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***Professor Nadia Badawi AM***
CP Alliance Chair of Cerebral Palsy Research

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## Interventions and Management

**1. Influence Of Rehacom System Programme On Hand Function In Spastic Hemiplegic Children**

Sara Yousef Elsebahy, Yomna Farag Ahmed, Abdelaziz Ali Sherief

Randomized Controlled Trial J Pak Med Assoc. 2023 Apr;73(Suppl 4)(4):S26-S30. doi: 10.47391/JPMA.EGY-S4-9.

Objectives: To assess the impact of cognitive therapy with the rehacom visual-motor module on the hand function in hemiplegic cerebral palsy children. Methods: The randomised case-control study was conducted at Kafrelsheikh University, Egypt, from September 2021 to February 2022, and comprised children aged 6-8 years with spastic hemiplegic cerebral palsy. They were randomised into control group A and intervention group B. Subjects in group A received designed physical therapy and hand function training, while those in group B additionally received visual-motor coordination training with the help of rehacom system. The groups were evaluated for both visual-motor coordination and fine motor skills at baseline and after 6-month training. SPSS version 26 was used to analyse the raw data of the current study. Results: Of the 40 subjects, 20(50%) were in each of the two groups. There were 13(65%) boys and 7(35%) girls with mean age 66±4.01 monthsin group A, and 9 (45%) boys and 11(55%) girls with mean age 67±4.06 monthsin group B ($p>0.05$). Both groups showed improvement related to grasping, visual-motor integration and fine motor quotient post-intervention, but improvement in group B was significantly higher on each count($p<0.05$) Conclusions: The addition of visual-motor integration programme by rehacom system wasfound to be more effective than the effect of routine physiotherapy training alone.

PMID: 37482824

**2. Effectiveness of virtual reality interventions of the upper limb in children and young adults with cerebral palsy: A systematic review with meta-analysis**

Simone Burin-Chu, Héloïse Baillet, Pascale Leconte, Laure Lejeune, Régis Thouvarecq, Nicolas Benguigui

Clin Rehabil. 2023 Jul 27;2692155231187858. doi: 10.1177/02692155231187858. Online ahead of print.

Objective: To examine the characteristics and the effectiveness of virtual reality systems on upper limb impairments in children and young adults with cerebral palsy. Data sources: An electronic search was conducted on PubMed, PEDro, Web of Science, Central, and EMBASE. Methods: The protocol of this review was prospectively registered in the PROSPERO database (CRD42022302271). Randomized controlled trials that tested the effects of virtual reality-based interventions on the upper limb of participants with cerebral palsy were included. The methodological quality of the studies was measured by the PEDro scale. The certainty of the evidence was assessed using the Grading of Recommendations Assessment, Development and Evaluation. The data of the studies were analyzed in meta-analysis and presented in forest plots and narrative synthesis. Results: Twenty-two studies involving 746 participants were included. Ten different virtual reality systems were used in the interventions, of which six were designed specifically for rehabilitation and four commercial video games. We found an effect in favor of virtual reality when it was used in combination with conventional therapy for upper limb activity (SMD = 0.65; 95% CI (0.19 to 1.11)). However, the certainty of the evidence of the comparisons ranged from very low to low. Conclusion: Virtual reality seems to be an effective tool for upper limb activity in children and young adults with cerebral palsy. Nevertheless, future studies should present a better methodological quality, a larger sample size, and well-defined

rehabilitation programs to reduce the inconsistency of the evidence in this domain.

PMID: 37499213

**3. Neural Correlates of Impaired Grasp Function in Children with Unilateral Spastic Cerebral Palsy**

Jennifer Gutterman, Andrew M Gordon

Review Brain Sci. 2023 Jul 21;13(7):1102. doi: 10.3390/brainsci13071102.

Unilateral spastic cerebral palsy (USCP) is caused by damage to the developing brain and affects motor function, mainly lateralized to one side of the body. Children with USCP have difficulties grasping objects, which can affect their ability to perform daily activities. Although cerebral palsy is typically classified according to motor function, sensory abnormalities are often present as well and may contribute to motor impairments, including grasping. In this review, we show that the integrity and connectivity pattern of the corticospinal tract (CST) is related to execution and anticipatory control of grasping. However, as this may not explain all the variance of impairments in grasping function, we also describe the potential roles of sensory and sensorimotor integration deficits that contribute to grasp impairments. We highlight studies measuring fingertip forces during object manipulation tasks, as this approach allows for the dissection of the close association of sensory and motor function and can detect the discriminant use of sensory information during a complex, functional task (i.e., grasping). In addition, we discuss the importance of examining the interactions of the sensory and motor systems together, rather than in isolation. Finally, we suggest future directions for research to understand the underlying mechanisms of grasp impairments.

PMID: 37509032

**4. Constraint Therapy Promotes Motor Cortex Remodeling and Functional Improvement by Regulating c-Jun/miR-182 -5p/Nogo-A Signals in Hemiplegic Cerebral Palsy Mice**

Hongmei Tang, Jing Pan, Yunxian Xu, Liru Liu, Xubo Yang, Shiya Huang, Tingting Peng, Yuan Huang, Yiting Zhao, Chaoqiong Fu, Hongyu Zhou, Zhaofang Chen, Wenda Wang, Lu He, Kaishou Xu

Ann Anat. 2023 Jul 26;152136. doi: 10.1016/j.aanat.2023.152136. Online ahead of print.

Background: Our previous study has confirmed that constraint-induced movement therapy (CIMT) could promote neural remodeling in hemiplegic cerebral palsy (HCP) mice through Nogo-A/NgR/RhoA/ROCK signaling, however, the upstream mechanism was still unclear. Therefore, the present study aimed to further explore the mechanism of CIMT regulating the expression of Nogo-A in HCP mice. Method: HCP mice were well established through ligating the left common carotid artery of 7-day-old pups and being placed in a hypoxic box which was filled with a mixture of 8% oxygen and 92% nitrogen. CIMT intervention was conducted by taping to fix the entire arm of the contralateral side (left) to force the mice to use the affected limb (right). Bioinformatics prediction and luciferase experiment were performed to confirm that miR-182-5p was targeted with Nogo-A. The beam test and grip test were applied to examine the behavioral performance under the intervention of c-Jun and CIMT. Also, immunofluorescence, Golgi staining, and transmission electron microscopy were conducted to show that the lenti-expression of c-Jun could increases the expression of myelin, and downregulates the expression of Nogo-A under the CIMT on HCP mice. Result: (1) The beam walking test and grip test experiment results showed that compared with the control group, the HCP + nCIMT group's forelimb grasping ability and balance coordination ability were decreased ($P < 0.05$). (2) The results of Golgi staining, and transmission electron microscopy showed that the thickness of myelin sheath and the density of dendritic spines in the HCP + nCIMT group were lower than those in the control group ($P < 0.05$). Compared with the HCP + nCIMT group, the cerebral cortex myelin sheath thickness, dendrite spine density and nerve filament expression were increased in HCP + CIMT group ($P < 0.05$). (3) Immunofluorescence staining showed that the expression of Nogo-A in the cerebral cortex of the HCP + nCIMT group was higher than that of the HCP + CIMT group ($P < 0.05$). Compared with the HCP + CIMT group, the expression of Nogo-A in the HCP + LC + CIMT group was decreased and, in the HCP, + SC + CIMT group was significantly increased ($P < 0.05$). Compared with the HCP + nCIMT group, the expression of c-Jun in the control, HCP + CIMT, HCP + LC + nCIMT and HCP + LC + CIMT groups was significantly increased, and in the HCP + SC + CIMT was decreased ($P < 0.05$). (4) Real-time quantitative polymerase chain reaction (RT-qPCR) results showed that the expression level of miR-182-5p in the HCP + LC + CIMT group was more increased than that in the HCP + nCIMT group ($P < 0.05$). The expression level of miR-182-5p in the HCP + LC + CIMT group was higher than that in the HCP + LC + nCIMT group and the HCP + SC + CIMT group ($P < 0.05$). Conclusion: These data identified that CIMT might stimulate the remodeling of neurons and myelin in the motor cortex by partially inhibiting the c-Jun/miR-182-5p/Nogo-A pathway, thereby facilitating the grasping performance and balance function of HCP mice.

PMID: 37506776

**5. Manual Abilities and Cognition in Children with Cerebral Palsy: Do Fine Motor Skills Impact Cognition as Measured by the Bayley Scales of Infant Development?**

Thais Invencao Cabral, Xueliang Pan, Tanya Tripathi, Jianing Ma, Jill C Heathcock

Behav Sci (Basel). 2023 Jun 29;13(7):542. doi: 10.3390/bs13070542.

Manual ability may be an important consideration when measuring cognition in children with CP because many items on cognitive tests require fine motor skills. This study investigated the association of fine motor dependent (FMD) and fine motor independent (FMI) items within the cognitive domain (COG) of the Bayley Scales of Infant Development-Third Edition (Bayley-III) and Manual Ability Classification System (MACS) in children with cerebral palsy. Children aged 2 to 8 (3.96 ± 1.68) years were included in this study. MACS levels were assigned at baseline. COG was administrated at baseline (n = 61) and nine months post-baseline (n = 28). The 91 items were classified into FMD (52) and FMI (39). Total raw score, FMD, and FMI scores were calculated. The association between MACS and cognitive scores (total, FMD, and FMI) were evaluated using linear regression and Spearman correlation coefficients. We found total, FMD, and FMI scores decrease significantly as the MACS level increases at the baseline. Both FMD and FMI scores decreased as MACS levels increased (worse function). There was a significant difference between the two slopes, with the FMD scores having a steeper slope. Similar patterns were observed nine months post-baseline. Children with lower manual ability scored lower in the cognitive domain at baseline and 9 months post-baseline. The significant difference in the performance of FMD items and FMI items across MACS levels with a steeper slope of changes in FMD items suggests fine motor skills impact cognition.

PMID: 37503989

**6. Treatment of pediatric spasticity, including children with cerebral palsy, with Botox (onabotulinumtoxinA): Development, insights, and impact**

Mark Gormley, Henry G Chambers, Heakyung Kim, Judith Leon, Rozalina Dimitrova, Mitchell F Brin

Medicine (Baltimore). 2023 Jul 1;102(S1):e32363. doi: 10.1097/MD.0000000000032363.

Spasticity is a velocity-dependent increase in muscle tone that has a negative effect on quality of life and hinders the ability of others to provide care. In children, most cases are caused by cerebral palsy. Traditionally, many children are treated with surgery, sometimes performed before their limbs had grown sufficiently to permit long-term success. Nonsurgical treatment comprises oral pharmacological options, but their efficacy is limited and side effects such as drowsiness and decreased short-term memory are common; nerve block procedures can cause painful dysesthesias and muscle scarring. OnabotulinumtoxinA was first approved for the treatment of pediatric lower limb spasticity in Europe in the 1990s and is now licensed for use in pediatric patients in over 80 countries worldwide, based on a large body of clinical evidence demonstrating its efficacy and safety. In 2019 the U.S. Food and Drug Administration approved onabotulinumtoxinA for the treatment of pediatric patients with upper or lower limb spasticity. This approval represents 3 decades of work to refine the dose, measurements, patient selection, and muscle selection. The availability of onabotulinumtoxinA as a treatment for pediatric spasticity can have a substantial impact on a patient's quality of life. The use of onabotulinumtoxinA in combination with orthoses and occupational/physical therapy can postpone corrective surgery until growth is nearly complete and minimize the number of corrective surgeries.

PMID: 37499087

**7. Soft Tissue Releases With Simultaneous Guided Growth Decrease Risk of Spastic Hip Displacement Recurrence**

Cheng-Min Hsu, Huan Sheu, Wei-Chun Lee, Hsuan-Kai Kao, Wen-E Yang, Chia-Hsieh Chang

J Pediatr Orthop. 2023 Jul 24. doi: 10.1097/BPO.0000000000002472. Online ahead of print.

Background: Soft tissue release (STR) is an established treatment for spastic hip displacement, but recurrence of hip displacement is not uncommon. This study aims to (1) evaluate the recurrence of hip displacement after STR, (2) define associated factors of recurrence, and (3) elucidate the effects of guided growth on hip displacement recurrence. Methods: The study subjects included 66 individuals with spastic cerebral palsy treated by STR with or without guided growth for hip displacement. The treatment goal was the maintenance of migration percentage (MP) to <40%. Recurrence was defined by a rebound of the MP by 5% or more after the first postoperative year. Children with recurrence were compared with those without recurrence using the Mann-Whitney U test and the $\chi 2$ test. The risk factors for recurrence were evaluated using multiple logistic regression analysis. Results: Nineteen individuals (29%) had a recurrence of hip displacement after the first postoperative year. They sustained a 2-fold increase in the rate of treatment failure ($P < 0.001$) and reoperation ($P = 0.04$). Age, sex, motor function, and preoperative radiographic parameters were comparable between individuals with and without recurrence. The use of guided growth was associated with less risk of recurrence than without (5% and 39%, respectively, odds ratio = 0.01 to 0.45, respectively) despite the similar risk of failure (35% and 48%, respectively, odds ratio = 0.15 to 4.82). Conclusions: Recurrence of the MP >5% after the first postoperative year is an important early indicator for failure to control MP to <40% and reoperation. Guided growth not only decreases coxa valga but also reduces the risk of recurrent hip displacement after STR. Level of evidence: Level III; case-control study.

PMID: 37493018

**8. The Effect of Selective Dorsal Rhizotomy on Hip Displacement in Children With Cerebral Palsy: A Long-term Follow-up Study**

Stacey D Miller, Maria Juricic, Jeffrey N Bone, Paul Steinbok, Kishore Mulpuri

J Pediatr Orthop. 2023 Jul 24. doi: 10.1097/BPO.0000000000002473. Online ahead of print.

Background: Hip displacement is common in children with cerebral palsy (CP). Spasticity in the hip adductor muscles, hip flexors, and medial hamstrings has been identified as a possible cause of progressive hip displacement. Selective dorsal rhizotomy (SDR) aims to reduce lower extremity spasticity in children with CP. Here, we investigate the influence of SDR on hip displacement in children with CP at long-term follow-up, a minimum of 5 years post-SDR. Methods: A retrospective review of children undergoing SDR at a Canadian pediatric hospital was completed. Migration percentage (MP) was measured on pelvis radiographs taken in the 6 months before SDR and minimum 5 years post-SDR or before hip surgery. The number of hips with displacement, defined as MP >30%, and the number of children with at least 1 hip displaced were determined. A linear mixed-effects model was used to assess potential risk factors for poor outcome post-SDR, defined as having MP >40% or surgical intervention for hip displacement. Results: Ninety children [50 males, 40 females, Gross Motor Function Classification System (GMFCS) levels I to V: 1/13/24/43/9] with a mean follow-up of 8.5 years (SD 5.1) were included. The mean age at SDR was 4.9 years (SD 1.5); more than half of children (52%) had hip displacement at the time of SDR. Post-SDR, MP exceeded 30% in 0 (0%) of children at GMFCS level I, 1 (8%) at II, 11 (46%) at III, 31 (72%) at IV, and 7 (78%) at V. A poor outcome was associated with preoperative MP, age, and GMFCS level. Conclusions: The incidence of hip displacement post-SDR was consistent with population-based studies when evaluated by GMFCS. Our findings suggest that SDR has neither a positive nor negative effect on hip displacement when assessed at least 5 years postintervention. Level of evidence: Level IV.

PMID: 37493022

**9. The impact of Three-Dimensional Gait Analysis in adults with pathological gait on management recommendations**

Michelle McGrath, James Wood, John Walsh, Peter Window

Gait Posture. 2023 Jun 22;105:75-80. doi: 10.1016/j.gaitpost.2023.06.014. Online ahead of print.

Background: Three-Dimensional Gait Analysis (3DGA) is a gold standard tool that can help identify pathological components of walking patterns. It has been well established that this tool influences the treatment decision making of clinicians treating paediatric patients with Cerebral Palsy, but it has not been established whether this tool changes decision making of clinicians treating adults with complex pathological gait. Research question: To investigate the impact of pre-treatment 3DGA on treatment plans and management of adults with complex pathological gait. Method: This retrospective audit examined the medical records of 87 patients undergoing pre-treatment 3DGA between 2014 and 2019. The review collected treatment plans from the initial referral, the post-gait analysis multidisciplinary report, and post-intervention progress notes with consistencies and differences noted throughout the care pathway. Results: Treatment plans of patients were altered in 80 % (N = 32) of patients following 3DGA assessment and recommendations. These treatment plan alterations included a change in surgery or avoidance of surgery, changes in orthosis prescriptions, casting or rehabilitation; and administration or changes in administration of Botulinum Neurotoxin (BoNT-A). In 47 % (N = 15) of cases the change in plans represented a de-escalation in intervention requirements (e.g. BoNT-A in lieu of surgical intervention), and in 31 % (N = 10) the change in plans represented an escalation in intervention requirements (e.g. requirement for surgery). These changes in treatment plans were either fully or partly enacted by the referring consultant in 86 % of cases. Significance: Pre-treatment 3DGA impacts the management of adult patients with complex pathological gait and facilitates patients potentially avoiding unnecessary interventions. Further investigation is needed to determine the cost effectiveness of 3DGA in this population and the impact of pre-treatment 3DGA on management outcomes.

PMID: 37490826

**10. Systematic review and network meta-analysis of robot-assisted gait training on lower limb function in patients with cerebral palsy**

Yueying Wang, Peipei Zhang, Chao Li

Review Neurol Sci. 2023 Jul 26. doi: 10.1007/s10072-023-06964-w. Online ahead of print.

Objective: This study aimed to evaluate the effectiveness of robot-assisted gait training (RAGT) in treating lower extremity function in patients with cerebral palsy (CP) and compare the efficacy differences between different robotic systems. Methods: PubMed, Web of Science, Cochrane Library, Embase, CNKI, VIP, CBM, and Wanfang databases were searched to collect randomized controlled trials of RAGT for lower extremity dysfunction in patients with CP from the time the databases were created until December 26, 2022. The D and E of Gross Motor Function Measure-88 (GMFM-88) assessed lower limb motor function. Berg Balance Scale (BBS) was used to assess balance function. Walking endurance and speed were assessed using

the 6-minute walk test (6MWT) and walking speed. The modified Ashworth Scale (MAS) was used to assess the degree of muscle spasticity in the lower extremities. The Cochrane Risk Assessment Scale and the Physiotherapy Evidence Database (PEDro) scale were used for qualitative assessment in the studies included. RevMan 5.4 was used for data merging and statistical analysis. R 4.2.0 and ADDIS 1.16.8 were used to map the network relationships and to perform the network meta-analysis. Results: A total of 14 studies were included in the review. The meta-analysis showed that RAGT significantly improved GMFM-88 D and E, BBS, and 6MWT scores in CP patients compared with conventional rehabilitation. However, for walking speed and MAS, the intervention effect of RAGT was insignificant. The network meta-analysis showed that the best probability ranking for the effect of the 3 different robots on the GMFM-88 D score was LokoHelp (P = 0.66) > Lokomat (P = 0.28) > 3DCaLT (P = 0.06) and the best probability ranking for the GMFM-88 E score was LokoHelp (P = 0.63) > 3DCaLT (P = 0.21) > Lokomat (P = 0.16). Conclusion: RAGT positively affects walking and balance function in patients with CP, while efficacy in improving gait speed and muscle spasticity is unknown. The best treatment among the different robots is LokoHelp. Future high-quality, long-term follow-up studies are needed to explore the clinical efficacy of RAGT in depth.

PMID: 37495708

**11. Comparing the Lower-Limb Muscle Activation Patterns of Simulated Walking Using an End-Effector-Type Robot with Real Level and Stair Walking in Children with Spastic Bilateral Cerebral Palsy**

Yongjin Ahn, Juntaek Hong, Dain Shim, Joong-On Choi, Dong-Wook Rha

Sensors (Basel). 2023 Jul 21;23(14):6579. doi: 10.3390/s23146579.

Cerebral palsy is a neurologic disorder caused by lesions on an immature brain, often resulting in spasticity and gait abnormality. This study aimed to compare the muscle activation patterns of real level and stair walking with those of simulated walking using an end-effector-type robot in children with spastic cerebral palsy. The electromyographic activities of the vastus lateralis, biceps femoris, tibialis anterior and medial gastrocnemius of nine children with spastic bilateral cerebral palsy were measured during gait using a wireless surface EMG device. Morning walk was used for the simulated gait. Differences in the muscle activation patterns between the real and simulated gait conditions were analyzed. In the loading response, all four muscles showed reduced activity during two simulated conditions. In mid-stance, mGCM showed reduced activity during simulated conditions, whereas BFem showed greater activity during simulated level walking. In the swing phase, BFem and TAnt activity was reduced during the simulated conditions. The onset-offset of the VLat, BFem and TAnt activity was significantly delayed during simulated versus real level walking. No differences in activity onset-offset were observed between the simulated level and stair conditions. In conclusion, the robot-simulated gait showed differences in its muscle activation patterns compared with the real gait conditions, which must be considered for gait training using an end-effector-type robot.

PMID: 37514872

**12. Why do children with unilateral cerebral palsy struggle with the single leg stance test? A kinematic and centre of pressure analysis**

Ailish Malone, Fiona Boland, Damien Kiernan

Clin Biomech (Bristol, Avon). 2023 Jul 24;108:106053. doi: 10.1016/j.clinbiomech.2023.106053. Online ahead of print.

Background: Children with unilateral cerebral palsy often report difficulty with balance in everyday life. The single leg stance test is a challenging task, requiring rapid sensory input and precise motor adjustment. The purpose of this study was to examine how children with cerebral palsy perform this test, compared to typically developing children. Methods: Three-dimensional kinematics of the trunk and lower limbs of 10 children with cerebral palsy and 15 children with typical development were captured as they performed a single leg stance test on their non-dominant leg on a force platform. Stance time, joint kinematics and centre of pressure sway were measured and examined. Findings: There was evidence of shorter single leg stance performance and increased mediolateral centre of pressure sway in children with cerebral palsy. Coronal plane movement at the subtalar joint and foot was reduced (-6.0° (-10.9, -1.2°)), while proximally there was greater trunk movement in the coronal (13.5° (2.4°, 24.5°)) and transverse planes (9.9° (0.7, 19°)) and pelvis movement in the transverse plane (6.1° (1.7, 10.5°). An association existed between stance time and mediolateral centre of pressure sway ($p < 0.01$), with an average reduction in stance time of 0.15 s for every 1 mm/s increase in mediolateral sway. Interpretation: Children with cerebral palsy showed poor mediolateral control of centre of pressure sway, leading to shorter stance time. They have a less effective coronal foot-tilt strategy and excessive trunk and pelvis movement. Interventions aimed at improving single leg stance performance should consider addressing both ankle / foot and trunk motor control.

PMID: 37506500

**13. Investigation of Motor Activity, Movement Kinematics and Forward-Backwards Gait in Children with Cerebral Palsy**

Fatih Özden, İsmail Uysal, İsmet Tümtürk, Mehmet Özkeskin

Percept Mot Skills. 2023 Jul 25;315125231191152. doi: 10.1177/00315125231191152. Online ahead of print.

Our aim in this study was to examine relationships between the motor activity ability, sensor-based kinematics and forward-backwards gait characteristics of children with cerebral palsy (CP). In this prospective cross-sectional study we studied 40 children with CP. We used the Pediatric Motor Activity Log Revised (PMAL-R) to assess motor activity, evaluated motion kinematics (acceleration and angular velocity) with a sensor-based application, applied the Edinburgh Visual Gait Score (EVGS) and the Timed Up and Go Test (TUG) to observe gait performance, and used the Three Meter Backward Walk Test (3MBWT) to assess backward gait. We found moderately positive significant correlations ($r1 = 0.416$, $r2 = 0.418$, $p < 0.05$) between the chilidren's minimum angular velocity on PMAL-R motor activity frequency (how often) and quality (how well) scores, respectively. We also found moderately negative significant correlations ($r1 = -0.529$, $r2 = -0.521$, $p < 0.05$) between PMAL-R frequency (how often) and quality (how well) scores with TUG, respectively. There were moderately high positive correlations ($r1 = 0.415$, $r2 = 0.726$, $p < 0.05$) between EVGS scores and 3MBWT and TUG scores, respectively. We concluded that angular velocity ability was moderately related to children's motor activity and showed that physical performance tests (TUG and 3MBWT) could monitor gait function and upper extremity motor activity level, including both forward and backward walking tasks, in children with CP.

PMID: 37490931

**14. Robust and Interpretable General Movement Assessment Using Fidgety Movement Detection**

Romero Morais, Vuong Le, Catherine Morgan, Alicia Spittle, Nadia Badawi, Jane Valentine, Elizabeth M Hurrion, Paul A Dawson, Truyen Tran, Svetha Venkatesh

IEEE J Biomed Health Inform. 2023 Jul 27;PP. doi: 10.1109/JBHI.2023.3299236. Online ahead of print.

Fidgety movements occur in infants between the age of 9 to 20 weeks post-term, and their absence are a strong indicator that an infant has cerebral palsy. Prechtl's General Movement Assessment method evaluates whether an infant has fidgety movements, but requires a trained expert to conduct it. Timely evaluation facilitates early interventions, and thus computer-based methods have been developed to aid domain experts. However, current solutions rely on complex models or high-dimensional representations of the data, which hinder their interpretability and generalization ability. To address that we propose FidgetyFind, a method that detects fidgety movements and uses them towards an assessment of the quality of an infant's general movements. FidgetyFind, is true to the domain expert process, more accurate, and highly interpretable due to its fine-grained scoring system. The main idea behind FidgetyFind, is to specify signal properties of fidgety movements that are measurable and quantifiable. In particular, we measure the movement direction variability of joints of interest, for movements of small amplitude in short video segments. FidgetyFind, also comprises a strategy to reduce those measurements to a single score that quantifies the quality of an infant's general movements; the strategy is a direct translation of the qualitative procedure domain experts use to assess infants. This brings FidgetyFind, closer to the process a domain expert applies to decide whether an infant produced enough fidgety movements. We evaluated FidgetyFind, on the largest clinical dataset reported, where it showed to be interpretable and more accurate than many methods published to date.

PMID: 37498761

**15. Lifelong Fitness in Ambulatory Children and Adolescents with Cerebral Palsy I: Key Ingredients for Bone and Muscle Health**

Noelle G Moreau, Kathleen M Friel, Robyn K Fuchs, Sudarshan Dayanidhi, Theresa Sukal-Moulton, Marybeth Grant-Beuttler, Mark D Peterson, Richard D Stevenson, Susan V Duff

Behav Sci (Basel). 2023 Jun 28;13(7):539. doi: 10.3390/bs13070539.

Physical activity of a sufficient amount and intensity is essential to health and the prevention of a sedentary lifestyle in all children as they transition into adolescence and adulthood. While fostering a fit lifestyle in all children can be challenging, it may be even more so for those with cerebral palsy (CP). Evidence suggests that bone and muscle health can improve with targeted exercise programs for children with CP. Yet, it is not clear how musculoskeletal improvements are sustained into adulthood. In this perspective, we introduce key ingredients and guidelines to promote bone and muscle health in ambulatory children with CP (GMFCS I-III), which could lay the foundation for sustained fitness and musculoskeletal health as they transition from childhood to adolescence and adulthood. First, one must consider crucial characteristics of the skeletal and muscular systems as well as key factors to augment bone and muscle integrity. Second, to build a better foundation, we must consider critical time periods and essential ingredients for programming. Finally, to foster the sustainability of a fit lifestyle, we must encourage commitment and self-initiated action while ensuring the attainment of skill acquisition and function. Thus, the

overall objective of this perspective paper is to guide exercise programming and community implementation to truly alter lifelong fitness in persons with CP.

PMID: 37503986

**16. Comparison of factors associated with drooling between intractable neuromuscular disease and cerebral palsy**

Natsuko Ishida, Shunsuke Ono, Ryohei Suzuki, Kei Nojiri, Shinnosuke Ootsuki, Nobuyuki Zakoji

J Clin Neurosci. 2023 Jul 25;115:71-76. doi: 10.1016/j.jocn.2023.07.013. Online ahead of print.

Drooling represents a common and noteworthy symptom in patients with intractable neuromuscular disease (IND) and cerebral palsy (CP) and can lead to poor quality of life (QOL) and higher incidence of death due to aspiration of saliva. Identifying the factors affecting drooling is crucial to improving QOL and improving the poor prognosis of patients with IND and CP. This study sought to assess the prevalence of drooling and to elucidate the associated factors, drugs, and differences between patients with IND and CP. We included hospitalized patients with IND and CP. Among the 269 patients, 69 of 162 patients with IND (42.6%) and 75 of 107 patients with CP (70.1%) exhibited drooling. Drooling in IND was significantly higher in patients with tube feeding and those who had a previous stroke than in patients with potential oral intake and those having no history of stroke. In individuals with CP, drooling was significantly negatively associated with age. Taltirelin in patients with IND had a significant positive association with drooling, and antipsychotics and centrally acting muscle relaxants in those with CP had a significant negative association with drooling. Our results suggest that the factors associated with frequent drooling differ between IND and CP cases, and patients who should be screened for drooling are those with decreased swallowing function, those with IND who have had a previous stroke, and young patients with CP. Moreover, clinicians should consider the impact of drugs on drooling in IND and CP cases.

PMID: 37499322

**17. Molecular Evaluation of Joubert Syndrome and Hearing Impairment in a Patient with Ataxic Cerebral Palsy**

N Sreedevi, N Swapna, Santosh Maruthy, T Jayakumar, Charles Sylvester

Case Reports Glob Med Genet. 2023 Jul 17;10(3):190-193. doi: 10.1055/s-0043-1771184. eCollection 2023 Sep.

Joubert syndrome (JBTS) is a rare autosomal recessive or X-linked congenital brain malformation with strong genetic heterogeneity. Other neurological features of JBTS include hypotonia, ataxia, developmental delay, and cognitive impairment. Hearing loss with JBTS has been reported in the literature. We present the case of a 3.5-year-old boy born to a healthy consanguineous South Indian couple who was presented with ataxic cerebral palsy (CP) and hearing impairment; medical reports confirmed typical brain malformations of JBTS. Hearing impairment was screened by audiological assessment, which confirmed the presence of severe-profound hearing loss with outer hair cell dysfunction. Whole-exome sequencing (WES) was performed to know the molecular aspects of the condition and to detect any novel mutations. The homozygous mutation AHI1 c.2023G > A associated with JBTS type 3 and GJB2 c.71G > A mutation associated with hearing impairment were identified. Sanger sequencing was performed to validate the result and it identified heterozygous AHI1 c.2023G > A and GJB2 c.71G > A in the patient's parents. This study confirms the diagnosis of JBTS by WES helps identify the genetic causes of hereditary disorders that accelerate genetic evaluation and counseling for at-risk families.

PMID: 37501760

**18. Relationship between Sensory Processing Skills and Feeding Behaviors in Children Aged 3-6 Years with Cerebral Palsy with Cerebral Visual Impairment**

Mustafa Cemali, Özge Cemali, Ayla Günal, Serkan Pekçetin

Children (Basel). 2023 Jul 9;10(7):1188. doi: 10.3390/children10071188.

The current study aimed to examine the relationship between sensory processing skills and feeding behavior in cerebral palsy (CP) children aged 3-6 years with cerebral visual impairment (CVI). A total of ninety mothers participated in the study in three groups: thirty mothers of children with CP with CVI, thirty mothers of children with CP without CVI, and thirty mothers of children with typical development (TD). The sensory processing skill of the children was evaluated with the Sensory Profile (SP), and feeding behavior was evaluated with the the Behavioral Pediatric Feeding Assessment Scale (BPFAS). In the triple comparison, a significant difference was found between the groups in all SP parameter and BPFAS scores ($p < 0.001$). Post hoc analysis revealed statistically significant differences between the groups in all parameters ($p < 0.001$). Feeding problems were detected in 65% of all groups. In the correlation analysis, a significant relationship was found between all parameters of the SP and the BPFAS ($p < 0.05$). In terms of sensory processing skills and feeding status, it was determined that children with CVI with CP had more problems than children with CP without CVI, and children with CP without CVI had more problems than

children with TD. With these results, it was concluded that sensory processing problems affect feeding status, and visual impairment causes both sensory problems and feeding problems.

PMID: 37508685

**19. Pre-pregnancy and pregnancy disorders, pre-term birth and the risk of cerebral palsy: a population-based study**

Neda Razaz, Sven Cnattingius, Sarka Lisonkova, Shahrzad Nematollahi, Maryam Oskoui, K S Joseph, Michael Kramer

Int J Epidemiol. 2023 Jul 26;dyad106. doi: 10.1093/ije/dyad106. Online ahead of print.

Background: Cerebral palsy (CP) is the most common cause of childhood physical disability whose aetiology remains unclear in most cases. Maternal pre-existing and pregnancy complications are recognized risk factors of CP but the extent to which their effects are mediated by pre-term birth is unknown. Methods: Population-based cohort study in Sweden including 2 055 378 singleton infants without congenital abnormalities, born between 1999 and 2019. Data on maternal and pregnancy characteristics and diagnoses of CP were obtained by individual record linkages of nationwide Swedish registries. Exposure was defined as maternal pre-pregnancy and pregnancy disorders. Inpatient and outpatient diagnoses were obtained for CP after 27 days of age. Adjusted rate ratios (aRRs) were calculated, along with 95% CIs. Results: A total of 515 771 (25%) offspring were exposed to maternal pre-existing chronic disorders and 3472 children with CP were identified for a cumulative incidence of 1.7 per 1000 live births. After adjusting for potential confounders, maternal chronic cardiovascular or metabolic disorders, other chronic diseases, mental health disorders and early-pregnancy obesity were associated with 1.89-, 1.24-, 1.26- and 1.35-times higher risk (aRRs) of CP, respectively. Most notably, offspring exposed to maternal antepartum haemorrhage had a 6-fold elevated risk of CP (aRR 5.78, 95% CI, 5.00-6.68). Mediation analysis revealed that ~50% of the effect of these associations was mediated by pre-term delivery; however, increased risks were also observed among term infants. Conclusions: Exposure to pre-existing maternal chronic disorders and pregnancy-related complications increases the risk of CP in offspring. Although most infants with CP were born at term, pre-term delivery explained 50% of the overall effect of pre-pregnancy and pregnancy disorders on CP.

PMID: 37494957

**20. Prevalence, Incidence, and Surgical Treatment Trends of Cerebral Palsy across Türkiye: A Nationwide Cohort Study**

İzzet Özay Subaşi, İzzet Bingöl, Niyazi Erdem Yaşar, Ebru Dumlupinar, Naim Ata, M Mahir Ülgü, Şuayip Birinci, Mustafa Okan Ayvali, Serkan Erkuş, Mehmet Salih Söylemez, Güzelali Özdemir

Children (Basel). 2023 Jul 7;10(7):1182. doi: 10.3390/children10071182.

Background: Cerebral Palsy (CP) is the most prevalent neurodevelopmental disorder in childhood. Our aim is to identify the demographics of CP in Turkish children in addition to clinical associations and surgical preferences. Methods: Based on national health system data and the International Classification of Diseases (ICD)-10 code for CP, data were evaluated from a total of 53,027 children with CP born between 2016 and 2022, and 9658 of them underwent orthopedic surgery in those years. The incidence and frequency of CP were assessed for the parameters of age and gender. Age at the time of surgery; codes pertaining to surgical interventions; and regions, cities, and hospitals where diagnoses and surgical procedures were performed were also evaluated. Results: There were 29,606 male (55.8%) and 23,421 (44.2%) female patients. The diagnoses of the patients were mostly (76.1%) performed in secondary and tertiary hospitals. The prevalence of CP among children in 2016-2022 was estimated to be 7.74/1000 children. The minimum and maximum incidence rates of cerebral palsy among children between 2016 and 2022 were calculated to be 0.45 and 1.05 per 1000, respectively. Tenoplasty-myoplasty tendon transfer operations were the most common surgeries (47.1%). Conclusion: CP remains a significant health challenge, underpinning a considerable proportion of childhood motor dysfunction. A dedicated national registry system for CP focused on classifying the condition, streamlining treatment, and tracking outcomes would be a valuable tool in our collective efforts to address this critical issue more effectively.

PMID: 37508679

**21. Responses to Sensory Events in Daily Life in Children with Cerebral Palsy from a Parent Reported Perspective and in a Swedish Context**

Annika Ericson, Åsa Bartone, Kristina Tedroff, Cecilia Lidbeck

Children (Basel). 2023 Jun 30;10(7):1139. doi: 10.3390/children10071139.

The motor disorders of cerebral palsy (CP) are often accompanied by sensory disturbances, but knowledge of their relationship to motor functioning is sparse. This study explored responses to sensory events in relation to spastic subtype and motor

functioning in children with CP. Parents of 60 children with CP (unilateral: 18, bilateral: 42) with GMFCS levels I:29, II:13, III:15 and IV:3 of mean age 12.3 years (3.7 SD) participated. The parents (n = 55) rated their children´s responses with the norm-referenced questionnaire Child Sensory Profile-2© (CSP-2©), Swedish version, incorporating nine sections and four sensory processing patterns/quadrants, and replied (n = 57) to two additional questions. On the CSP-2©, thirty (55%) of the children were reported to have responses "much more than others" (>2 SD) in one or more of the sections and/or quadrants and 22 (40%) in the section of Body Position, overrepresented by the children with bilateral CP. The additional questions revealed that a greater proportion of children at GMFCS levels III-IV compared to level I frequently were requested to sit/stand up straight (14/17 versus 6/26, $p < 0.001$) and were sound sensitive at a younger age (14/17 versus 10/26, $p = 0.005$). The findings of this study highlight the sensory aspects of motor functioning in children with spastic CP.

PMID: 37508634

**22. Suitability of Quality of Life Outcome Measures for Children with Severe Cerebral Palsy Receiving Postural Care Interventions: A scoping review**

Jennifer Hutson, Paula Stommes, Teresa Wickboldt, Sandy Callen Tierney

Review Assist Technol. 2023 Jul 28. doi: 10.1080/10400435.2023.2240876. Online ahead of print.

Background: Children with Cerebral Palsy (CP) have complex conditions affecting their health which makes it challenging for assistive technology professionals to achieve desired intervention outcomes. Persons with CP identify quality of life (QOL) as one of the most important outcomes to examine when determining the helpfulness of treatment. Objective: Investigators aimed to complete a scoping review of QOL-related postural care (PC) publications, identify QOL-based assessments and critically analyze their suitability in measuring intervention outcomes for children with non-ambulatory CP. Methods: Investigators searched articles published between 1998-2022 relevant to children with CP that addressed QOL-related: meanings/domains, outcome measures and clinical intervention outcomes. Investigators followed the PRISMA scoping review guidelines and integrated the recommendations proposed by Westphaln et al. (2021), which built upon Arksey and O'Malley's framework (2005) for article selection and summarization. Subsequently, investigators conducted an analysis of the PC outcome measures identified in the review process, examining their suitability for the target population using Coster's (2013) questions. Potential impact: Results of this review will help care teams understand QOL and choose outcome assessments capable of measuring QOL-related intervention changes. Thus, making it possible for them to better serve children with severe CP.

PMID: 37506079

**23. Caregiver perspectives on powered mobility devices and participation for children with cerebral palsy in Gross Motor Function Classification System level V**

Bethany M Sloane, Lisa K Kenyon, Samuel W Logan, Heather A Feldner

Dev Med Child Neurol. 2023 Jul 28. doi: 10.1111/dmcn.15718. Online ahead of print.

Aim: To describe caregiver experiences, perceptions, and device preferences between a modified ride-on car (MROC) and an Explorer Mini, including perceived changes in participation, barriers, and benefits for young children with cerebral palsy (CP) classified in Gross Motor Function Classification System (GMFCS) level V. Method: A subset of data were analyzed from a larger multisite study. Semi-structured interviews were conducted with 10 caregivers of children with CP in GMFCS level V across a 16-week trial with two mobility devices. Each interview was audio-recorded, transcribed verbatim, and analysed using constant comparison methods. Results: Seven of 10 caregivers preferred the Explorer Mini over the MROC. Four themes emerged. One related to the perceived benefits and barriers of each device (ease and convenience is essential) and three related to perceived changes in participation: (1) autonomy enacted through mobility; (2) belonging and being present; and (3) participation recognized as an area of growth. Interpretation: Despite limited consideration of powered mobility for this population, caregivers of children in GMFCS level V reported similar benefits and barriers compared to children in other GMFCS levels shown in the literature. Particularly, caregivers perceived positive changes in their child's participation and recognized the ability for continued improvements in participation when using powered mobility.

PMID: 37515376

**24. Understanding a videogame home intervention for children with hemiplegia: a mixed methods multi-case study**

Daniela Chan-Víquez, Ajmal Khan, Sarah Munce, Darcy Fehlings, F Virginia Wright, Elaine Biddiss

Front Med Technol. 2023 Jul 12;5:1217797. doi: 10.3389/fmedt.2023.1217797. eCollection 2023.

Introduction: Access to rehabilitation therapies is a salient and growing issue for children with cerebral palsy (CP) and their families, motivating interest in home-based interventions. Bootle Blast is a low-cost, movement-tracking videogame that can be used at home to encourage upper limb (UL) functional exercise tailored to each child's abilities and therapy goals. The study

objectives were to: 1) Establish the extent to which children achieve their self-directed play-time goal over a 12-week intervention, 2) Measure changes in UL motor outcomes, and 3) Explore participants' experiences of using Bootle Blast at home. Methods: Mixed methods case series study of four children with hemiplegic cerebral palsy (HCP), each with a participating parent. Participants played Bootle Blast at home for 12 weeks. Study assessments occurred at baseline, post-intervention and four week follow up. A post-intervention interview explored participants' experiences. Game-logs provided play time and progress data. Results: Three of four participants (8-13 yrs., Manual Ability Classification Level I-II) completed the intervention. One dropped out at week 6. Play-time goals were achieved in most weeks, with two of four children surpassing their overall intervention goals. Outcomes varied across the three participants, however consistent improvements were observed on the Canadian Occupational Performance Measure and the Box and Blocks Test. Inductive analysis generated four main themes: 1) Intrinsic motivators fostered play engagement, 2) Virtual play for real-world gains, 3) Therapy on demand (at home), and 4) Shifting the onus from the parent to the game. Integration of qualitative and quantitative data was important for interpreting play patterns/usage and clinical outcomes. Discussion: This mixed methods study describes a novel videogaming intervention designed for home-rehabilitation for children with HCP and provides preliminary evidence to guide future study design and research.

PMID: 37502272

**25. Social participation in adults with cerebral palsy: a systematic review of the evidence-base**

Claire Cooper, Mark Linden, Claire Kerr

Review Disabil Rehabil. 2023 Jul 27;1-14. doi: 10.1080/09638288.2023.2236026. Online ahead of print.

Purpose: To identify and synthesise the current evidence on social participation in adults with cerebral palsy (CP). Methods: Four databases (PubMed, CINAHL Plus, PsycINFO, Web of Science) were systematically searched between December 2021 and February 2022. Pre-specified eligibility criteria were applied to all identified studies resulting in the inclusion of 16 articles. Data extraction was performed using a standardised tool and quality appraisal was assessed using the Mixed Methods Appraisal Tool. A narrative synthesis approach was taken for data analysis. Results: The 16 included studies were rated as high (n = 11) and medium quality (n = 5). Numbers of participants included in the studies ranged from 7 to 335. Definitions of social participation were discussed. Common themes were identified: the impact of home and work environments on social participation, the importance of age-appropriate support and interventions, and the impact of limited autonomy on social participation. Conclusions: Adults with CP experience limited social participation due to lack of appropriate support in childhood, issues across the lifespan including physical limitations when ageing, and factors such as societal expectations and inaccessible environments which limit opportunities for autonomy. Social participation may be improved by supporting families to provide opportunities in childhood, providing timely interventions, and by enhancing autonomy.

PMID: 37497638

**26. Unequal Cerebral Magnetic Resonance Imaging Changes in Perinatal Hypoxic Ischemic Injury of Term Neonates**

Shyam Sunder B Venkatakrishna, Mohamed Elsingergy, Fikadu Worede, Jelena Curic, Savvas Andronikou

J Comput Assist Tomogr. 2023 Jul 10. doi: 10.1097/RCT.0000000000001486. Online ahead of print.

Background: Perinatal hypoxic ischemic injury (HII) has a higher prevalence in the developing world. One of the primary concepts for suggesting that an imaging pattern reflects a global insult to the brain is when the injury is noted to be bilateral and symmetric in distribution. In the context of HII in term neonates, this is either bilateral symmetric (a) peripheral/watershed (WS) injury or (b) bilateral symmetric basal-ganglia-thalamus (BGT) pattern, often with the peri-Rolandic and hippocampal injury. Unilateral, asymmetric, or unequal distribution of injury may therefore be misdiagnosed as perinatal arterial ischemic stroke. Objectives: We aimed to determine the prevalence of unequal cerebral injury in HII, identify patterns, and determine their relationship with existing classification of HII. Materials and methods: Review of brain magnetic resonance imaging from a database of children with HII. Reports with any unequal pattern of injury were included and further classified as a unilateral, bilateral asymmetric, or symmetric but unequal degree pattern of HII. Results: A total of 1213 MRI scans in patients with a diagnosis of HII revealed 156 (13%) with unequal involvement of the hemispheres: unilateral in 2 of 1213 (0.2%) (involvement only in the WS), asymmetric in 48 of 1213 (4%) (WS in 6 [0.5%], BGT in 4 [0.3%], and combined BGT and WS in 38 [3.1%]), and bilateral symmetric but unequal degree in 106 of 1213 (8.7%) (WS in 20 [1.6%], BGT in 17 [1.4%], and combined BGT and WS in 69 [5.7%]). Conclusions: The majority of children with cerebral palsy due to HII demonstrate a characteristic bilateral symmetric pattern of injury. In our study, 13% demonstrated an unequal pattern. Differentiation from perinatal arterial ischemic stroke, which is mostly unilateral and distributed typically in the middle cerebral artery territory, should be possible and recognition of the typical BGT or WS magnetic resonance imaging patterns should add confidence to the diagnosis, in such scenarios.

PMID: 37495549

**27. Hippotherapy concepts: A scoping review to inform transdisciplinary practice guidelines**

Ninette du Plessis, Kitty Uys, Tania Buys

Scand J Occup Ther. 2023 Jul 26;1-17. doi: 10.1080/11038128.2023.2231562. Online ahead of print.

Background: Hippotherapy, an equine-assisted service, uses the movement of the horse as a treatment tool. Hippotherapy is often used by occupational therapists, physiotherapists, and speech and language pathologists. To optimise hippotherapy and facilitate the development of transdisciplinary hippotherapy practise guidelines, this scoping review identified novel hippotherapy concepts used during hippotherapy interventions for clients with spastic cerebral palsy. Aim: To explore, identify, and describe concepts that constitute hippotherapy practices for clients with spastic cerebral palsy. Methods: An exploratory descriptive qualitative research design, using Arksey and O'Malley's five stages of scoping review. Results: We identified and tabulated 19 hippotherapy concepts. Conclusions: Hippotherapy is a complex intervention with multiple concepts. This review contributed to the development of hippotherapy practice guidelines for clients with spastic cerebral palsy. Significance: Including hippotherapy concepts into hippotherapy practice will inform therapists, benefit clients, and contribute to future research.

PMID: 37493646

**28. F-words e ingredientes das intervenções precoces para crianças com paralisia cerebral não deambuladoras: uma revisão de escopo [Article in Portuguese]**

Ana Carolina De Campos, Álvaro Hidalgo-Robles, Egmar Longo, Claire Shrader, Ginny Paleg

Review Dev Med Child Neurol. 2023 Jul 25. doi: 10.1111/dmcn.15717. Online ahead of print.

Objectives: To explore the ingredients of early interventions provided to young children with cerebral palsy (CP) classified at levels IV and V of the Gross Motor Function Classification System (GMFCS) and to identify the F-words addressed by the interventions. METHOD: Searches were completed in four electronic databases. Inclusion criteria were original experimental studies that fit the following components of the PCC: Population: young children (0-5 years old, at least 30% of the sample) with CP and significant motor impairment (GMFCS levels IV or V, at least least 30% of the sample); Concept: non-surgical and non-pharmacological early intervention services that measure the results of any of the domains of the International Classification of Functioning, Disability and Health; and Context: Studies published from 2001 to 2021, across all settings and not limited to any specific geographic location. Results: Eighty-seven articles were included for review, with qualitative (n = 3), mixed (n = 4), quantitative descriptive (n = 22), non-randomized quantitative (n = 39) and quantitative randomized (n = 19) designs. ). Health ingredients (n = 59), family (n = 46) and functionality (n = 33) were addressed by most experimental studies, while studies on fun (n = 6), friends (n = 5) and future (n = 5) = 5) =14) were scarce. Several other factors (n = 55) related to the environment, for example, provision of services, professional training, therapeutic dose and environmental modifications, were also relevant. INTERPRETATION: Many studies have positively supported formal parent training and the use of assistive technology to promote several of the F-words. A menu of intervention ingredients was provided, with suggestions for future research to incorporate them into a real context in family and clinical practice.

PMID: 37491829

**29. F-words e ingredientes de las intervenciones tempranas dirigidas a niños no ambulantes con parálisis cerebral: Una revisión exploratoria [Article in Spanish]**

Ana Carolina de Campos, Álvaro Hidalgo-Robles, Egmar Longo, Claire Shrader, Ginny Paleg

Review Dev Med Child Neurol. 2023 Jul 25. doi: 10.1111/dmcn.15716. Online ahead of print.

Objectives: To explore the ingredients of early interventions delivered to young children with cerebral palsy (CP) classified in the Gross Motor Function Classification System (GMFCS) levels IV and V, and to identify the 'F-words' addressed by the interventions. METHOD: Four electronic databases were searched. The inclusion criteria were original experimental studies that met the following PCC components: population: young children (ages 0-5 years, at least 30% of the sample) with CP and significant motor impairments (GMFCS levels IV or V, at least 30% of the sample); concept: non-pharmacological, non-surgical early intervention services measuring outcomes in any domain of the International Classification of Functioning, Disability and Health; and setting: studies published from 2001 to 2021, in all settings and without specific geographic limitations. Results: Eighty-seven articles were included in the review, with qualitative (n = 3), mixed methods (n = 4), quantitative descriptive (n = 22), quantitative non-randomized (n = 39), and quantitative randomized designs. (n=19). The ingredients of fitness (n = 59), family (n = 46) and functioning (n = 33) were addressed by most of the experimental studies, while studies on fun (n = 6), friends (n = 5) and future (n = 14) were scarce. Other factors (n = 55) related to the setting, eg, service delivery, professional training, therapy dose, and environmental modifications, were also relevant. INTERPRETATION: Many studies positively supported formal parent training and the use of assistive technology to promote various F-words. A menu of intervention ingredients was provided, with suggestions for future research, to incorporate it in a

real context within the family and clinical practice.

PMID: 37491808

**30. The cost of respiratory hospitalizations in children with cerebral palsy**

Natasha L Bear, Andrew Wilson, A Marie Blackmore, Elizabeth Geelhoed, Shannon Simpson, Katherine Langdon

Dev Med Child Neurol. 2023 Jul 25. doi: 10.1111/dmcn.15714. Online ahead of print.

Aim: To establish the burden of respiratory illness in cerebral palsy (CP) on the Western Australian health care system by quantifying the costs of respiratory hospitalizations in children with CP, compared with non-respiratory hospitalizations. Method: A 2-year (2014-2015) retrospective study using linked hospital data (excluding emergency department visits), in a population of children with CP in Western Australia aged 18 years and under (median age at hospitalization 7 years; interquartile range 5-12 years). Results: In 671 individuals (57% male) there were 726 emergency hospitalizations, and 1631 elective hospitalizations. Although there were more elective hospitalizations, emergency hospitalizations were associated with longer stays in hospital, and more days in an intensive care unit, resulting in a higher total cost of emergency hospitalizations than elective hospitalizations (total costs: emergency AU$7 748 718 vs elective AU$6 738 187). 'Respiratory' was the leading cause of emergency hospitalizations, contributing to 36% of all emergency admission costs. For a group of high-cost inpatient users (top 5% of individuals with the highest total inpatient costs) the most common reason for hospitalization was 'respiratory'. Where non-respiratory admissions were complicated by an additional respiratory diagnosis, length of stay was greater. Interpretation: Respiratory hospitalizations in CP are a significant driver of health care costs. In the paediatric group, they are a burden for a subgroup of children with CP.

PMID: 37491764

**31. Early detection of neurodevelopmental disorders in paediatric primary care: A scoping review**

Paulette T O'Hara, Pamela Talero Cabrejo, Tracey V Earland

Fam Pract. 2023 Jul 25;cmad072. doi: 10.1093/fampra/cmad072. Online ahead of print.

Background: Earlier detection of children at risk for neurodevelopmental disorders is critical and has longstanding repercussions if not addressed early enough. Objectives: To explore the supporting or facilitating characteristics of paediatric primary care models of care for early detection in infants and toddlers at risk for neurodevelopmental disorders, identify practitioners involved, and describe how they align with occupational therapy's scope of practice. Methods: A scoping review following the Joanna Briggs Institute framework was used. PubMed Central, Cumulative Index to Nursing & Allied Health Literature, and Scopus databases were searched. The search was conducted between January and February 2022. Inclusion criteria were: children aged 0-3 years old; neurodevelopmental disorders including cerebral palsy (CP) and autism spectrum disorder (ASD); models of care used in the paediatric primary care setting and addressing concepts of timing and plasticity; peer-reviewed literature written in English; published between 2010 and 2022. Study protocol registered at https://doi.org/10.17605/OSF.IO/MD4K5. Results: We identified 1,434 publications, yielding 22 studies that met inclusion criteria. Models of care characteristics included the use of technology, education to parents and staff, funding to utilize innovative models of care, assessment variability, organizational management changes, increased visit length, earlier timeline for neurodevelopmental screening, and collaboration with current office staff or nonphysician practitioners. The top 4 providers were paediatricians, general or family practitioners, nurse/nurse practitioners, and office staff. All studies aligned with occupational therapy health promotion scope of practice and intervention approach yet did not include occupational therapy within the paediatric primary care setting. Conclusions: No studies included occupational therapy as a healthcare provider that could be used within the paediatric primary care setting. However, all studies demonstrated models of care facilitating characteristics aligning with occupational therapy practice. Models of care facilitating characteristics identified interdisciplinary staff as a major contributor, which can include occupational therapy, to improve early detection within paediatric primary care.

PMID: 37491000

**32. Classification of events contributing to postneonatal cerebral palsy: Development, reliability, and recommendations for use**

Luise Pudig, Malika Delobel-Ayoub, Karen Horridge, Anja Troha Gergeli, Elodie Sellier, Virginie Ehlinger, Katalin Hollody, Daniel Virella, Torstein Vik, Catherine Arnaud

Dev Med Child Neurol. 2023 Jul 24. doi: 10.1111/dmcn.15710. Online ahead of print.

Aim: This paper introduces the Surveillance of Cerebral Palsy in Europe (SCPE) classification of events contributing to

postneonatally acquired cerebral palsy, presents its interrater reliability, and describes the cases identified in the SCPE database. Method: The development of the classification, based on literature review and expert discussions, resulted in six main categories and 19 subcategories. The first chronological event designated as the primary event was mainly reported. Interrater reliability was assessed through online exercise providing 24 clinical vignettes representing single/complex pathways. Percent agreement and Gwet's AC1 index of reliability were estimated. Primary events were described using data of 221 children born between 2008 and 2012. Results: Thirty-nine professionals (21 registries) participated in the reliability exercise. Substantial overall agreement was reached (0.75), with some contrast between complex (0.48, moderate agreement) and single events involved (0.89, almost perfect). The distribution of primary events showed that 32.1% were infections (category A), 23.1% head injuries (B), 15.4% related to surgery or medical interventions (C), 13.1% cerebrovascular accidents (D), 9.1% hypoxic brain damaging events of other origins (E), and 7.2% miscellaneous (F). Interpretation: This classification allows all the events involved to be recorded while consistently reporting the primary event, and may be used in different settings.

PMID: 37488719

**33. Childhood outcomes after low-grade intraventricular haemorrhage: A systematic review and meta-analysis**

Philippa Rees, Caitriona Callan, Karan R Chadda, James Diviney, Fergus Harnden, Julian Gardiner, Cheryl Battersby, Chris Gale, Alastair Sutcliffe

Review Dev Med Child Neurol. 2023 Jul 24. doi: 10.1111/dmcn.15713. Online ahead of print.

Aim: To undertake a systematic review and meta-analysis exploring school-age neurodevelopmental outcomes of children after low-grade intraventricular haemorrhage (IVH). Method: The published and grey literature was extensively searched to identify observational comparative studies exploring neurodevelopmental outcomes after IVH grades 1 and 2. Our primary outcome was neurodevelopmental impairment after 5 years of age, which included cognitive, motor, speech and language, behavioural, hearing, or visual impairments. Results: This review included 12 studies and over 2036 infants born preterm with low grade IVH. Studies used 30 different neurodevelopmental tools to determine outcomes. There was conflicting evidence of the composite risk of neurodevelopmental impairment after low-grade IVH. There was evidence of an association between low-grade IVH and lower IQ at school age (-4.23, 95% confidence interval [CI] -7.53, -0.92, I2 = 0%) but impact on school performance was unclear. Studies reported an increased crude risk of cerebral palsy after low-grade IVH (odds ratio [OR] 2.92, 95% CI 1.95, 4.37, I2 = 41%). No increased risk of speech and language impairment or behavioural impairment was found. Few studies addressed hearing and visual impairment. Interpretation: This systematic review presents evidence that low-grade IVH is associated with specific neurodevelopmental impairments at school age, lending support to the theory that low-grade IVH is not a benign condition.

PMID: 37488717

**34. A Meta-Analysis of Neurodevelopmental Outcomes following Intravitreal Bevacizumab for the Treatment of Retinopathy of Prematurity**

Abed A Baiad, Imaan Z Kherani, Marko M Popovic, Glen Katsnelson, Rajeev H Muni, Kamiar Mireskandari, Nasrin N Tehrani, Tianwei Ellen Zhou, Peter J Kertes

Meta-Analysis Neonatology. 2023 Jul 24;1-12. doi: 10.1159/000531541. Online ahead of print.

Background: Retinopathy of prematurity (ROP) is the most common cause of preventable blindness in preterm infants. First-line treatments include intravitreal bevacizumab (IVB) or laser photocoagulation (LPC). Objectives: The aim of the study was to evaluate neurodevelopmental safety of IVB compared to LPC for ROP. Methods: MEDLINE, Embase, and Cochrane library were searched up to September 2022. Studies were included with at least 12-month follow-up of primary outcomes such as severe neurodevelopmental impairment (sNDI), cerebral palsy (CP), and hearing impairment (HI). Secondary outcomes were moderate-to-severe neurodevelopmental impairment (msNDI), Bayley Scores of Infant Development (BSID-III), and visual impairment. Results: 1,231 patients from 11 comparative studies were included. Quality of evidence was rated low for all outcomes. IVB was associated with a higher risk for sNDI (risk ratio [RR] = 1.25, 95% confidence interval [CI]: [1.01, 1.53], p = 0.04); and CP (RR = 1.40, CI: [1.08, 1.81], p = 0.01) compared to LPC. There was no significant difference between IVB and LPC for msNDI (RR = 1.15, CI: [0.98, 1.35], p = 0.08) and HI (RR = 1.43, CI: [0.86, 2.39], p = 0.17). BSID-III percentile scores were similar between IVB and LPC, with weighted mean differences of 1.51 [CI = -1.25, 4.27], 2.43 [CI = -1.36, 6.22], and 1.97 [CI = -1.06, 5.01] for cognitive, language, and motor domains, respectively (p > 0.05). Conclusion: To our knowledge, this is the largest meta-analysis on neurodevelopmental outcomes and the first to rigorously examine IVB monotherapy in ROP treatment. Compared to LPC, there was a marginally increased risk for sNDI and CP with IVB but little or no difference in the risk of msNDI and HI. Further randomized studies are needed to strengthen these findings.

PMID: 37487481

**35. Tools for Nutrition Assessment of Adults with Cerebral Palsy: Development of a Gold Standard**

D Expósito, M M Morales-Suarez, J M Soriano, C Soler

Review Curr Nutr Rep. 2023 Jul 24. doi: 10.1007/s13668-023-00485-w. Online ahead of print.

Purpose of review: Cerebral palsy (CP) is a group of disorders caused by non-stabilized cerebral lesions. Individuals with this disorder are at a higher risk of suffering from malnutrition and other related detrimental effects to their quality of life. For this reason, accurate methods of nutritional assessment are vital for people suffering from this condition. While assessment of nutritional status in children with CP has been extensively studied, very few studies have been carried out on adults. These limitations are due to the great anatomical-functional variability characteristic of this syndrome. Difficulties that derive from this variability in adult patients with CP mean that there remains an urgent need for certain standards of nutritional assessment for this population. The objective of this review is to compile the latest trends in nutritional assessment in adults with CP to guide the development of a conceptual framework for future research. Recent findings: With this aim, relevant studies have been identified. The most commonly used technique to evaluate nutritional status is the BMI because of its ease-of-use. However, its well-known limitations fail to adequately estimate the nutritional status in this population, with measurements of patients with CP yielding results that are much less accurate than those that already exist in the general population. Although more studies are needed, kinanthropometry is considered one of the most reliable techniques; nevertheless, the anatomical limitation characteristic of CP plays a limiting factor.

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**36. Beyond survival: the lasting effects of premature birth**

Daniela Morniroli, Valentina Tiraferri, Giulia Maiocco, Domenico Umberto De Rose, Francesco Cresi, Alessandra Coscia, Fabio Mosca, Maria Lorella Giannì

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Preterm birth, defined as birth before 37 weeks of gestation, is a major public health concern. It affects about 10% of all newborns globally and is the main cause of infant death and morbidity. Prematurity increases the likelihood of respiratory distress syndrome, cerebral palsy, and developmental abnormalities. Furthermore, premature newborns are at risk of acquiring chronic noncommunicable diseases later in life due to interference with organ system development during the in-utero and perinatal period. Because of the greater risk of long-term repercussions, preterm birth should be considered a chronic disorder, and gestational age and other birth histories should be included in all medical records for patients of all ages, especially when assessing the risk of multiple chronic diseases. Conventional methods for assessing preterm infant development, as well as reliable and precise growth monitoring, can lead to the early detection of growth decline and the adjustment of feeding regimens as needed. Because of its unique composition and useful components, human milk is a powerful tool for mitigating the negative outcomes associated with prematurity. It contains a variety of growth factors that promote the development of organs and systems, counteracting the negative effects of the abrupt interruption of intrauterine development and promoting better outcomes in all altered functions. Despite its multiple benefits, human milk cannot totally restore the lasting damage caused by premature birth. Premature infants cannot be completely overcome by nutrition alone, and yet adequate nutritional intake and human milk feeding are critical to their health and development.

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## Prevention and Cure

**37. Two Year Neurodevelopmental Outcome after Fetoscopic Laser Therapy for Twin-Twin Transfusion Syndrome: Comparison with Uncomplicated Monochorionic Diamniotic Twins**

Ángel Chimenea, Lutgardo García-Díaz, Guillermo Antiñolo

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Background: Twin-twin Transfusion Syndrome (TTTS) represents a significant complication in monochorionic twin pregnancies, caused by an unbalanced shunting of blood through intertwin placental vascular anastomoses. Despite advances in fetoscopic laser surgery, TTTS is still associated with a high rate of cerebral injury. However, there are no studies comparing these pregnancies with uncomplicated monochorionic diamniotic (MCDA) twin pregnancies, establishing the baseline risk of neurodevelopmental impairment. The aim of this study is to evaluate the odds of neurodevelopmental impairment in MCDA twins who undergo fetoscopic laser surgery for twin-twin transfusion syndrome, in comparison to a cohort of uncomplicated MCDA twin pregnancies. Study design: This is a retrospective cohort study of children born from MCDA twin pregnancies at a

single center between 2008 and 2019. A routine, standardized follow-up assessment was conducted at a minimum of 2 years after delivery. The primary outcome of this was a 2 year neurodevelopmental impairment. Neurological, motor, and cognitive development was assessed by using the revised Brunet-Lézine scale. Results: 176 children met the enrolment criteria. Of these, 42 (24%; TTTS group) underwent fetoscopic laser surgery for TTTS during pregnancy, and 134 (76%; uncomplicated MCDA group) were uncomplicated MCDA pregnancies. The primary outcome was found in four children (9.52%) in the TTTS group and ten children (7.46%) in the uncomplicated MCDA group (p = 0.67, aOR 2.82, 95% CI 0.49-16.23). Major neurologic impairment was found in 2.38% after fetoscopic laser surgery and 1.49% in uncomplicated MCDA twins (p = 0.70, aOR 0.97, 95% CI 0.22-4.24). The data were adjusted by birth order, birth weight, and gestational age at birth. Conclusions: The outcome in MCDA twins who underwent fetoscopic laser surgery for TTTS is comparable to the outcome in uncomplicated MCDA twins. Our findings emphasize the need for long-term neurodevelopmental follow-ups in all children from monochorionic twin gestations.

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