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NEWS
Cerebral Palsy Research

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# Interventions and Management

**1. How children with cerebral palsy master bimanual activities from a parental perspective.**

Lidman G, Himmelmann K, Gosman-Hedström G, Peny-Dahlstrand M.

Scand J Occup Ther. 2017 Jun 9:1-8. doi: 10.1080/11038128.2017.1337807. [Epub ahead of print]

BACKGROUND: During childhood, children learn the daily life activities they want and need to do. Children with unilateral spastic cerebral palsy often have difficulties performing activities requiring two hands. AIM: To describe parental reasoning on how children with unilateral spastic cerebral palsy learn to master the performance of bimanual activities in everyday life. MATERIAL AND METHODS: Sixteen parents participated in focus groups, a qualitative research approach with its own methodological criteria and research methods. RESULTS: One overall theme emerged from the analysis: 'Finding harmony between pleasure and effort is the key to learning'. This overall theme arose as a synthesis of four themes: 'awakening of the inner drive', 'trying on one's own', 'enabling things to work' and 'it must be worth the effort´. The parents described when an activity woke their children´s inner drive to perform. Their children also strived to develop their own way to perform an activity, sometimes with the support of others, still, some activities were not possible to learn. CONCLUSIONS: Occupational therapists and others in the children's environment have an important mission to support the children to find their own harmony between pleasure and effort and their individual key to success in learning bimanual everyday activities.

PMID: 28599586

**2. Histological and functional assessment of the efficacy of constraint-induced movement therapy in rats following neonatal hypoxic-ischemic brain injury.**

Kim H, Kim MJ, Koo YS, Lee HI, Lee SW, Shin MJ, Kim SY, Shin YB, Shin YI, Choi BT, Yun YJ, Shin HK.

Exp Ther Med. 2017 Jun;13(6):2775-2782. doi: 10.3892/etm.2017.4371. Epub 2017 Apr 21.

Constraint-induced movement therapy (CIMT) is used in stroke rehabilitation to promote recovery of upper limb motor function. However, its efficacy in improving functional outcomes in children with hemiplegic cerebral palsy has not been clearly determined in clinical or experimental research. The aim of our study was to assess the efficacy of a new experimental model of CIMT, evaluated in terms of mortality, stress, motor and cognitive function in rats having undergone a neonatal hypoxic-ischemic (HI) brain injury. Neonatal HI injury was induced at post-natal day 7 through unilateral ligation of the common carotid artery followed by exposure to hypoxia for 2 h. CIMT was implemented at 3 weeks, post-HI injury, using a pouch to constrain the unimpaired forelimb and forcing use of the affected forelimb using a motorized treadmill. After HI injury, animals demonstrated motor and cognitive deficits, as well as volumetric decreases in the ipsilateral hemisphere to arterial occlusion. CIMT yielded a modest recovery of motor and cognitive function, with no effect in reducing the size of the HI lesion or post-HI volumetric decreases in brain tissue. Therefore, although animal models of stroke have identified benefits of CIMT, CIMT was not sufficient to enhance brain tissue development and functional outcomes in an animal model of

hemiplegic cerebral palsy. Based on our outcomes, we suggest that CIMT can be used as an adjunct treatment to further enhance the efficacy of a program of rehabilitation in children with hemiplegic cerebral palsy.

PMID: 28587341

**3. Home-based Nintendo Wii training to improve upper-limb function in children ages 7 to 12 with spastic hemiplegic cerebral palsy.**

Kassee C, Hunt C, Holmes MWR, Lloyd M.

J Pediatr Rehabil Med. 2017 May 17;10(2):145-154. doi: 10.3233/PRM-170439.

This pilot study compared a Nintendo Wii intervention to single-joint resistance training for the upper limb in children ages 7 to 12 with spastic hemiplegic cerebral palsy (CP). Children were randomized to Wii training (n= 3), or resistance training (n= 3) and trained at home for 6 weeks. Pre, post and 4-week follow-up measures were collected. Outcome measures were the Melbourne Assessment (MA2), and ABILHAND-Kids, and grip strength. Compliance, motivation and feasibility of each intervention was explored using daily logbook responses and questionnaires. Descriptive statistics were used. Three children improved in the MA2, two of which were in the Wii training group. Improvements in the ABILHAND-Kids were minimal for all participants. Grip strength improvements were observed in 3 participants, two of which were in the resistance training group. The Wii training group reported higher compliance and more consistently positive responses to motivation and feasibility questions. Therefore, Wii training may be an effective home-based rehabilitation strategy, and is worth exploring in a larger trial. Implications of Wii training in the context of motivation theory are discussed.

PMID: 28582885

**4. Reliability of the Assisting Hand Assessment in adolescents.**

Louwers A, Krumlinde-Sundholm L, Boeschoten K, Beelen A.

Dev Med Child Neurol. 2017 May 29. doi: 10.1111/dmcn.13465. [Epub ahead of print]

AIM: To investigate the interrater and test-retest reliability of the Assisting Hand Assessment in adolescents (Ad-AHA) with cerebral palsy (CP) and to evaluate the alternate-form reliability of different test activities. METHOD: Participants were 112 adolescents with unilateral CP (60 males, 52 females; mean age 14y 5mo [standard deviation {SD} 2y 8mo], Manual Ability Classification System levels I-III). Reliability was evaluated using intraclass correlation coefficients (ICC), smallest detectable change (SDC), and Bland-Altman plots. RESULTS:ICCs for interrater (n=38) and test-retest reliability (n=31) were excellent: 0.97 (95% CI 0.94-0.98) and 0.99 (95% CI 0.98-0.99) respectively. The alternate-form reliability of different test activities was excellent for children (age 10-12y, n=30) performing the School-Kids AHA and Ad-AHA Board Game 0.99 (95% CI 0.98-0.99) and for adolescents (age 13-18y) performing the Ad-AHA Board Game compared to the Ad-AHA Present (n=28) 0.99 (95% CI 0.95-0.98), or the Ad-AHA Sandwich (n=29) 0.99 (95% CI 0.98-0.99) tasks. SDC for test-retest was 4.5 AHA-units. INTERPRETATION: Ad-AHA scores are consistent across different raters and occasions. The good alternate-form reliability indicates that the different test activities can be used interchangeably in adolescents with unilateral CP. Differences greater than or equal to 5 AHA-units can be considered a change beyond measurement error. The use of logit based AHA-units makes change comparable for persons at different ability levels.

PMID: 28555755

**5. Development and psychometric properties of the Hand-Use-at-Home questionnaire to assess amount of affected hand -use in children with unilateral paresis.**

Geerdink Y, Aarts P, Van Der Holst M, Lindeboom R, Van Der Burg J, Steenbergen B, Geurts AC.

Dev Med Child Neurol. 2017 May 29. doi: 10.1111/dmcn.13449. [Epub ahead of print]

AIM: To describe the development of the parent-rated Hand-Use-at-Home questionnaire (HUH) assessing the amount of spontaneous use of the affected hand in children with unilateral paresis, and to test its internal structure, unidimensionality, and validity. METHOD: Parents of children with unilateral cerebral palsy (CP) and professionals participated in the development of

the HUH. To examine internal validity, data of 322 children (158 males, 164 females; mean age 6y 7mo, standard deviation [SD] 2y 1mo) with unilateral CP (n=131) or neonatal brachial plexus palsy (NBPP) (n=191) were collected. Rasch analysis was used to examine discriminative capacity of the 5-category rating scale as well as unidimensionality and hierarchy of the item set. Additionally, data of 55 children with typical development (24 males, 31 females; 6y 9mo, SD 2y 5mo) were used to examine construct validity. RESULTS: The 5-category rating scale was disordered in all items and was collapsed to obtain the best discriminating sum score. Ten misfitting or redundant items were removed. Eighteen hierarchically ordered bimanual items fitted the unidimensional model within acceptable range. The HUH significantly discriminated between the three groups (children with typical development, NBPP, unilateral CP; $H(2) = 118.985$, $p<0.001$), supporting its construct validity. INTERPRETATION: The HUH is a valid instrument to assess the amount of spontaneous use of the affected hand in children with unilateral upper-limb paresis.

PMID: 28555780

**6. Do active video games benefit the motor skill development of non-typically developing children and adolescents: A systematic review.**

Page ZE, Barrington S, Edwards J, Barnett LM.

J Sci Med Sport. 2017 May 18. pii: S1440-2440(17)30411-5. doi: 10.1016/j.jsams.2017.05.001. [Epub ahead of print]

OBJECTIVES: The use of interactive video gaming, known as 'exergames' or 'active video games (AVG)' may provide an opportunity for motor skill development. Youth with non-typical patterns of development may have deficits in gross motor skill capacities and are therefore an intervention target. The aim was to determine the effectiveness of AVG use on motor skill development in non-typically developing children and adolescents. DESIGN: Review article. METHODS: The PRISMA protocol was used to conduct a systematic review of EBSCOhost, Embase, Gale Cengage, Informit, Ovid, ProQuest, PubMed, Scopus and Web of Science databases. A total of 19 articles met inclusion criteria (non-typically developing participants such as those with a learning or developmental delay aged 3-18, use of an AVG console, assessed one or more gross motor skills). Studies were excluded if gross motor skill outcomes encompassed fine motor skills or reflected mobility related to daily living. RESULTS: Interventions included children and adolescents with eight different conditions. The Nintendo Wii was the most utilised gaming platform (14/19 studies). Studies examined a combination of skills, with most examining balance (15/19), five studies examining ball skills, and other gross motor skills such as coordination (3 studies), running (3 studies) and jumping (3 studies). There was strong evidence that AVG's improved balance. AVG's also appeared to benefit participants with Cerebral Palsy. CONCLUSIONS: AVG's could be a valuable tool to improve gross motor skills of non-typically developing children. There is scope for further exploration, particularly of ball, coordination and locomotor skills and varying platforms to draw more conclusive evaluations.

PMID: 28600111

**7. Prevention of hip displacement in children with cerebral palsy: a systematic review.**

Miller SD, Juricic M, Hesketh K, Mclean L, Magnuson S, Gasior S, Schaeffer E, O'donnell M, Mulpuri K.

Dev Med Child Neurol. 2017 Jun 2. doi: 10.1111/dmcn.13480. [Epub ahead of print]

AIM: To conduct a systematic review and evaluate the quality of evidence for interventions to prevent hip displacement in children with cerebral palsy (CP). METHOD: A systematic review was performed using American Academy of Cerebral Palsy and Developmental Medicine (AACPDM) and Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology. Searches were completed in seven electronic databases. Studies were included if participants had CP and the effectiveness of the intervention was reported using a radiological measure. Results of orthopaedic surgical interventions were excluded. RESULTS: Twenty-four studies fulfilled the inclusion criteria (4 botulinum neurotoxin A; 2 botulinum neurotoxin A and bracing; 1 complementary and alternative medicine; 1 intrathecal baclofen; 1 obturator nerve block; 8 positioning; 7 selective dorsal rhizotomy). There was significant variability in treatment dosages, participant characteristics, and duration of follow-up among the studies. Overall, the level of evidence was low. No intervention in this review demonstrated a large treatment effect on hip displacement. INTERPRETATION: The level and quality of evidence for all interventions aimed at slowing or preventing hip displacement is low. There is currently insufficient evidence to support or refute the use of the identified interventions to prevent hip displacement or dislocation in children and young people with CP.

PMID: 28574172

**8. Surgical Outcomes of Posterior Spinal Fusion Alone Using Cervical Pedicle Screw Constructs for Cervical Disorders Associated With Athetoid Cerebral Palsy.**

Watanabe K, Hirano T, Katsumi K, Ohashi M, Shoji H, Yamazaki A, Izumi T, Hasegawa K, Ito T, Endo N.

Spine (Phila Pa 1976). 2017 Jun 1. doi: 10.1097/BRS.0000000000002257. [Epub ahead of print]

STUDY DESIGN: Retrospective case series. OBJECTIVE: To investigate clinical outcomes after posterior spinal fusion (PSF) using cervical pedicle screw (CPS) constructs for cervical disorders associated with athetoid cerebral palsy (CP). SUMMARY OF BACKGROUND DATA: Traditionally, most patients with cervical myelopathy associated with CP have required combined anterior and posterior fusion to achieve solid stability against severe involuntary movement. METHODS: Thirty-one CP patients with cervical disorders who underwent PSF alone with a minimum 2-year follow-up (mean 58 months) were analyzed. All patients were treated with PSF using CPS constructs with or without decompression procedures. The average number of fused segments was 5.1 (range, 1 to 10 segments), and a halo jacket was applied in 16 patients for at least 2 months after surgery. Clinical outcomes using the Japanese Orthopaedic Association scoring system (JOA score) and walking ability, radiographic sagittal alignment, fusion status, surgery-related complications were evaluated. RESULTS: The JOA score improved from 8.3 points preoperatively to 10.9 points at the final follow-up ($p<0.05$). While no patients experienced deterioration in their walking ability postoperatively, 10 patients were unable to walk at the final follow-up. Sagittal alignment, including C0-2 angle, C2-7 angle, and local alignment in fused segments, was maintained postoperatively. Twenty-five patients achieved fusion at the final follow-up (fusion rate: 81%), and 5 patients with non-union required additional surgery. With regard to complications, 5 patients encountered postoperative upper extremity palsy. CONCLUSIONS: The CPS construct is amenable to achieve a relatively high fusion rate without correction loss, and good clinical outcomes can be achieved with a posterior single approach for CP patients. In the future, efforts should be made to make appropriate decisions regarding the fusion area, take preventative measures against postoperative upper extremity palsy, and simplify external orthoses after surgery, especially with the use of a halo jacket.

PMID: 28574882

**9. Orthopedic surgery in cerebral palsy: Instructional course lecture.**

Sharan D.

Indian J Orthop. 2017 May-Jun;51(3):240-255. doi: 10.4103/ortho.IJOrtho_197_16.

Orthopedic surgery (OS) plays an important role in the management of cerebral palsy (CP). The objectives of OS are to optimize functions and prevent deformity. Newer developments in OS for CP include emphasis on hip surveillance, minimally invasive procedures, use of external fixators instead of plates and screws, better understanding of lever arm dysfunctions (that can only be corrected by bony OS), orthopedic selective spasticity-control surgery, and single-event multilevel lever arm restoration and anti spasticity surgery, which have led to significant improvements in gross motor function and ambulation, especially in spastic quadriplegia, athetosis, and dystonia. The results of OS can be dramatic and life altering for the person with CP and their caregivers if it is performed meticulously by a specialized surgical team, at the appropriate age, for the correct indications, employing sound biomechanical principles and is followed by physician-led, protocol based, intensive, multidisciplinary, institutional rehabilitation, and long term followup. However, OS can be a double-edged sword, and if performed less than optimally, and without the supporting multidisciplinary medical and rehabilitation team, expertise and infrastructure, it often leads to significant functional worsening of the person with CP, including irretrievable loss of previous ambulatory capacity. OS must be integrated into the long term management of the person with CP and should be anticipated and planned at the optimal time and not viewed as a "last resort" intervention or failure of rehabilitation. This instructional course lecture reviews the relevant contemporary principles and techniques of OS in CP.

PMID: 28566775

**10. Participation and community-based walking activity after neuroprosthesis use in children with hemiplegic cerebral palsy: A pilot study.**

Bailes AF, Caldwell C, Clay M, Tremper M, Dunning K, Long J.

J Pediatr Rehabil Med. 2017 May 17;10(2):71-79. doi: 10.3233/PRM-170434.

PURPOSE: To explore the effects of neuroprosthesis use on participation, level of community-based walking activity, safety and satisfaction in children with hemiplegic CP. METHODS: Eleven children (mean 9 years 11 months) with hemiplegic CP Gross Motor Function Classification System (GMFCS) Level I and II participated in a 16-week intervention using the Ness L300 neuroprosthesis. Outcome measures included satisfaction and performance with self-selected participation goals (Canadian Occupational Performance Measure (COPM)), level of community-based walking activity (Step Watch Activity Monitor (SAM)), trip and fall frequency (caregiver report) and a satisfaction questionnaire. RESULTS: Significant ($p< 0.001$) improvements in performance and satisfaction with self-selected participation goals (COPM) were demonstrated. No significant changes were noted in SAM values. A significant ($p= 0.01$) decrease in trips was demonstrated from baseline to post. Satisfaction with the device was high. CONCLUSION: Results indicate that daily neuroprosthesis use may improve performance and satisfaction with participation goals and reduce trips. No changes in community-based walking activity were noted. Further study is needed to examine response based on GMFCS levels, across geographical regions and between FES neuroprosthesis and a control group.

PMID: 28582881

**11. Robotic resistance treadmill training improves locomotor function in children with cerebral palsy: a randomized controlled pilot study.**

Wu M, Kim J, Gaebler-Spira DJ, Schmit BD, Arora P.

Arch Phys Med Rehabil. 2017 May 30. pii: S0003-9993(17)30367-2. doi: 10.1016/j.apmr.2017.04.022. [Epub ahead of print]

OBJECTIVE: To determine whether applying controlled resistance forces to the legs during the swing phase of gait may improve the efficacy of treadmill training compared to applying controlled assistance forces in children with cerebral palsy (CP). DESIGN: Randomized controlled study. SETTING: Research unit of rehabilitation hospital. PARTICIPANTS: Children with spastic CP (n = 23, average age 10.6 years old, ranged from 6-14, GMFCS levels: I to IV). INTERVENTIONS: Participants were randomly assigned to receive controlled assistance (n=11) or resistance (n=12) loads applied to the legs at the ankle. Participants underwent robotic treadmill training 3 times a week for 6 weeks (18 sessions). A controlled swing assistance/resistance load was applied to both legs starting from toe-off to mid-swing phase of gait during training. MAIN OUTCOME MEASURES: Outcome measures consisted of overground walking speed, 6 minute walking distance, and GMFM scores, and were assessed pre, post 6 weeks of training, and 8 weeks after the end of training. RESULTS: Following 6 weeks of treadmill training for participants from the resistance training group, fast walking speed and 6 minute walking distance significantly improved (18% and 30% increases, respectively), and 6 minute walking distance was still significantly greater than baseline (35% increase) 8 weeks after the end of training. In contrast, overground gait speed and 6 minute walking distance had no significant changes after robotic assistance training. CONCLUSION: Results from the current study indicated that robotic resistance treadmill training is more effective than assistance training in improving locomotor function in children with CP.

PMID: 28576629

**12. A home-based body weight supported treadmill training program for children with cerebral palsy: A case series.**

Kenyon LK, Westman M, Hefferan A, McCrary P, Baker BJ.

Physiother Theory Pract. 2017 May 30:1-10. doi: 10.1080/09593985.2017.1325956. [Epub ahead of print]

BACKGROUND AND PURPOSE: Contemporary approaches to the treatment of cerebral palsy (CP) advocate a task-specific approach that emphasizes repetition and practice of specific tasks. Recent studies suggest that body-weight-supported treadmill training (BWSTT) programs may be beneficial in clinical settings. The purposes of this case series were to explore the outcomes and feasibility of a home-based BWSTT program for three children with CP. CASE DESCRIPTION: Three children

with CP at Gross Motor Function Classification System (GMFCS) Levels III or IV participated in this case series. Examination included the Functional Assessment Questionnaire (FAQ), the 10-meter walk test, the Gross Motor Function Measure (GMFM-66), and the Pediatric Evaluation of Disability Inventory-Computer Adaptive Test (PEDI-CAT). A harness system was used to conduct the BWSTT program over an 8-12 week period. OUTCOMES: All of the families reported enjoying the BWSTT program and found the harness easy to use. Participant 2 increased from a 2 to a 4 on the FAQ, while Participant 3 increased from a 6 to a 7. DISCUSSION: Two of the participants demonstrated post-intervention improvements in functional mobility. In addition to mobility outcomes, future research should explore the potential health benefits of a home-based BWSTT program.

PMID: 28557625

**13. Beneficial effects of Jiawei Shenqi-wan and treadmill training on deficits associated with neonatal hypoxic-ischemia in rats.**

Kim HN, Pak ME, Shin MJ, Kim SY, Shin YB, Yun YJ, Shin HK, Choi BT.

Exp Ther Med. 2017 May;13(5):2134-2142. doi: 10.3892/etm.2017.4286. Epub 2017 Mar 30.

Jiawei Shenqi-wan (JSQW), which comprises Shenqi-wan and two additional medicinal herbs, has been widely used for the treatment of various growth impairments, including cerebral palsy. In the present study, JSQW was administered to hypoxic-ischemic Sprague-Dawley rats that underwent treadmill training from 4-7 weeks of age to examine the beneficial effects of combined JSQW and treadmill therapy. Behavioral examinations were performed and a significant improvement in cylinder test performance was observed in rats treated with treadmill training compared with hypoxic-ischemia rats ($P<0.05$), as well as a significant improvement in passive avoidance test performance for rats treated with JSQW ($P<0.05$). The thickness of the corpus callosum and the integrated optical density (IOD) of myelin basic protein (MBP) were significantly increased by treatment with treadmill therapy alone ($P<0.01$ and $P<0.001$, respectively) and treatment with both JSQW and treadmill significantly increased the IOD of MBP compared with hypoxic-ischemia rats ($P<0.001$). Western blot analysis revealed that the expression of neuronal nuclei (NeuN) and doublecortin (Dcx) significantly decreased ($P<0.001$ and $P<0.05$, respectively) and MBP expression markedly decreased in the ipsilateral subventricular zone of hypoxic-ischemic rats compared with the control group; however, the expression of NeuN was significantly recovered by treatment with both JSQW and treadmill training ($P<0.05$). Furthermore, Dcx expression was significantly recovered by treatment with JSQW ($P<0.05$), and MBP expression was significantly restored by treatment with treadmill training ($P<0.01$). In the immunohistochemical analyses, a significant increase in the number of bromodeoxyuridine (BrdU) positive cells in this region was observed in treadmill-treated rats ($P<0.05$), whereas significant increases in the number of Brdu/Dcx or NeuN or glial fibrillary acidic protein double-positive cells were observed only in the group co-treated with JSQW and treadmill ($P<0.01$, $P<0.05$ and $P<0.001$, respectively). These results suggest that JSQW and treadmill training may contribute to behavior recovery following hypoxic-ischemia, and JSQW treatment was particularly effective in promoting memory function via enhancing the differentiation of neuronal progenitor cells. The results of the present study therefore suggest that JSQW may provide an additional treatment option for functional recovery with treadmill training in cerebral palsy.

PMID: 28565820

**14. Physical strain: a new perspective on walking in cerebral palsy.**

Balemans AC, Bolster E, Brehm MA, Dallmeijer AJ.

Arch Phys Med Rehabil. 2017 Jun 5. pii: S0003-9993(17)30380-5. doi: 10.1016/j.apmr.2017.05.004. [Epub ahead of print]

OBJECTIVE: The objectives of this study in children and adolescents with cerebral palsy (CP) were to 1) describe physical strain of walking, 2) describe the proportion of participants walking above the anaerobic threshold and 3) describe 4 phenotypes of physical strain of walking based on deviations in aerobic capacity and walking energy cost (EC). DESIGN: Cohort SETTING: Academic medical center PARTICIPANTS: Thirty-seven participants (13y5mo(4y0mo)) with CP (Gross Motor Function Classification System (GMFCS) levels I[n=13], II[N=17] and III[N=7]) and 20 typically developing participants (TD) (11y8mo(3y5mo)). INTERVENTIONS: Not applicable MAIN OUTCOME MEASURE(S): Oxygen consumption (VO2walk), speed and EC were determined during walking at comfortable speed. Peak oxygen uptake (VO2peak) and anaerobic threshold were measured during a maximal cycling exercise test. Aerobic capacity was decreased if <10th percentile and EC was increased if >3SD's. Physical strain was defined as [VO2walk/VO2peak]*100. RESULTS: Participants with CP had a higher physical strain (GMFCS levels I:55±12%, II:62±17% and III:78±14%) than TD (40±11%, $p<0.001$). 43% of the participants with CP showed a VO2walk at or higher than their anaerobic threshold compared to 10% in TD ($p=0.007$).

Phenotypes showed that a decreased VO2peak [N=9] or an increased EC [N=9] lead to 18-20% higher physical strain, while a combination [N=12] leads to 40% increase. CONCLUSIONS: Children and adolescents with CP walk at a high physical strain, approximating intense exercise and a considerable part walks around or above their anaerobic threshold, probably explaining fatigue and reduced walking distance. Both an increased EC and/or a decreased VO2peak contribute to high physical strain in children or adolescents with CP. The different causes of high physical strain in CP require different intervention strategies.

PMID: 28596080

**15. Pain in cerebral palsy: a neglected comorbidity.**

Fehlings D.

Dev Med Child Neurol. 2017 May 29. doi: 10.1111/dmcn.13477. [Epub ahead of print]

[No abstract available]

PMID: 28555892

**16. Inertial Sensors to Assess Gait Quality in Patients with Neurological Disorders: A Systematic Review of Technical and Analytical Challenges.**

Vienne A, Barrois RP, Buffat S, Ricard D, Vidal PP.

Front Psychol. 2017 May 18;8:817. doi: 10.3389/fpsyg.2017.00817. eCollection 2017.

Gait disorders are major causes of falls in patients with neurological diseases. Understanding these disorders allows prevention and better insights into underlying diseases. InertiaLocoGraphy (ILG) -the quantification of gait by using inertial measurement units (IMUs) -shows great potential to address this public health challenge, but protocols vary widely and normative values of gait parameters are still unavailable. This systematic review critically compares ILG protocols, questions features extracted from inertial signals and proposes a semeiological analysis of clinimetric characteristics for use in neurological clinical routine. For this systematic review, PubMed, Cochrane and EMBASE were searched for articles assessing gait quality by using IMUs that were published from January 1, 2014 to August 31, 2016. ILG was used to assess gait in a wide range of neurological disorders - including Parkinson disease, mild cognitive impairment, Alzheimer disease, cerebral palsy, and cerebellar atrophy - as well as in the faller or frail older population and in people presenting rheumatological pathologies. However, results have not yet been driving changes in clinical practice. One reason could be that studies mainly aimed at comparing pathological gait to healthy gait, but there is stronger need for semiological descriptions of gait perturbation, severity or prognostic assessment. Furthermore, protocols used to assess gait using IMUs are too many. Likely, outcomes are highly heterogeneous and difficult to compare across large panels of studies. Therefore, homogenization is needed to foster the use of ILG to assess gait quality in neurological routine practice. The pros and cons of each protocol are emphasized so that a compromise can be reached. As well, analysis of seven complementary clinical criteria (springiness, sturdiness, smoothness, steadiness, stability, symmetry, synchronization) is advocated.

PMID: 28572784

**17. Does expert knowledge improve automatic probabilistic classification of gait joint motion patterns in children with cerebral palsy?**

De Laet T, Papageorgiou E, Nieuwenhuys A, Desloovere K.

PLoS One. 2017 Jun 1;12(6):e0178378. doi: 10.1371/journal.pone.0178378. eCollection 2017.

BACKGROUND: This study aimed to improve the automatic probabilistic classification of joint motion gait patterns in children with cerebral palsy by using the expert knowledge available via a recently developed Delphi-consensus study. To this end, this study applied both Naïve Bayes and Logistic Regression classification with varying degrees of usage of the expert knowledge (expert-defined and discretized features). A database of 356 patients and 1719 gait trials was used to validate the

classification performance of eleven joint motions. HYPOTHESES: Two main hypotheses stated that: (1) Joint motion patterns in children with CP, obtained through a Delphi-consensus study, can be automatically classified following a probabilistic approach, with an accuracy similar to clinical expert classification, and (2) The inclusion of clinical expert knowledge in the selection of relevant gait features and the discretization of continuous features increases the performance of automatic probabilistic joint motion classification. FINDINGS: This study provided objective evidence supporting the first hypothesis. Automatic probabilistic gait classification using the expert knowledge available from the Delphi-consensus study resulted in accuracy (91%) similar to that obtained with two expert raters (90%), and higher accuracy than that obtained with non-expert raters (78%). Regarding the second hypothesis, this study demonstrated that the use of more advanced machine learning techniques such as automatic feature selection and discretization instead of expert-defined and discretized features can result in slightly higher joint motion classification performance. However, the increase in performance is limited and does not outweigh the additional computational cost and the higher risk of loss of clinical interpretability, which threatens the clinical acceptance and applicability.

PMID: 28570616

**18. Interval setting selection affects ambulatory activity outputs in children with cerebral palsy.**

Stevens WR Jr, Tulchin-Francis K.

Gait Posture. 2017 May 23;57:69-73. doi: 10.1016/j.gaitpost.2017.05.020. [Epub ahead of print]

INTRODUCTION: Accelerometer based devices have been widely used to assess the ambulatory activity of children with and without functional disabilities. Many researchers who utilize the StepWatch Activity Monitor (SAM) collect at a 60second (60sec) interval setting. The purpose of this study was to assess the effect of SAM interval settings on ambulatory activity outputs in children with cerebral palsy (CP) and typically developing youth. METHODS: Participants wore a SAM which recorded the number of strides every 10seconds (10s) for one week. Raw 10s data was downsampled to combine strides into 60sec intervals. Strides were ensembled into walking bouts with the Intensity/Duration calculated as a percentage of Total Ambulatory Time (TAT). RESULTS: Twenty-eight children with CP (14 boys; avg. 12 yrs. 4 mths.; GMFCS Level I n=4, Level II n=19, Level III n=5) completed testing and 28 age matched typically developing youth (14 boys; avg. 12 yrs. 6 mths.) were included. Using the 10sec interval, ~80% of walking bouts in both groups were less than or equal to 60s. Data recorded at 60sec intervals had higher daily TAT but fewer walking bouts. In children with CP, daily steps were higher using the 60sec interval. At the Easy intensity, the 60sec interval reported an increased volume of Long duration walking, and it rarely identified any Moderate+ intensity activity. CONCLUSIONS: 60sec interval data overestimated low intensity and long duration ambulatory activity. It is imperative that investigators choose a finer interval setting (10sec) to maximize the detection of gait transitions and rest periods which are critical in describing community ambulation of patients with cerebral palsy.

PMID: 28578136

**19. Management of Severe Equinovalgus in Patients With Cerebral Palsy by Naviculectomy in Combination With Midfoot Arthrodesis.**

Dussa CU, Döderlein L, Forst R, Böhm H, Fujak A.

Foot Ankle Int. 2017 Jun 1:1071100717709577. doi: 10.1177/1071100717709577. [Epub ahead of print]

BACKGROUND: Equinovalgus deformity is the second most common deformity in cerebral palsy and may be flexible or rigid. Several operative methods from joint sparing to arthrodesis have been described with varying success rates. The aim of this study was to investigate the effectiveness of naviculectomy in combination with midfoot arthrodesis (talo-cuneiform and calcaneocuboid arthrodesis) in the correction of a rigid equinovalgus foot deformity in cerebral palsy. METHODS: Forty-eight rigid equinovalgus feet were operated upon in 30 patients from 2008 to 2013. Of these, 44 feet in 26 patients with cerebral palsy (Gross Motor Function Classification System III, IV, or V) with follow-up of more than 2 years were included in the study. The mean age at surgery was 18.1 years. The outcomes were measured objectively using radiographic angles and subjectively using 5 questions to be answered by the caregiver. The feet were then graded into excellent, good, fair, and poor. The mean follow-up was 5.0 ± 1.7 years. RESULTS: Excellent to good results were obtained in 81% of the feet. Both objective and subjective outcomes improved significantly postoperatively ( $P < .001$). Three feet in 2 patients were graded as poor and underwent a revision operation for pain and recurrence. CONCLUSIONS: Naviculectomy in combination with midfoot arthrodesis enabled a good 3-dimensional correction of the forefoot. However, the procedure did not necessarily correct the fixed subtalar joint deformity. Several additional bony and soft-tissue procedures were necessary to achieve a complete correction in these difficult feet.



PMID: 28587475

**20. Children with Cerebral Palsy Hyper-Gate Somatosensory Stimulations of the Foot.**

Kurz MJ, Wiesman AI, Coolidge NM, Wilson TW.

Cereb Cortex. 2017 Jun 7:1-8. doi: 10.1093/cercor/bhx144. [Epub ahead of print]

We currently have a substantial knowledge gap in our understanding of the neurophysiological underpinnings of the sensory perception deficits often reported in the clinic for children with cerebral palsy (CP). In this investigation, we have begun to address this knowledge gap by using magnetoencephalography (MEG) brain imaging to evaluate the sensory gating of neural oscillations in the somatosensory cortices. A cohort of children with CP (Gross Motor Function Classification System II-III) and typically developing children underwent paired-pulse electrical stimulation of the tibial nerve during MEG. Advanced beamforming methods were used to image significant oscillatory responses, and subsequently the time series of neural activity was extracted from peak voxels. Our experimental results showed that somatosensory cortical oscillations (10-75 Hz) were weaker in the children with CP for both stimulations. Despite this reduction, the children with CP actually exhibited a hyper-gating response to the second, redundant peripheral stimulation applied to the foot. These results have further established the nexus of the cortical somatosensory processing deficits that are likely responsible for the degraded sensory perceptions reported in the clinic for children with CP.

PMID: 28591842

**21. Comparison of mid-term efficacy of spastic flatfoot in ambulant children with cerebral palsy by 2 different methods.**

Wen J, Liu H, Xiao S, Li X, Fang K, Zeng M, Tang Z, Cao S, Li F.

Medicine (Baltimore). 2017 Jun;96(22):e7044. doi: 10.1097/MD.0000000000007044.

To compare the treatment efficacy of spastic flatfoot surgery by 2 different surgical methods: nonfusion subtalar arthroereisis using subtalar joint stabilizer (SJS) and Dennyson-Fulford subtalar arthrodesis (D-FSA).A total of 26 cases of ambulant children with cerebral palsy diagnosed as spastic flatfoot were surgically treated from January 2011 to December 2014. Preoperative and postoperative American Orthopedic Foot and Ankle Society-Ankle and Hindfoot (AOFAS-AH) scores, anteroposterior-talocalcaneal angles (ATAs), and lateral talar-first metatarsal angles (Meary angles) of the affected foot were recorded.Among 12 children in the SJS group, the AOFAS-AH scores were median preoperative score of 61 (58-64) versus median postoperative score of 83 (75-92), with significant difference ($P<.05$). Of the 20 feet treated, only 1 foot developed occasional pain. Postoperative ATA was decreased from preoperative 35° (20°-50°) to 19° (12°-25°); lateral X-ray films showed that the Meary angle was decreased from preoperative 20° (15°-40°) to postoperative 0° (0°-3°). The differences in both findings were statistically significant ($P<.05$). Fourteen children (22 treated feet) formed the D-FSA group; all demonstrated fusion of the talocalcaneal joint; AOFAS-AH scores were median preoperative score of 61 (58-64) versus median postoperative score of 83 (75-92), with significant difference ($P<.05$). Only 1 foot had occasional pain. Postoperative ATA was decreased from preoperative 35° (20°-45°) to 16° (12°-25°); lateral X-ray films showed that the Meary angle was decreased from preoperative 19° (10°-40°) to postoperative 2° (0°-5°); the differences in both findings were statistically significant ($P<.05$).Both nonfusion subtalar arthroereisis using SJS and D-FSA were effective for the surgical treatment of spastic flatfoot, with similar clinical outcomes.

PMID: 28562561

**22. The effect of botulinum toxin A (Botox) injections used to treat limb spasticity on speech patterns in children with dysarthria and cerebral palsy: A report of two cases.**

Workinger MS, Kent RD, Meilahn JR.

J Pediatr Rehabil Med. 2017 May 19;10(2):137-143. doi: 10.3233/PRM-170433.

Botulinum toxin A (Btx-A) injections are used to treat limb spasticity in children with cerebral palsy (CP) resulting in improved gross and fine motor control. This treatment has also been reported to have additional functional effects, but the effect of treatment on speech has not been reported. This report presents results of longitudinal speech evaluation of two children with CP given injections of Btx-A for treatment of limb spasticity. Speech evaluations were accomplished at baseline (date of injections) and 4- and 10-weeks post-injections. Improvements in production of consonants, loudness control, and syllables produced per breath were found. Parental survey also suggested improvements in subjects' speech production and

willingness to speak outside the testing situation. Future larger studies are warranted to assess the nature of the changes observed related to Btx-A.

PMID: 28582880

**23. The Role of the Corpus Callosum in Pediatric Dysphagia: Preliminary Findings from a Diffusion Tensor Imaging Study in Children with Unilateral Spastic Cerebral Palsy.**

Mourão LF, Friel KM, Sheppard JJ, Kuo HC, Luchesi KF, Gordon AM, Malandraki GA.

Dysphagia. 2017 Jun 8. doi: 10.1007/s00455-017-9816-0. [Epub ahead of print]

The purpose of this study is to determine the relationship between the structural integrity of the corpus callosum (CC) and clinical feeding/swallowing performance in children with unilateral spastic cerebral palsy (USCP). Twenty children with USCP, (11 males, 5.11-17.6 yoa) were assessed via the Dysphagia Disorder Survey (DDS) and diffusion tensor imaging. Children were grouped into left hemisphere lesion (LHL; n = 13) and right hemisphere lesion (RHL; n = 7) groups. DTI variables analyzed for three CC regions (anterior, middle, posterior) were: fractional anisotropy (FA), radial diffusivity (RD), mean diffusivity (MD), and fibers count. Children with RHL presented with higher clinical dysphagia severity ($p = 0.03$). Six of seven children with RHL had lesions affecting periventricular/subcortical areas, and 8/13 children with LHL had lesions affecting the sensorimotor cortex. In the LHL group, as FA and fiber count of the anterior CC decreased and RD increased (all indicating reduced CC structural integrity), signs of dysphagia increased ($r = -0.667$, $p = 0.013$; $r = -0.829$, $p \leq 0.001$; $r = 0.594$, $p = 0.032$, respectively). Reduced fiber count in the middle and posterior CC was also significantly associated with increased DDS scores ($r = -0.762$, $p = 0.002$; $r = -0.739$, $p = 0.004$, respectively). For the RHL group no significant correlations were observed. We provide preliminary evidence that corpus callosum integrity correlates with feeding/swallowing performance in children with USCP, especially when cortical sensorimotor areas of the left hemisphere are impacted. In this sample, CC integrity appeared to enable interhemispheric cortical plasticity for swallowing, but was not as critical when intrahemispheric connections were disrupted, as seen in the RHL group.

PMID: 28597327

**24. Changes in brain activity following intensive voice treatment in children with cerebral palsy.**

Bakhtiari R, Cummine J, Reed A, Fox CM, Chouinard B, Cribben I, Boliek CA.

Hum Brain Mapp. 2017 Jun 5. doi: 10.1002/hbm.23669. [Epub ahead of print]

Eight children (3 females; 8-16 years) with motor speech disorders secondary to cerebral palsy underwent 4 weeks of an intensive neuroplasticity-principled voice treatment protocol, LSVT LOUD® , followed by a structured 12-week maintenance program. Children were asked to overtly produce phonation (ah) at conversational loudness, cued-phonation at perceived twice -conversational loudness, a series of single words, and a prosodic imitation task while being scanned using fMRI, immediately pre- and post-treatment and 12 weeks following a maintenance program. Eight age- and sex-matched controls were scanned at each of the same three time points. Based on the speech and language literature, 16 bilateral regions of interest were selected a priori to detect potential neural changes following treatment. Reduced neural activity in the motor areas (decreased motor system effort) before and immediately after treatment, and increased activity in the anterior cingulate gyrus after treatment (increased contribution of decision making processes) were observed in the group with cerebral palsy compared to the control group. Using graphical models, post-treatment changes in connectivity were observed between the left supramarginal gyrus and the right supramarginal gyrus and the left precentral gyrus for the children with cerebral palsy, suggesting LSVT LOUD enhanced contributions of the feedback system in the speech production network instead of high reliance on feedforward control system and the somatosensory target map for regulating vocal effort. Network pruning indicates greater processing efficiency and the recruitment of the auditory and somatosensory feedback control systems following intensive treatment. Hum Brain Mapp, 2017. 

PMID: 28580693

**25. Treatment of drooling with sublingual atropine sulfate in children and adolescents with cerebral palsy.**

Dias BLS, Fernandes AR, Maia HS Filho.

Arq Neuropsiquiatr. 2017 May;75(5):282-287. doi: 10.1590/0004-282X20170033.

OBJECTIVE: To report the effect of sublingual atropine sulfate to treat drooling in children with cerebral palsy by comparing the results of the Drooling Impact Scale in a non-controlled open clinical trial. RESULTS: Twenty-five children were assessed. The difference in the mean scores of the pre- and post-treatment scales reached statistical significance. There was a low frequency of side effects compared to studies with other anticholinergics. CONCLUSION: The use of sublingual atropine sulfate seems to be safe and there is a reduction in the Drooling Impact Scale score, which suggests efficacy in the treatment of drooling in children and adolescents with cerebral palsy. Our results should be replicated in randomized, placebo-controlled studies with larger numbers of participants.

PMID: 28591387

**26. Using the electronic medical record to study the association of child and environmental characteristics on the type of physical therapy services delivered to individuals with cerebral palsy.**

Bailes AF, Gannotti M, Fenchel M.

Physiother Theory Pract. 2017 Jun 7:1-9. doi: 10.1080/09593985.2017.1328717. [Epub ahead of print]

OBJECTIVE: The purpose of this study was to characterize the intervention type delivered to individuals with cerebral palsy (CP) in a pediatric outpatient medical setting and to identify factors associated with the total amount of service within each type. SUBJECTS: Four hundred and twenty-five individuals with CP (1-33 years) Gross Motor Function Classification System (GMFCS): Level I (n = 152); II (n = 63); III (n = 55); IV (n = 80); and V (n = 75). METHODS: Billing code data was extracted retrospectively from 2008 medical records and categorized to reflect four types: body structures and function (BSF), activity (ACT), environment (ENV), and examination (EXAM). Age at first visit, type of insurance at first visit and GMFCS level was also collected. RESULTS: The majority (47%) of the PT delivered was categorized as activity based units, 25% as body structure and function, 21% as environment, and 7% as examination. Significant differences were found in: total BSF therapy units among GMFCS ($p = 0.008$) and insurance type ($p < 0.001$), ACT units among GMFCS ($p < 0.001$), age groups ($p < 0.001$), and insurance type ($p = 0.008$), and ENV units among GMFCS ($p = 0.04$). The amount of variability (R2) explained by the model for each category BSF, ACT, and ENV was 0.09 ($p < 0.0001$), 0.15 ($p < 0.0001$) and 0.02 ($p = 0.04$), respectively. CONCLUSION: Variations in amount of services received among types of intervention are associated with child and environmental characteristics. Low R2 values indicate the need to collect information on other factors that influence service delivery. Data that are standardized and reliably collected should be validated and compared across institutions to support larger studies of service delivery patterns.

PMID: 28590797

**27. Predicting the prevalence of cerebral palsy by severity level in children aged 3 to 15 years across England and Wales by 2020.**

Glinianaia SV, Best KE, Lingam R, Rankin J.

Dev Med Child Neurol. 2017 Jun 2. doi: 10.1111/dmcn.13475. [Epub ahead of print]

AIM: To estimate the number of children living with cerebral palsy (CP) in England and Wales in 2013 by severity, and to extrapolate this figure to 2020. METHOD: Data from the North of England Collaborative Cerebral Palsy Survey for births during the period 1991 to 2000 were restricted to individuals aged at or above 3 years to estimate the prevalence of CP and to calculate 15-year survival by severity according to the number of severe impairments and lifestyle assessment score. The number of 3- to 15-year-olds with CP of different severity in England and Wales was estimated in 2013 and 2019 using actual and nationally projected births. RESULTS: Cumulative survival estimates up to the age of 16 years in children with CP differ significantly by severity, ranging between 97 per cent and 100 per cent for children with non-severe CP, and between 64 per cent and 67 per cent for those with the most severe CP. By the end of 2013, the estimated number of children aged 3 to 15 years living with CP in England and Wales will be about 20 500 rising to approximately 22 100 by 2020, a 7.5 per cent increase. INTERPRETATION: Owing to an increasing population, the number of children living with CP in England and Wales will increase by 2020. This will have significant implications for health and social care service planning.



PMID: 28574167

**28. Mastery Motivation and Executive Functions as Predictors of Adaptive Behavior in Adolescents and Young Adults With Cerebral Palsy or Myelomeningocele.**

Warschausky S, Kaufman JN, Evitts M, Schutt W, Hurvitz EA.

Rehabil Psychol. 2017 Jun 1. doi: 10.1037/rep0000151. [Epub ahead of print]

PURPOSE/OBJECTIVE: To examine mastery motivation and executive functions or behaviors as predictors of adaptive behavior in adolescents and young adults with congenital neurodevelopmental conditions. METHOD: Participants were 2 groups of adolescents and young adults, ages 13-29, including 43 with cerebral palsy and 36 with myelomeningocele living with a parent or caregiver. Participants completed measures of mastery motivation, executive functions or behaviors, and a measure of adaptive behavior. RESULTS: Group differences in mastery motivation, executive functions and executive behaviors, and adaptive behavior profiles were not significant. Mastery motivation, executive functions, and executive behaviors explained a significant portion of variance in adaptive behavior. CONCLUSIONS: Findings highlight the importance of assessing and addressing motivational and executive needs in developing interventions to promote independence. Findings also suggest the need for more comprehensive assessment of adaptive behaviors that include the ability to self-direct others in the completion of tasks necessary for successful daily functioning. (PsycINFO Database Record

PMID: 28569523

**29. Intelligence, Functioning, and Related Factors in Children with Cerebral Palsy.**

Türkoğlu G, Türkoğlu S, Çelik C, Uçan H.

Noro Psikiyatr Ars. 2017 Mar;54(1):33-37. doi: 10.5152/npa.2015.12676. Epub 2017 Mar 1.

INTRODUCTION: Cerebral palsy (CP) is the most common significant motor impairment in childhood. CP is defined as a primary disorder of posture and movement; however, intellectual impairment is prevalent in children with CP. The purpose of this study was to examine the intelligence level associated with gross motor function and hand function, type of CP, the presence of comorbid disorders such as epilepsy, and other factors. METHODS: In total, 107 children with CP were included. Age, gender, prenatal/natal/postnatal risk factors, type of CP, and presence of other neurodevelopmental disorders were recorded as demographic findings. Intellectual functions of the patients were determined by clinical assessment, adaptive function of daily life, and individualized, standardized intelligence testing. The gross motor function and hand function of the patients were classified using the "Gross Motor Function Classification System" and "Bimanual Fine Motor Function" measurements, respectively. RESULTS: The mean age of the patients was 8.10±3.43 years (2-16 years). The study included 63 (58.9%) male patients and 44 (41.1%) female patients. During clinical typing, 80.4% of the patients were spastic, 11.2% were mixed, 4.7% were dyskinetic, and 3.7% were ataxic. Intellectual functioning tests found 26.2% of the children within the intellectual norm and that 10% of the children had a borderline intellectual disability, 16% of them had a mild intellectual disability, 17% of them had a moderate intellectual disability, and 30.8% of them had a severe intellectual disability. No significant relationship was determined between the CP type and intellectual functioning ($p>0.05$). Intellectual functioning was found to be significantly correlated with hand functions and motor levels ($p<0.001$). Factors related with intellectual functioning were neonatal convulsion, epilepsy, and speech disorders. CONCLUSION: Intelligence assessment should be an essential part of CP evaluation and research. There is not enough reliable knowledge, unanimity regarding validity data, and population-specific norms in the intelligence assessments of children with CP. Research is required to assess properly intelligence for children with CP.

PMID: 28566956

**30. Social dominance in children with cerebral palsy during a problem-solving task with peers.**

Voyer AP, Nadeau L, Tessier R.

Disabil Rehabil. 2017 Jun 6:1-5. doi: 10.1080/09638288.2017.1334237. [Epub ahead of print]

PURPOSE: Children with cerebral palsy tend to have poorer social competence outcomes than their peers without a disability in mainstream school settings. To understand their social competence, this study compared children with cerebral palsy with paired children without cerebral palsy with respect to their ability to access resources, defined here as "social dominance", in a problem-solving situation. METHOD: Children with cerebral palsy were randomly paired to a peer (teammate) and put in a

competitive context where each team of two children was instructed to solve an impossible problem. To control for social status, a sociometric measure was administered previously in the classroom (Social Preference score). Behaviors related to social dominance (prosocial and coercive behaviors) were coded using an observation scale validated for this study. RESULTS: The results showed that regardless of social status, children with cerebral palsy were less socially dominant than controls without cerebral palsy. Furthermore, their teams seemed to be less dominant than teams composed of two controls. CONCLUSIONS: The lower social competence in children with cerebral palsy could be partly explained by their reduced social dominance behavior in activities requiring speed and fluidity as an expression of executive functions. This might be viewed as a marker for social risks in the integration process at school. Implications for rehabilitation Gross Motor Function Classification System level I or II cerebral palsy is a condition that affects not only motor abilities but also social competence in children. Lower social competence in children with cerebral palsy could be partly explained by reduced social dominance behavior in activities such as problem solving with peers. To improve social competence, rehabilitation interventions should include social participation opportunities in which children with cerebral palsy are encouraged to take an active role in the activity.

PMID: 28585442

**31. Advocacy for refugee children with disabilities.**

Rice J.

Dev Med Child Neurol. 2017 Jul;59(7):669. doi: 10.1111/dmcn.13446.

[No abstract available]

PMID: 28599357

# Prevention and Cure

**32. General movement trajectories and neurodevelopment at 3months of age following neonatal surgery.**

Crowle C, Walker K, Galea C, Novak I, Badawi N.

Early Hum Dev. 2017 May 31;111:42-48. doi: 10.1016/j.earlhumdev.2017.05.010. [Epub ahead of print]

BACKGROUND: Neonates who undergo major surgery are at risk of neurodevelopmental disability. The General Movements Assessment (GMA) is a valid and reliable method to predict neurodevelopment, however, there are minimal data on the applicability among infants post-surgery. AIM: To describe GMs trajectories following neonatal surgery. STUDY DESIGN: Prospective cohort study. SUBJECTS: 217 infants following major cardiac and non-cardiac neonatal surgery. OUTCOME MEASURES: Infants were assessed following surgery at term age (mean 40weeks, SD 2.3), and at 3months of age (mean 12weeks, SD 1.6) using the GMA and the Bayley Scales of Infant and Toddler Development III. GMA videos were independently scored by three advanced trained assessors, two blinded to infant details. RESULTS: The most common result in the writhing period was 'poor repertoire' (n=117, 54%), however, 99 (84%) of these infants had normal fidgety movements. For infants with normal writhing (n=75, 34%), only four had absent fidgety movements. Cramped synchronised movements were seen in 10 infants, and three of these were rated as absent fidgety. There was no significant difference between the surgical groups. In total, 24 infants (11%) had absent fidgety movements and lower scores on average in all subtests of the BSID-III than those with normal fidgety movements. CONCLUSIONS: This is the first report describing GMs trajectories in infants who have undergone neonatal surgery. Similar to other high risk infant populations, this group showed a high proportion of poor repertoire writhing movements, however, most infants demonstrated normal fidgety movements and development at 3months of age.

PMID: 28577472

**33. The "Fetal Reserve Index": Re-Engineering the Interpretation and Responses to Fetal Heart Rate Patterns.**

Eden RD, Evans MI, Evans SM, Schifrin BS.

Fetal Diagn Ther. 2017 Jun 8. doi: 10.1159/000475927. [Epub ahead of print]

OBJECTIVE: Electronic fetal monitoring (EFM) correlates poorly with neonatal outcome. We present a new metric: the "Fetal Reserve Index" (FRI), formally incorporating EFM with maternal, obstetrical, fetal risk factors, and excessive uterine activity for assessment of risk for cerebral palsy (CP). METHODS: We performed a retrospective, case-control series of 50 term CP cases with apparent intrapartum neurological injury and 200 controls. All were deemed neurologically normal on admission. We compared the FRI against ACOG Category (I-III) system and long-term outcome parameters against ACOG monograph (NEACP) requirements for labor-induced fetal neurological injury. RESULTS: Abnormal FRI's identified 100% of CP cases and did so hours before injury. ACOG Category III identified only 44% and much later. Retrospective ACOG monograph criteria were found in at most 30% of intrapartum-acquired CP patients; only 27% had umbilical or neonatal pH <7.0. CONCLUSIONS: In this initial, retrospective trial, an abnormal FRI identified all cases of labor-related neurological injury more reliably and earlier than Category III, which may allow fetal therapy by intrauterine resuscitation. The combination of traditional EFM with maternal, obstetrical, and fetal risk factors creating the FRI performed much better as a screening test than EFM alone. Our quantified screening system needs further evaluation in prospective trials.

PMID: 28591756

**34. Evoked potentials recorded during routine EEG predict outcome after perinatal asphyxia.**

Nevalainen P, Marchi V, Metsäranta M, Lönnqvist T, Toiviainen-Salo S, Vanhatalo S, Lauronen L.

Clin Neurophysiol. 2017 Jul;128(7):1337-1343. doi: 10.1016/j.clinph.2017.04.025. Epub 2017 May 11.

OBJECTIVE: To evaluate the added value of somatosensory (SEPs) and visual evoked potentials (VEPs) recorded simultaneously with routine EEG in early outcome prediction of newborns with hypoxic-ischemic encephalopathy under modern intensive care. METHODS: We simultaneously recorded multichannel EEG, median nerve SEPs, and flash VEPs during the first few postnatal days in 50 term newborns with hypoxic-ischemic encephalopathy. EEG background was scored into five grades and the worst two grades were considered to indicate poor cerebral recovery. Evoked potentials were classified as absent or present. Clinical outcome was determined from the medical records at a median age of 21months. Unfavorable outcome included cerebral palsy, severe mental retardation, severe epilepsy, or death. RESULTS: The accuracy of outcome prediction was 98% with SEPs compared to 90% with EEG. EEG alone always predicted unfavorable outcome when it was inactive (n=9), and favorable outcome when it was normal or only mildly abnormal (n=17). However, newborns with moderate or severe EEG background abnormality could have either favorable or unfavorable outcome, which was correctly predicted by SEP in all but one newborn (accuracy in this subgroup 96%). Absent VEPs were always associated with an inactive EEG, and an unfavorable outcome. However, presence of VEPs did not guarantee a favorable outcome. CONCLUSIONS: SEPs accurately predict clinical outcomes in newborns with hypoxic-ischemic encephalopathy and improve the EEG-based prediction particularly in those newborns with severely or moderately abnormal EEG findings. SIGNIFICANCE: SEPs should be added to routine EEG recordings for early bedside assessment of newborns with hypoxic-ischemic encephalopathy.

PMID: 28570867

**35. Optimization of Maternal Magnesium Sulfate Administration for Fetal Neuroprotection: Application of a Prospectively Constructed Pharmacokinetic Model to the BEAM Cohort.**

Brookfield KF, Elkomy M, Su F, Drover DR, Carvalho B.

J Clin Pharmacol. 2017 Jun 6. doi: 10.1002/jcph.941. [Epub ahead of print]

The aim of the study was to identify the optimal therapeutic maternal magnesium drug exposure and maternal serum concentration to prevent cerebral palsy in the extremely preterm fetus. We applied a previously constructed pharmacokinetic model adjusted for indication to a large cohort of pregnant women receiving magnesium sulfate to prevent cerebral palsy in their preterm offspring at 20 different US academic centers between December 1997 and May 2004. We simulated the population-based individual maternal serum magnesium concentration at the time of delivery and the total magnesium dose for each woman who received magnesium sulfate to determine the relationship between maternal serum magnesium level at the

time of delivery and the development of cerebral palsy. Among 1905 women who met inclusion criteria, the incidence of cerebral palsy in the cohort was 3.6% for women who had received magnesium sulfate and 6.4% for controls. The simulated maternal serum concentration at delivery associated with the lowest probability of delivering an infant with cerebral palsy was 4.1 mg/dL (95%CI 3.7 to 4.4). Our population-based estimates of magnesium disposition suggest that to optimize fetal neuroprotection and prevent cerebral palsy, magnesium sulfate administration should target a maternal serum magnesium level between 3.7 and 4.4 mg/dL at delivery.

PMID: 28589614

**36. Prophylactic Early Erythropoietin for Neuroprotection in Preterm Infants: A Meta-analysis.**

Fischer HS, Reibel NJ, Bührer C, Dame C.

Pediatrics. 2017 May;139(5). pii: e20164317. doi: 10.1542/peds.2016-4317. Epub 2017 Apr 7.

CONTEXT: Recombinant human erythropoietin (rhEPO) is a promising pharmacological agent for neuroprotection in neonates. OBJECTIVE: To investigate whether prophylactic rhEPO administration in very preterm infants improves neurodevelopmental outcomes in a meta-analysis of randomized controlled trials (RCTs). DATA SOURCES: Medline, Embase, and the Cochrane Central Register of Controlled Trials were searched in December 2016 and complemented by other sources. STUDY SELECTION: RCTs investigating the use of rhEPO in preterm infants versus a control group were selected if they were published in a peer-reviewed journal and reported neurodevelopmental outcomes at 18 to 24 months' corrected age. DATA EXTRACTION: Data extraction and analysis followed the standard methods of the Cochrane Neonatal Review Group. The primary outcome was the number of infants with a Mental Developmental Index (MDI) <70 on the Bayley Scales of Infant Development. Secondary outcomes included a Psychomotor Development Index <70, cerebral palsy, visual impairment, and hearing impairment. RESULTS: Four RCTs, comprising 1133 infants, were included in the meta-analysis. Prophylactic rhEPO administration reduced the incidence of children with an MDI <70, with an odds ratio (95% confidence interval) of 0.51 (0.31-0.81), P < .005. The number needed to treat was 14. There was no statistically significant effect on any secondary outcome. CONCLUSIONS: Prophylactic rhEPO improved the cognitive development of very preterm infants, as assessed by the MDI at a corrected age of 18 to 24 months, without affecting other neurodevelopmental outcomes. Current and future RCTs should investigate optimal dosing and timing of prophylactic rhEPO and plan for long-term neurodevelopmental follow-up.

PMID: 28557760

**37. Understanding the autonomic nervous system in cerebral palsy.**

Dan B.

Dev Med Child Neurol. 2017 Jul;59(7):668. doi: 10.1111/dmcn.13440.

[No abstract available]

PMID: 28599358

**38. Postnatal Development of Spasticity Following Transgene Insertion in the Mouse βIV Spectrin Gene (SPTBN4).**

Kichkin E, Visvanathan A, Lovicu FJ, Shu DY, Das SJ, Reddel SW, McCann EP, Zhang KY, Williams KL, Blair IP, Phillips WD.

J Neuromuscul Dis. 2017;4(2):159-164. doi: 10.3233/JND-160197.

BACKGROUND: The L25 mouse line was generated by random genomic insertion of a lens-specific transgene. Inbreeding of L25 hemizygotes revealed an unanticipated spastic phenotype in the hind limbs. OBJECTIVE: The goals were to characterize the motor phenotype in the L25 mice and to map the transgene insert site within the mouse genome. METHODS: Six pairs of L25+/- mice were repeatedly mated. Beginning at weaning, all progeny were inspected for body weight and motor signs twice weekly until they displayed predefined ethical criteria for termination. The transgene insert site was determined by whole genome sequencing. Western blotting was used to compare the expression levels of beta-IV spectrin protein in the brain.

RESULTS: Matings of hemizygous L25+/- × L25+/- mice yielded 20% (29/148) affected weanlings, identified by an abnormal retraction of the hind limbs when lifted by the tail, and a fine tremor. Affected mice were less mobile and grew more slowly than wild-type littermates. All affected mice required termination due to >15% loss of body weight (50% survival age 92 days). At the endpoint, mice showed varying degrees of spastic paresis or spastic paralysis localised to the hind limbs. Motor endplates remained fully innervated. Genome sequencing confirmed that the transgene was inserted in the locus of βIV spectrin of L25 mice. Western blotting indicated that this random insertion had greatly reduced the expression of βIV spectrin protein in the affected L25 mice. CONCLUSIONS: The results confirm the importance of βIV spectrin for maintaining central motor pathway control of the hind limbs, and provide a developmental time course for the phenotype.

PMID: 28582869

**39. Transplantation of allogeneic adipose-derived mesenchymal stem cells in a cerebral palsy patient.**

Kantake M, Hirano A, Sano M, Urushihata N, Tanemura H, Oki K, Suzaki E.

Regen Med. 2017 Jun 2. doi: 10.2217/rme-2017-0043. [Epub ahead of print]
We studied the safety and efficacy of allogeneic human adipose-derived mesenchymal cell (hAMSC) transplantation in a patient with cerebral palsy (CP). The patient received six infusions of allogeneic hAMSCs intravenously, without or with intramuscular or local injections and was followed up for 12 months. Changes in quality of life were assessed using the Short Form 8 health survey questionnaire incorporating physical and mental component summary scores. Clinical manifestations improved remarkably, with significant improvements in the quality of life physical and mental scores. No serious adverse effect or toxicity was observed. The patient maintained his recovery very well at 12 months follow-up. This case study suggests that allogeneic hAMSCs can be administered safely and feasibly in a pediatric patient with CP. Whether the results can be generalized to other pediatric patients with CP warrants further investigation.

PMID: 28573917

**40. Children with cerebral palsy have altered oscillatory activity in the motor and visual cortices during a knee motor task.**

Kurz MJ, Proskovec AL, Gehringer JE, Heinrichs-Graham E, Wilson TW.

Neuroimage Clin. 2017 May 15;15:298-305. doi: 10.1016/j.nicl.2017.05.008. eCollection 2017.

The neuroimaging literature on cerebral palsy (CP) has predominantly focused on identifying structural aberrations within the white matter (e.g., fiber track integrity), with very few studies examining neural activity within the key networks that serve the production of motor actions. The current investigation used high-density magnetoencephalography to begin to fill this knowledge gap by quantifying the temporal dynamics of the alpha and beta cortical oscillations in children with CP (age = 15.5 ± 3 years; GMFCS levels II-III) and typically developing (TD) children (age = 14.1 ± 3 years) during a goal-directed isometric target-matching task using the knee joint. Advanced beamforming methods were used to image the cortical oscillations during the movement planning and execution stages. Compared with the TD children, our results showed that the children with CP had stronger alpha and beta event-related desynchronization (ERD) within the primary motor cortices, premotor area, inferior parietal lobule, and inferior frontal gyrus during the motor planning stage. Differences in beta ERD amplitude extended through the motor execution stage within the supplementary motor area and premotor cortices, and a stronger alpha ERD was detected in the anterior cingulate. Interestingly, our results also indicated that alpha and beta oscillations were weaker in the children with CP within the occipital cortices and visual MT area during movement execution. These altered alpha and beta oscillations were accompanied by slower reaction times and substantial target matching errors in the children with CP. We also identified that the strength of the alpha and beta ERDs during the motor planning and execution stages were correlated with the motor performance. Lastly, our regression analyses suggested that the beta ERD within visual areas during motor execution primarily predicted the amount of motor errors. Overall, these data suggest that uncharacteristic alpha and beta oscillations within visuomotor cortical networks play a prominent role in the atypical motor actions exhibited by children with CP.

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**41. Clinical Spectrum, Comorbidities, and Risk Factor Profile of Cerebral Palsy Children: A Prospective Study.**

Minocha P, Sitaraman S, Sachdeva P.

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AIM AND OBJECTIVE: Cerebral palsy (CP) is the most common motor disability in childhood. This study aimed to describe clinical spectrum, comorbidities, and risk factors associated with CP children. MATERIALS AND METHODS: This hospital-based observational study was conducted in tertiary level hospital in Jaipur including 180 CP children aged 1-12 years, attending the Paediatric Neurology Outdoor and Child Development Centre. A detailed history of antenatal, natal, and postnatal events taken and thorough examination was performed to stratify children in proper topographical and physiological classification. RESULTS: Mothers of 47.7% CP children were primigravida and 17.7% mothers had anemia during pregnancy. Among natal factors, asphyxia contributed to maximum cases (52.2%). Seizure in postnatal life was the second most common risk factor for CP after asphyxia. Spastic CP (84.4%) was the most common physiological type, and quadriplegia (56.6%) was the most common topographical type observed in this study. Intellectual disability (47.7%) followed by epilepsy (41.6%) was the most common comorbidity. CONCLUSION: Even with the advancement of health-care system, asphyxia is the most common risk factor, and spastic quadriplegia is the most common type of CP. There is still a need of improving the health facilities to overcome this costly and common neuromotor disability. Widespread knowledge of common risk factors that can predispose to CP can prevent the CP development to some extent and knowledge of clinical spectrum, and comorbidities can improve their targeted treatment which can improve their growth and social participation.

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