravity Treadmill Training on Gait Characteristics in Children with Cerebral Palsy.

Lotfian M, Dadashi F, Rafieenazari Z, Shahroki A, Rasteh M, Molavi M, Mirbagheri A, Mirbagheri MM.

Conf Proc IEEE Eng Med Biol Soc. 2019 Jul;2019:5256-5259. doi: 10.1109/EMBC.2019.8856660.

Cerebral palsy is a disorder that affects muscle tone, movement and motor skills. Most of the children with cerebral palsy (CP) are not able to walk or can walk in incorrect pattern and are dependent on assistive devices. Recently an antigravity treadmill has been found to be beneficial as a new therapeutic approach. Thus, we aimed to investigate the effects of antigravity treadmill training (AlterG) on gait characteristic in children with cerebral palsy. We provided a 45-minute training program, 3 times a week for 8 weeks for six CP children as our experimental group. Our control group was a group consisted of four CP children who took typical occupational therapy, accordingly. All subjects in both AlterG and control groups were evaluated at the gait lab before and after 8 weeks training. Gait patterns were characterized using spatiotemporal parameters and dynamic balance features. We also evaluated the popular clinical gait measures including walking speed and endurance, and mobility and balance. Our results demonstrated that spatiotemporal, dynamic balance and clinical features all improved more after 8 weeks AlterG training rather than control group ones. These findings suggest that AlterG training can be considered as an effective approach for improving walking ability and gait characteristics in children with cerebral palsy.

PMID: [31947043](#)

14. Surgical outcomes after single event multilevel surgery in cerebral palsy patients with mid-stance knee hyperextension.

Chung CY1, Kwon SS2, Park MS1, Lee KM1, Sung KH3.

Gait Posture. 2020 Jan 10;77:1-5. doi: 10.1016/j.gaitpost.2020.01.005. [Epub ahead of print]

BACKGROUND: Some patients with cerebral palsy (CP) exhibit excessive knee flexion at initial contact followed by knee hyperextension (KE) in mid-stance. **RESEARCH QUESTION:** This study investigated the change in sagittal kinematics after distal hamstring lengthening (DHL) and triceps surae lengthening procedures in CP patients with KE, and compared it to those without KE. In addition, the risk factors for the worsening of postoperative KE were analyzed. **METHODS:** Consecutive 312 patients (596 limbs) with CP who underwent DHL and triceps surae lengthening were included. All patients underwent preoperative and 1-year postoperative three-dimensional gait analysis. Patients' limbs were divided into the KE and knee flexion (KF) groups, according to preoperative minimum knee flexion in stance. KE was defined as minimum knee flexion in stance less than 0°. **RESULTS:** The KE and KF groups included 130 and 466 limbs, respectively. Knee and ankle sagittal kinematics significantly improved after surgery in both groups. Minimum knee flexion in stance significantly increased from -6.6° to 0.5° in the KE group, but decreased from 14.6° to 7.8° in the KF group. Among the KE group, minimum knee flexion in stance improved in 103 limbs (79.2 %), but worsened in 27 limbs (20.8 %). Degree of preoperative KE was the only factor significantly associated with postoperative worsening of KE ($p=0.002$). The cutoff value for the worsening of KE was -5.8° of preoperative minimum knee flexion in stance. **SIGNIFICANCE:** This study demonstrated that the sagittal kinematics of the knee and ankle joints improved after DHL and triceps surae lengthening procedures in CP patients with and without KE. Preoperative degree of KE was a risk factor for the worsening of KE after surgery. Therefore, careful selection for indication of DHL is required to prevent postoperative KE due to overlengthening of the hamstrings, particularly in patients with severe preoperative KE.

PMID: [31945635](#)

15. Pilot Study of Cadence, a Novel Shoe for Patients with Foot Drop.

Evora A, Sloan E, Castellino S, Hawkes EW, Susko T.

Conf Proc IEEE Eng Med Biol Soc. 2019 Jul;2019:5291-5296. doi: 10.1109/EMBC.2019.8857096.

Foot Drop is a mobility disorder that limits ankle dorsiflexion, complicating the swing phase of gait and balance. It is a common result of a neurological injury or disease such as stroke, cerebral palsy or multiple sclerosis. Here we present Cadence, a low-cost assistive shoe designed to passively improve the biomechanics and rhythmicity of gait for people with foot drop.

The shoe reduces the magnitude of scuffing forces when dragging the foot forward across the ground by using regions of low-friction material that can retract into the shoe to restore friction during stance phase. We report the results from a pilot study of Cadence, which show the biomechanical and performance effects of the device for five adults with foot drop due to neurological disorder. In 3 of the 5 subjects, we found that the shoe immediately improved gait mechanics, speed over ground, and qualitative gait comfort.

PMID: [31947051](#)

16. The Therapeutic Effects of Low-Amplitude, High-Frequency Perturbations on Neuromuscular Abnormalities Associated with Spasticity in Children with Cerebral Palsy.

Noroozi S, Lotfian M, Nooshiravan F, Shahrokhi A, Irani A, Mirbagheri MM.

Conf Proc IEEE Eng Med Biol Soc. 2019 Jul;2019:114-117. doi: 10.1109/EMBC.2019.8856551.

We aimed to investigate the impact of ankle joint therapy with low-amplitude, high-frequency perturbation training on neuromuscular abnormalities associated with spasticity in children with Cerebral Palsy (CP). Four spastic CP children (2 males and 2 females) received a 10-session training of high-frequency and low-amplitude perturbations superimposed on passive stretches over the range of motion of their ankle as well as local perturbations at dorsiflexion position. The associated passive parameters, including total passive range of motions, passive range of motions toward dorsiflexion, stiffness, energy loss and torque dynamic gain were evaluated at the baseline and after a 10 session training. Our findings indicate that passive range of motion increased, and passive reflex stiffness, which usually increases in CP children, decreased following the completion of training. Our results demonstrate that intensive sessions of perturbation therapy could be considered an effective therapeutic mean for the management of spasticity and contracture, and eventually the enhancement of mobility of CP children.

PMID: [31945857](#)

17. Ankle Exoskeleton Assistance Can Improve Over-Ground Walking Economy in Individuals with Cerebral Palsy.

Orekhov G, Fang Y, Luque J, Lerner ZF.

IEEE Trans Neural Syst Rehabil Eng. 2020 Jan 8. doi: 10.1109/TNSRE.2020.2965029. [Epub ahead of print]

Individuals with neuromuscular impairment from conditions like cerebral palsy face reduced quality of life due to diminishing mobility and independence. Lower-limb exoskeletons have potential to aid mobility, yet few studies have investigated their use during over-ground walking - an exercise that may contribute to our understanding of potential benefit in free-living settings. The goal of this study was to determine the potential for adaptive plantar-flexor assistance from an untethered ankle exoskeleton to improve over-ground walking economy and speed. Six individuals with cerebral palsy completed three consecutive daily over-ground training sessions to acclimate to, and tune, assistance. During a final assessment visit, metabolic cost, walking speed, and soleus electromyography were collected for baseline, unpowered, low, training-tuned, and high assistance conditions. Compared to each participant's baseline condition, we observed a $3.9 \pm 1.9\%$ ($p=0.050$) increase in walking speed and a $22.0 \pm 4.5\%$ ($p=0.002$) reduction in soleus activity with training-tuned assistance; metabolic cost of transport was unchanged ($p=0.130$). High assistance resulted in an $8.5 \pm 4.0\%$ ($p=0.042$) reduction in metabolic cost of transport, a $6.3 \pm 2.6\%$ ($p=0.029$) increase in walking speed, and a $25.0 \pm 4.0\%$ ($p<0.001$) reduction in soleus activity. Improvement in exoskeleton-assisted walking economy was related to pre-training baseline walking speed ($R^2=0.94$, $p=0.001$); the slower and more impaired participants improved the most. Energy cost and preferred walking speed remained generally unchanged for the faster and less impaired participants. These findings demonstrate that powered ankle exoskeletons have the potential to improve mobility-related outcomes for some people with cerebral palsy.

PMID: [31940542](#)

18. Pain in children and adolescents with cerebral palsy - a cross-sectional register study of 3545 individuals.

Eriksson E, Hägglund G, Alriksson-Schmidt AI.

BMC Neurol. 2020 Jan 11;20(1):15. doi: 10.1186/s12883-019-1597-7.

BACKGROUND: Pain is a common problem for individuals with cerebral palsy (CP). In Sweden, 95% of children and adolescents with CP are followed in a national follow-up programme (CPUP), which includes data on pain. The purpose of this study was to investigate the prevalence of pain based on age, sex, gross motor function and source of report (self or proxy). Pain intensity, pain site, and how much pain disturbed sleep and daily activities were also studied. **METHODS:** This was a cross-sectional register study based on all participants in CPUP, 4-18-years of age, with data reported in 2017-2018. Gross motor function was classified using the Gross Motor Function Classification System (GMFCS). Logistic regression was used to analyse prevalence of pain and how much pain had disturbed sleep and daily activities in the last four weeks. **RESULTS:** In total, 3545 participants (2065 boys) were included. The overall prevalence of pain was 44%. Older age and female sex were associated with higher risk of pain with odds ratios of 1.07 (95% confidence interval (CI) 1.06-1.09) and 1.28 (CI 1.12-1.47), respectively. Pain was most common in the lower extremities. There was no statistically significant difference in prevalence of pain related to source of report. Pain intensity was higher at older ages and higher GMFCS-levels. Hip/thigh pain and abdominal pain were associated with the most intense pain. Of those who reported pain, pain disturbed sleep for 36% and daily activities for 61%. **CONCLUSIONS:** Both pain frequency and pain intensity were higher at higher age. Pain intensity increased with increasing GMFCS-level. Two-thirds of all children and adolescents with CP reported that their pain disturbed their daily activities, and one-third reported that pain disturbed their sleep.

PMID: [31926546](#)

19. Facilitating transition of young people with long-term health conditions from children's to adults' healthcare services - implications of a 5-year research programme.

Colver A, Rapley T, Parr JR, McConachie H, Dovey-Pearce G, Couteur AL, McDonagh JE, Bennett C, Maniatopoulos G, Pearce MS, Reape D, Chater N, Gleeson H, Vale L.

Clin Med (Lond). 2020 Jan;20(1):74-80. doi: 10.7861/clinmed.2019-0077.

BACKGROUND: During transition from children's to adults' healthcare, young adults with long-term conditions may show delays in psychosocial development compared to their peers without long-term conditions, and deterioration of their conditions' medical control. **METHODS:** This paper integrates the findings, already published in 10 separate papers, of a 5-year transition research programme. **IMPLICATIONS:** There is an important role for funders (commissioners) of adults' services to fund transitional healthcare, in addition to funders of children's services who currently take responsibility. It is important that healthcare provider organisations adopt an organisation-wide approach to implementation to ensure that good practice is adopted in children's and adults' services, not just adopted by enthusiasts in some specialties. This includes provision of 'developmentally appropriate healthcare' which recognises the changing biopsychosocial developmental needs of young people. Three features of transitional healthcare were associated with improved outcomes: appropriate parent involvement, promotion of young people's confidence in managing their health and meeting the adult team before transfer. These should be maintained or introduced as a priority. Child and adult healthcare providers should routinely explore with a young person how they approach transition and personalise their clinical approach thereafter. These implications are relevant for a range of stakeholders, including funders of transitional healthcare, organisations providing transitional healthcare and clinical practitioners.

PMID: [31941736](#)

20. Caregivers' perceptions of the oral-health-related quality of life of children with special needs in Johannesburg, South Africa.

Nqco C, Ralephenya T, Kolisa YM, Esan T, Yengopal V.

Health SA. 2019 Sep 23;24:1056. doi: 10.4102/hsag.v24i0.1056. eCollection 2019.

BACKGROUND: The prevalence of dental caries and its effect on the oral-health-related quality of life (OHRQoL) of children with special needs (CSNs) have not been established in South Africa. **AIM:** The study aimed to assess how caregivers of CSNs who attended Down Syndrome Association outreach sites in Johannesburg, South Africa, perceived the contribution of OHRQoL to the quality of life of these children. **SETTING:** The study was conducted at Down Syndrome Association (DSA) outreach sites in Johannesburg. These sites cater for children with several types of disabilities including cerebral palsy,

hydrocephalus, autism, epilepsy and developmental delays. The association schedules and facilitates support group meetings for the caregivers of children with Down syndrome and other disabilities. These meetings are held at the outreach sites that are located at different district hospitals and community health centres in Johannesburg and are co-facilitated by the association's outreach coordinator together with a team of physiotherapists, occupational therapists and speech therapists. **METHODS:** This cross-sectional study was composed of a convenient sample of 150 caregiver and child pairs from five outreach sites during January - June 2015. The short-form Parent-Caregiver Perception Questionnaire (P-CPQ) was used. The caries status of the children was assessed using the decayed, missing and filled teeth (dmft/DMFT) indices (whereby dmft or DMFT stands for decayed missing filled teeth in primary dentition [dmft] and in permanent dentition [DMFT]) based on World Health Organization guidelines. **RESULTS:** The mean age of the caregivers was 39.52 years (standard deviation [SD] 9.26) and 8.72 years (SD 6.07) for the children. The mean P-CPQ score was 12.88 (SD 12.14). All the caregivers stated that dental caries had a negative impact on the OHRQoL of the CSNs. However, 60% of caregivers stated that an oral condition had no impact on the child's overall well-being. The majority (56.7%) of the caregivers rated their children's overall oral health status as average and only 12% reported the oral health status to be poor. There was a high prevalence of untreated caries among the CSNs regardless of the type of disability. **CONCLUSION:** All the caregivers stated that dental caries had a negative impact on the OHRQoL of the CSNs. However, they appeared to have contradictory perceptions of the oral health needs or status of their children.

PMID: [31934405](#)

21. Gustatory function in persons with cerebral palsy.

Nakashima T, Suzuki H, Sugiura S, Beppu R, Ishida K.

J Oral Rehabil. 2020 Jan 11. doi: 10.1111/joor.12933. [Epub ahead of print]

BACKGROUND: Gustatory function is closely related to chewing and swallowing; however, there are currently no reports regarding gustatory function in persons with cerebral palsy (CP). **OBJECTIVE:** The aim of this study was to compare the gustatory function between persons with CP and healthy controls. **METHODS:** We investigated sweet, salty, sour, and bitter tastes using the whole-mouth method and measured the electrogustometric thresholds in the chorda tympani nerve area. Twelve participants with CP (6 women and 6 men) for whom gustatory testing was possible at our facilities, and 17 age-matched controls (9 women and 8 men) were included. The mean age±standard deviation was 58.6±8.1 years and 58.5±8.7 years in subjects with CP and controls, respectively. **RESULTS:** Taste detection and identification were significantly worse in persons with CP compared with the controls. Taste identification was more impaired than taste detection. At the highest concentration, taste identification was impossible 11 times out of 48 (12 persons x 4 kinds of tastes) in persons with CP but such a deficit was not observed in 68 attempts (17 persons x 4 kinds of tastes) involving controls. The electrogustometric thresholds were not significantly different between the groups. **CONCLUSION:** Gustatory function associated with chewing and swallowing is worse in persons with CP compared to the controls.

PMID: [31925969](#)

22. Safety and Efficacy of RimabotulinumtoxinB for Treatment of Sialorrhea in Adults: A Randomized Clinical Trial.

Isaacson SH, Ondo W, Jackson CE, Trosch RM, Molho E, Pagan F, Lew M, Dashtipour K, Clinch T, Espay AJ; MYSTICOL Study Group.

JAMA Neurol. 2020 Jan 13. doi: 10.1001/jamaneurol.2019.4565. [Epub ahead of print]

IMPORTANCE: RimabotulinumtoxinB (RIMA) may be preferable as an anti-sialorrhea treatment compared with current oral anticholinergic drugs in people with neurological disorders. **OBJECTIVE:** To assess the safety, efficacy, and tolerability of RIMA injections for the treatment of sialorrhea in adults. **DESIGN, SETTING, AND PARTICIPANTS:** This randomized, parallel, double-blind, placebo-controlled clinical trial of RIMA 2500 U and 3500 U was conducted from November 14, 2013, to January 23, 2017. A total of 249 adult patients with troublesome sialorrhea secondary to any disorder or cause were screened. Of them, 13 refused further participation in the study or were lost to follow-up and 49 did not fulfill the criteria for participation; 187 were ultimately enrolled. Patients had to have a minimum unstimulated salivary flow rate (USFR) of 0.2 g/min and a minimum Drooling Frequency and Severity Scale score of 4. **EXPOSURES:** Patients were randomized 1:1:1 to RIMA, 2500 U (n = 63); RIMA, 3500 U (n = 64); or placebo (n = 60). **MAIN OUTCOMES AND MEASURES:** Primary outcomes were the change in USFR from baseline to week 4 and the Clinical Global Impression of Change (CGI-C) at week 4. The CGI-C scores were recorded on a 7-point scale ranging from very much improved to very much worse. Adverse events were recorded throughout the trial period. **RESULTS:** Of 187 patients enrolled (147 men [78.6%]; mean [SD] age, 63.9 [13.3] years), 122 patients had Parkinson disease (65.2%), 13 (7.0%) were stroke survivors, 12 had amyotrophic lateral sclerosis

(6.4%), 6 had medication-induced sialorrhea (3.2%), 4 had adult cerebral palsy (2.1%), and 30 had sialorrhea owing to other causes (16.0%). A total of 176 completed the study. Treatment with both doses of RIMA significantly reduced USFR at week 4 vs placebo (mean treatment difference, -0.30 g/min [95% CI, -0.39 to -0.21] for both doses vs placebo, $P < .001$). The CGI-C scores were statistically significantly improved at week 4 for both treatment groups vs placebo (-1.21 [95% CI, -1.56 to -0.87] for 2500 U, -1.14 [95% CI, -1.49 to -0.80] for 3500 U, both $P < .001$). Treatment benefits were seen as early as 1 week after injection and were maintained over the treatment cycle of approximately 13 weeks. The RIMA injections were well tolerated compared with placebo. The most common adverse events were self-limited mild to moderate dry mouth, dysphagia, and dental caries. **CONCLUSIONS AND RELEVANCE:** Treatment with RIMA (2500 U and 3500 U) in adults was well tolerated and reduced sialorrhea, with the onset of the effect at 1 week after the injection. These data support the clinical use of RIMA in the management of sialorrhea in adults. **TRIAL REGISTRATION:** ClinicalTrials.gov identifier: NCT01994109.

PMID: [31930364](#)

23. An Exploratory Study of Depot-Medroxyprogesterone Acetate and Bone Mineral Density in Adolescents and Young Adult Women with Cerebral Palsy.

Claire Roden R, Noritz G, McKnight ER, Bonny AE.

Contraception. 2020 Jan 11. pii: S0010-7824(19)30498-6. doi: 10.1016/j.contraception.2019.12.009. [Epub ahead of print]

OBJECTIVE: To explore whether use of depot-medroxyprogesterone acetate (DMPA) in adolescent and young adult females with cerebral palsy is associated with lower bone mineral density (BMD). **METHODS:** A chart review of adolescent and young adult females with cerebral palsy who had undergone dual-energy X-ray absorptiometry, comparing BMD among those with (n=19) and without DMPA (n=84) exposure. **RESULTS:** BMD was similar in patients with and without DMPA exposure. All patients had low BMD, with average z-scores of less than -2 at most sites. **CONCLUSION:** Results suggest that DMPA is not associated with lower BMD in non-ambulatory adolescent and young adult females with cerebral palsy.

PMID: [31935387](#)

24. Impact of Iron Deficiency Anemia on Functional Abilities and Muscle Strength in Children with Spastic Cerebral Palsy.

El Shemy SA, Amer FE, Madani HA.

Pak J Biol Sci. 2019 Jan;22(5):214-219. doi: 10.3923/pjbs.2019.214.219.

BACKGROUND AND OBJECTIVE: The most common nutritional deficiency is iron deficiency that leads to anemia. The purpose of the study was to investigate the impact of iron deficiency anemia on functional abilities and muscle strength in children with spastic cerebral palsy. **MATERIALS AND METHODS:** One hundred children with spastic CP from both gender ranging in age from 4-6 years participated in this study. They were selected from the Outpatient Clinic of Pediatrics, Faculty of Physical Therapy, Cairo University. The selected children were assigned into 2 groups of equal number i.e., 5 children in each group. Group A included 50 anemic spastic CP children and Group B included 50 non-anemic spastic CP children. All children were evaluated for hemoglobin, serum iron, functional abilities, hand grip strength and knee extensor strength. **RESULTS:** The results showed statistically significant differences in all measured variables between both groups in favor of group B ($p < 0.05$). Additionally, there were strong positive significant correlations between hemoglobin and motor skills and muscle strength as well as serum iron and all measured variables. **CONCLUSION:** Iron deficiency anemia had a negative impact on functional abilities and strength. Anemic children had a lower motor function scores and strength compared to non-anemic children.

PMID: [31930864](#)

25. Ongoing sleep disruption in a 5-year-old child with cerebral palsy, cortical blindness and a history of pre-natal cerebral haemorrhage.

Rosen D.

J Paediatr Child Health. 2020 Jan 13. doi: 10.1111/jpc.14772. [Epub ahead of print]

PMID: [31943456](#)

26. Joystick Grip for Electric Wheelchair for Tension-Athetosis-Type Cerebral Palsy.

Ogata Y, Katsumura M, Yano K, Nakao T, Hamada A, Torii K.

Conf Proc IEEE Eng Med Biol Soc. 2019 Jul;2019:1666-1669. doi: 10.1109/EMBC.2019.8857419.

In Japan, the number of people who have difficulty walking has been increasing with the rise in the aging population and that of people with physical disabilities. Individuals with athetosis-type cerebral palsy may use electric wheelchairs due to abnormal walking. However, since they have problems with fine motor control, including the occurrence of involuntary movements and difficulty maintaining posture, they have difficulty intentionally controlling their hand movements. Therefore, they cannot operate a joystick, even if they desire to use electric wheelchairs, and there are risks of accidents. In this study, by considering the arch structure of hand, we developed a new joystick grip that enables the suppression of involuntary movement. We evaluated our proposed grip by comparing running stability with a conventional grip, and demonstrated the effectiveness of proposed method.

PMID: [31946216](#)

27. Dynamic Activation Patterns of the Motor Brain Revealed by Diffuse Optical Tomography.

Khan AF, Zhang F, Yuan H, Ding L.

Conf Proc IEEE Eng Med Biol Soc. 2019 Jul;2019:6028-6031. doi: 10.1109/EMBC.2019.8857370.

Diffuse optical tomography (DOT), a subset of functional near-infrared spectroscopy (fNIRS), is a noninvasive functional imaging modality for studying the human brain in normal and diseased conditions. It measures changes in concentrations of oxygenated hemoglobin (HbO) and deoxygenated hemoglobin (Hb) in the blood vasculature of the brain. In contrast to functional magnetic resonance imaging (fMRI), the gold standard in human brain imaging, DOT offers the advantage of higher temporal resolution, portability, lower cost, multiple contrasts and usability for persons who cannot otherwise utilize MRI-based imaging modalities, including bedridden patients and infants, etc. The goal of the present study was to evaluate performance of a DOT method in studying dynamic patterns of brain activations involving motor control. CW-fNIRS data were acquired in four sessions from a healthy male participant when he performed a motor task in a block-design experiment. Results from experimental data showed pronounced activity in the primary motor cortex (M1), contralateral to the clenching hand. It was further observed that the M1 activity was consistent over four sessions. Furthermore, temporal dynamics of motor activity at each session further revealed well-sequenced activation patterns among M1, premotor cortex (PMC), and supplementary motor area (SMA). Timed ipsilateral motor activity suppression was also observed several seconds after the onset of contralateral M1 activity. More importantly, these temporal dynamics were similarly observed in all four sessions. These preliminary results suggest that the DOT method has the sensitivity, reliability, and spatio-temporal resolutions to study activities originated from the motor cortices. A full-scope evaluation and validation in more participants on the motor system can establish it as a promising neuroimaging tool to study, such as, infants at the risk of cerebral palsy or elders with Parkinson's due to its portability and usability in clinical environments.

PMID: [31947220](#)

28. Integration of Forearm sEMG Signals with IMU Sensors for Trajectory Planning and Control of Assistive Robotic Arm.

Schabron B, Reust A, Desai J, Yihun Y.

Conf Proc IEEE Eng Med Biol Soc. 2019 Jul;2019:5274-5277. doi: 10.1109/EMBC.2019.8856699.

Patients with issues such as cerebral palsy, spinal cord injury, and multiple sclerosis have difficulties with activities of daily living (ADL). Their abilities to perform tasks can be improved through vigorous physical therapy. When that therapy is either

not effective or lacking in its progression an assistive robotic device can be used to improve patients' quality of life and help them in accomplishing ADL's. This study presents implementation of an EMG controlled assistive robotic arm to aid patients with upper limb mobility limitations. Using the MYO armband, EMG signals were obtained from three healthy human test subjects and were analyzed in MATLAB® Simulink®. Post signal acquisition, signals were classified to be used as inputs for a Kinova MICO 6 DOF manipulator. Trajectories are planned based on the user EMG signals and robot position data obtained from the Polhemus 6D motion tracker, an IMU-type sensor, which automatically provide position and orientation data. An inverse dynamics controller is developed to drive the robot joints accordingly. Results have shown that the classification accuracy of the EMG signals to control commands for the robot was greater than 90%. The classification accuracy was achieved through the use of a pattern recognition neural network. This preliminary investigation demonstrates the possible future implementation of the system for its intended application.

PMID: [31947047](#)

29. Artificial Neural Network to Detect Human Hand Gestures for a Robotic Arm Control.

Schabron B, Alashqar Z, Fuhrman N, Jibbe K, Desai J.

Conf Proc IEEE Eng Med Biol Soc. 2019 Jul;2019:1662-1665. doi: 10.1109/EMBC.2019.8857264.

Assistive technology is critical to improving daily life of those with muscular issues such as Cerebral Palsy and Duchenne Muscular Dystrophy by augmenting their activities of daily living (ADL). Robotic manipulators are one solution for helping with ADL; however, intuitive, accurate interfaces for higher degrees of freedom (DOF) robotic arms are still lacking. An intuitive control system based on artificial neural network (ANN) classification of real-time surface electromyography (sEMG) signals from the user's forearm to detect nine hand gestures and control the movement of the 6 DOF robotic arm is proposed in this paper. The regular machine learning classifiers with the highest classification accuracies were ensemble-bagged trees at 90.3% and cubic SVM at 89.6%, with linear SVM being 84.8%. However, the classifier chosen was a scaled conjugate gradient backpropagation neural network model, with a classification accuracy of 85%, due to accuracy and usability in a Simulink model. The trained ANN model was incorporated into the control system for the robotic arm and tested in virtual environment. Preliminary testing of the robotic arm shows that the forward kinematic control system works well for most hand poses. Future improvements will include more processing of the sEMG signals and training on sEMG data from multiple subjects for a generalized ANN model.

PMID: [31946215](#)

30. Autism spectrum disorder and attention-deficit/hyperactivity disorder in children with cerebral palsy: results from screening in a population-based group.

Påhlman M, Gillberg C, Wentz E, Himmelmann K.

Eur Child Adolesc Psychiatry. 2020 Jan 11. doi: 10.1007/s00787-020-01471-1. [Epub ahead of print]

Autism spectrum disorder (ASD) and attention-deficit/hyperactivity disorder (ADHD) are more common in children with cerebral palsy (CP) than in the general population, but may still be underdiagnosed. This study aimed to estimate screen-positive ASD and ADHD in a population-based group of 264 school-aged children with CP born 1999-2006 from the CP register of western Sweden. Validated parent-completed questionnaires were used at a median age of 12 years 11 months (range 8-17 years). Three different scales were used to detect signs of ASD and ADHD, respectively. Response rate was 88% (232/264). In 19 children, all in the most disabled group, the screening procedure was not feasible due to too few questionnaire items completed, leaving 213 for analyses. One third (74/213) of the children screened positive for ASD and half of the children (106/213) for ADHD, which was about twice as often as ASD/ADHD diagnoses had been clinically identified. Children with intellectual disability, epilepsy and/or impaired speech ability more often screened positive for ASD as well as ADHD. Severe motor impairment was more frequently associated with screen-positive ASD, but not ADHD. Neither sex nor CP type was associated with screen-positive ASD/ADHD. In conclusion, school-aged children with CP very often screened positive for ASD and/or ADHD. The prevalence of ASD and ADHD is most likely underestimated in children with CP. These screening findings require further investigations.

PMID: [31927764](#)

31. Another look at returns to birthweight.

Maruyama S, Heinesen E.

J Health Econ. 2019 Nov 27;70:102269. doi: 10.1016/j.jhealeco.2019.102269. [Epub ahead of print]

We revisit the causal effect of birthweight. Because variation in birthweight in developed countries primarily stems from variation in gestational age rather than intrauterine growth restriction, we depart from the widely-used twin fixed-effects estimator and employ an instrumental variable - the diagnosis of placenta previa, which provides exogenous variation in gestation length. We find protective effects of additional birthweight against infant mortality and health capital loss, such as cerebral palsy, but in contrast to sibling and twin studies, no strong evidence for non-health long-run outcomes, such as test scores. We also find that short-run birthweight effects have diminished significantly over the decades.

PMID: [31951828](#)**32. Development of a Wearable Sensor Network for Quantification of Infant General Movements for the Diagnosis of Cerebral Palsy.**

Redd CB, Barber LA, Boyd RN, Varnfield M, Karunanithi MK.

Conf Proc IEEE Eng Med Biol Soc. 2019 Jul;2019:7134-7139. doi: 10.1109/EMBC.2019.8857377.

Qualitative assessments of infant spontaneous movements can be performed to measure neurodevelopmental status and provide early insight into the presence of any abnormalities. Clinical assessments of infant movements at 12 weeks post term age are up to 98% predictive of the eventual development of Cerebral Palsy, but their reach is often limited to infants already identified as high-risk within the traditional healthcare system. We present the development of a network of wearable sensors designed to noninvasively measure spontaneous movements in infants from 12-20 weeks post-term- age both within the clinic and for future home use. Pilot data on a single healthy term infant is presented to demonstrate clinical functionality towards future validation studies in infants at high-risk of Cerebral Palsy. Using this system for tele- delivered assessments in the home could enhance screening of neurodevelopmental disorders for infants and families in rural and remote areas, a population with reduced health services.

PMID: [31947480](#)**33. Automatically Identified Micro-scale Sharp-wave Transients in the Early-Latent Phase of Hypoxic-Ischemic EEG from Preterm Fetal Sheep Reveal Timing Relationship to Subcortical Neuronal Survival.**

Abbasi H, Bennet L, Gunn AJ, Unsworth CP.

Conf Proc IEEE Eng Med Biol Soc. 2019 Jul;2019:7084-7087. doi: 10.1109/EMBC.2019.8856906.

Perinatal Hypoxic-Ischemia Encephalopathy (HIE) in newborn infants, due to birth-related circumstances such as oxygen deprivation in brain cells, is caused by the disruption in blood flow through the umbilical cord. Subcortical neuronal loss due to the HIE can lead to cerebral palsy and other chronic neurological conditions. Pre-clinical EEG studies using in utero sheep have demonstrated that particular micro-scale HI transients emerge along a suppressed EEG background during a latent phase of 3-6 hours, after a severe HI insult. Whilst the nature of these micro-scale transients is not well understood, it has been hypothesized that such transients may be signatures of the evolving hypoxic-ischemic brain injury, possessing the potential to be served as the diagnosis biomarkers for the injury. Cerebral hypothermia is optimally neuroprotective only if administered within the first 2-3 hours post HI insult. Using data from a cohort of in utero preterm fetal sheep (n=5, at 0.7 of gestational age), this paper indicates how the number of automatically quantified micro-scale sharp wave transients from asphyxiated preterm fetal sheep, statistically correlate to the amount of NeuN-positive neurons measured in caudate nucleus of striatum. Different temporal window sizes of 2hrs, 1hr, ½hr and 10mins within the early phase of the latent phase are examined using our developed Wavelet Type-2 Fuzzy classifier for sharp detection. Analyses were narrowed down to 10min intervals to assess where exactly in time the occurrence of the HI micro-scale sharp waves demonstrate a significant correlation. Signal processing wise, results from the sub-windows indicate a timing trend that highlights a positive correlation, between the number of automatic quantifications and the amount of surviving neurons in the preterm brain, permitting the possibility of a point of care (POC) intervention to stop the spread of injury before it becomes irreversible.

PMID: [31947469](#)

34. Establishing Pose Based Features Using Histograms for the Detection of Abnormal Infant Movements.

McCay KD, Ho ESL, Marcroft C, Embleton ND.

Conf Proc IEEE Eng Med Biol Soc. 2019 Jul;2019:5469-5472. doi: 10.1109/EMBC.2019.8857680.

The pursuit of early diagnosis of cerebral palsy has been an active research area with some very promising results using tools such as the General Movements Assessment (GMA). In this paper, we conducted a pilot study on extracting important information from video sequences to classify the body movement into two categories, normal and abnormal, and compared the results provided by an independent expert reviewer based on GMA. We present two new pose-based features, Histograms of Joint Orientation 2D (HOJO2D) and Histograms of Joint Displacement 2D (HOJD2D), for the pose-based analysis and classification of infant body movement from video footage. We extract the 2D skeletal joint locations from 2D RGB images using Cao et al.'s method [1]. Using the MINI-RGBD dataset [2], we further segment the body into local regions to extract part specific features. As a result, the pose and the degree of displacement are represented by histograms of normalised data. To demonstrate the effectiveness of the proposed features, we trained several classifiers using combinations of HOJO2D and HOJD2D features and conducted a series of experiments to classify the body movement into categories. The classification algorithms used included k-Nearest Neighbour (kNN, k=1 and k=3), Linear Discriminant Analysis (LDA) and the Ensemble classifier. Encouraging results were attained, with high accuracy (91.67%) obtained using the Ensemble classifier.

PMID: [31947093](#)

35. A Randomized Trial of Erythropoietin for Neuroprotection in Preterm Infants.

Juul SE1, Comstock BA, Wadhawan R, Mayock DE, Courtney SE, Robinson T, Ahmad KA, Bendel-Stenzel E, Baserga M, LaGamma EF, Downey LC, Rao R, Fahim N, Lampland A, Frantz Iii ID, Khan JY, Weiss M, Gilmore MM, Ohls RK, Srinivasan N, Perez JE, McKay V, Vu PT, Lowe J, Kuban K, O'Shea TM, Hartman AL, Heagerty PJ; PENUT Trial Consortium.

N Engl J Med. 2020 Jan 16;382(3):233-243. doi: 10.1056/NEJMoa1907423.

BACKGROUND: High-dose erythropoietin has been shown to have a neuroprotective effect in preclinical models of neonatal brain injury, and phase 2 trials have suggested possible efficacy; however, the benefits and safety of this therapy in extremely preterm infants have not been established. **METHODS:** In this multicenter, randomized, double-blind trial of high-dose erythropoietin, we assigned 941 infants who were born at 24 weeks 0 days to 27 weeks 6 days of gestation to receive erythropoietin or placebo within 24 hours after birth. Erythropoietin was administered intravenously at a dose of 1000 U per kilogram of body weight every 48 hours for a total of six doses, followed by a maintenance dose of 400 U per kilogram three times per week by subcutaneous injection through 32 completed weeks of postmenstrual age. Placebo was administered as intravenous saline followed by sham injections. The primary outcome was death or severe neurodevelopmental impairment at 22 to 26 months of postmenstrual age. Severe neurodevelopmental impairment was defined as severe cerebral palsy or a composite motor or composite cognitive score of less than 70 (which corresponds to 2 SD below the mean, with higher scores indicating better performance) on the Bayley Scales of Infant and Toddler Development, third edition. **RESULTS:** A total of 741 infants were included in the per-protocol efficacy analysis: 376 received erythropoietin and 365 received placebo. There was no significant difference between the erythropoietin group and the placebo group in the incidence of death or severe neurodevelopmental impairment at 2 years of age (97 children [26%] vs. 94 children [26%]; relative risk, 1.03; 95% confidence interval, 0.81 to 1.32; P = 0.80). There were no significant differences between the groups in the rates of retinopathy of prematurity, intracranial hemorrhage, sepsis, necrotizing enterocolitis, bronchopulmonary dysplasia, or death or in the frequency of serious adverse events. **CONCLUSIONS:** High-dose erythropoietin treatment administered to extremely preterm infants from 24 hours after birth through 32 weeks of postmenstrual age did not result in a lower risk of severe neurodevelopmental impairment or death at 2 years of age. (Funded by the National Institute of Neurological Disorders and Stroke; PENUT ClinicalTrials.gov number, NCT01378273.).

PMID: [31940698](#)

36. Machine learning models for identifying preterm infants at risk of cerebral hemorrhage.

Turova V, Sidorenko I, Eckardt L, Rieger-Fackeldey E, Felderhoff-Müser U, Alves-Pinto A, Lampe R.

PLoS One. 2020 Jan 15;15(1):e0227419. doi: 10.1371/journal.pone.0227419. eCollection 2020.

Intracerebral hemorrhage in preterm infants is a major cause of brain damage and cerebral palsy. The pathogenesis of cerebral hemorrhage is multifactorial. Among the risk factors are impaired cerebral autoregulation, infections, and coagulation disorders. Machine learning methods allow the identification of combinations of clinical factors to best differentiate preterm infants with intra-cerebral bleeding and the development of models for patients at risk of cerebral hemorrhage. In the current study, a Random Forest approach is applied to develop such models for extremely and very preterm infants (23-30 weeks gestation) based on data collected from a cohort of 229 individuals. The constructed models exhibit good prediction accuracy and might be used in clinical practice to reduce the risk of cerebral bleeding in prematurity.

PMID: [31940391](#)

37. Automatic Posture and Movement Tracking of Infants with Wearable Movement Sensors.

Airaksinen M, Räsänen O, Ilén E, Häyrynen T, Kivi A, Marchi V, Gallen A, Blom S, Varhe A, Kaartinen N, Haataja L, Vanhatalo S.

Sci Rep. 2020 Jan 13;10(1):169. doi: 10.1038/s41598-019-56862-5.

Infants' spontaneous and voluntary movements mirror developmental integrity of brain networks since they require coordinated activation of multiple sites in the central nervous system. Accordingly, early detection of infants with atypical motor development holds promise for recognizing those infants who are at risk for a wide range of neurodevelopmental disorders (e.g., cerebral palsy, autism spectrum disorders). Previously, novel wearable technology has shown promise for offering efficient, scalable and automated methods for movement assessment in adults. Here, we describe the development of an infant wearable, a multi-sensor smart jumpsuit that allows mobile accelerometer and gyroscope data collection during movements. Using this suit, we first recorded play sessions of 22 typically developing infants of approximately 7 months of age. These data were manually annotated for infant posture and movement based on video recordings of the sessions, and using a novel annotation scheme specifically designed to assess the overall movement pattern of infants in the given age group. A machine learning algorithm, based on deep convolutional neural networks (CNNs) was then trained for automatic detection of posture and movement classes using the data and annotations. Our experiments show that the setup can be used for quantitative tracking of infant movement activities with a human equivalent accuracy, i.e., it meets the human inter-rater agreement levels in infant posture and movement classification. We also quantify the ambiguity of human observers in analyzing infant movements, and propose a method for utilizing this uncertainty for performance improvements in training of the automated classifier. Comparison of different sensor configurations also shows that four-limb recording leads to the best performance in posture and movement classification.

PMID: [31932616](#)

38. Neurodevelopmental outcome descriptions in cohorts of extremely preterm children.

Ding S, Mew EJ, Chee-A-Tow A, Offringa M, Butcher NJ, Moore GP.

Arch Dis Child Fetal Neonatal Ed. 2020 Jan 13. pii: fetalneonatal-2019-318144. doi: 10.1136/archdischild-2019-318144. [Epub ahead of print]

BACKGROUND AND OBJECTIVES: Caregivers and clinicians of extremely preterm infants (born before 26 weeks' gestation) depend on long-term follow-up research to inform clinical decision-making. The completeness of outcome reporting in this area is unknown. The objective of this study was to evaluate the reporting of outcome definitions, selection, measurement and analysis in existing cohort studies that report on neurodevelopmental outcomes of children born extremely preterm. **METHODS:** We evaluated the completeness of reporting of 'cognitive function' and 'cerebral palsy' in prospective cohort studies summarised in a meta-analysis that assessed the effect of preterm birth on school-age neurodevelopment. Outcome reporting was evaluated using a checklist of 55 items addressing outcome selection, definition, measurement, analysis, presentation and interpretation. Reporting frequencies were calculated to identify strengths and deficiencies in

outcome descriptions. RESULTS: All 14 included studies reported 'cognitive function' as an outcome; nine reported both 'cognitive function' and 'cerebral palsy' as outcomes. Studies reported between 26% and 46% of the 55 outcome reporting items assessed; results were similar for 'cognitive function' and 'cerebral palsy' (on average 34% and 33% of items reported, respectively). Key methodological concepts often omitted included the reporting of masking of outcome assessors, methods used to handle missing data and stakeholder involvement in outcome selection. CONCLUSIONS: The reporting of neurodevelopmental outcomes in cohort studies of infants born extremely preterm is variable and often incomplete. This may affect stakeholders' interpretation of study results, impair knowledge synthesis efforts and limit evidence-based decision-making for this population.

PMID: [31932362](#)

39. Neuronal vulnerability to fetal hypoxia-reoxygenation injury and motor deficit development relies on regional brain tetrahydrobiopterin levels.

Vasquez-Vivar J, Shi Z, Jeong JW, Luo K, Sharma A, Thirugnanam K, Tan S.

Redox Biol. 2020 Jan;29:101407. doi: 10.1016/j.redox.2019.101407. Epub 2019 Dec 12.

Hypertonia is pathognomonic of cerebral palsy (CP), often caused by brain injury before birth. To understand the early driving events of hypertonia, we utilized magnetic resonance imaging (MRI) assessment of early critical brain injury in rabbit fetuses (79% term) that will predict hypertonia after birth following antenatal hypoxia-ischemia. We examined if individual variations in the tetrahydrobiopterin cofactor in the parts of the brain controlling motor function could indicate a role in specific damage to motor regions and disruption of circuit integration as an underlying mechanism for acquiring motor disorders, which has not been considered before. The rabbit model mimicked acute placental insufficiency and used uterine ischemia at a premature gestation. MRI during the time of hypoxia-ischemia was used to differentiate which individual fetal brains would become hypertonic. Four brain regions collected immediately after hypoxia-ischemia or 48 h later were analyzed in a blinded fashion. Age-matched sham-operated animals were used as controls. Changes in the reactive nitrogen species and gene expression of the tetrahydrobiopterin biosynthetic enzymes in brain regions were also studied. We found that a combination of low tetrahydrobiopterin content in the cortex, basal ganglia, cerebellum, and thalamus brain regions, but not a unique low threshold of tetrahydrobiopterin, contributed etiologically to hypertonia. The biggest contribution was from the thalamus. Evidence for increased reactive nitrogen species was found in the cortex. By 48 h, tetrahydrobiopterin and gene expression levels in the different parts of the brain were not different between MRI stratified hypertonia and non-hypertonia groups. Sepiapterin treatment given to pregnant dams immediately after hypoxia-ischemia ameliorated hypertonia and death. We conclude that a developmental tetrahydrobiopterin variation is necessary with fetal hypoxia-ischemia and is critical for disrupting normal motor circuits that develop into hypertonia. The possible mechanistic pathway involves reactive nitrogen species.

PMID: [31926630](#)

40. Factors Associated with Neurodevelopmental Impairment in Bronchopulmonary Dysplasia.

Bauer SE, Schneider L, Lynch SK, Malleske DT, Shepherd EG, Nelin LD.

J Pediatr. 2020 Jan 8. pii: S0022-3476(19)31553-7. doi: 10.1016/j.jpeds.2019.11.016. [Epub ahead of print]

OBJECTIVE: To identify factors associated with neurodevelopmental impairment (NDI) in patients with bronchopulmonary dysplasia (BPD). STUDY DESIGN: We identified 151 patients with moderate to severe BPD from 2010 to 2014 with complete Bayley Scales of Infant Development (BSID) scores at 24 months corrected age. We defined NDI as any diagnosis of cerebral palsy or ≥ 1 BSID composite scores of < 80 . RESULTS: The mean corrected age at BSID was 23 ± 1 months; 18% had a cognitive score of < 80 , 37% had a communication score of < 80 , and 26% had a motor score of < 80 . Cerebral palsy was diagnosed in 22 patients (15%); 84 (56%) patients did not have NDI. Patients with NDI had lower birth weight, but there was no difference in gestational age at birth, severe intraventricular hemorrhage (IVH), necrotizing enterocolitis, or patent ductus arteriosus ligation compared with patients with no NDI. Ventilator days were greater in patients with NDI than in patients without NDI. More patients with NDI received furosemide and systemic corticosteroids and the hospital length of stay was longer than in patients with no NDI. Logistic regression modeling demonstrated that for every additional 100 g of birth weight the odds of NDI decreased by 35% and for every additional hospital day the odds of NDI increased by 1.3%. CONCLUSIONS: In our cohort of patients with moderate to severe BPD, the majority had no NDI, and low birth weight and length of hospital stay were associated with increased risk of developing NDI. This finding suggests that there are potentially modifiable factors associated with better neurodevelopmental outcomes in patients with BPD that deserve further study.

PMID: [31926665](#)

41. A Solution-Focused Coaching Intervention with Children and Youth with Cerebral Palsy to Achieve Participation-Oriented Goals.

Schwellnus H, King G, Baldwin P, Keenan S, Hartman LR.

Phys Occup Ther Pediatr. 2020 Jan 15:1-18. doi: 10.1080/01942638.2020.1711841. [Epub ahead of print]

Background: The ultimate goal of therapeutic intervention is meaningful participation in one's world. For people with Cerebral Palsy (CP), limitations can often become a focus of care. **Aim:** Our purpose was to investigate the impact of a Solution-Focused Coaching intervention designed for pediatric rehabilitation (SFC-peds) on the attainment of participation goals for children/youth with CP. **Method:** Twelve participants participated in a repeated measures quantitative study and in qualitative interviews. Children and youth (ages 6-19) and their families participated in three to five coaching sessions, including an initial baseline goal setting session, with one additional follow-up session as well as the qualitative interviews. The Canadian Occupational Performance Measure and Goal Attainment Scaling were incorporated into initial coaching sessions and then re-administered by a blind assessor within one month post-intervention. Qualitative interviews were conducted at this time. **Results:** Statistically significant improvements were found in goal performance, satisfaction, and attainment. Interview data included consideration of both the content of the intervention (what the practitioner is doing) and the unique SFC-peds process (how the client feels about the intervention). **Conclusions:** SFC-peds may present an effective approach for working with children/youth with CP to achieve self-selected participation-oriented goals in a relatively short time-period.

PMID: [31939337](#)

42. Effects of the Parenting Efficacy Improvement Program for mothers as primary caregivers of children with cerebral palsy under rehabilitation.

Kim DJ, Kim YJ.

J Exerc Rehabil. 2019 Dec 31;15(6):763-768. doi: 10.12965/jer.1938654.327. eCollection 2019 Dec.

The purpose of this study was done to determine the effect of a Parenting Efficacy Improvement Program (PEIP) to mothers of cerebral palsy. To investigate the PEIP on parenting efficacy and parenting stress. 60 subjects were composed with experimental group (n=30) and control group (n=30). The study was performed in the rehabilitation ward and rehabilitation daytime ward of National Health Insurance Service Ilsan Hospital in Goyang, Gyeonggi-do, Korea. The data were analyzed by chi-square test, independent t-test, and two-way repeated analysis of variance design using IBM SPSS Statistics ver. 20.0. Experimental group showed significantly improved parenting efficacy than that of control group ($F=295.79, P<0.001$) and experimental group showed significant decrease parenting stress than that of control group ($F=138.76, P<0.001$). The effect of a PEIP in this study was certainly improve parenting efficacy, decreased the parenting stress of cerebral palsy patient's mothers. This program can be deployed as a proper nursing intervention on mothers of patients with cerebral palsy.

PMID: [31938696](#)

43. Understanding Children with Cerebral Palsy and Bullying: A Mixed Methods-Approach.

Stang K, Frainey B, Tann B, Ehrlich-Jones L, Deike D, Gaebler-Spira D.

Child Care Health Dev. 2020 Jan 10. doi: 10.1111/cch.12740. [Epub ahead of print]

AIM: To explore the views of children with cerebral palsy (CP) regarding their experiences being bullied and their perceptions of their primary bully. **METHOD:** Forty-three children aged 10-18 with CP were given the California Bullying Victimization Scale (CBVS). Fourteen of the children shared a bullying experience orally or written after the survey. Using a mixed-methods analysis, the survey answers were tabulated with descriptive statistics and analyzed by Gross Motor Function Classification

Scale (GMFCS) level. The comments were coded to determine qualitative responses. RESULTS: Most bullied children viewed the bully as less than or at least equal to them regarding popularity (73%), performance in schoolwork (85%), and physical strength (56%). Bullied children preferentially told an adult at home. Code words and common categories of bullying were determined from their experiences. INTERPRETATION: Children with CP experience bullying but don't view themselves as inferior to their bully in popularity, intelligence, or physical strength. Most bullied participants confided in an adult at home. Children with GMFCS 1, 2, and 3 seem to be at greater risk for bullying than children with GMFCS 4 and 5. Children with CP demonstrate individualized strategies for resilience with reliance on adults for resources.

PMID: [31925803](#)

44. STATURE ESTIMATE OF CHILDREN WITH CEREBRAL PALSY THROUGH SEGMENTAL MEASURES: A SYSTEMATIC REVIEW.[Article in English, Portuguese]

Lamounier JA, Marteletto NM, Calixto CA, Andrade MR, Tibúrcio JD.

Rev Paul Pediatr. 2020 Jan 13;38:e2018185. doi: 10.1590/1984-0462/2020/38/2018185. eCollection 2020.

OBJECTIVE: To review studies that evaluate the correspondence between the estimate height via segmental measures and the actual height of children with cerebral palsy. DATA SOURCES: Systematic literature review between 1995-2018, guided by the PRISMA criteria (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), in PubMed, BVS, MEDLINE and Lilacs databases. The descriptors, connected by the AND Boolean Operators, were: anthropometry, cerebral palsy, child and body height. The research comprised papers in Portuguese, English and Spanish, with Qualis-CAPES equal or superior to B3 that addressed the question: "Is there any correlation between estimate height by equations and direct height measures in children with cerebral palsy?" 152 studies were recovered and seven were selected. Their methodological quality was assessed by the scale of the Agency for Healthcare Research and Quality (AHRQ). DATA SYNTHESIS: Most studies showed no correspondence between estimated and real height. Studies that showed coincidence of the measures contain limitations that could jeopardize the results (sample losses, small samples and exclusion of patients with severe contractures, scoliosis and severe cerebral palsy). Japanese researchers developed an equation which harmoniously aligns the statures; the study comprised only Japanese patients, though. CONCLUSIONS: Given the importance of accuracy in height measures to evaluate infant health, it is crucial to carry out more researches in order to safely establish an association between both estimate and real statures. The development of anthropometric protocols, emerged from such researches, would benefit the follow-up of children with severe psychomotor disabilities.

PMID: [31939510](#)