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# Interventions and Management

**1. Effects of Upper-Extremity Surgery on Manual Performance of Children and Adolescents with Cerebral Palsy: A Multidisciplinary Approach Using Shared Decision-Making.**
Louwers A, Warnink-Kavelaars J, Obdeijn M, Kreulen M, Nollet F, Beelen A.

BACKGROUND: Little is known about the effects of upper-extremity surgery on the manual performance of children and adolescents with cerebral palsy (CP). This clinical cohort study describes our experience with patient selection based on multidisciplinary assessment and shared decision-making and the effects of upper-extremity surgery on manual performance and patient-relevant outcomes. METHODS: All patients (up to 20 years of age) with CP referred to our multidisciplinary team for evaluation for upper-extremity surgery between July 2011 and May 2017 were included. Suitability for upper-extremity surgery was assessed with comprehensive, multidisciplinary screening, and the decision to proceed with surgery was made together with the patient. Individual patient-relevant goals were identified with the Canadian Occupational Performance Measure (COPM); perceived independence in performing bimanual activities at home was assessed with the ABILHAND-Kids tool, and perceived quality of use of the affected hand during daily activities was assessed with a visual analog scale (VAS). The quality of use of the affected hand during bimanual performance was measured with the Assisting Hand Assessment (AHA), and gross manual dexterity was evaluated with the Box and Block Test (BBT). All baseline assessments were repeated at an average of 9 months after the surgery. RESULTS: Of 66 patients assessed by the multidisciplinary upper-extremity-surgery team, 44 were considered eligible for upper-extremity surgery. Of these patients, 39 (mean age and standard deviation [SD], $14.9 \pm 2.10$ years, 87% with unilateral CP, and 72% at Manual Ability Classification System [MACS] level II) underwent upper-extremity surgery and were evaluated in the pre-post study. All outcomes improved significantly after upper-extremity surgery, with average improvements of $3.1 \pm 1.6$ points in the COPM-Performance (COPM-P) score (p < 0.001), $3.3 \pm 2.1$ points in the COPM-Satisfaction (COPM-S) score (p < 0.001), $1.5 \pm 1.2$ logits in the ABILHAND score (p < 0.001), $2.4 \pm 1.9$ cm in the VAS score (p < 0.001), $6.7 \pm 4.2$ units in the AHA score (p < 0.001), and $2.2 \pm 5.0$ blocks/minute on the BBT (p = 0.021). The improvement in the COPM-P, COPM-S, ABILHAND, VAS, AHA, and BBT scores was clinically meaningful in 80%, 77%, 55%, 62%, 71%, and 31% of the patients, respectively. CONCLUSIONS: Careful assessment of eligibility for upper-extremity surgery, based on multidisciplinary screening and shared decision-making, resulted in a clinically relevant improvement in patient-specific functional and/or cosmetic goals and manual performance after upper-extremity surgery in most patients with CP. LEVEL OF EVIDENCE: Therapeutic Level IV. See Instructions for Authors for a complete description of levels of evidence.

PMID: 30106823

**2. Force Resistance Training in Hand Grasp and Arm Therapy: Feasibility of a Low-Cost Videogame Controller.**
Hernández HA, Khan A, Fay L, Roy JS, Biddiss E.

OBJECTIVE: To design and evaluate a low-cost gaming station that supports force resistance training in pediatric arm/hand

grasp therapies through mainstream videogame play. METHODS: The gaming station was developed through an iterative participatory design process and includes a force feedback game controller (Novint Falcon), custom grips, arm/wrist supports, and software to interface with mainstream games and manage difficulty settings in the controller. The station was tested for usability and feasibility with six therapists and six children with cerebral palsy, 7-16 years of age, attending weekly therapy sessions over 12 weeks. Pre- and post-assessments of perceived performance and satisfaction on self-identified goals were measured on the Canadian Occupational Performance Measure (COPM). RESULTS: The gaming station was considered highly usable by therapists with a score of 76.7 (standard deviation [SD] = 6.1) on the System Usability Scale. Overall, children enjoyed the games, achieved high repetition rates for wrist extensions and arm movements, and all made clinically significant progress on therapy goals. Increases of 3.13 (SD = 1.69) on the performance scale and 2.97 (SD = 0.98) on the satisfaction scale were reported on the COPM. Conclusion: In-clinic force resistance training for development of upper limb functional capacities is feasible using low-cost video game components adapted to therapy through a participatory design process.

PMID: 30106641

### 3. Bilateral reaching deficits after unilateral perinatal ischemic stroke: a population-based case-control study.
Kuczynski AM, Kirton A, Semrau J, Dukelow S.

J Neuroeng Rehabil. 2018 Aug 17;15(1):77. doi: 10.1186/s12984-018-0420-9.

BACKGROUND: Detailed kinematics of motor impairment of the contralesional ("affected") and ipsilesional ("unaffected") limbs in children with hemiparetic cerebral palsy are not well understood. We aimed to 1) quantify the kinematics of reaching in both arms of hemiparetic children with perinatal stroke using a robotic exoskeleton, and 2) assess the correlation of kinematic reaching parameters with clinical motor assessments. METHODS: This prospective, case-control study involved the Alberta Perinatal Stroke Project, a population-based research cohort, and the Foothills Medical Center Stroke Robotics Laboratory in Calgary, Alberta over a four year period. Prospective cases were collected through the Calgary Stroke Program and included term-born children with magnetic resonance imaging confirmed perinatal ischemic stroke and upper extremity deficits. Control participants were recruited from the community. Participants completed a visually guided reaching task in the KINARM robot with each arm separately, with 10 parameters quantifying motor function. Kinematic measures were compared to clinical assessments and stroke type. RESULTS: Fifty children with perinatal ischemic stroke (28 arterial, mean age: $12.5 \pm 3.9$ years; 22 venous, mean age: $11.5 \pm 3.8$ years) and upper extremity deficits were compared to healthy controls (n = 147, mean age: $12.7 \pm 3.9$ years). Perinatal stroke groups demonstrated contralesional motor impairments compared to controls when reaching out (arterial = 10/10, venous = 8/10), and back (arterial = 10/10, venous = 6/10) with largest errors in reaction time, initial direction error, movement length and time. Ipsilesional impairments were also found when reaching out (arterial = 7/10, venous = 1/10) and back (arterial = 6/10). The arterial group performed worse than venous on both contralesional and ipsilesional parameters. Contralesional reaching parameters showed modest correlations with clinical measures in the arterial group. CONCLUSIONS: Robotic assessment of reaching behavior can quantify complex, upper limb dysfunction in children with perinatal ischemic stroke. The ipsilesional, "unaffected" limb is often abnormal and may be a target for therapeutic interventions in stroke-induced hemiparetic cerebral palsy.

PMID: 30115093

### 4. Simultaneous Selective Dorsal Rhizotomy and Baclofen Pump Removal Improve Ambulation in Patients with Spastic Cerebral Palsy.
Park TS, Miller BA, Cho J.

Cureus. 2018 Jun 12;10(6):e2791. doi: 10.7759/cureus.2791.

BACKGROUND: Intrathecal baclofen (ITB) administration via an implanted programmable pump and selective dorsal rhizotomy (SDR) are both used for the treatment of cerebral palsy (CP) spasticity. OBJECTIVE: To examine whether SDR can improve ambulation in children who have been receiving ITB therapy for spastic cerebral palsy. METHODS: We reviewed 13 patients who received prior ITB placement with subsequent simultaneous SDR and ITB removal. Patients also completed a follow-up survey to document long-term motor function. RESULTS: In our 13-patient cohort, patients received ITB treatment for an average of 4.4 [Formula: see text] 1.8 years and the mean age of ITB removal/SDR was 12.5 [Formula: see text] 5.8 years. The follow-up period ranged from 3 to 19 months (mean duration: 6.9 [Formula: see text] 5 months). Pre-operatively, all patients had Gross Motor Function Classification System (GMFCS) scores between 2 and 4. Nine patients were diagnosed with spastic diplegia, two had spastic triplegia and two had spastic quadriplegia. SDR and ITB removal led to improved lower limb spasticity and ambulation. GMFCS scores remained stable in all patients. One patient developed a cerebrospinal fluid (CSF) collection in the abdominal wall due to a CSF leak from the baclofen pump site. All 11 patients who completed the follow-up survey noted improved motor function. CONCLUSION: This study demonstrates that SDR can reduce spasticity and improve mobility after years of ITB treatment for spastic cerebral palsy.

PMID: 30112267

**5. Improving effect of enhanced axial rehabilitation on trunk control deficit in children with cerebral palsy.**
Pierret J, Caudron S, Beyaert C.

Gait Posture. 2018 Jul 24. pii: S0966-6362(18)31103-2. doi: 10.1016/j.gaitpost.2018.07.039. [Epub ahead of print]

PMID: 30098898

**6. Feasibility of Dual Energy X-Ray Absorptiometry Based Images for Measurement of Height, Sitting Height, and Leg Length in Children.**
Capaldi N, Kao KT, MacDonald R, Grainger KC, Joseph S, Shepherd S, Mason A, Wong SC.

J Clin Densitom. 2018 Jun 30. pii: S1094-6950(18)30075-1. doi: 10.1016/j.jocd.2018.06.006. [Epub ahead of print]

BACKGROUND: Interpretation of pediatric bone mineral density by dual energy absorptiometry (DXA) requires adjustment for height (Ht). This is often not easily obtainable in nonambulant subjects. AIMS: To investigate the feasibility of using DXA images to evaluate measurements of Ht, sitting height (SH), and leg length (LL). METHODOLOGY: A total of 2 observers performed measurements of Ht, SH, and LL on 3 separate occasion using DXA digital images in 125 children. Intraclass correlation and relative technical error of measurement (rTEM) were performed to assess reliability of repeated measurements. In 25 children, Ht and SH were measured in clinic on the same day and Bland-Altman analysis was performed to compare DXA measured Ht, SH, LL with clinic measurements for these 25 children. RESULTS: Intraclass correlation for DXA based Ht, SH, and LL measurements ranged from 0.996 to 0.998 (p < 0.0001). rTEM of Ht, SH, and LL for observer 1 was 0.0016%, 0.002%, and 0.0034%, respectively. rTEM of Ht, SH, and LL between observer 1 and 2 was 0.0047%, 0.0049%, and 0.0087%, respectively. Mean difference between clinic and DXA measurements from Bland-Altman plots were +0.57 cm (95% confidence interval [CI] -0.54 to +1.68) for Ht, +1.33cm (-1.60 to +4.24) for SH, and -0.76cm (-3.88 to +2.37) for LL. CONCLUSIONS: Our study demonstrated for the first time that Ht, SH, and LL in children can be measured very precisely using DXA images. Ht can be measured accurately. We believe this may be a convenient method to obtain Ht measurements to allow size adjustment of DXA bone mineral density in immobile children with chronic conditions.

PMID: 30098887

**7. Preoperative radiologic predictors of successful soft tissue release surgery for hip subluxation among cerebral palsy patients: A STROBE compliant study.**
Ha M, Okamoto T, Fukuta T, Tsuboi Y, Shirai Y, Hattori K, Sakuma E, Wakabayashi K, Wada I, Otsuka T.

Medicine (Baltimore). 2018 Aug;97(33):e11847. doi: 10.1097/MD.0000000000011847.

Paralytic hip subluxation is a common problem in children with cerebral palsy. Although surgical procedures such as soft tissue release and osteotomy have been advocated for its prevention, the exact indications of such procedures remain unclear. We attempted to evaluate preoperative radiographic parameters and identify prognostic factors in children with cerebral palsy. We retrospectively investigated 43 hips in 27 children with cerebral palsy who had undergone soft tissue release surgery for hip subluxation. We evaluated the age at the time of surgery and the radiographic parameters such as the center-edge angle (CEA), the migration percentage (MP), and the acetabular index (AI) at 3 time points: preoperation, 1 year after surgery, and at final follow-up. The outcome measure was determined by the MP value at final follow-up. Student t test was used to compare the quantitative variables between 2 groups (good vs poor outcome). Then the multiple regression analysis was applied to determine the prognostic factors upon soft tissue release surgery. Children with good outcome exhibited higher CEA (average value of -1.43° vs -13.2° in those with poor outcome), lower MP (53.9% vs 71.3%), and lower AI (28.1° vs 35.3°). Upon multiple regression analysis, we found that the age at the time of surgery, preoperative CEA, and preoperative MP did not appear to be independent prognostic factors. The only independent factor that affected prognosis after soft tissue release surgery was the preoperative AI. The preoperative AI values <34° were associated with the good outcome with specificity of 87% and sensitivity of 60% according to the receiver operating characteristic curve analysis. These findings indicate that the outcome of soft tissue release surgery can be predicted by the preoperative AI value.

PMID: 30113477

**8. Are seating systems with a medial knee support really helpful for hip displacement in children with spastic cerebral palsy GMFCS IV and V?**
Kim IS, Park D, Ko JY, Ryu JS.

OBJECTIVE: To evaluate whether medial knee support in seating systems aggravates hip displacement in children with cerebral palsy. DESIGN: Retrospective chart review SETTING: Rehabilitation department of tertiary university hospital PARTICIPANTS: Children with cerebral palsy using seating systems (Intervention group, n=42; mean age 6.86y) and using regular wheelchairs (Control group, n=34; mean age 8.15y). INTERVENTIONS: The intervention group was provided with a seating system with medial knee support. We enrolled children who did not use a seating system in the control group, retrospectively. MAIN OUTCOME MEASURE(S): By radiographic images, Reimer's migration index, lateral center edge angle, and femur neck shaft angle were measured. We compared the demographic data, clinical variables, and radiographs between the two groups. RESULTS: In the intervention group, there was a significant deterioration in the Reimer's migration index, from 26.89% to 44.18% after using the system (p<0.001). The progression of migration index was 14.72 % and 7.82 % per year in the intervention and control groups, respectively (p=0.016). CONCLUSION: We should consider the possibility that seating systems with medial knee support may exacerbate hip displacement in children with cerebral palsy.

PMID: 30102899

### 9. Impact of multilevel joint contractures of the hips, knees and ankles on the Gait Profile score in children with cerebral palsy.
Holmes SJ, Mudge AJ, Wojciechowski EA, Axt MW, Burns J.

BACKGROUND: Children with cerebral palsy are at risk of developing muscle contractures, often contributing to pain, structural deformities and mobility limitations. With the increasing use of gait indices to summarise the findings of three dimensional gait analysis (3DGA), the purpose of this study is to determine whether there is a relationship between multilevel joint contractures and the Gait Profile Score in children with cerebral palsy. METHODS: The Gait Profile Score, calculated from 3D gait analysis, and passive range of motion, strength and spasticity of the hips, knees and ankles in the sagittal plane were measured in 145 children with cerebral palsy (mean age:11 years,4 months; SD:2 years,10 months) (83 males) enrolled in the NSW Paediatric Gait Analysis Service Research Registry from 2011 to 2016. The relationships between these physical measures and the Gait Profile Score were explored using bivariate and multivariate correlations. FINDINGS: Reduced hip extension, knee extension and ankle dorsiflexion (knee extended) range of motion were correlated with a higher (worse) Gait Profile Score (r = -0.348 to -0.466, p < .001). Children with all joints contracted had a significantly higher Gait Profile Score (mean 17.5°, SD 6.2°) than those with no contractures (mean 11.0°, SD 2.3°) or ankle contractures only (mean 12.8°, SD 5.1°) (p < .05). Knee flexion weakness, reduced hip extension and ankle dorsiflexion (knee extended) range of motion predicted 47% of the Gait Profile Score. INTERPRETATION: The Gait Profile Score is a sensitive measure for demonstrating the relationship between multilevel sagittal plane joint contractures and kinematic gait. Clinically, this supports the use of the Gait Profile Score as a simplified measure to understand the contribution of contractures to functional gait limitations. Monitoring knee flexion strength, and hip extension and ankle dorsiflexion (knee extended) range of motion may assist clinicians in prioritising interventions to improve gait in this population.

PMID: 30099242

### 10. Do unilateral femoral derotation modify controlateral pelvic, hip and foot rotations in patients with cerebral palsy?
Desailly E, Badina A, Khouri N.

In single event multilevel surgery, femoral derotation is commonly performed. When the kinematic deviations are asymmetrical its indication is frequently one-sided. What are the effects of this procedure on the transverse kinematics of the pelvis and on the contralateral hip rotation and foot progression angles? Among 170 children with CP, operated, with at least a clinical gait analysis before and after surgery, 42 having had a unilateral femoral derotation are included. Patients with tibial derotation are excluded. This study focuses on "remote" effects on the pelvis and the contralateral side. Unilateral hip derotation in asymmetric patients is effective in reducing pelvic asymmetry without altering contralateral hip kinematics, thus affecting the angle of progression of the contralateral foot.

PMID: 30098901

### 11. An examination of the relationship between dynamic knee joint stiffness and gait pattern of children with cerebral palsy.

Galli M, Cimolin V, Condoluci C, Costici PF, Brunner R.

Dynamic joint stiffness represents the resistance that a joint opposes to an applied moment. Stiffness arises in conditions of joint laxity, instability and increased co-contraction and is commonly utilized as a means to stabilize the joint. The knee joint seems to be crucial for determining the walking pattern. The aim of this study was to investigate the association between the gait pattern, globally quantified by the Gait Profile Score (GPS), which indicates the 'quality' of a particular walking strategy, and knee dynamic joint stiffness (Kk) in children with diplegia. Kk is expressed by plotting the values of the knee flexion-extension moment versus the knee flexion-extension angle during weight acceptance. In this interval, the linear regression was fitted. The angular coefficient of the linear regression corresponded to the joint stiffness index. Sixty-one children with diplegia and 18 healthy individuals took part in this study. From their gait analysis data, the GPS (with its Gait Variable Scores-GVSs) and the Kk were calculated. Data showed that GPS ($p = 2.73 \times 10^{-21}$) and GVSs values for the patients with diplegia were higher in comparison to healthy controls. The Kk values for patients were not statistically different from those of controls. The correlation between Kk and GPS did not show the presence of any significant relationship ($r = -0.04$; $p > 0.05$). Thus, the functional limitation in diplegic children does not seems to be strictly related to Kk.

PMID: 30100307

## 12. Femoral Derotation Osteotomy in Adults for Version Abnormalities.
Buly RL, Sosa BR, Poultsides LA, Caldwell E, Rozbruch SR.

BACKGROUND: Version abnormalities of the femur can cause pain and hip joint damage due to impingement or instability. A retrospective clinical review was conducted on patients undergoing a subtrochanteric derotation osteotomy for either excessive anteversion or retroversion of the femur. METHODS: A total of 55 derotation osteotomies were performed in 43 patients: 36 females and 7 males. The average age was 29 years (range, 14 to 59 years). The osteotomies were performed closed with an intramedullary saw. Fixation was performed with a variety of intramedullary nails. Twenty-nine percent of patients had a retroversion deformity (average, -9° of retroversion; range, +2° to -23°) and 71% had excessive anteversion of the femur (average, +37° of anteversion; range, +22° to +53°). The etiology was posttraumatic in 5 patients (12%), diplegic cerebral palsy in 2 patients (5%), Prader-Willi syndrome in 1 patient (2%), and idiopathic in 35 patients (81%). Forty-nine percent underwent concomitant surgery with the index femoral derotation osteotomy, including hip arthroscopy in 40%, tibial derotation osteotomy in 13%, and a periacetabular osteotomy in 5%. Tibial osteotomies were performed to correct a compensatory excessive external tibial torsion that would be exacerbated in the correction of excessive femoral anteversion. RESULTS: No patient was lost to follow-up. Failures occurred in three hips in three patients (5%): two hip arthroplasties and one nonunion that healed after rerodding. There was one late infection treated successfully with implant removal and antibiotics with an excellent final clinical outcome. At an average follow-up of 6.5 years (range, 2 to 19.7 years), the modified Harris Hip Score improved by 29 points in the remaining 52 cases (P < 0.001, Wilcoxon signed-rank test). The results were rated as excellent in 75%, good in 23%, and fair in 2%. Subsequent surgery was required in 78% of hips, 91% of which were implant removals. CONCLUSIONS: A closed, subtrochanteric derotation osteotomy of the femur is a safe and effective procedure to treat either femoral retroversion or excessive anteversion. Excellent or good results were obtained in 93%, despite the need for subsequent implant removal in more than two-thirds of the patients.This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives License 4.0 (CC BY-NC-ND), which permits downloading and sharing the work provided it is properly cited. The work cannot be changed in any way or used commercially without permission from the journal.

PMID: 30106763

## 13. Relationship between sensorimotor cortical activation as assessed by functional near infrared spectroscopy and lower extremity motor coordination in bilateral cerebral palsy.
Sukal-Moulton T, de Campos AC, Alter KE, Huppert TJ, Damiano DL.

BACKGROUND: Evaluation of task-evoked cortical responses during movement has been limited in individuals with bilateral cerebral palsy (CP), despite documented alterations in brain structure/function and deficits in motor control. OBJECTIVE: To systematically evaluate cortical activity associated with lower extremity tasks, and relate activation parameters to clinical measures in CP. METHODS: 28 ambulatory participants (14 with bilateral CP and 14 with typical development) completed five motor tasks (non-dominant ankle dorsiflexion, hip flexion and leg cycling as well as bilateral dorsiflexion and cycling) in a

block design while their sensorimotor cortex was monitored using functional near infrared spectroscopy (fNIRS), in addition to laboratory and clinical measures of performance. RESULTS: Main effects for group and task were found for extent of fNIRS activation (number of active channels; $p < 0.001$ and $p = 0.010$, respectively), magnitude of activation (sum of beta values; $p < 0.001$ for both), and number of active muscles ($p = 0.001$ and $p < 0.001$, respectively), but no group by task interactions. Collectively, subgroups with CP and especially those with greater impairments, showed higher extent and magnitude of cortical sensorimotor activation as well as higher amounts of concurrent activity in muscles not required for task performance. Magnitude of fNIRS activation during non-dominant dorsiflexion correlated with validated measures of selective control ($r = -0.60$, $p = 0.03$), as well as mobility and daily activity ($r = -0.55$, $p = 0.04$ and $r = -0.52$, $p = 0.05$, respectively) and self-reported gait function ($r = -0.68$, $p = 0.01$) in those with CP. CONCLUSIONS: The association between higher activity in the sensorimotor cortex and decreased selectivity in cortical organization suggests a potential neural mechanism of motor deficits and target for intervention.

PMID: 30101059

## 14. Management of foreign body ingestion in children with cerebral palsy: Need for proper trauma management protocol.
Prasad V, Samuel V, Ramakrishnan M, Ravikumar D, Sharna N.

J Family Med Prim Care. 2018 May-Jun;7(3):638-641. doi: 10.4103/jfmpc.jfmpc_91_18.

Cerebral palsy (CP) is described as a group of permanent, nonprogressive movement disorders that cause physical disability in development and further affecting body movement and muscle coordination. The condition develops when certain abnormalities persist inside the developing brain that ultimately disrupts the brain's ability to control movement and maintain posture and balance. Patients with CP are more susceptible to dental trauma due to the lack of muscle coordination and unexpected involuntary movements. The present case series highlights the need for emergency protocol management when these patients report with dental trauma and complications which can happen in dental office. The first case report is about ingestion of permanent incisor following trauma which was diagnosed incidentally in the abdominal radiograph, and the second case is reported to be accidental ingestion of head of dental mouth mirror during the routine oral examination. These two case reports emphasize the need for more comprehensive trauma management protocol in these children.

PMID: 30112324

## 15. Experience of Engagement in a Somatosensory Discrimination Intervention for Children with Hemiplegic Cerebral Palsy: A Qualitative Investigation.
McLean B, Girdler S, Taylor S, Valentine J, Carey L, Elliott C.

Dev Neurorehabil. 2018 Aug 16:1-11. doi: 10.1080/17518423.2018.1503620. [Epub ahead of print]

BACKGROUND: To successfully modify an intervention from an adult population for use with children with cerebral palsy, it is important to understand the components that support a child's motivation and engagement. METHOD: Ten children who had participated in the Sense© intervention (mean age = 11 years 2 m [SD = 2 years]; four males; Manual Ability Classification System level I = 1, II = 9) and their primary caregivers (N = 11, 10 females) were interviewed. Transcripts were analyzed using framework analysis. RESULTS: Key themes were identified in the core domains of the Synthesis of Child, Occupational Performance and Environment in Time model. Child: children's somatosensory discrimination ability improved; Motivation: incorporating child's goals was essential, as were real-world gains; Environmental: parents were interested in having more involvement in the intervention. CONCLUSION: The most engaging elements of the intervention for children were the attainment of their self-selected goals. Opportunities to modify the intervention for improved partnership with parents were identified.

PMID: 30113250

## 16. Factors that Predict Overall Health and Quality of Life in Non-Ambulatory Individuals with Cerebral Palsy.
Kolman SE, Glanzman AM, Prosser L, Spiegel DA, Baldwin KD.

Iowa Orthop J. 2018;38:147-152.

BACKGROUND: It is unknown what role specific tasks associated with personal care, positioning, communication and social interaction, and comfort and emotions play in predicting the overall health and quality of life of individuals with non-

ambulatory cerebral palsy (CP). In this study, we prospectively evaluated which of these factors were significant predictors of overall health and quality of life. METHODS: Parents and guardians of non-ambulatory children, adolescents and young adults with CP were prospectively recruited from the Cerebral Palsy Clinic of a large pediatric academic hospital. Caregivers completed the CP Child Questionnaire®. Univariate analyses were used to identify relationships between overall health, overall quality of life (QOL), and responses in the following categories: personal care and activities of daily living, positioning and transfer mobility, comfort and emotions, and communication and social interaction. Significant predictors of overall health and QOL were then determined via logistic regression. RESULTS: 64 patients ages 0-20 years and Gross Motor Function Classification System levels IV and V were included in our study (mean age 9.16 ±4.96 years). Overall QOL (OR 194.2, 95% CI, 9.5-3964.9) and comfort while sitting (OR 15.9, 95% CI, 1.2-205.3) were significant predictors of overall health. Feelings of unhappiness or sadness (OR 59.9, 95% CI, 1.6-2209.8), difficulty understanding the parent or guardian (OR 29.8, 95% CI, 1.6-543.7), and not attending school (OR 57.2, 95% CI, 2.6-1274.4) were significant predictors of lower overall quality of life. CONCLUSIONS: Overall QOL appears to predict overall health. Factors associated with comfort and emotions and communication and social interaction appear to predict overall QOL to a greater extent than personal care and transfer mobility. Level of Evidence: Prognostic II.

PMID: 30104938

## 17. Quality of goal setting in pediatric rehabilitation-A SMART approach.
Bexelius A, Carlberg EB, Löwing K.

Child Care Health Dev. 2018 Aug 15. doi: 10.1111/cch.12609. [Epub ahead of print]

BACKGROUND: Setting goals for treatment is often the core of the rehabilitation process. The quality of the set goals has however rarely been evaluated. The aims of this study were therefore to assess the quality of goals set in clinical practice of pediatric rehabilitation using SMART criteria (Specific, Measurable, Achievable, Relevant, and Timed) and to assess if the goals were considered relevant from both a client perspective and expertise perspective. METHODS: In a retrospective multicase study, a total of 161 goals from 42 children with disabilities (cerebral palsy, n = 22; Down syndrome, n = 16; and developmental disability, n = 4) were assessed. The children were 1.5-5.5 years and had previously participated in goal-directed, activity-focused therapy at four pediatric rehabilitation centers. Collaborative goal setting had been used to define the desired treatment outcome. The quality of the goals was assessed using defined SMART criteria. RESULTS: Specific: All goals could be reliably linked to International Classification of Functioning, Disability and Health-Children and Youth version chapters within the Activity/Participation domain. Measurable: A total of 75% of the goals were rated as having a well-defined scaling; in 20%, the scaling was less clear, and in 5%, a scaling could not be determined. Achievable: A total of 80% of the goals were attained. Relevant: All goals were set in collaboration with the family and could therefore be considered relevant from a client perspective. Relevancy judged from a professional perspective was strengthened by the fact that age, baseline status, and diagnosis had an influence on the choice of goals. Timed: All goals were set within a specific time frame. CONCLUSIONS: The goals set in clinical practice showed high quality with respect to the SMART criteria. The most difficult part was the construction of the goal attainment scale. The goals settled in clinical practice were considered relevant from both a client perspective and expertise perspective.

PMID: 30112766

## 18. Comparing differences in support needs as perceived by parents of adult offspring with down syndrome, autism spectrum disorder and cerebral palsy.
Lee CE, Burke MM, Arnold CK, Owen A.

J Appl Res Intellect Disabil. 2018 Aug 12. doi: 10.1111/jar.12521. [Epub ahead of print]

BACKGROUND: Parents often face many barriers when taking care of their offspring with disabilities. In childhood, support needs vary with families of children with Down syndrome often reporting less caregiving challenges. However, it is unclear whether support needs vary in adulthood. This study compared parents of adults with Down syndrome (DS), autism spectrum disorder (ASD) and cerebral palsy (CP) regarding support needs of their offspring with intellectual and developmental disabilities (IDD) and their families. METHOD: Data were collected via a national survey in the United States with 189 parents of adults with IDD. RESULTS: Across the quantitative and qualitative analyses, parents of adults with DS (versus CP and ASD) reported significantly greater recreational, natural supports, more formal services and less future planning barriers. CONCLUSION: The results indicate that the DS advantage may persist in adulthood regarding support needs. More research is needed to understand different types of support needs.

PMID: 30101573

**19. Qualitative and quantitative comparative study of accelerometer cut-points to evaluate physical activity in children with cerebral palsy.**
Guinet AL, Desailly E.

Gait Posture. 2018 Jul 24. pii: S0966-6362(18)31155-X. doi: 10.1016/j.gaitpost.2018.07.083. [Epub ahead of print]

To evaluate the physical activity in free-living environment, we can used accelerometer. For children with cerebral palsy, we have tried to determine the best algorithm to evaluate the level of physical activity.

PMID: 30098896

**20. Controlling of smart home system based on brain-computer interface.**
Gao Q, Zhao X, Yu X, Song Y, Wang Z.

Technol Health Care. 2018 Jul 27. doi: 10.3233/THC-181292. [Epub ahead of print]

BACKGROUND: Brain computer interface (BCI) technology is a communication and control approach. Up to now many studies have attempted to develop an EEG-based BCI system to improve the quality of life of people with severe disabilities, such as amyotrophic lateral sclerosis (ALS), paralysis, brain stroke and so on. The proposed BCIBSHS could help to provide a new way for supporting life of paralyzed people and elderly people. OBJECTIVE: The goal of this paper is to explore how to set up a cost-effective and safe-to-use online BCIBSHS to recognize multi-commands and control smart devices based on SSVEP. METHODS: The portable EEG acquisition device (Emotiv EPOC) was used to collect EEG signals. The raw signals were denoised by discrete wavelet transform (DWT) method, and then the canonical correlation analysis (CCA) method was used for feature extraction and classification. Another part is the control of smart home devices. The classification results of SSVEP can be translated into commands to control several devices for the smart home. RESULTS: Here, the Power over Ethernet (PoE) technology was utilized to provide electrical energy and communication for those devices. During online experiments, four different control commands have been achieved to control four smart home devices (lamp, web camera, guardianship telephone and intelligent blinds). Experimental results showed that the online BCIBSHS obtained $86.88 \pm 5.30\%$ average classification accuracy rate. CONCLUSION: The BCI and PoE technology, combined with smart home system, overcoming the shortcomings of traditional systems and achieving home applications management rely on EEG signal. In this paper, we proposed an online steady-state visual evoked potential (SSVEP) based BCI system on controlling several smart home devices.

PMID: 30103356

**21. The complex aetiology of cerebral palsy.**
Korzeniewski SJ, Slaughter J, Lenski M, Haak P, Paneth N.

Nat Rev Neurol. 2018 Aug 13. doi: 10.1038/s41582-018-0043-6. [Epub ahead of print]

Cerebral palsy (CP) is the most prevalent, severe and costly motor disability of childhood. Consequently, CP is a public health priority for prevention, but its aetiology has proved complex. In this Review, we summarize the evidence for a decline in the birth prevalence of CP in some high-income nations, describe the epidemiological evidence for risk factors, such as preterm delivery and fetal growth restriction, genetics, pregnancy infection and other exposures, and discuss the success achieved so far in prevention through the use of magnesium sulfate in preterm labour and therapeutic hypothermia for birth-asphyxiated infants. We also consider the complexities of disentangling prenatal and perinatal influences, and of establishing subtypes of the disorder, with a view to accelerating the translation of evidence into the development of strategies for the prevention of CP.

PMID: 30104744

**22. Prediction of postnatal developmental disabilities using the antenatal fetal neurodevelopmental test: KANET assessment.**
Hata T, Kanenishi K, Mori N, AboEllail MAM, Hanaoka U, Koyano K, Kato I, Kusaka T.

J Perinat Med. 2018 Aug 11. pii: /j/jpme.ahead-of-print/jpm-2018-0169/jpm-2018-0169.xml. doi: 10.1515/jpm-2018-0169. [Epub ahead of print]

Objective To assess the usefulness of the antenatal fetal neurodevelopmental test for the prediction of postnatal developmental disabilities. Methods Fetal behavior was assessed with Kurjak's antenatal neurodevelopmental test (KANET) using four-dimensional ultrasound between 28 and 38 weeks of gestation. A score range of 0-5 was characterized as abnormal, from 6 to 9 was considered borderline, and 10-16 was normal. After birth, follow-up was conducted for at least 2 years in all fetuses. Results There were 337 normal (95.47%) and 16 borderline (4.53%) cases among the 353 cases studied, whereas there was no abnormal case. Five cases with postnatal developmental disabilities (one case of Werdig-Hoffmann disease diagnosed just after delivery, one case of autism spectrum disorder diagnosed at 24 months, one case of Ullrich congenital muscular dystrophy diagnosed at 9 months and two cases of developmental disorders diagnosed at age 3 and 18 months) were noted among the 337 normal cases (1.48%), whereas three cases with developmental disabilities (one case of motor development delay diagnosed at 6 months, one case of Duchenne muscular dystrophy diagnosed at 18 months and one case of autism spectrum disorder diagnosed at age 30 months) were found among the 16 borderline cases (18.75%). There was a significant difference in the prevalence of postnatal developmental disabilities between the normal and borderline KANET groups (P<0.001). Conclusion Our results suggest that the KANET assessment may be a useful diagnostic modality for the prediction of postnatal developmental disabilities.

PMID: 30098288

# Prevention and Cure

**23. Risk of childhood cerebral palsy following prenatal exposure to ß2-adrenergic receptor agonist: A nationwide cohort study.**
Li L, Wang Z, Liang H, Yang F, Yuan W, Gelaye B, Yu Y, Miao M, Nørgaard M, Li J.

PLoS One. 2018 Aug 16;13(8):e0202078. doi: 10.1371/journal.pone.0202078. eCollection 2018.

BACKGROUND: Cerebral palsy (CP) is the most common physical developmental disability in childhood with a prevalence of 2 to 3 per 1000 live births. β2-adrenoreceptor agonist (β2AA) are widely used for the treatment of asthma. Maternal use of β2AAs may increase the risk of adverse neuro-psychiatric health outcomes in the offspring. No study, however, has evaluated the effect of prenatal exposure to β2AAs on the risk of CP. OBJECTIVE: To examine the association between prenatal exposure to β2AAs and the risk of childhood cerebral palsy. METHODS: This population-based cohort study included all live singleton births in Denmark from January 1, 1997 to December 31, 2003. The information on outpatient prescriptions of β2AAs was extracted from Danish National Prescription Registry. Children born to mothers who used β2AAs from 30 days before pregnancy until delivery were categorized as the exposed. To differentiate the effect of β2AAs from the underlying indications, the exposure window was further extended to 2 years before pregnancy and the exposed groups were re-defined to represent different periods of exposure to maternal use of β2AAs (use only before pregnancy, use only during pregnancy, and use both before and during pregnancy). Cases of CP were identified from the Danish Cerebral Palsy Register. Logistic regression was used to estimate incidence odds ratio (OR) of CP. RESULTS: Among all the 442,278 singletons, 19,616 (4.44%) were exposed to β2AAs in utero (from 30 days before pregnancy until delivery). The risk of childhood CP was 0.21% in exposed and 0.19% in unexposed group, yielding an adjusted OR (aOR) 1.12 (95% confidence interval (CI): 0.82, 1.53). When extending the exposure time window to 2 years prior to pregnancy, no overall significant association was observed regardless of the exposure period. However, an increased risk of CP (aOR = 1.41, 95%CI: 0.92, 2.18) for maternal β2AAs use during pregnancy was observed in female offspring, especially in those born at term (aOR = 1.65, 95%CI: 1.02, 2.67). This increase was mainly attributed to an increased risk in those born to mothers who used β2AAs both before and during pregnancy (aOR = 1.81, 95%CI: 0.99, 3.33). CONCLUSIONS: We observed an association between maternal β2AAs use during pregnancy and an increased risk of CP in female offspring, but we could not rule out confounding by the underlying indications for β2AAs.

PMID: 30114199

**24. Identification of pathways and genes associated with cerebral palsy.**
Zhu Q, Ni Y, Wang J, Yin H, Zhang Q, Zhang L, Bian W, Liang B, Kong L, Xuan L, Lu N.

Genes Genomics. 2018 Aug 14. doi: 10.1007/s13258-018-0729-6. [Epub ahead of print]

Cerebral palsy (CP) is a non-progressive neurological disease, of which susceptibility is linked to genetic and environmental risk factors. More and more studies have shown that CP might be caused by multiple genetic factors, similar to other neurodevelopmental disorders. Due to the high genetic heterogeneity of CP, we focused on investigating related molecular pathways. Ten children with CP were collected for whole-exome sequencing by next-generation sequencing (NGS) technology. Customized processes were used to identify potential pathogenic pathways and variants. Three pathways (axon guidance,

transmission across chemical synapses, protein-protein interactions at synapses) with twenty-three genes were identified to be highly correlated with CP. This study showed that the three pathways associated with CP might be the molecular mechanism of pathogenesis. These findings could provide useful clues for developing pathway-based pharmacotherapies. Further studies are required to confirm potential roles for these pathways in the pathogenesis of CP.

PMID: 30109564

### 25. The effects of bone marrow mononuclear cell transplantation on the quality of life of children with cerebral palsy.
Nguyen TL, Nguyen HP, Nguyen TK.

Health Qual Life Outcomes. 2018 Aug 14;16(1):164. doi: 10.1186/s12955-018-0992-x.

BACKGROUND: Quality of life (QOL) is an important factor in evaluating the effectiveness of treatment in children with cerebral palsy (CP). The aim of this study was to evaluate the effects of autologous bone marrow mononuclear cells (BM MNCs) on the QOL of children with CP. METHODS: From December 2015 to December 2016, 30 children with CP aged from 2 to 15 years received two intrathecal infusions of BM MNCs, one at baseline and the other 3 months later, at Vinmec International Hospital. The motor function and muscle tone of the patients were evaluated using the Gross Motor Function Measure (GMFM)-88 and Modified Ashworth Score, respectively. Their QOL was assessed at baseline and 6 months after the first BM MNC transplant using the Vietnamese version of the Cerebral Palsy Quality of Life Questionnaire for children (CP QOL-Child)-the parental proxy report, which comprises seven domains. Nineteen mothers (mean age: 32.9±4.9 years) and 11 fathers (mean age: 36.1±6.8 years) were invited to complete the CP QOL-Child assessment before and after the transplantations, Paired t-tests and multivariate regression analyses were used to evaluate the changes in QOL and GMFM scores and to identify the key factors correlated with the QOL score. RESULTS: Significant changes were observed in the children's gross motor function and muscle spasticity, as evidenced by the GMFM-88 total score, scores for each of its domains, the GMFM-66 percentile and the muscle tone (P < 0.001). Six months after the transplantations, the QOL scores of children with CP were markedly increased (P < 0.001) for all the domains, except for the domain of access to services. In the multivariate regression analysis, significant associations were found between higher age of children and higher QOL except for feeling about functioning and pain and impact of disability domains. Gross Motor Function Classification System (GMFCS) level was negatively correlated with the score of pain and impact of disability domain, while the GMFM-88 scores were positively correlated with the QOL in terms of feelings about functioning and family health domain (P < 0.05). CONCLUSION: The QOL of the children with CP was noticeably improved 6 months after BM MNC transplantation and was accompanied by improvements in gross motor function and muscle tone. TRIAL REGISTRATION: ClinicalTrials.gov Identifier: NCT02574923 . Registered on October 14, 2015.

PMID: 30107811

### 26. Cost Analysis of Azithromycin versus Erythromycin in Pregnancies Complicated by Preterm Premature Rupture of Membranes.
Finneran MM, Smith DD, Buhimschi CS.

Am J Perinatol. 2018 Aug 13. doi: 10.1055/s-0038-1667369. [Epub ahead of print]

OBJECTIVE: To quantify the potential cost savings if azithromycin is substituted for erythromycin in women with preterm premature rupture of membranes (PPROM). STUDY DESIGN: Secondary analysis of a multicentered study investigating magnesium sulfate for the prevention of cerebral palsy in premature infants. All patients with PPROM who received antibiotics for prophylaxis were included in the analysis. The number of expected doses each patient would have received was calculated for erythromycin, multidose azithromycin, and single-dose azithromycin regimens accounting for latency from PPROM to delivery. The wholesale acquisition cost was used to calculate the expected cost of each regimen. RESULTS: There were 981 PPROM patients who received a penicillin class antibiotic and erythromycin. Patients would have received 7,528 intravenous doses and 10,194 oral doses of erythromycin at a combined cost of $357,169. In comparison, patients would have received 6,422 and 3,942 doses at a cost of $15,669 and $9,574 for the multidose and single-dose azithromycin regimens respectively, which represents a more than 95% cost reduction for either regimen compared with erythromycin. CONCLUSION: The use of azithromycin substituted for erythromycin in the standard antibiotic regimen of women with PPROM represents a potential for substantial cost reduction.

PMID: 30103220