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Interventions and Management

1. Goal attainment after treatment with abobotulinumtoxina and a tailored home therapy programme in children with upper limb spasticity: descriptive, exploratory analysis of a large randomized, controlled study
Jorge Carranza-Del Río, Nigar Dursun, Cigdem Cekmece, Marcin Bonikowski, Weronika Pyrzanowska, Edward Dabrowski, Ann Tilton, Joyce Oleszek, Magali Volteau, Simon Page, Angela Shierk, Mauricio Delgado

Objective: This exploratory analysis of a large, randomized, double-blind study (NCT02106351) describes the effect of treatment with abobotulinumtoxinA followed by a tailored home exercises therapy programme in enabling children with upper limb spasticity due to cerebral palsy to achieve their functional goals using goal attainment scaling (GAS). Methods: Children with cerebral palsy and spasticity in ≥ 1 upper limb received up to 4 injection cycles of abobotulinumtoxinA (2 U/kg (cycle 1 only), 8U/kg and 16U/kg) into the elbow and wrist flexors and other upper limb muscles selected to support individual treatment goals. Children followed a home exercises therapy programme, which included stretches and exercises specifically chosen to facilitate goal achievement and engagement in activities. Results: For cycle 1, most children had active function goals set as their primary goal (69.7% vs 19.2% passive function goals). GAS T- scores and goal responder rates at week 16 indicated that most types of primary goal were achieved at least as expected during cycle 1 (all groups). Primary goal GAS T-scores were generally maintained for the first 3 abobotulinumtoxinA treatment cycles. Conclusion: Most children with upper limb spasticity treated with repeat cycles of abobotulinumtoxinA supported by an individualized home exercises therapy programme achieved their functional goals.

PMID: 36306168

2. Assessment of spinal alignment in children with unilateral cerebral palsy
Doğan Porsnok, Akmer Mutlu, Ayşe Livanelioğlu

Background: Children/youths with unilateral cerebral palsy are at high risk for the development of scoliosis and other postural deformities. The purpose of this study was to perform spinal assessment in the frontal and sagittal plane using Spinal Mouse® in children/youths with unilateral cerebral palsy and to compare their spinal shape and angles with typically developing children/youths. Methods: 25 children/youths with unilateral cerebral palsy and 25 typical children/youths, aged 6-18 years, were included. The subject's frontal (scoliosis) and sagittal plane (kyphosis and lordosis) spinal curvatures were compared by assessing them with Spinal Mouse®. Findings: Scoliosis was detected in 40% of subjects in the unilateral cerebral palsy group and this rate was considerably higher than that in typical subjects (12%). The median angle of scoliosis was 8° in subjects with unilateral cerebral palsy and 5.3° in typical subjects. While the median angle of scoliosis was higher in subjects with unilateral

cerebral palsy than typical subjects (p < 0.001), there was no significant difference in the angles of lordosis and kyphosis between both groups (p > 0.05). Curvature patterns of subjects with unilateral cerebral palsy differed from typical subjects. Interpretation: Our findings will allow children/youths with unilateral cerebral palsy, who are at risk of developing spinal deformity, to be identified earliest possible and included in the intervention. Children/youths with unilateral cerebral palsy have to be assessed in detail from the earliest period, especially when the possibility of an age-related increase in scoliosis is considered.

PMID: 36279632

3. Effectiveness of Botulinum Neurotoxin in Treatment of Scoliosis among Children and Adolescents: A Systematic Review and Meta-Analysis
Yu-Chi Su, Yu-Ching Lin, Pei-Chun Hsieh, Chung-Lun Liao, Yao-Hong Guo

Children (Basel). 2022 Oct 1;9(10):1505. doi: 10.3390/children9101505.

Scoliosis refers to a three-dimensional deviation in the axis of the spine. Muscle imbalance is believed to play a role in scoliosis. Botulinum neurotoxin (BoNT) can reduce muscle overactivity and may have the potential to ameliorate spinal scoliosis. This study investigated the effectiveness of intramuscular BoNT injection in vertebral curve correction and reviewed the possible influencing factors. PubMed, Medline, Cochrane Central Register of Controlled Trials, Web of Science, Airiti Library, and Index of the Taiwan Periodical Literature System databases were searched from inception until 7 September 2022 for eligible studies. The main outcome was the change in Cobb angle after BoNT application. Subgroup analysis was conducted according to differences in study designs, etiology of scoliosis, and methods used for target muscle selection. We enrolled three studies including 31 participants aged between 2 and 18 years. The meta-analysis revealed no significant reduction in the Cobb angle after BoNT injection (standardized mean difference, -0.783, 95% CI, -2.142 to 0.576). Study designs (p = 0.011) and methods used for target muscle selection (p = 0.017) but not etiology of scoliosis (p = 0.997) reached statistical significance between subgroups. In conclusion, the current meta-analysis does not support the application of BoNT in children and adolescents with scoliosis. However, a decisive conclusion could not be made due to high between-study heterogeneity and small sample size. More randomized controlled trials with appropriate target muscle selection and standard outcome measurement should be conducted to examine the efficacy of botulinum neurotoxin in treating scoliosis. INPLASY ID: INPLASY202290031.

PMID: 36291441

4. Current trends in surgical magnitude of neuromuscular scoliosis curves: a study of 489 operative patients with non-ambulatory cerebral palsy
Jenny L Zheng, Patrick J Cahill, Jessica H Heyer, Paul D Sponseller, Burt Yaszay, HARMS Study Group; Keith D Baldwin

Spine Deform. 2022 Oct 22. doi: 10.1007/s43390-022-00604-7. Online ahead of print.

Purpose: A curve magnitude at which posterior spinal fusion (PSF) is indicated for children with cerebral palsy (CP) scoliosis is not defined. We sought to evaluate whether agreement exists for a curve magnitude at which PSF is undertaken for CP scoliosis and to evaluate outcomes by quartile of curve magnitude and flexibility at time of fusion. Methods: A prospective multicenter pediatric spine database was queried for patients with a Gross Motor Function Classification Scale (GMFCS) IV or V who underwent PSF for CP scoliosis. Demographics, surgical indications, and correlations between curve magnitude, postoperative radiographic outcomes, and Caregiver's Priorities and Child Health Index of Life and Disabilities (CPCHILD) scores were evaluated for patients with at least 2 years of follow-up. Results: 489 patients from 15 sites were analyzed. Median major Cobb angle at time of PSF was 87° and significantly varied by site (p < 0.001). Median Cobb angle on flexibility studies was 55° and median percent correction on flexibility studies was 36.3%. Severity of the curve at surgery correlated significantly with lower overall quality of life and CPCHILD score (p < 0.05). Larger residual curves correlated with larger operative curves (p < 0.001) and decreased flexibility on preoperative flexibility studies (p < 0.001), although postoperative CPCHILD scores did not differ by curve size or flexibility at time of fusion or by size of residual curve (p > 0.05). Conclusion: The median curve magnitude is large and there is substantial variability in curve size of CP scoliosis at time of fusion, although clinical outcomes are not negatively influenced by larger operative magnitudes. Further study should aim to narrow surgical indications by defining unacceptable radiographic outcomes. Level of evidence: Level III.

PMID: 36272062

5. Surgical correction of proximal junctional kyphosis

Jamal McClendon, Richard Shindell, Karl R Abi-Aad, Ahmad Kareem Almekkawi, Tanmoy Maiti, Bernard R Bendok

This 3D video showcases the surgical techniques for patients with proximal junctional kyphosis. The surgical repair for patients with proximal junctional kyphosis is an individualized approach depending on patient history and imaging with adequate surgical measurements. This video will shed light on two cases with proximal junctional kyphosis and the method taken for their repair. The first case is of an 11-year-old female known to have osteogenesis imperfecta and status post T5-L3 posterior spinal fusion with segmental instrumentation. The patient underwent change of older instruments and scoliosis repair, with full correction on postoperative x-ray. The second patient is a 16-year-old male known to have cerebral palsy and kyphoscoliosis status post spinal fusion. The patient underwent scoliosis repair surgery with replacement of old instrumentation and scoliosis correction. The video can be found here: https://youtu.be/f5iLwqbU26Q.

PMID: 36284690

6. Use of Epidural Analgesia in Children With Neuromuscular Conditions Following Hip Reconstruction

Sean Tabaie, Aribah Shah, Omar Tarawneh, Grace Blaylock, Evan Sheppard, Kevin Cho

Background: Neuromuscular conditions, such as cerebral palsy, are the most common motor disabilities in the pediatric population. Children with these conditions frequently have accompanying hip deformities that require pelvic and femur osteotomy to correct the spastic hip dislocations. However, postoperative pain management remains an elusive and challenging problem. The purpose of this study was to determine whether postoperative use of epidural analgesia in patients with neuromuscular conditions provided similar outcomes with regard to pain scores, length of stay, duration of foley placement, duration of pain control, and complications as compared to traditional pain management regimens. To our knowledge, this is the first study comparing the use of epidural analgesia to conventional pain relief modalities following hip reconstruction in patients with neuromuscular conditions. Methods: A retrospective cohort study was performed using records of pediatric patients with neuromuscular conditions treated at our tertiary care center between January 2009 and December 2019. Patients with neuromuscular conditions treated with epidural or non-epidural analgesia for pain relief following unilateral or bilateral proximal femoral osteotomies, pelvic osteotomies, or open hip reduction were eligible for study inclusion. Multiple linear regression was used to determine differences in length of stay, pain score, pain modality, duration of Foley placement, and complications between the two cohorts. Results: Seventy patients met the inclusion criteria for the study. In all, 58 patients underwent unilateral procedures, of which 30 (52%) received epidural analgesia, and 28 (48%) received non-epidural pain control modalities. Demographic and baseline characteristics were similar among the cohort, except for BMI, which varied slightly. Average pain scores and pain control duration were not statistically different between the pain control modalities. After controlling for demographics, procedure, and immobilization type, the epidural group experienced significantly increased length of stay (+3.18 days, P=0.032) and duration of Foley placement (+1.04 days, P=.013). Complication rates between the two groups were not statistically significant. Conclusions: The use of epidural analgesia in children with neuromuscular conditions was associated with comparable pain scores, despite the increased length of stay and duration of Foley placement. No statistically significant difference in complication rates was observed between patients receiving epidural anesthesia and those receiving traditional pain modalities.

PMID: 36285108

7. Postoperative Urinary Retention after Pediatric Orthopedic Surgery

Mohan V Belthur, Ian M Singleton, Jessica D Burns, M'hamed H Temkit, Thomas J Sitzman

Purpose: This study aims to describe the incidence of postoperative urinary retention among pediatric patients undergoing orthopedic surgery and identify risk factors. Methods: The Pediatric Health Information System was used to identify children aged 1-18 years who underwent orthopedic surgery. Collected from each patient's record were demographic information,

principal procedure during hospitalization, the presence of neurologic/neuromuscular conditions and other complex chronic medical conditions, the total postoperative length of stay, and the presence of postoperative urinary retention. Results: The overall incidence of postoperative urinary retention was 0.38%. Children with complex chronic neuromuscular conditions (OR 11.54 (95% CI 9.60-13.88), p = < 0.001) and complex chronic non-neuromuscular medical conditions (OR 5.07 (95% CI 4.11-6.25), p ≤ 0.001) had a substantially increased incidence of urinary retention. Surgeries on the spine (OR 3.98 (95% CI 3.28-4.82, p ≤ 0.001) and femur/hip (OR 3.63 (95% CI 3.03-4.36), p ≤ 0.001) were also associated with an increased incidence. Conclusions: Children with complex chronic neuromuscular conditions have a substantially increased risk of experiencing postoperative urinary retention. Complex chronic non-neuromuscular medical conditions and surgeries to the spine, hip, and femur also carry a notably increased risk.

PMID: 36291424

8. Contribution of Different Impairments to Restricted Knee Flexion during Gait in Individuals with Cerebral Palsy
Faustyna Manikowska, Sabina Brazevič, Marek Jóźwiak, Maria K Lebiedowska

J Pers Med. 2022 Sep 23;12(10):1568. doi: 10.3390/jpm12101568.

The coexistence of overlapping impairments modulates the knee pattern in the swing phase of walking in children with cerebral palsy (CP). The impact and contribution of each impairment to the reduction of knee range-of-motion is unknown. The aim of the study was to establish the gradation of the impact of individual coexisting impairments on the knee flexion range-of-motion. Passive range-of-motion, selective motor control, strength, and spasticity from 132 patients (Male = 76, Female = 56, age:11 ± 4 years) with spastic CP were tested with clinical tools. Knee flexion range-of-motion at terminal stance, pre-swing, and initial swing phases were assessed by gait analysis. Hypertonia (β = -5.75) and weakness (β = 2.76) of knee extensors were associated with lower range of knee flexion ($R2$ = 0.0801, F = 11.0963, p < 0.0001). The predictive factors ($R2$ = 0.0744, F = 7.2135, p < 0.0001) were strength (β = 4.04) and spasticity (β = -2.74) of knee extensors and strength of hip flexors (β = -2.01); in swing those were knee extensors hypertonia (β = -2.55) and passive range of flexion (β = 0.16) ($R2$ = 0.0398, F = 3.4010, p = 0.01). Hypertonia of knee extensors has the strongest impact on knee flexion range-of-motion; secondary is the strength of knee extensors. The knee extensors strength with knee extensors hypertonia and strength of hip flexors contributes in stance. Knee extensors hypertonia with passive knee flexion range-of-motion contributes in swing.

PMID: 36294708

9. Mid-Term Results of Distal Femoral Extension and Shortening Osteotomy in Treating Flexed Knee Gait in Children with Cerebral Palsy
Andreas Geisbüsch, Matthias C M Klotz, Cornelia Putz, Tobias Renkawitz, Axel Horsch

Children (Basel). 2022 Sep 20;9(10):1427. doi: 10.3390/children9101427.

Background: Distal femoral extension and shortening osteotomy (DFESO) seems to be an effective method for the treatment of flexed knee gait in children with cerebral palsy. Nevertheless, studies investigating the mid- and long-term outcomes after such procedures are lacking in the literature. Therefore, the purpose of this study was to assess the mid-term outcomes regarding sagittal plane kinematics of the knee after DFESO with or without concomitant patella advancement. Furthermore, an evaluation of the postoperative course and possible recurrence of flexed knee gait was planned. Methods: In a prospective observational study, 19 patients (28 limbs; mean age 11.8 years (6.7-16.0 years)) were examined using 3-D gait analysis and clinical exam before (E0) and at a mean of 38 months (E2: 24-55 months) after surgery. Fifteen patients (22 limbs) had an additional first postoperative gait analysis (E1) after a mean of 14 (10-20) months after surgery. In these patients, the postoperative changes between the short-term and mid-term gait analyses were evaluated. Results: DFESO led to a significant decrease in flexed knee gait with an improvement in sagittal plane kinematics during the stance phase. In addition, a slightly increased anterior pelvic tilt was observed at E1, and we found a tendency towards stiff knee gait with a decrease in mean knee flexion in swing at E2. Conclusions: DFESO led to a significant improvement in flexed knee gait in children with cerebral palsy. The therapeutic effect seems to be lasting on mid-term follow-up with a slight overall tendency to recurrence.

PMID: 36291363

10. Selective motor control correlates with gross motor ability, functional balance and gait performance in ambulant children with bilateral spastic cerebral palsy

Guojun Yun, Meihuan Huang, Jianguo Cao, Xianming Hu

Background: Selective motor control (SMC) is a fundamental component of typical human motion. As a result of brain damage, impaired SMC often leads to difficulties with coordination, balance, gait efficiency and symmetry. Research question: What is the association between impaired SMC and lower limb motor ability, functional balance and gait performance in children with bilateral spastic cerebral palsy (CP)? Methods: Thirty-six children (aged 5-16 years) with spastic bilateral CP in Gross Motor Function Classification System (GMFCS) level I to II were included in this study. SMC was assessed using Selective Control Assessment of the Lower Extremity (SCALE). Gross motor function was assessed using Gross Motor Function Measure-88 items D and E dimension (GMFM-88 D&E). Functional balance was assessed using Pediatric Balance Scale (PBS) and Timed Up and Go Test (TUG). Gait quality was assessed using Edinburg Visual Gait Score (EVGS) and 10-Meter Walk Test (10MWT). Spearman's rank correlation analyses were used to determine the association between SMC and other factors. Results: Correlation analyses showed that SCALE was strongly positively correlated with GMFM-88 (D&E) (rs=0.756, p < 0.001), PBS (rs=0.769, p < 0.001), and height-normalized fast walking speed (rs=0.632, p < 0.001), and strongly negatively correlated with TUG (rs=-0.766, p < 0.001) and EVGS (rs=-0.893, p < 0.001). Significance: Lower extremity SMC deficits are associated with poor gross motor function and balance control, more severe overall gait deviations and decreased fast walking speed in children with bilateral spastic CP. Physical therapy should include interventions that promote selective motor control in order to improve overall functional ability.

PMID: 36283302

11. The Short-Term Impact of Botulinum Neurotoxin-A on Muscle Morphology and Gait in Children with Spastic Cerebral Palsy

Nicky Peeters, Eirini Papageorgiou, Britta Hanssen, Nathalie De Beukelaer, Lauraine Staut, Marc Degelaen, Christine Van den Broeck, Patrick Calders, Hilde Feys, Anja Van Campenhout, Kaat Desloovere

Children with spastic cerebral palsy (SCP) are often treated with intramuscular Botulinum Neurotoxin type-A (BoNT-A). Recent studies demonstrated BoNT-A-induced muscle atrophy and variable effects on gait pathology. This group-matched controlled study in children with SCP compared changes in muscle morphology 8-10 weeks post-BoNT-A treatment (n = 25, median age 6.4 years, GMFCS level I/II/III (14/9/2)) to morphological changes of an untreated control group (n = 20, median age 7.6 years, GMFCS level I/II/III (14/5/1)). Additionally, the effects on gait and spasticity were assessed in all treated children and a subgroup (n = 14), respectively. BoNT-A treatment was applied following an established integrated approach. Gastrocnemius and semitendinosus volume and echogenicity intensity were assessed by 3D-freehand ultrasound, spasticity was quantified through electromyography during passive muscle stretches at different velocities. Ankle and knee kinematics were evaluated by 3D-gait analysis. Medial gastrocnemius (p = 0.018, -5.2%) and semitendinosus muscle volume (p = 0.030, -16.2%) reduced post-BoNT-A, but not in the untreated control group, while echogenicity intensity did not change. Spasticity reduced and ankle gait kinematics significantly improved, combined with limited effects on knee kinematics. This study demonstrated that BoNT-A reduces spasticity and partly improves pathological gait but reduces muscle volume 8-10 weeks post-injections. Close post-BoNT-A follow-up and well-considered treatment selection is advised before BoNT-A application in SCP.

PMID: 36287944

12. Accuracy of Ground Reaction Force and Muscle Activation Prediction in a Child-Adapted Musculoskeletal Model

Kristina Daunoraviciene, Jurgita Ziziene

(1) Background: Significant advances in digital modelling worldwide have been attributed to the practical application of digital

musculoskeletal (MS) models in clinical practice. However, the vast majority of MS models are designed to assess adults' mobility, and the range suitable for children is very limited. (2) Methods: Seventeen healthy and 4 cerebral palsy (CP) children were recruited for the gait measurements. Surface electromyography (EMG) and ground reaction forces (GRFs) were acquired simultaneously. The MS model of the adult was adapted to the child and simulated in AnyBody. The differences between measured and MS model-estimated GRFs and muscle activations were evaluated using the following methods: the root-mean-square error (RMSE); the Pearson coefficient r; statistical parametric mapping (SPM) analysis; the coincidence of muscle activity. (3) Results: For muscle activity, the RMSE ranged from 10.4% to 35.3%, the mismatch varied between 16.4% and 30.5%, and the coincidence ranged between 50.7% and 68.4%; the obtained strong or very strong correlations between the measured and model-calculated GRFs, with RMSE values in the y and z axes ranged from 7.1% to 17.5%. (4) Conclusions: Child-adapted MS model calculated muscle activations and GRFs with sufficient accuracy, so it is suitable for practical use in both healthy children and children with limited mobility.

PMID: 36298175

13. Targeted muscle reinnervation for a recurrent traumatic neuroma of the sural nerve: illustrative case
Mark P van Opijnen, Hans Marten Hazelbag, Godard C W de Ruiter

J Neurosurg Case Lessons. 2022 Apr 11;3(15):CASE2264. doi: 10.3171/CASE2264. Print 2022 Apr 11.

Background: Traumatic neuromata often recur after resection. Recently, targeted muscle reinnervation (TMR) has been shown to be a promising alternative for the treatment of traumatic neuroma, also in nonamputees. This case shows that TMR can also be applied for this indication in recurrent traumatic neuroma. Observations: A 55-year-old patient with a history of cerebral palsy presented with a painful swelling in his right knee, 40 years after multiple Achilles tendon surgeries for contractures. On imaging, the lesion was suspect for a traumatic neuroma of the posterior sural nerve. After two failed resections, TMR was performed by connecting the proximal end of the sural nerve to the motor branch of the lateral gastrocnemius muscle. During outpatient visits at 3, 6, and 12 months, the patient reported significantly less pain compared to before the TMR. He had no weakness of plantar flexion. Postoperative imaging, however, showed atrophy of the lateral gastrocnemius muscle. Lessons: This case shows that TMR can be a successful strategy to treat recurrent traumatic neuroma after previous failed transection of single neuromata in nonamputee cases. In the authors' patient, TMR did not result in motor deficit, but more research is needed to investigate this consequence of TMR for this indication.

PMID: 36303503

14. Balance Rehabilitation Approach by Bobath and Vojta Methods in Cerebral Palsy: A Pilot Study
Andreea Ungureanu, Ligia Rusu, Mihai Robert Rusu, Mihnea Ion Marin

Children (Basel). 2022 Sep 28;9(10):1481. doi: 10.3390/children9101481.

In cerebral palsy (CP) the basis for rehabilitation comes from neuroplasticity. One of the leading therapeutic approaches used in the management of CP is the NDT Bobath therapy and Vojta therapy consists in trying to program the ideal movement patterns for the age. The aim of our research was to analyze, from a functional point of view, the evolution of the biomechanical parameters characterizing the balance, in children with CP. The group of 12 subjects average age of 7 ± 3.28 years. The subject's evaluation included a functional clinical evaluation by Berg pediatric scale and a biomechanical evaluation performed using the "Stabilometry footboard PoData 2.00" for evaluation the body weight distribution on the foot level. The rehabilitation program was developed based on two methods, NDT Bobath and Vojta. A 90-min physiotherapy session starts with a Vojta therapy activation, for 20 min. Between the two therapies there is a 10-min break, then the session continues with NDT Bobath exercises within the 3 physical exercises proposed for 60 min. 5 days per week, 6 months. The analysis of the data collected before and after the application of the rehabilitation program, regarding the using the Berg scale indicates a progress of 32.35%, (p = 0.0001 < 0.05) and the effect size is large. The evolution of the data that indicate the distribution of body weight at the level of the two lower limbs, at the two moments pre/post, evaluation. For left side a progress of 8.39%, (p = 0.027 < 0.05) but a small effect size of 0.86. For right side a progress of 10.36% (p = 0.027 < 0.05) and also a small effect size of 0.86. Analyzing the results, we find that there is a left-right rebalancing in most patients. The favorable results that were obtained by drawing up a physiotherapy program composed of the combination of the two Vojta and NDT Bobath methods are proof of the fact that both methods are based on the creation of a stimulating peripheral pressure, which, if maintained, generates an extended stereotyped motor response. A pattern of symmetrical muscle contraction is thus created and thus balance and postural control can be achieved. The left-right rebalancing, proven by the percentage distribution analysis of the weight at the lower segmental level, demonstrated that the body alignment approach through the Vojta method on the one hand and the inhibitory facilitating postures/exercises promoted by the NDT Bobath method, allows obtaining a symmetry.

PMID: 36291417

15. The Effect of Neuro-Physiotherapy on Gross Motor Function in a Male Child With Spastic Diplegic Cerebral Palsy: A Case Report
Pallavi Harjpal, Anushka Raipure, Rakesh K Kovela, Moh'd Irshad Qureshi

Case Reports Cureus. 2022 Sep 19;14(9):e29310. doi: 10.7759/cureus.29310. eCollection 2022 Sep.

Cerebral palsy (CP) is a condition caused by a non-progressive lesion in the developing brain. CP has a wide range of prevalence, ranging from 1.5 to three cases per 1,000 persons. Newborns weighing less than 2,500 grams now account for half of all incidences of CP. Clinical management in physical therapy is a paradigm for enhancing organizational capacity, integrating evidence-based best practices, and enhancing outcomes. This is a case report of a 21-month-old male child with a history of sudden onset of seizure, fever, drowsiness, frothing from the mouth, and up rolling of eyes. He had a global developmental delay with microcephaly and breakthrough seizures with anemia under evaluation. Magnetic resonance imaging (MRI) brain revealed the possibility of hypoxic-ischemic insult. The child was managed conservatively using medications i.e., ibuprofen (7.5mL/6hrly), cephalosporin (450mg/day in divided doses), and phenytoin. Physiotherapy management was provided with integrative approaches including Neurodevelopmental treatment principles, passive stretching, static weight-bearing exercises, and task-oriented approaches. The evaluation was done using the Modified Ashworth Scale and Gross Motor Function Measure-88 (GMFM-88). Early physiotherapy with integrative approaches helps in the improvement of gross motor developmental milestones in children with Spastic diplegic CP.

PMID: 36277570

16. Paretic-Limb-Only Plyometric Training Outperforms Volume-Matched Double-Limb Training for Ameliorating Balance Capability and Gait Symmetry in Adolescents with Unilateral Cerebral Palsy: A Comparative Study
Ragab K Elnaggar, Reham H Diab, Asmaa A Abonour, Saud F Alsubaie, Saud M Alrawaili, Mshari Alghadier, Elsayed H Mohamed, Amira M Abd-Elmonem

Children (Basel). 2022 Oct 15;9(10):1563. doi: 10.3390/children9101563.

Adolescents with unilateral cerebral palsy (U-CP) experience an asymmetrical posture because the less-affected lower limb is preferred for bodyweight support as a strategy of compensating for the paretic side's muscular weakness. This study was designed to compare the effect of 12 weeks of paretic-limb-only plyometric training (PLPT) and volume-matched double-limb training (DLPT) on balance capability and gait symmetry in adolescents with U-CP. Sixty-nine adolescents with U-CP were randomly assigned to PLPT, DLPT, or a control group (n = 23 each). Treatment was delivered twice/week (with at least 48 h recovery intervals) for 12 weeks in succession. The directional (LoSdirectional) and overall (LoSoverall) limits of stability in addition to the temporal (T-GSI) and spatial (S-GSI) gait symmetry indicis were assessed pre- and post-treatment. The LoSdirectional improved significantly in the PLPT group compared to either the DLPT or control group (for the forward (p = 0.027 and <0.001, respectively), backward (p = 0.037 and <0.001, respectively), affected-side (p = 0.038 and 0.004, respectively), and less-affected-side (p = 0.018 and 0.016, respectively)), and this was also the case for the LoSoverall (p < 0.001). Additionally, The T-GSI and S-GSI scores decreased significantly in the PLPT group compared to the DLPT (p = 0.003 and 0.047, respectively) or control (p = 0.003 and 0.036, respectively) group, indicating the development more symmetrical gait patterns. In conclusion, PLPT is likely more effective for enhancing balance capabilities and promoting symmetrical gait patterns than DLPT. Thereupon, it is worthwhile for physical rehabilitation practitioners to include the PLPT paradigm into the intervention plans for adolescents with U-CP.

PMID: 36291499

17. Telehealth Movement-to-Music to Increase Physical Activity Participation Among Adolescents With Cerebral Palsy: Pilot Randomized Controlled Trial
Byron Lai, Laura Vogtle, Raven Young, Mary Craig, Yumi Kim, Marissa Gowey, Erin Swanson-Kimani, Drew Davis, James H Rimmer

JMIR Form Res. 2022 Oct 28;6(10):e36049. doi: 10.2196/36049.

Background: Adolescents with cerebral palsy (CP) who have mobility limitations have almost no access to inexpensive and enjoyable home-based programs that can be disseminated on a large scale to help them independently manage their health through participation in leisure-time physical activity (LTPA). Objective: The primary aim of this study was to determine the preliminary efficacy of the early adoption phase of an adult Movement-to-Music (M2M) program with behavioral telecoaching for increasing LTPA and activity participation compared with a waitlist control group in adolescents with CP. The secondary aim was to explore the effects of the program on perceived levels of pain and fatigue. The tertiary aim was to qualitatively evaluate the factors that influenced adherence and develop a theory that would inform the development of a more targeted M2M telehealth program for this group. Methods: This randomized controlled trial piloted a 4-week M2M program with weekly behavioral telecoaching among 58 adolescents with CP who walked or used wheelchairs. The participants were randomized into one of 2 groups: M2M or control, which maintained their daily activities. M2M included videos that participants were asked to complete 3 times each week at home (asynchronous training). Adherence to video minutes was objectively measured using cloud-based analytics. Changes in activity and LTPA participation were measured before and after the intervention using the Children's Assessment of Participation and Enjoyment total domain scores and active physical recreation domain scores, respectively. Perceived pain and fatigue were measured using the National Institutes of Health Neuro -QoL short forms. The changes in scores were compared between the groups using analysis of covariance. A grounded theory approach was used to analyze one-on-one interviews, coaching notes, and feedback surveys. Results: A total of 58 people were enrolled, of which 49 (84%) completed the primary outcome follow-up assessment. The mean adherence to the prescribed exercise video minutes across all 4 weeks was 68%, starting from 90% in week 1 and gradually declining to 43% in week 4. Mean adherence to coaching calls was 91%. Analysis of covariance revealed a statistically significant difference between the pre- to postchange scores for Children's Assessment of Participation and Enjoyment Active Physical Recreation-Intensity domain scores in favor of the intervention group ($F_{1,47}=8.76$; $P=.005$; effect size=0.17, also known as volume of LTPA). The qualitative findings highlighted 5 critical factors that influenced participants' adherence to the program: caregiver support, video elements, suitable exercises, music, and behavioral coaching. Conclusions: This project determined that adolescents with CP responded well to an M2M telehealth program that could enhance their LTPA levels. This paper describes a theory in which adherence to a telehealth LTPA program can be optimized through functional and age-specific modifications for adolescents with CP. Trial registration: ClinicalTrials.gov NCT04264390; https://clinicaltrials.gov/ct2/show/NCT04264390.

PMID: 36306154

18. Impact of maximal strength training on countermovement jump phase characteristics in athletes with cerebral palsy

Jennifer R M Fleeton, Ross H Sanders, Ché Fornusek

Analysis of the countermovement jump (CMJ) force-time curve phases provides insight into athlete neuromuscular function and methods by which jump height improves in response to training. A CMJ phase analysis and the dynamic strength index (DSI) have yet to be explored in athletes with cerebral palsy (CP). This study aimed to address this knowledge gap. Eleven state- to international-level athletes with CP completed a pre-post maximal strength training intervention with waitlist control. CMJ was assessed via force plate pre/post baseline and after the 12-week intervention. Following the intervention, CMJ height, takeoff velocity, and concentric phase peak and mean force, impulse and mean acceleration improved significantly ($p = 0.006$-0.001). No changes were observed in any eccentric braking phase variable ($p = 0.79$-0.13), while DSI lowered ($p = 0.03$). In athletes with CP, strength training increased CMJ concentric phase peak and mean force and impulse, increasing velocity and acceleration and therefore jump height. DSI lowered due to moderate and small increases in isometric mid-thigh pull and CMJ peak force, respectively. Unlike in non-disabled athletes, strength training did not alter any eccentric phase variable; therefore, other modalities may be required to further optimize jumping performance in athletes with CP.

PMID: 36273245

19. Impact of early brain lesions on the optic radiations in children with cerebral palsy

Rodrigo Araneda, Daniela Ebner-Karestinos, Laurance Dricot, Enimie Herman, Samar M Hatem, Kathleen M Friel, Andrew M Gordon, Yannick Bleyenheuft

Due to their early brain lesion, children with unilateral spastic cerebral palsy (USCP) present important changes in brain gray

and white matter, often manifested by perturbed sensorimotor functions. We predicted that type and side of the lesion could influence the microstructure of white matter tracts. Using diffusion tensor imaging in 40 children with USCP, we investigated optic radiation (OR) characteristics: fractional anisotropy (FA), mean diffusivity (MD), axial diffusivity (AD) and radial diffusivity (RD). First, we compared the OR of the lesional and non-lesional hemisphere. Then we evaluated the impact of the brain lesion type (periventricular or cortico-subcortical) and side in the differences observed in the lesional and non-lesional OR. Additionally, we examined the relationship between OR characteristics and performance of a visuospatial attention task. We observed alterations in the OR of children with USCP on the lesional hemisphere compared with the non-lesional hemisphere in the FA, MD and RD. These differences were influenced by the type of lesion and by the side of the lesion. A correlation was also observed between FA, MD and RD and the visuospatial assessment mainly in children with periventricular and right lesions. Our results indicate an important role of the timing and side of the lesion in the resulting features of these children's OR and probably in the compensation resulting from neuroplastic changes.

PMID: 36278011

20. A Randomised Crossover Trial of Behaviour Guidance Techniques on Children with Special Health Care Needs during Dental Treatment: The Physiological Variations

Norsaima Ismail, Khairil Anuar Md Isa, Ilham Wan Mokhtar

Children (Basel). 2022 Oct 5;9(10):1526. doi: 10.3390/children9101526.

Passive immobilisation is regarded as able to potentially cause physical distress and intense anxiety manifestations. The study aims to investigate the physiological variations of children with special health care needs while using a Papoose board and a combination of basic behaviour guidance during dental treatment. This is a randomised crossover trial involving 90 children with special health care needs receiving standard dental care with two methods of behaviour guidance sequentially. Exposure A is a combination of tell-show-do, distraction, and positive reinforcement, while exposure B is passive immobilisation with a Papoose board. The subject child's blood pressure, heart rate, and oxygen saturation level were measured at four different times during dental treatment. In total, 74 children's physiological data were successfully collected with a mean age of 9.85 years (SD = 2.71). Further, 64.9% of the children were diagnosed with autism spectrum disorder, 12.2% with attention deficit hyperactivity disorder, 9.5% with intellectual disability, 8.1% with Down syndrome, 2.2% with global developmental delay, and 1.1% with dyslexia and cerebral palsy, respectively. The measurement of children's blood pressure, heart rate, and oxygen saturation level with the application of a Papoose board or a combination of the basic behaviour guidance revealed no significant changes (p > 0.05). The use of a Papoose board is safe and has no discernible influence on the child's physiological responses.

PMID: 36291461

21. Dysarthria Speech Detection Using Convolutional Neural Networks with Gated Recurrent Unit

Dong-Her Shih, Ching-Hsien Liao, Ting-Wei Wu, Xiao-Yin Xu, Ming-Hung Shih

Healthcare (Basel). 2022 Oct 7;10(10):1956. doi: 10.3390/healthcare10101956.

In recent years, due to the rise in the population and aging, the prevalence of neurological diseases is also increasing year by year. Among these patients with Parkinson's disease, stroke, cerebral palsy, and other neurological symptoms, dysarthria often appears. If these dysarthria patients are not quickly detected and treated, it is easy to cause difficulties in disease course management. When the symptoms worsen, they can also affect the patient's psychology and physiology. Most of the past studies on dysarthria detection used machine learning or deep learning models as classification models. This study proposes an integrated CNN-GRU model with convolutional neural networks and gated recurrent units to detect dysarthria. The experimental results show that the CNN-GRU model proposed in this study has the highest accuracy of 98.38%, which is superior to other research models.

PMID: 36292403

22. Nutritional status and function after high-calorie formula vs. Chinese food intervention in undernourished children with cerebral palsy

Yiting Zhao, Lu He, Tingting Peng, Liru Liu, Hongyu Zhou, Yunxian Xu, Xubo Yang, Yuan Huang, Zhaofang Chen, Yi Xu, Jinling Li, Xiaohui Hou, Hongmei Tang, Kaishou Xu

Front Nutr. 2022 Oct 6;9:960763. doi: 10.3389/fnut.2022.960763. eCollection 2022.

Aim: To investigate the efficacy and safety of high-calorie formula vs. Chinese daily food on the nutritional status and motor function of undernourished children with cerebral palsy (CP). Methods: In this prospective, assessor-blind, and randomized controlled trial, we recruited children (1-10 years) with CP and undernutrition based on the WHO and the American Society for Parenteral and Enteral Nutrition criteria from the National Children's Medical Center. Participants were randomly allocated (1:1) to a high-calorie formula group or a Chinese daily food diet group (control group) for 6 months. Indirect calorimetry was used to estimate energy requirements. We compared the nutritional status and gross motor function of participants in both groups based on weight, height, z-scores (weight-for-age, height-for-age, weight-for-height, and BMI-for-age), and the Gross Motor Function Measure (GMFM), respectively, at baseline, 3-, and 6-months follow-up. In addition, the effective rate of nutritional intervention, and adverse events were simultaneously assessed. Results: From July 2020 to December 2021, a total of 119 participants were enrolled and randomized, and 110 participants completed the study (with 54 children in the high-calorie formula group and 56 children in the control group). After 6 months of treatment, the weight, height, z-scores (weight-for-height, weight-for-age, and BMI-for-age), and GMFM of both groups were significantly improved (p < 0.05). There were significant differences in changes in weight, weight-for-age z-scores, and GMFM between the two groups (p < 0.05). During the study period, 16 children experienced at least one mild adverse event [9 (16.7%) in the formula group and 7 (12.5%) in the control group]. Conclusion: Nutritional intervention with a high-calorie formula may be an effective and safe option in children with CP for improving undernutrition and gross motor dysfunction. Clinical trial registration: www.chictr.org.cn, identifier: ChiCTR2000033878.

PMID: 36276835

23. Development of social functioning in children with cerebral palsy: A longitudinal study

Andrea Burgess, Leanne Sakzewski, Koa Whittingham, Jane Wotherspoon, Mark D Chatfield, Robert S Ware, Roslyn N Boyd

Dev Med Child Neurol. 2022 Oct 25. doi: 10.1111/dmcn.15439. Online ahead of print.

Aim: To describe the development of social function in children with cerebral palsy (CP) classified in all levels of the Communication Function Classification System (CFCS). Method: This prospective, longitudinal population-based cohort study recruited children with CP born in Queensland, Australia. Social functioning was measured using the Pediatric Evaluation of Disability Inventory (PEDI) social function domain at 2 years, 2 years 6 months, 3 years, 4 years, and 5 years, and the PEDI Computer Adaptive Test (PEDI-CAT) social/cognitive domain at 8 to 12 years. Results: Seventy-four children provided 356 observations. PEDI-CAT social/cognitive scaled scores at 8 to 12 years were (mean [SD] n) CFCS level I, 68.6 (2.7) 45; CFCS level II, 64.0 (3.4) 10; CFCS level III, 63.5 (3.7) 4; CFCS level IV, 56.8 (5.0) 9; CFCS level V, 47.2 (5.8) 6. Scores within expected range for age (not less than 2 SD below mean) at 8 to 12 years were achieved by 35 (78%) children in CFCS level I and four (14%) in CFCS levels II to V. Forty-nine per cent of children scored at least two standard deviations below the population mean on a proxy measure of fluid intelligence. Intellectual impairment was associated with lower PEDI-CAT social/cognitive scaled scores in univariable analysis (β = -8.3, 95% confidence interval - 10.91 to -5.63; p < 0.001) but had a smaller effect when modelled together with CFCS. Interpretation: Social function attained by 8 to 12 years of age was strongly related to level of communication function (CFCS). The small number of children classified in CFCS levels II to V necessitates caution when viewing these individual CFCS level trajectories.

PMID: 36282970

24. Exploring the Effects of Literacy Instruction for Children With Cerebral Palsy: A Systematic Review

Annemarie Murphy, Benjamin Bailey, Joanne Arciuli

Lang Speech Hear Serv Sch. 2022 Oct 28;1-23. doi: 10.1044/2022_LSHSS-22-00014. Online ahead of print.

Purpose: Some children with cerebral palsy (CP) have difficulty acquiring conventional reading and writing skills. This systematic review explores the different types of literacy instruction and their effects on the reading and writing skills of children with CP. Method: Relevant studies published between 2000 and 2020 were identified using electronic databases and terms related to CP and literacy. Data on participant characteristics, instruction characteristics, and instruction outcomes were extracted. A standardized measure of effect size was used to quantify reported treatment effects. Results: The systematic search identified 2,970 potentially relevant studies, of which 24 met inclusion criteria. These studies included 66 children with CP aged 5-18 years. One of the included studies utilized a group research design, whereas the remaining used single-subject designs. Studies investigated literacy instruction methods designed to teach phonics, sight-word recognition, reading fluency, reading comprehension, spelling, or written expression skills, or multicomponent instruction (instruction methods encompassing three or more of these skills). Most instruction methods were associated with gains in reading and writing skills with medium to large effects; however, our analysis of methodological rigor suggests that these findings need to be interpreted with caution. Conclusions: We propose that literacy instruction utilizing evidence-based principles can be effective for children with CP, provided instruction is accessible and allows children to demonstrate and receive feedback on their skills; however, further research is greatly needed. Clinical implications and priorities for future research are discussed. Supplemental material: https://doi.org/10.23641/asha.21357558.

PMID: 36306504

25. Communication skills in children aged 6-8 years, without cerebral palsy cooled for neonatal hypoxic-ischemic encephalopathy

Thomas J Robb, James Tonks, Arthur P C Spencer, Sally Jary, Charlotte K Whitfield, Marianne Thoresen, Frances M Cowan, Ela Chakkarapani

We assessed communication skills of 48 children without cerebral palsy (CP) treated with therapeutic hypothermia (TH) for neonatal hypoxic-ischemic encephalopathy (HIE) (cases) compared to 42 controls at early school-age and examined their association with white matter diffusion properties in both groups and 18-month Bayley-III developmental assessments in cases. Parents completed a Children's Communication Checklist (CCC-2) yielding a General Communication Composite (GCC), structural and pragmatic language scores and autistic-type behavior score. GCC ≤ 54 and thresholds of structural and pragmatic language score differences defined language impairment. Using tract-based spatial statistics (TBSS), fractional anisotropy (FA) was compared between 31 cases and 35 controls. Compared to controls, cases had lower GCC ($p = 0.02$), structural ($p = 0.03$) and pragmatic language score ($p = 0.04$) and higher language impairments ($p = 0.03$). GCC correlated with FA in the mid-body of the corpus callosum, the cingulum and the superior longitudinal fasciculus ($p < 0.05$) in cases. Bayley-III Language Composite correlated with GCC ($r = 0.34$, $p = 0.017$), structural ($r = 0.34$, $p = 0.02$) and pragmatic ($r = 0.32$, $p = 0.03$) language scores and autistic-type behaviors ($r = 0.36$, $p = 0.01$).

PMID: 36272982

26. Could an Immersive Virtual Reality Training Improve Navigation Skills in Children with Cerebral Palsy? A Pilot Controlled Study

Roberta Nossa, Chiara Gagliardi, Daniele Panzeri, Eleonora Diella, Cristina Maghini, Chiara Genova, Anna Carla Turconi, Emilia Biffi

Children with cerebral palsy (CP) suffer deficits in their motor, sensory, and cognitive abilities, as well as in their visuospatial competences. In the last years, several authors have tried to correlate the visuospatial abilities with the navigational ones. Given their importance in everyday functions, navigation skills have been deeply studied using increasingly cutting-edge techniques such as virtual reality (VR). However, to our knowledge, there are no studies focused on training using immersive VR (IVR) in children with movement disorders. For this reason, we proposed an IVR training to 35 young participants with CP and conceived to improve their navigation skills in a "simil-real" environment while playing on a dynamic platform. A subgroup performed a part of the training which was specifically dedicated to the use of the allocentric strategy (i.e., looking for landmarks) to navigate the virtual environment. We then compared the children's navigation and spatial skills pre- and post-intervention. All the children improved their visual-spatial abilities; particularly, if the IVR activities specifically trained their ability to look for landmarks and use them to navigate. The results of this work highlight the potential of an IVR training program to increase the navigation abilities of patients with CPs.

PMID: 36294467

27. Fully Immersive Virtual Reality Game-Based Training for an Adolescent with Spastic Diplegic Cerebral Palsy: A Case Report
Kyeongbong Lee, HyeJin Oh, GyuChang Lee

Case Reports Children (Basel). 2022 Oct 3;9(10):1512. doi: 10.3390/children9101512.

Background: Recently, virtual reality-based training (VR-based training) is receiving attention as greater emphasis is placed on the importance of interest and motivation in participation. However, studies investigating the effects of fully immersive VR-based training are insufficient. Case presentation: We report a case of using a fully immersive VR game-based training in a patient with cerebral palsy. A 15-year-old girl was diagnosed with spastic diplegia cerebral palsy Gross Motor Function Classification System level II. A six-week intervention (18 sessions) phase was performed with one fully immersive VR game using PlayStation®VR in three sessions per week. After 18 sessions of training, the scores on the gross motor function measure -88 (Gross Motor Function Measure-88-GMFM-88), pediatric balance scale (PBS), timed up and go test (TUG), functional gait assessment (FGA), and 10 m walking test (10MWT) were improved: GMFM-88, 91.56 points (9.31 points increase); PBS, 45 points (6 points increase); TUG, 8.23 s (6.9 s decrease); FGA, 11 points (3 points increase); the 10 MWT, 5.27 s (6.59 s decrease). Conclusions: This study found that a fully immersive VR game-based training using PlayStation®VR may be an effective intervention for GMFCS level II adolescent, leading to some improvement of motor function, balance and gait skills in adolescents with cerebral palsy.

PMID: 36291448

28. Effectiveness of robotic exoskeletons for improving gait in children with cerebral palsy: A systematic review
Markus Hunt, Laure Everaert, Mathew Brown, Luiza Muraru, Eleni Hatzidimitriadou, Kaat Desloovere

Review Gait Posture. 2022 Sep 26;98:343-354. doi: 10.1016/j.gaitpost.2022.09.082. Online ahead of print.

Background: Robotic exoskeletons have been developed to assist locomotion and address gait abnormalities in children with cerebral palsy (CP). These wearable assistive devices provide powered assistance to the lower-extremity joints, as well as support and stability. Research question: Does exoskeleton-assisted walking improve gait in children with CP? Methods: The PRISMA guidelines were used to conduct this systematic review. Articles were obtained in a search of the following electronic databases: Embase, CINAHL Complete, PubMed, Web of Science and MEDLINE. Studies investigating spatiotemporal, kinematic, kinetic, muscle activity and/or physiological parameters during exoskeleton-assisted walking in children with CP were included. All articles were assessed for methodological quality using an adapted version of the Quality Assessment Tool for Before-After (Pre-Post) Studies with No Control Group, provided by the National Institutes of Health (NIH). Results: Thirteen studies were included. They involved the use of the following exoskeletons: tethered knee exoskeleton, pediatric knee exoskeleton (P.REX), untethered ankle exoskeleton, WAKE-Up ankle module, WAKE-Up ankle & knee module and unilateral ankle exosuit. Methodological quality varied, with key limitations in sample size and allocated time to adapt to the exoskeleton. There was a consensus that robotic exoskeletons improve gait given careful optimisation of exoskeleton torque and sufficient exoskeleton practice time for each participant. Improvements in gait included reduced metabolic cost of walking, increased walking speed, and increased knee and hip extension during stance. Furthermore, exoskeletons with an actuated ankle module were shown to promote normal ankle rocker function. Significance: Robotic exoskeletons have the potential to improve the mobility of CP children and may therefore increase community participation and improve quality of life. Future work should involve larger controlled intervention studies utilising robotic exoskeletons to improve gait in children with CP. These studies should ensure sufficient exoskeleton practice time for each participant.

PMID: 36306544

29. Improvement of Gait after Robotic-Assisted Training in Children with Cerebral Palsy: Are We Heading in the Right Direction?
Rosaria De Luca, Mirjam Bonanno, Carmela Settimo, Rosalia Muratore, Rocco Salvatore Calabrò

Med Sci (Basel). 2022 Oct 13;10(4):59. doi: 10.3390/medsci10040059.

Cerebral palsy (CP) is a non-progressive congenital neurological disorder that affects different physical and cognitive functions in children. In addition to standard rehabilitation, advanced robotic gait devices are novel tools that are becoming progressively more common as part of the treatment of CP. The aim of this study is to evaluate the effects of Lokomat training, in addition to conventional rehabilitation, on the motor function and quality of life of children with ataxic-spastic CP (ASCP). Ten children with ASCP who attended the Robotic Rehabilitation OutClinic of the IRCCS Centro Neurolesi "Bonino Pulejo", from April to June 2019, were enrolled in this study. They received twenty-four robotic rehabilitation sessions, twice a week for three months, each session lasting about 45 min. They were also provided with conventional physical and occupational therapy. After the innovative training, we found significant changes in the children's outcomes, i.e., in GMFM ($p < 0.001$), with significant improvements in sitting ($p < 0.03$) and walking ($p < 0.03$). Moreover, the quality of life of the young patients, evaluated by their parents, significantly improved ($p < 0.005$). The use of robotic systems could be considered to be an effective complementary treatment to improve gait, as well as quality of life, in children with CP.

PMID: 36278529

30. Fidelity of 3D Printed Brains from MRI Scan in Children with Pathology (Prior Hypoxic Ischemic Injury)
Anith Chacko, Phassawan Rungsiprakarn, Ivan Erlic, Ngoc Jade Thai, Savvas Andronikou

J Digit Imaging. 2022 Oct 24. doi: 10.1007/s10278-022-00723-7. Online ahead of print.

Cortical injury on the surface of the brain in children with hypoxic ischemic injury (HII) can be difficult to demonstrate to non-radiologists and lay people using brain images alone. Three-dimensional (3D) printing is helpful to communicate the volume loss and pathology due to HII in children's brains. 3D printed models represent the brain to scale and can be held up against models of normal brains for appreciation of volume loss. If 3D printed brains are to be used for formal communication, e.g., with medical colleagues or in court, they should have high fidelity of reproduction of the actual size of patients' brains. Here, we evaluate the size fidelity of 3D printed models from MRI scans of the brain, in children with prior HII. Twelve 3D prints of the brain were created from MRI scans of children with HII and selected to represent a variety of cortical pathologies. Specific predetermined measures of the 3D prints were made and compared to measures in matched planes on MRI. Fronto-occipital length (FOL) and bi-temporal/bi-parietal diameters (BTD/BPD) demonstrated high interclass correlations (ICC). Correlations were moderate to weak for hemispheric height, temporal height, and pons-cerebellar thickness. The average standard error of measurement (SEM) was 0.48 cm. Our results demonstrate high correlations in overall measurements of each 3D printed model derived from brain MRI scans versus the original MRI, evidenced by high ICC values for FOL and BTD/BPD. Measures with low correlation values can be explained by variability in matching the plane of measurement to the MRI slice orientation.

PMID: 36280655

31. Knowledge-Based Recurrent Neural Network for TCM Cerebral Palsy Diagnosis
Dongmei Li, Jintao Qu, Ziwei Tian, Zijun Mou, Lei Zhang, Xiaoping Zhang

Evid Based Complement Alternat Med. 2022 Oct 12;2022:7708376. doi: 10.1155/2022/7708376. eCollection 2022.

Cerebral palsy is one of the most prevalent neurological disorders and the most frequent cause of disability. Identifying the syndrome by patients' symptoms is the key to traditional Chinese medicine (TCM) cerebral palsy treatment. Artificial intelligence (AI) is advancing quickly in several sectors, including TCM. AI will considerably enhance the dependability and precision of diagnoses, expanding effective treatment methods' usage. Thus, for cerebral palsy, it is necessary to build a decision-making model to aid in the syndrome diagnosis process. While the recurrent neural network (RNN) model has the potential to capture the correlation between symptoms and syndromes from electronic medical records (EMRs), it lacks TCM knowledge. To make the model benefit from both TCM knowledge and EMRs, unlike the ordinary training routine, we begin by constructing a knowledge-based RNN (KBRNN) based on the cerebral palsy knowledge graph for domain knowledge. More specifically, we design an evolution algorithm for extracting knowledge in the cerebral palsy knowledge graph. Then, we embed the knowledge into tensors and inject them into the RNN. In addition, the KBRNN can benefit from the labeled EMRs. We use EMRs to fine-tune the KBRNN, which improves prediction accuracy. Our study shows that knowledge injection can effectively improve the model effect. The KBRNN can achieve 79.31% diagnostic accuracy with only knowledge injection. Moreover, the KBRNN can be further trained by the EMRs. The results show that the accuracy of fully trained KBRNN is 83.12%.

PMID: 36276852

32. Molecular Diagnostic Yield of Exome Sequencing and Chromosomal Microarray in Cerebral Palsy: A Systematic Review and Meta-analysis

Siddharth Srivastava, Sara A Lewis, Julie S Cohen, Bo Zhang, Bhooma R Aravamuthan, Maya Chopra, Mustafa Sahin, Michael C Kruer, Annapurna Poduri

Importance: There are many known acquired risk factors for cerebral palsy (CP), but in some cases, CP is evident without risk factors (cryptogenic CP). Early CP cohort studies report a wide range of diagnostic yields for sequence variants assessed by exome sequencing (ES) and copy number variants (CNVs) assessed by chromosomal microarray (CMA). Objective: To synthesize the emerging CP genetics literature and address the question of what percentage of individuals with CP have a genetic disorder via ES and CMA. Data sources: Searched articles were indexed by PubMed with relevant queries pertaining to CP and ES/CMA (query date, March 15, 2022). Study selection: Inclusion criteria were as follows: primary research study, case series with 10 or more nonrelated individuals, CP diagnosis, and ES and/or CMA data used for genetic evaluation. Nonblinded review was performed. Data extraction and synthesis: Preferred Reporting Items for Systematic Reviews and Meta-analyses guidelines were used for assessing data quality and validity. Data were extracted by a single observer. Main outcomes and measures: A separate meta-analysis was performed for each modality (ES, CMA). The primary outcome was proportion/ molecular diagnostic yield (number of patients with a discovered genetic disorder divided by the total number of patients in the cohort), evaluated via meta-analysis of single proportions using random-effects logistic regression. A subgroup meta-analysis was conducted, using risk factor classification as a subgroup. A forest plot was used to display diagnostic yields of individual studies. Results: In the meta-analysis of ES yield in CP, the overall diagnostic yield of ES among the cohorts (15 study cohorts comprising 2419 individuals from 11 articles) was 23% (95% CI, 15%-34%). The diagnostic yield across cryptogenic CP cohorts was 35% (95% CI, 27%-45%), compared with 7% (95% CI, 4%-12%) across cohorts with known risk factors (noncryptogenic CP). In the meta-analysis of CMA yield in CP, the diagnostic yield of CMA among the cohorts (5 study cohorts comprising 294 individuals from 5 articles) was 5% (95% CI, 2%-12%). Conclusions and relevance: Results of this systematic review and meta-analysis suggest that for individuals with cryptogenic CP, ES followed by CMA to identify molecular disorders may be warranted.

PMID: 36279113

33. The General Movements Motor Optimality Score in High-Risk Infants: A Systematic Scoping Review

Cathryn Crowle, Michelle Jackman, Catherine Morgan

Purpose: The aim of this systematic scoping review was to explore the use of the motor optimality score in the fidgety movement period in clinical practice, and to investigate evidence for the motor optimality score in predicting neurodevelopmental outcomes. Summary of key points: Thirty-seven studies, with 3662 infants, were included. Studies were conceptualized and charted into 4 categories based on the motor optimality score: prediction, outcome measure, descriptive, or psychometric properties. The most represented populations were preterm or low-birth-weight infants (16 studies), infants with cerebral palsy or neurological concerns (5 studies), and healthy or term-born infants (4 studies). Conclusion: The motor optimality score has the potential to add value to existing tools used to predict risk of adverse neurodevelopmental outcomes. Further research is needed regarding the reliability and validity of the motor optimality score to support increased use of this tool in clinical practice. What this adds to the evidence: The motor optimality score has potential to improve the prediction of adverse neurodevelopmental outcomes. Further research on validity and reliability of the motor optimality score is needed; however, a revised version, the motor optimality score-R (with accompanying manual) will likely contribute to more consistency in the reporting of the motor optimality score in future.

PMID: 36288244

34. Physicians' Ineffective Communication Leading to Cerebral Injuries in Children With Cerebral Palsy

Suliman Elwagei Ahmed

Inspirational enlightenment has guided me to write this review article while encountering, during my practice as a pediatrician, referred cases of previously stable, positively progressing cerebral palsy (CP) children who had not yet celebrated their first

teen birthday but ended up being in a deep coma and mechanical ventilation-dependent post a cardiac arrest outside the hospital. The dramatic end was believed to be probably caused by food aspiration, which could have been prevented by effective counseling to the in-denial, struggling parents about their children's condition. This report tries to emphasize the importance of effective communication between physicians and caregivers of children who were diagnosed with CP. The importance is elaborated by linking the level of the provided communication/education to the caregivers with cerebral injuries, such as intracranial hemorrhage (ICH), which potentially could have been prevented among CP children. The sequence of the injury is believed to be initiated by aspiration of food, which resulted in apnea/asphyxia, followed by a cardiopulmonary arrest outside hospital settings. Such a life-threatening event is hypothesized to be the leading cause of non-reversible intracranial injuries to the CP child of misinformed/unaware parents. Data on unsolved parental status, parent-provider miscommunications, and aspiration pneumonia leading to cerebral injuries and their permanent neurological insult in CP children were reviewed.

PMID: 36299928

35. 50% effective concentration of sevoflurane for immobility in cerebral palsy children undergoing botulinum toxin injection

Kanghui Kim, Eunhee Lee, Sung Mee Jung, Jongyoon Baek

Background: This prospective study aimed to determine the optimum end-tidal sevoflurane concentration required for immobility during botulinum toxin injection in spontaneously breathing children with cerebral palsy (CP). Methods: Twenty-three children with spastic CP, aged 3 to 12 years, with American Society of Anesthesiologists (ASA) physical status I and II, scheduled to receive botulinum toxin type A injection were enrolled in the study. After induction of deep sedation using pre-filled 8% sevoflurane in oxygen and maintenance of the predetermined end-tidal sevoflurane concentration, the botulinum toxin was injected in spontaneously breathing children. The response to the botulinum toxin injection was classified as "movement" or "no movement" by an independent investigator who was blinded to the predetermined end-tidal sevoflurane concentration and bispectral index (BIS) value. The end-tidal sevoflurane concentration was predetermined, initiating at 2.0% with 0.2% as a step size in the next patient depending on the previous patient's response using the modified Dixon's up-and-down method. Results: Of 21 children, 12 (57.1%) showed "no movement" in response to the botulinum toxin injection. By Dixon's up-and-down method, the 50% effective end-tidal concentration (EC50) of sevoflurane for successful botulinum toxin injection was $1.76 \pm 0.15\%$ (95% CI 1.62-1.90). Based on the dose-response curve using probit analysis, the predicted EC50 and 95% effective end-tidal concentrations (EC95) of sevoflurane without movement were 1.77% (95% CI 1.59-2.35) and 2.09% (95% CI 1.89-5.80), respectively. Conclusion: Botulinum toxin injection can be successfully accomplished at an end-tidal sevoflurane concentration of $1.76 \pm 0.15\%$ in 50% of spontaneously breathing children with CP aged 3-12 years. Trial registration: ClinicalTrials.gov NCT03553446.

PMID: 36281165

36. The Perioperative Anesthetic Management of the Pediatric Patient with Special Needs: An Overview of Literature

Alessandra Ciccozzi, Barbara Pizzi, Alessandro Vittori, Alba Piroli, Gioele Marrocco, Federica Della Vecchia, Marco Cascella, Emiliano Petrucci, Franco Marinangeli

The perioperative management of pediatric patients with psycho-physical disorders with related relational and cognitive problems must be carefully planned, in order to make the entire hospitalization process as comfortable and as less traumatic as possible. This article reports an overview of the anesthetic management of non-cooperative patients between 6 and 14 years old. The pathologies most frequently responsible for psycho-physical disorders can be summarized into three groups: (1) collaboration difficulties (autism spectrum disorders, intellectual impairment, phobia); (2) motor dysfunction (cerebral palsy, epilepsy, other brain pathologies, neuromuscular disorders), and (3) craniofacial anomalies (Down syndrome, other genetic syndromes). Anesthesia can be performed safely and successfully due to careful management of all specific problems of these patients, such as a difficult preoperative evaluation (medical history, physical examination, blood sampling, evaluation of vital parameters and predictive indices of difficult airway) and the inapplicability of a "standard" perioperative path (timing and length of the hospitalization, anesthetic premedication, postoperative management). It is necessary to ensure a dedicated perioperative process that is safe, comfortable, tailored to specific needs, and as less traumatic as possible. At the same time, all

necessary precautions must be taken to minimize possible complications.

PMID: 36291372

37. Parenting with a physical disability: A scoping review of assessment methods

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Introduction: Daily childcare can be challenging for parents with a physical disability who have young children. Occupational therapists are valuable facilitators to family participation. However, occupational therapists have reported significant gaps in knowledge when documenting the parenting role of parents with a physical disability in occupational therapy practice. This study explored and described the parenting assessment methods used with parents with a physical disability in the scientific literature. Methods: A scoping review was conducted, and search results were reviewed by two separate reviewers. The search strategy was applied to five databases (Embase, CINAHL, MEDLINE, HaPI, PsycInfo). Numerical and thematic analyses were conducted. Results: Four thousand one hundred fifty articles were screened, and 73 relevant scientific articles were included. Seventy-six assessment methods were identified, including 20 assessment instruments with few reported population-specific psychometric studies. Most assessments were conducted via interviews (n = 45), followed by questionnaires (n = 27), and only six were performance based. Parenting practices and experience were the two dimensions most assessed, with little attention given to parenting responsibility. Mothers with multiple sclerosis, spinal cord injury, rheumatoid arthritis, and cerebral palsy were the most assessed. Conclusion: Further research is needed to develop specific, multidimensional, and validated parenting assessments for all parents with a physical disability, including performance-based assessments. Formal assessments should be conducted by professionals, including occupational therapists, who have the necessary training.

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38. The Cost of Neurodevelopmental Disability: Scoping Review of Economic Evaluation Methods

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The provision of effective care models for children with neurodevelopmental delay or disability can be challenging in resource constrained healthcare systems. Economic evaluations have an important role in informing resource allocation decisions. This review systematically examined the scope and methods of economic models evaluating interventions for supporting neurodevelopment among children with common neurodevelopmental disorders and identified methods of economic models and presented policy implications. This scoping review employed the Arksey and O'Malley framework and aligned with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR). Four electronic databases were systematically searched to identify eligible model-based economic evaluations of neurodevelopmental care models published since 2000. The Consolidated Health Economic Evaluation Reporting Standards (CHEERS) checklist was used to assess quality of reporting. Data were systematically extracted, tabulated, and qualitatively synthesised across diagnostic categories. Searches identified 1431 unique articles. Twelve studies used a decision analytic model to evaluate care for neurodevelopmental disorders and were included in the review. Included studies focused on attention-deficit/hyperactivity disorder (ADHD, n=6), autism spectrum disorder (ASD, n=3), cerebral palsy (n=2), and dyslexia (n=1). The most used decision analytic modelling approach was a Markov model (n=6), followed by a decision tree (n=3), and a combination of decision tree and Markov model (n=3). Most studies (n=7) adopted a societal perspective for reporting costs. None of the reviewed studies modelled impact on families and caregivers. Four studies reported cost-savings, three identified greater quality of life, and three identified cost increases.

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39. The development of the International Classification of Functioning, Disability and Health for Child and Youth (ICF-CY) Core Sets: a systematic review
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Purpose: The aim of this systematic review is to verify the development of the International Classification of Functioning, Disability and Health for Child and Youth (ICF-CY), investigating methodology and how many core sets have been created. Methods: Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines were used to carry out the systematic review. Six bibliographic databases were searched: MEDLINE, SCOPUS, Web of Sciences, CINHAL, PEDro, and OT Seeker. Papers included in the study have the following characteristics: (a) pediatric population with different health conditions, (b) assessment of ICF domains, (c) development of ICF-CY core set in different health conditions, and (d) recommendation for clinical uses. Results: Search strategies allowed to identify 270 research papers. After the elimination of duplicates, 154 articles were analyzed. Finally, 28 records were included for qualitative synthesis. Twelve different ICF-CY Core Sets were identified. Autism spectrum disorder, attention-deficit/hyperactivity disorder, and cerebral palsy were the main health conditions studied at international level. Most of the studies involved international experts using Cieza' methodology to inform ICF-CY Core Set. Conclusions: After 15 years since the adoption of ICF-CY, it still finds some barriers to use. Concrete actions should be taken to develop further core sets following a rigorous methodology and to contribute implementing the ICF framework. Implication for rehabilitation: In 15 years since the implementation of International Classification of Functioning, Disability and Health for Child and Youth (ICF-CY), only 12 core sets have been developed. To develop ICF-CY Core Set, health professionals should follow methodology described by Cieza et al. Strong collaboration between low- and middle-income countries and high-income countries are recommended.

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40. Early neurodevelopmental reflex impairments in a rodent model of Cerebral Palsy
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Cerebral Palsy (CP) causes sensorimotor disabilities due to injury to the developing brain. Experimental models do not always induce the CP phenotype completely. Early neurological assessment predicts future impairments and is valuable during development. Using a rodent model characterized by brain injury caused by maternal inflammation and perinatal anoxia, and sensorimotor restriction (ECP), we describe early neurodevelopmental delays by assessing reflexes in a stage corresponding to the brain development of term infants (postnatal day 8 in rats). Pregnant Wistar rats were injected with Lipopolysaccharide (LPS - 200μg/kg) (n=6) or saline (n=4) on embryonic days 18/19. Following delivery, 87 male and female pups were used. At P0, injured animals were exposed to anoxia for 20'. From postnatal day 2 to 21, ECP rats were subjected to hindlimb movement restriction for 16h/day. ECP group had impaired righting reflex and negative geotaxis and interestingly, performed home bedding test better than Controls. From P7, ECP animals showed decreased body weight compared to Controls. Overall, data provide evidence showing that this CP model based on the association of brain damage followed by sensorimotor restriction mimics CP delays and highlights the valuable information given by early neurological assessment during the establishment of the Cerebral Palsy phenotype.

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