NEWS
Cerebral Palsy Research

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Interventions and Management

1. A validated computational framework to evaluate the stiffness of 3D printed ankle foot orthoses.
Ielapi A, Lammens N, Van Paepegem W, Forward M, Deckers JP, Vermandel M, De Beule M.

Comput Methods Biomech Biomed Engin. 2019 Apr 8:1-8. doi: 10.1080/10255842.2019.1601712. [Epub ahead of print]

The purpose of this study was to create and validate a standardized framework for the evaluation of the ankle stiffness of two designs of 3D printed ankle foot orthoses (AFOs). The creation of four finite element (FE) models allowed patient-specific quantification of the stiffness and stress distribution over their specific range of motion during the second rocker of the gait. Validation was performed by comparing the model outputs with the results obtained from a dedicated experimental setup, which showed an overall good agreement with a maximum relative error of 10.38% in plantarflexion and 10.66% in dorsiflexion. The combination of advanced computer modelling algorithms and 3D printing techniques clearly shows potential to further improve the manufacturing process of AFOs.

PMID: 30958030

2. High-density electromyographic data during isometric contractions of the ankle joint in children with cerebral palsy pre and post BoNT-A treatment.
Wiedemann LG, Ward S, Lim E, Wilson NC, Hogan A, Holobar A, McDaid A.

Data Brief. 2019 Mar 21;24:103840. doi: 10.1016/j.dib.2019.103840. eCollection 2019 Jun.

Understanding the underlying mechanisms leading to progressive muscle pathologies in spastic Cerebral Palsy remains a challenging field of research. Furthermore, Botulinum Neurotoxin-A (BoNT-A) is a frequent intervention to treat spasticity in CP but its effects on neuromuscular properties are not yet fully explored. High-density Electromyographic (HD-EMG) data have been collected before and after BoNT-A injections from children aged 5-15 years during isometric contractions of the ankle joint together with torque output, clinical assessments and demographic details. Data collected from a total of 13 children with and 29 children without spastic CP allow for between-group comparisons and are made available using Mendeley Data (https://doi.org/10.17632/3sbptrk54c.2 and https://doi.org/10.17632/3b98g5fyff.1).

PMID: 30976636

3. Prescribing upper limb orthoses for children with cerebral palsy: a Q methodology study of occupational therapists' decision making.
Garbellini S, Randall M, Steele M, Elliott C, Imms C.

Disabil Rehabil. 2019 Apr 11:1-11. doi: 10.1080/09638288.2019.1573931. [Epub ahead of print]

PURPOSE: This study identified occupational therapists' viewpoints that guide their practice of upper limb orthosis prescription for children with cerebral palsy (CP). METHODS: A qualitative study utilising Q methodology explored participants' viewpoints. Thirty-nine occupational therapists (38 females) were purposively recruited to rank statements generated from interviews of experienced clinicians and peer reviewed and published literature. Statements about reasons for orthoses prescription, were ranked according to what guides decision making the most to least. Data from ranked statements were analysed using by-person factor analysis to reveal the different ways statements were grouped. The resultant factors, based on the average arrangement of statements associated with each factor, were interpreted and named as viewpoints. RESULTS: Viewpoints identified: 1. Potential effect of the orthosis (n = 12 sorts); 2. Biomechanical presentation (n = 12 sorts); and 3. Client/therapist relationship (n = 10 sorts). The "Client's goals" statement was ranked highest across all viewpoints. CONCLUSIONS: Viewpoints identified may inform development of clinical guidelines. Further research is required to (i) identify valid and reliable classification and assessment tools to guide decision making; and (ii) establish the mechanism of the effect of orthotic intervention by considering the link between the biomechanical purpose of the orthosis (e.g., mobilise tissue) and aim of intervention (prevent contracture). Implications for rehabilitation Q methodology provided an opportunity to identify viewpoints of occupational therapists that guide their upper extremity orthosis prescription decision making. Consistent with best-practice, clients' goals were the primary focus of decision making in each viewpoint. It is recommended that clinicians consider the identified viewpoints; 1) the potential effects of the orthosis, 2) the biomechanical presentation of the child, within 3) an established client/therapist relationship when prescribing upper extremity orthoses. Practice guidelines to inform upper limb orthotic intervention may be developed using the identified viewpoints.

PMID: 30973762

4. 3-D lower extremity bone morphology in ambulant children with cerebral palsy and its relation to gait.
Rodolphe B, Lempereur M, Pons C, Houx L, Thepaut M, Borotikar B, Gross R, Brochard S.

Ann Phys Rehabil Med. 2019 Apr 9. pii: S1877-0657(19)30037-5. doi: 10.1016/j.rehab.2019.03.001. [Epub ahead of print]

Changes in lower extremity bone morphology are potential mid- to long-term secondary consequences of cerebral palsy (CP), affecting activity. Little is known about the 3-D morphology of lower-extremity bones in children with CP and the association with gait deviations. The main aim of this study was to describe and compare 3-D lower-extremity bone morphology in ambulant children with unilateral or bilateral CP. Secondary aims were to determine whether certain bone parameters were related to the unilateral or bilateral CP and to quantify the association between bone parameters and gait deviations. Among 105 ambulant children with CP (aged 3 to 17 years), 48 had bilateral CP (Bilat-CP) and 57 had unilateral CP (Unilat-CP); the unaffected limb of children with Unilat-CP was used as control limbs. Fifteen bone parameters were calculated by EOS® biplanar radiography, and the Gait Deviation Index (GDI) was calculated by 3-D gait analysis. Data were compared by descriptive and comparative statistical analysis [ANOVA, principal component analysis (PCA) and focused-PCA]. Mean (SD) neck shaft angle was significantly greater for Unilat-CP than control limbs (134.9° [5.9] vs 131.3° [5]). Mean mechanical tibial angle was significantly smaller (85.8° [6.7] vs 89° [4.6]) and mean femoral torsion was significantly greater (29.4° [1.6] vs 19.1° [11.8]) for Bilat-CP than control limbs. On PCA of the main determinants of 3-D bone morphology, bone shape was more complex with Bilat-CP, with changes in all 3 dimensions of space, than Unilat-CP and control limbs. Few bone parameters were correlated with the GDI in any limbs. In ambulant children with CP, femoral and tibial growth are not affected by the condition. The unilateral or bilateral nature of CP must be considered during treatment to prevent bone deformities and bone morphology affecting gait quality.

PMID: 30978527

5. The Validity and Reliability of a Kinect v2-Based Gait Analysis System for Children with Cerebral Palsy.
Ma Y, Mithraratne K, Wilson NC, Wang X, Ma Y, Zhang Y.

Sensors (Basel). 2019 Apr 7;19(7). pii: E1660. doi: 10.3390/s19071660.

The aim of this study is to evaluate if Kinect is a valid and reliable clinical gait analysis tool for children with cerebral palsy (CP), and whether linear regression and long short-term memory (LSTM) recurrent neural network methods can improve its performance. A gait analysis was conducted on ten children with CP, on two occasions. Lower limb joint kinematics computed from the Kinect and a traditional marker-based Motion Analysis system were investigated by calculating the root mean square errors (RMSE), the coefficients of multiple correlation (CMC), and the intra-class correlation coefficients (ICC2,k). Results showed that the Kinect-based kinematics had an overall modest to poor correlation (CMC-less than 0.001 to 0.70) and an angle

pattern similarity with Motion Analysis. After the calibration, RMSE on every degree of freedom decreased. The two calibration methods indicated similar levels of improvement in hip sagittal (CMC-0.81 ± 0.10 vs. 0.75 ± 0.22)/frontal (CMC-0.41 ± 0.35 vs. 0.42 ± 0.37) and knee sagittal kinematics (CMC-0.85±0.07 vs. 0.87 ± 0.12). The hip sagittal (CMC-0.97±0.05) and knee sagittal (CMC-0.88 ± 0.12) angle patterns showed a very good agreement over two days. Modest to excellent reliability (ICC2,k-0.45 to 0.93) for most parameters renders it feasible for observing ongoing changes in gait kinematics.

PMID: 30959970

6. Reliability of single-day walking performance and physical activity measures using inertial sensors in children with cerebral palsy.
N Gerber C, Carcreff L, Paraschiv-Ionescu A, Armand S, J Newman C.

Ann Phys Rehabil Med. 2019 Apr 9. pii: S1877-0657(19)30033-8. doi: 10.1016/j.rehab.2019.02.003. [Epub ahead of print]

BACKGROUND: There is a lack of objective and reliable tools to measure walking performance in children with cerebral palsy (CP). OBJECTIVE: To evaluate the reliability of inertial measurement units (IMUs) measuring daily-life walking performance and physical activity (PA) in children with CP and healthy controls. METHODS: Algorithms were developed to analyse data collected with IMUs during 2 standard school days of the same week and 1 weekend day in 15 children with CP and 14 controls. Additionally, within a clinical trial, 10 children with CP were measured twice, on the same weekday 2 to 4 weeks apart. Relative and absolute reliabilities of PA (% time walking, standing, sitting/lying) and gait parameters (e.g., velocity, cadence) were evaluated by using the intraclass correlation coefficient (ICC) and minimal detectable change (MDC95), comparing 2 school days of the same week, a school day with a weekend day, and the same weekday 2 to 4 weeks apart. RESULTS: For the 15 children with CP (mean [SD] age 13.5 [3.4] years), ICCs were very high (0.70-0.98) when comparing gait parameters for 2 school days. ICCs were lower when comparing 2 school days for 14 control children (mean [SD] age 13.9 [3.0] years) and lowest when comparing a school day with a weekend day for both CP and control children. ICCs for PA were 0.90-0.91 when measuring the same weekday 2 to 4 weeks apart but were very low when comparing 2 school days of the same week or a school day with a weekend day. MDC95 values were high for both groups and all comparisons but comparable with findings of in-lab studies of similar parameters. CONCLUSIONS: Our IMU and algorithm setup appears to be a reliable tool to measure daily life gait parameters in children with CP when repeatedly measured on 2 school days. PA was also reliably assessed but when measuring the same school day some weeks apart. However, the high MDC95 values question whether the setup can be used as a responsive outcome measure of interventions.

PMID: 30978529

7. Effects of robotic rehabilitation on walking and balance in pediatric patients with hemiparetic cerebral palsy.
Yazıcı M, Livanelioğlu A, Gücüyener K, Tekin L, Sümer E, Yakut Y.

Gait Posture. 2019 Mar 30;70:397-402. doi: 10.1016/j.gaitpost.2019.03.017. [Epub ahead of print]

BACKGROUND: The most prominent characteristics of hemiparetic cerebral palsy (hCP) children are structural and functional asymmetries. These children have low walking speeds, endurance and poor balance. The robotic walking devices repeat and experience symmetrical stepping at the corresponding speed and angles of the lower extremities. RESEARCH QUESTION 1: Are robotic walking devices effective in the development of walking in hCP children who can walk? RESEARCH QUESTION 2: How does the aerobic exercise experience with assisted and symmetrical movement affect the walking and local muscle, peripheral oxygenation of children with hCP? METHODS: This prospective, controlled study included 24 children with hCP. All children attended to a standard physiotherapy rehabilitation (PTR) program (three days a week for 12 weeks); those in the study group (n=12) also attended to an Robotic Gait Training (RGT) program three times a week. Evaluations performed before treatment, after treatment, and at the 3rd month after treatment included assessment of balance, functionality walking and measurements for oxygenation of vastus lateralis muscle and peripheral oxygenation. RESULTS: The evaluations were similar for both groups before treatment. After treatment, walking speed, endurance and peripheral O2 saturation were increased and balance abilities and functional performances improved in the RGT group as compared with the pre-treatment evaluations; these improvements in balance and functional performance were generally preserved after 3 months of treatment. An increase in 6-min walking distance and a partial increase in gross motor functions and functional muscle strength were observed in the control group; however, these abilities were not preserved after the treatment. SIGNIFICANCE: RGT can provide a faster and higher effect on the development of functional muscle strength, balance, walking speed and endurance than the standard PTR program. It improves functional walking performance. RGT can be used for aerobic exercise training in children with walking hCP.

PMID: 30974395

8. Selective dorsal rhizotomy improves muscle forces during walking in children with spastic cerebral palsy.
Kainz H, Hoang H, Pitto L, Wesseling M, Van Rossom S, Van Campenhout A, Molenaers G, De Groote F, Desloovere K, Jonkers I.

Clin Biomech (Bristol, Avon). 2019 Mar 20;65:26-33. doi: 10.1016/j.clinbiomech.2019.03.014. [Epub ahead of print]

BACKGROUND: Selective dorsal rhizotomy aims to reduce spasticity in children with cerebral palsy. Early investigations indicated postoperative weakness, whereas more recent studies showed that selective dorsal rhizotomy either does not change or improves muscle strength. All previous studies assessed muscle strength in a static position, which did not represent the walking situation. The aim of this study was to analyze the influence of selective dorsal rhizotomy on muscle forces during gait. METHODS: Motion capture data of 25 children with spastic cerebral palsy and 10 typically developing participants were collected. A musculoskeletal OpenSim model was used to calculate joint kinematics, joint kinetics and muscle forces during gait. Static optimization and an electromyography-informed approach to calculate muscle forces were compared. A Muscle-Force-Profile was introduced and used to compare the muscle forces during walking before and after a selective dorsal rhizotomy. FINDINGS: Independent of the approach used (electromyography-informed versus static optimization), selective dorsal rhizotomy significantly normalized forces in spastic muscles during walking and did not reduce the contribution of non-spastic muscles. INTERPRETATION: This study showed that selective dorsal rhizotomy improves dynamic muscle forces in children with cerebral palsy and leads to less gait pathology, as shown in the improvement in joint kinematics and joint kinetics. Individual muscle force analyses using the Muscle-Force-Profile extend standard joint kinematics and joint moment analyses, which might improve clinical-decision making in children with cerebral palsy in the future. The reference data of our participants and MATLAB code for the Muscle-Force-Profile are publicly available on simtk.org/projects/muscleprofile.

PMID: 30953917

9. Parental internet search in the field of pediatric orthopedics.
Peterlein CD, Bosch M, Timmesfeld N, Fuchs-Winkelmann S.

Eur J Pediatr. 2019 Apr 10. doi: 10.1007/s00431-019-03369-w. [Epub ahead of print]

Parents whose children are affected by systemic diseases, anomalies, deformities, or further orthopedic defective positions use the Internet to increase their knowledge. However, there have been few studies that focus, as this one does, on Internet enquiries done before the parents contact the pediatric orthopedic surgeon. This study analyzed data gathered through a standardized questionnaire on general habits of Internet use, parents' hardware, age, and educational background of the parents. A total of 521 questionnaires were completed for a response rate of 96%. One-quarter of parents (n = 127) attended the consultation because of a gait anomaly or foot deformity, followed by children with DDH (20%, n = 99), clubfoot (9%, n = 47), and scoliosis (6%, n = 29). Parents of children with clubfoot were especially likely to look for health information online (84%, n = 38), followed by parents of children with scoliosis (69%, n = 20), with DDH (67%, n = 66), and with foot deformity/gait anomaly (49%, n = 62). Most people (97%, n = 295) using the Internet for health research purposes made use of a search engine. Concerning use of social media, respondents with clubfoot children were the most numerous (38%, n = 18). There were 35 parents who intended to discuss the results of their Internet research with the pediatric orthopedic surgeon. Most (84%, n = 254) of the respondents who used the Internet for health research planned to do so again.Conclusion: This study documented that the Internet is an important and popular source of information for parents or caregivers in the field of pediatric orthopedics.Level of evidence: Level II; prospective study What is known: Parents and caregivers often search the Internet for information, particularly before an upcoming operation in the field of orthopedic disorders. What is new: This study provides recent data on parental Internet research in a large study population.

PMID: 30972481

10. Is there evidence of benefits associated with dancing in children and adults with cerebral palsy? A scoping review.
Cherriere C, Robert M, Fung K, Tremblay Racine F, Tallet J, Lemay M.

Disabil Rehabil. 2019 Apr 11:1-8. doi: 10.1080/09638288.2019.1590866. [Epub ahead of print]

PURPOSE: Cerebral palsy is a neurological disorder not only affecting motor functions but also cognitive and psychosocial dimension. Multispecialty therapies are needed to address these dimensions. Dance practice provides multidimensional benefits for people with various neurological disorders and may present a real potential for people with cerebral palsy. A scoping review is conducted to evaluate the impact of dance in children and adults with cerebral palsy, based on the Human

Development Model-Disability Creation Process 2 and its three key concepts: personal factors, environmental factors and life habits. MATERIALS AND METHODS: Studies were selected based on a systematic search of published literature in the following databases PubMed, Medline, EBM Reviews, EMBASE and CINAHL. Studies addressing any concepts on the impact of dance training on motor, cognitive and psychosocial dimensions in people with cerebral palsy were included. RESULTS: Seven studies representing 45 children and 12 adults with cerebral palsy were selected. They had heterogeneous populations, protocols and outcomes measures, but overall covered the three main concepts of the model. Dance may have both motor and social benefits although the evidence remains weak. CONCLUSIONS: Dance appears to be a promising activity for people with cerebral palsy. Recommendations are proposed for future studies. Implications for rehabilitation Cerebral palsy affects motor and cognitive functions and has social repercussions. Dance can be a promising activity for people with a cerebral palsy. Dance may have both motor and social benefits although the evidence remains weak.

PMID: 30973761

11. Normative values and discriminative ability across functional levels of ACTIVLIM-CP, a measure of global activity performance for children with cerebral palsy.
Paradis J, Arnould C, Bleyenheuft Y.

Disabil Rehabil. 2019 Apr 11:1-7. doi: 10.1080/09638288.2019.1573270. [Epub ahead of print]

PURPOSE: This study aims to provide normative values of a global activity performance questionnaire (ACTIVLIM-CP) and investigate its ability to discriminate children with cerebral palsy of various functional levels. METHODS: Parents of 503 typically developing children aged 2-18 years old (mean age ± standard deviation (SD): 9.56 ± 4.62 years) and 285 children with cerebral palsy aged 2-18 years old (mean age ± SD: 10.08 ± 4.09 years) answered ACTIVLIM-CP. To provide normative values, influence of typically developing children's characteristics on ACTIVLIM-CP measures was investigated with a multiple linear regression. A Kruskal-Wallis test and Dunn's post-hoc tests were performed to investigate age differences in ACTIVLIM-CP measures. Discriminative ability of ACTIVLIM-CP was investigated using a one-way analysis of variance and post-hoc tests between children with cerebral palsy who differed in manual and gross motor functional levels. RESULTS: In typically developing children, age was the strongest predictor, explaining 74% of the variance of ACTIVLIM-CP measures ($\beta = 0.86$, $t = 38.21$, $p < 0.001$). ACTIVLIM-CP measure increased with age until 17-18 years old where all children reached the maximal value, although 50% of the children at 12 years old already reached the maximal measure. Normative values were developed for each age bracket. In addition, ACTIVLIM-CP was able to discriminate children with CP's performance measures across most manual ability and gross motor functional levels. CONCLUSIONS: Normative values developed in this study with a representative sample of typically developing children allow clinicians to appraise the functional delay of children with cerebral palsy from the normal development of global activity performance. The good discriminative ability of ACTIVLIM-CP support its precision, construct validity, and clinical relevance to describe global activity limitations in children with cerebral palsy with manual ability levels and gross motor function levels II-V. Implications for rehabilitation Normative data of ACTIVLIM-CP developed with a representative sample of typically developing children can be used with children with CP to differentiate the age effect from the disruption caused by cerebral palsy. ACTIVLIM-CP showed the ability to discriminate across children with cerebral palsy having different manual and gross motor function, highlighting its precision, construct validity, and its clinical relevance to describe limitations in children with manual ability levels and gross motor function levels II-V. ACTIVLIM-CP covers a wide age range, is a cost-effective, easy and freely-available assessment of global activity performance in activities of daily living for clinicians.

PMID: 30973788

12. Effectiveness of paediatric occupational therapy for children with disabilities: A systematic review.
Novak I, Honan I.

Aust Occup Ther J. 2019 Apr 10. doi: 10.1111/1440-1630.12573. [Epub ahead of print]

INTRODUCTION: Paediatric occupational therapy seeks to improve children's engagement and participation in life roles. A wide variety of intervention approaches exist. Our aim was to summarise the best-available intervention evidence for children with disabilities, to assist families and therapists choose effective care. METHODS: We conducted a systematic review (SR) using the Cochrane methodology, and reported findings according to PRISMA. CINAHL, Cochrane Library, MEDLINE, OTSeeker, PEDro, PsycINFO were searched. Two independent reviewers: (i) determined whether studies met inclusion: SR or randomised controlled trial (RCT); an occupational therapy intervention for children with a disability; (ii) categorised interventions based on name, core components and diagnostic population; (iii) rated quality of evidence and determined the strength of recommendation using GRADE criteria; and (iv) made recommendations using the Evidence Alert Traffic Light System. RESULTS: 129 articles met inclusion (n = 75 (58%) SRs; n = 54 (42%)) RCTs, measuring the effectiveness of 52

interventions, across 22 diagnoses, enabling analysis of 135 intervention indications. Thirty percent of the indications assessed (n = 40/135) were graded 'do it' (Green Go); 56% (75/135) 'probably do it' (Yellow Measure); 10% (n = 14/135) 'probably don't do it' (Yellow Measure); and 4% (n = 6/135) 'don't do it' (Red Stop). Green lights were: Behavioural Interventions; Bimanual; Coaching; Cognitive Cog-Fun & CAPS; CO-OP; CIMT; CIMT plus Bimanual; Context-Focused; Ditto; Early Intervention (ABA, Developmental Care); Family Centred Care; Feeding interventions; Goal Directed Training; Handwriting Task-Specific Practice; Home Programs; Joint Attention; Mental Health Interventions; occupational therapy after toxin; Kinesiotape; Pain Management; Parent Education; PECS; Positioning; Pressure Care; Social Skills Training; Treadmill Training and Weight Loss 'Mighty Moves'. CONCLUSION: Evidence supports 40 intervention indications, with the greatest number at the activities-level of the International Classification of Function. Yellow light interventions should be accompanied by a sensitive outcome measure to monitor progress and red light interventions could be discontinued because effective alternatives existed.

PMID: 30968419

13. Densidad mineral ósea e indicadores bioquímicos y hormonales en niños con parálisis cerebral cuadripléjica.
Vasquez-Garibay EM, Álvarez Zaragoza C, García Contreras AA, Larrosa Haro A, Romero Velarde E, Rea Rosas A, Cabrales de Anda JL, Vega Olea IF.

Nutr Hosp. 2019 Apr 8. doi: 10.20960/nh.2262. [Epub ahead of print]

INTRODUCTION: children with cerebral palsy (CP) have multiple risk factors for low bone mineral density or osteoporosis. OBJECTIVE: to explore the association between bone mineral density (BMD) and biochemical and hormonal indicators of bone metabolism in children with quadriplegic cerebral palsy (CP). METHODS: a cross-sectional analytical study included 59 participants from six to 18 years of age with quadriplegic CP. Serum concentrations of calcium, phosphorus, 25OHD metabolite, parathyroid hormone (PTH), alkaline phosphatase, and thyroid hormones were determined using standardized methods. The BMD measurement was obtained from the lumbar spine expressed in g/cm2 and Z-score. Unpaired Student's t-test, Chi-square test, odds ratio and Pearson's correlation were performed. RESULTS: participants with CP and malnutrition had lower serum concentrations of calcium, phosphorus and alkaline phosphatase. Those who had low BMD showed lower serum concentrations of calcium, phosphorus and alkaline phosphatase. Most participants with low and normal BMD had vitamin D deficiency (27.1% and 10%) and insufficiency (35.4% and 30%), respectively. There was a significant correlation between BMD and serum concentrations of calcium, phosphorus, alkaline phosphatase, vitamin D and thyroid-stimulating hormone (TSH). There were no differences in the biochemical and hormonal indicators by level of gross motor function, use of anticonvulsants and oral versus enteral feeding method. CONCLUSION: malnutrition and alteration of vitamin D nutritional status were associated with low BMD and alterations of biochemical indicators of bone metabolism in pediatric patients with quadriplegic CP. The relationship between BMD and biochemical indicators of bone metabolism in children with quadriplegic CP was also demonstrated.

PMID: 30958686

14. Standardized music therapy with and without acclimatization, to improve EEG data acquisition in young children with and without disability.
Chorna O, Emery L, Hamm E, Moore-Clingenpeel M, Shrivastava H, Miller A, Richard C, Maitre NL.

J Neurosci Methods. 2019 Apr 6;321:12-19. doi: 10.1016/j.jneumeth.2019.02.013. [Epub ahead of print]

INTRODUCTION: In young children, EEG data acquisition during stimulation tasks is difficult due to anxiety, movement and behaviorally-related interruptions, especially in those with disabilities. NEW METHOD: We used standardized music therapy (MT) protocols with and without acclimatization, during and prior to time-locked EEG with a published tactile testing protocol. Our prospective study leveraged a larger trial in children with/without cerebral palsy aged 7-27 months. Group1 received no preparation, Group2 received 15-minute MT prior to the EEG session, Group3 received the same as Group2 plus a rubber cap for home practice. All groups received MT procedural support during the EEG session. Sessions were stopped/started to acquire a full dataset. Trials were reviewed using a two-step artifact detection strategy by specialists masked to group allocation. RESULTS: 64 patients were included, 20 each in Groups 2 and 3, and 24 in Group1. Average age was 16.08 ± 6.33 months. All (100%) of children had data of sufficient quality and quantity for outcomes measurement without a second testing visit. There were no differences in useable trials by procedural group, disability status, age or stimulus condition. EEG recording time was shorter in Group3 vs. 1 ($p = 0.02$) and more patients in Group1 required repeat trials compared to Groups2 and 3 ($p = 0.04$ for both). COMPARISON WITH OLD METHOD: Our new methods resulted in no attrition from data loss, an improvement compared to published similar studies with data loss 30-55%. Acclimatization had minimal effects. CONCLUSION: In children under 3, MT protocols result in high rates of EEG data acquisition, decrease behaviorally-related interruptions and session acquisition time. This method is successful for typically developing children and those with cerebral palsy.

PMID: 30965072

15. Simultaneous explantation and implantation of intrathecal pumps: a case series.
Leibold AT, Weyhenmeyer J, Lee A.

J Neurosurg. 2019 Apr 12:1-7. doi: 10.3171/2019.1.JNS18919. [Epub ahead of print]

OBJECTIVE Intrathecal drug delivery devices (IDDDs) are a mainstay in the treatment of spasticity and refractory pain. While these devices have been shown to greatly improve the quality of life for patients, they also have a high perioperative complication and failure rate. A major complication of IDDD implantation is infection. The current standard of care in the treatment of IDDD infection necessitates that the pump be explanted and the infection treated prior to implantation of a new IDDD. This process leads to long hospital stays, interruptions in optimal medical management, and a high risk for dangerous drug withdrawals. The authors describe a technique that allows for the explantation of the infected pump and implantation of a new pump concurrently, which they have named the "Turner Switch" technique in honor of its inventor. METHODS The authors conducted a retrospective analysis of cases of infected IDDDs in which patients underwent simultaneous explantation of the infected pump and implantation of a new pump. Demographics and clinical data were collected. RESULTS Data from a total of 17 patients (11 male, 6 female) who underwent simultaneous IDDD explantation and implantation to treat infections were analyzed from a 3-year period. No patients experienced infection of the newly implanted pump or catheter. Of the 17 patients, 14 (82.4%) had baclofen pumps to treat spasticity and 3 (17.6%) had fentanyl pumps to treat chronic pain. The median hospital stay was 7 days, with 16 of 17 (94.1%) patients able to be discharged home or to a facility with a level of care similar to their preoperative care. All patients ultimately experienced complete resolution of their initial infections. Five patients (29.4%) required a return to the operating room within the next 5 months (for repair of a CSF leak in 2 cases, for treatment of infection at the old pump site in 2 cases, and for treatment of a CSF leak compounded with infection in 1 case). No patient experienced infection of the newly implanted pump or catheter. CONCLUSIONS IDDD infections represent a large portion of morbidity associated with these devices. The current standard of care for deep pump infections requires pump explantation and a course of antibiotics prior to reimplantation of the IDDD. The authors demonstrate the effectiveness of a procedure involving simultaneous explantation of an infected pump and implantation of a new pump on the contralateral side in the treatment of IDDD infections.

PMID: 30978693

16. The Impact of Pediatric Epilepsy on Children and Families: A Multicenter Cross-Sectional Study.
Subki AH, Mukhtar AM, Al-Harbi RS, Alotaibi AK, Mosaad FG, Alsallum MS, Jan MMS.

Clin Pract Epidemiol Ment Health. 2018 Dec 31;14:323-333. doi: 10.2174/1745017901814010323. eCollection 2018.

BACKGROUND AND OBJECTIVES: Epilepsy is considered one of the most prevalent causes of morbidity in children. The aim of this study is to determine how epilepsy impacts the lives of children with epilepsy and their families. METHODS: A translated version of the "Impact of Pediatric Epilepsy Scale" (IPES) questionnaire was completed by the 80 mothers of children with epilepsy, recruited at three hospitals in Jeddah, Saudi Arabia This is a validated self-administered questionnaire used to assess the impact of epilepsy on the lives of the child and family, as well as the quality of life (QoL) of the child. RESULTS: The mean age of children epilepsy was 6.32 years (SD = 3.22). The mean IPES score was 6.28 (SD = 8.42) and the mean child's QoL was 2.85 (SD= 0.83). 87.5% of the mothers rated their child's QoL as low. IPES score was significantly associated with cause of seizure (β=0.259; 95%-CI= 0.263 - 10.334; p = 0.039). Child's QoL was significantly associated with frequency of seizure (β=0.251; 95%-CI= 0.016 - 0.568; p= 0.039) and child's nationality (β=-0.270; 95%-CI -0.252, -0.013; p= 0.031). CONCLUSIONS: Pediatric epilepsy may have a greater impact on the lives of the child and the family when it is not comorbid with cerebral palsy. Quality of life tends to be lower for non-Saudi children, and children with more frequent seizures. Therefore, these groups may need more support in managing the impact that epilepsy has on their daily functioning and quality of life.

PMID: 30972132

17. Behavioural and neurodevelopmental impairment at school age following necrotising enterocolitis in the newborn period.
Hansen ML, Jensen IV, Gregersen R, Juhl SM, Greisen G.

PLoS One. 2019 Apr 11;14(4):e0215220. doi: 10.1371/journal.pone.0215220. eCollection 2019.

AIM: The aim of this study was to evaluate long-term behavioural and neurodevelopmental complications of neonatal

necrotizing enterocolitis at school age. METHOD: This was a historic cohort study comparing all surviving children born in Denmark between 1st of January 2002 and 31st of December 2011 with a diagnosis of necrotizing enterocolitis to a group of children without necrotizing enterocolitis, but same gestational age, birth weight and year of birth. Outcomes were investigated through a parental questionnaire. The primary outcome was the Strength and Difficulties Questionnaire score and secondary outcomes were cerebral palsy and impaired head growth. RESULTS: Response rates were 50% (163 of 328) and 36% (237 of 652) among children with and without necrotizing enterocolitis, respectively. There was a higher rate of abnormal Strength and Difficulties score (23.9 versus 17.8%), moderate/severe cerebral palsy (3.1 versus 0.9%) and small head circumference for age (11.7 versus 7.2%) among children with necrotizing enterocolitis. However, these differences were all statistically insignificant and did not change significantly by adjustment for potential confounders. CONCLUSION: To our knowledge, this study includes the largest cohort of necrotizing enterocolitis children evaluated for possible long-term complications at school age. The increased risks of behavioural- and neurodevelopmental impairments were statistically insignificant, moderate in magnitude and may be of little clinical importance for management in the neonatal period or when planning follow-up.

PMID: 30973924

18. Umbilical artery pH and base excess at birth are poor predictors of neurodevelopmental morbidity in early childhood.
Leinonen E, Gissler M, Haataja L, Andersson S, Rahkonen P, Rahkonen L, Metsäranta M.

Acta Paediatr. 2019 Apr 7. doi: 10.1111/apa.14812. [Epub ahead of print]

AIM: We sought to evaluate the associations between umbilical artery pH and base excess and neurodevelopmental outcome at four years of age. METHODS: This study comprised 84,588 singleton children born alive at term in 2005-2011 in the hospital district of Helsinki and Uusimaa in Finland. Data from the maternity hospital information system were linked to the data from the Medical Birth Register and the Hospital Discharge Register. Neurodevelopmental morbidity included cerebral palsy, epilepsy, intellectual or sensorineural impairment. RESULTS: After adjustment for maternal and perinatal factors, a combination of pH <7.00 and base excess <-16.00 was associated with infant death (adjusted odds ratio 19.97; 95% confidence interval 5.38-74.17). Values of pH 7.00-7.10 was associated with cerebral palsy (adjusted odds ratio 2.40; 95% confidence interval 1.05-5.47). A combination of low five-minute Apgar score and umbilical artery base excess <-16.00 showed the highest positive predictive value (9.1%) for neurodevelopmental impairments. When umbilical artery pH <7.00 was included, a positive predictive value of 25.0% was observed for infant mortality. CONCLUSION: Low umbilical artery pH and base excess at birth were poor predictors of long-term neurodevelopmental morbidity in an unselected population. However, these parameters might be useful in assessing the risk of infant mortality.

PMID: 30955219

19. Thought-based interaction: Same data, same methods, different results?
Scherer R.

PLoS Biol. 2019 Apr 8;17(4):e3000190. doi: 10.1371/journal.pbio.3000190. eCollection 2019 Apr.

Restoration of communication in people with complete motor paralysis-a condition called complete locked-in state (CLIS)-is one of the greatest challenges of brain-computer interface (BCI) research. New findings have recently been presented that bring us one step closer to this goal. However, the validity of the evidence has been questioned: independent reanalysis of the same data yielded significantly different results. Reasons for the failure to replicate the findings must be of a methodological nature. What is the best practice to ensure that results are stringent and conclusive and analyses replicable? Confirmation bias and the counterintuitive nature of probability may lead to an overly optimistic interpretation of new evidence. Lack of detail complicates replicability.

PMID: 30958813

20. [Epidemiology, cost and economic impact of cerebral palsy in Hungary].
Fejes M, Varga B, Hollódy K.

Ideggyogy Sz. 2019 Mar 30;72(3-4):115-122. doi: 10.18071/isz.72.0115. [Article in Hungarian; Abstract available in Hungarian from the publisher]

BACKGROUND AND PURPOSE: The purpose of our communication was to determine the total cost of cerebral paretic patients in Hungary between 0 and 18 years and to assess their impact on the national budget. METHODS: Based on the data of Borsod county we calculated the CP characteristics. The cost of CP was determined by routine care of individuals. Lost Parental Income and Tax were calculated on the basis of average earnings. The ratio of GDP, Health and Social Budget and Health Budget to CP is based on CP annual average cost and frequency. We have developed a repeatable computational model. RESULTS: Of the risk groups, premature birth (30.97%), low birth weight (29.64%), perinatal asphyxia (19.47%) were the most common. Source is unknown of 37.61% of the cases. CP prevalence was 2.1‰. The two-sided (59.7%) and the one-sided (19.0%) spastic pareses dominated. The most serious form is the two-sided spastic paresis (42.5% GMFCS 3-5 degrees). Epilepsy was 22.0%, incontinence was 27%, mental involvement was 46%. Care for one child up to 18 years of age costs an average of 73 million HUF (€ 251,724). The lost family income was 27.36 million HUF (€ 94,345), and lost tax and health care contributions were 14.46 million HUF (€ 49,862). Additionally, 0.525% of the GDP, 0.88% of the full health and social budget and 1.83% of direct medical costs were spent for CP families. CONCLUSION: The cost of CP disease is significant. Costs can be reduced by improving primary prevention. From the perspective of the family and government, it is better to care for families so they can take care of their disabled children.

PMID: 30957466

21. Genetic or Other Causation Should Not Change the Clinical Diagnosis of Cerebral Palsy.
MacLennan AH, Lewis S, Moreno-De-Luca A, Fahey M, Leventer RJ, McIntyre S, Ben-Pazi H, Corbett M, Wang X, Baynam G, Fehlings D, Kurian MA, Zhu C, Himmelmann K, Smithers-Sheedy H, Wilson Y, Ocaña CS, van Eyk C, Badawi N, Wintle RF, Jacobsson B, Amor DJ, Mallard C, Pérez-Jurado LA, Hallman M, Rosenbaum PJ, Kruer MC, Gecz J.

J Child Neurol. 2019 Apr 9:883073819840449. doi: 10.1177/0883073819840449. [Epub ahead of print]

High throughput sequencing is discovering many likely causative genetic variants in individuals with cerebral palsy. Some investigators have suggested that this changes the clinical diagnosis of cerebral palsy and that these individuals should be removed from this diagnostic category. Cerebral palsy is a neurodevelopmental disorder diagnosed on clinical signs, not etiology. All nonprogressive permanent disorders of movement and posture attributed to disturbances that occurred in the developing fetal and infant brain can be described as "cerebral palsy." This definition of cerebral palsy should not be changed, whatever the cause. Reasons include stability, utility and accuracy of cerebral palsy registers, direct access to services, financial and social support specifically offered to families with cerebral palsy, and community understanding of the clinical diagnosis. Other neurodevelopmental disorders, for example, epilepsy, have not changed the diagnosis when genomic causes are found. The clinical diagnosis of cerebral palsy should remain, should prompt appropriate genetic studies and can subsequently be subclassified by etiology.

PMID: 30963790

22. Dyke-Davidoff-Masson syndrome: unusual cause of hemiplegic cerebral palsy.
Sharawat IK, Suthar R, Sankhyan N.

BMJ Case Rep. 2019 Apr 5;12(4). pii: e229862. doi: 10.1136/bcr-2019-229862.

PMID: 30954966

23. A Critical Evaluation of Current Concepts in Cerebral Palsy.
Brandenburg JE, Fogarty MJ, Sieck GC.

Physiology (Bethesda). 2019 May 1;34(3):216-229. doi: 10.1152/physiol.00054.2018.

Spastic cerebral palsy (CP), despite the name, is not consistently identifiable by specific brain lesions. CP animal models focus on risk factors for development of CP, yet few reproduce the diagnostic symptoms. Animal models of CP must advance beyond risk factors to etiologies, including both the brain and spinal cord.

PMID: 30968751

24. Ethics of human enhancement in cerebral palsy.
Dan B, Pelc K.

Ann Phys Rehabil Med. 2019 Apr 9. pii: S1877-0657(19)30038-7. doi: 10.1016/j.rehab.2019.03.002. [Epub ahead of print]

PMID: 30978528

Prevention and Cure

25. Human Umbilical Cord Therapy Improves Long-Term Behavioral Outcomes Following Neonatal Hypoxic Ischemic Brain Injury.
Penny TR, Sutherland AE, Mihelakis JG, Paton MCB, Pham Y, Lee J, Jones NM, Jenkin G, Fahey MC, Miller SL, McDonald CA.

Front Physiol. 2019 Mar 22;10:283. doi: 10.3389/fphys.2019.00283. eCollection 2019.

Background: Hypoxic ischemic (HI) insult in term babies at labor or birth can cause long-term neurodevelopmental disorders, including cerebral palsy (CP). The current standard treatment for term infants with hypoxic ischemic encephalopathy (HIE) is hypothermia. Because hypothermia is only partially effective, novel therapies are required to improve outcomes further. Human umbilical cord blood cells (UCB) are a rich source of stem and progenitor cells making them a potential treatment for neonatal HI brain injury. Recent clinical trials have shown that UCB therapy is a safe and efficacious treatment for confirmed cerebral palsy. In this study, we assessed whether early administration of UCB to the neonate could improve long-term behavioral outcomes and promote brain repair following neonatal HI brain injury. Methods: HI brain injury was induced in postnatal day (PND) 7 rat pups via permanent ligation of the left carotid artery, followed by a 90 min hypoxic challenge. UCB was administered intraperitoneally on PND 8. Behavioral tests, including negative geotaxis, forelimb preference and open field test, were performed on PND 14, 30, and 50, following brains were collected for assessment of neuropathology. Results: Neonatal HI resulted in decreased brain weight, cerebral tissue loss and apoptosis in the somatosensory cortex, as well as compromised behavioral outcomes. UCB administration following HI improved short and long-term behavioral outcomes but did not reduce long-term histological evidence of brain injury compared to HI alone. In addition, UCB following HI increased microglia activation in the somatosensory cortex compared to HI alone. Conclusion: Administration of a single dose of UCB cells 24 h after HI injury improves behavior, however, a single dose of cells does not modulate pathological evidence of long-term brain injury.

PMID: 30967791

26. Minocycline mitigates the effect of neonatal hypoxic insult on human brain organoids.
Boisvert EM, Means RE, Michaud M, Madri JA, Katz SG.

Cell Death Dis. 2019 Apr 11;10(4):325. doi: 10.1038/s41419-019-1553-x.

Neonatal hypoxic injury (NHI) is a devastating cause of disease that affects >60% of babies born with a very low birth weight, resulting in significant morbidity and mortality, including life-long neurological consequences such as seizures, cerebral palsy, and intellectual disability. Hypoxic injury results in increased neuronal death, which disrupts normal brain development. Although animal model systems have been useful to study the effects of NHI, they do not fully represent the uniqueness and complexities of the human brain. To better understand the effects of hypoxia on human brain development, we have generated a brain organoid protocol and evaluated these cells over the course of 6 months. As anticipated, the expression of a forebrain marker, FOXG1, increased and then remained expressed over time, while there was a transition in the expression of the deep-layer (TBR1) and upper-layer (SATB2) cortical markers. In addition, ventral genes (Eng1 and Nkx2.1) as well as markers of specialized nonneuronal cells (Olig2 and GFAP) also increased at later time points. We next tested the development of our in vitro cerebral organoid model at different oxygen concentrations and found that hypoxia repressed gene markers for forebrain, oligodendrocytes, glial cells, and cortical layers, as well as genes important for the migration of cortical neurons. In contrast, ventral markers were either unaffected or even increased in expression with hypoxic insult. Interestingly, the negative effect of hypoxia on the dorsal brain genes as well as oligodendrocytes, and neuronal progenitors could be mitigated by the use of minocycline, an FDA-approved small molecule. Taken together, we have generated a unique and relevant in vitro human brain model system to study diseases such as NHI as well as their potential treatments. Using this system, we have shown the efficacy of minocycline for human NHI.

PMID: 30975982

27. Long-term effects of postnatal corticosteroids to prevent or treat bronchopulmonary dysplasia: Balancing the risks and benefits.
Cheong JLY, Doyle LW.

Semin Fetal Neonatal Med. 2019 Mar 28. pii: S1744-165X(19)30030-7. doi: 10.1016/j.siny.2019.03.002. [Epub ahead of print]

Postnatal corticosteroids are effective in preventing or treating bronchopulmonary dysplasia (BPD) in preterm newborns, but their benefits need to exceed their risks. Several types of corticosteroids, and different timing and administration modes have been trialed. Systemic corticosteroids, given either early or late, have proven efficacy for reducing BPD and the combined outcome of death or BPD. Inhaled corticosteroids are less effective. However, systemic dexamethasone given early is associated with more neurosensory disability and cerebral palsy in survivors. The risk of adverse neurodevelopment is highest if dexamethasone is given to preterm infants at low risk of BPD. Current trials focus on corticosteroids, mixed with surfactant, delivered intratracheally directly to the lung, which may avoid some systemic adverse effects of corticosteroids. Early trials of intratracheal corticosteroids are encouraging, but more data are needed to determine whether this method of administration is preferable to systemic corticosteroids for preventing or treating BPD.

PMID: 30962159