1. A systematic review of upper limb activity measures for 5- to 18-year-old children with bilateral cerebral palsy.

Burgess A, Boyd RN, Ziviani J, Sakzewski L.


AIM: To investigate measurement properties and feasibility of upper limb activity measures in children aged 5-18 years with bilateral cerebral palsy (CP). METHODS: Five electronic databases were searched to identify measures of upper limb activity with published psychometric data for children with bilateral CP aged 5-18 years. Measures included both Patient-Reported Outcome Measures (PROMs) and observational measures. The COnsensus-based Standards for selection of health Measurement Instruments checklist was used to evaluate methodological quality of studies for each measure. RESULTS: Forty-eight measures were identified, eight of which met inclusion criteria for reliability and validity. Four PROMs were included: the ABILHAND-Kids and Children’s Arm Rehabilitation Measure are parent questionnaires measuring overall manual ability; the ACTIVLIM-CP is a parent questionnaire measuring global activity (upper and lower extremity) performance, and, the Pediatric Upper Limb Measure, Short Form is a child self-report questionnaire. Four observational measures were included: the Both Hands Assessment (BoHA) is an observational measure of bimanual activity performance; the Melbourne Assessment of Unilateral Upper Limb Function and the Melbourne Assessment 2 measure quality of movement of each upper limb separately, and the Peabody Developmental Motor Scales-Second Edition assesses fine motor skill capacity in young children. Based upon available evidence, the most suitable PROM for evaluation of upper limb activity in children with bilateral CP is the ACTIVLIM-CP, and the most suitable observational measure is the BoHA. CONCLUSION: Selection of upper limb measures depend on clinical information required and available resources. The BoHA is the only observational-based assessment which measures bimanual upper limb activity performance in children with bilateral CP. Recommendation for future measurement studies include familiarisation with the standards required for excellence, which include adequate sample size and content validity studies for PROMs.

PMID: 31385319

2. Influence of visual-coupling on bimanual coordination in unilateral spastic cerebral palsy.

Mutalib SA, Mace M, Ong HT, Burdet E.


Controlling two objects simultaneously during a bimanual task is a cognitively demanding process; both hands need to be temporally and spatially coordinated to achieve the shared task goal. Children with unilateral spastic cerebral palsy (USCP) exhibit severe sensory and motor impairments to one side of their body that make the process of coordinating bimanual movements particularly exhausting. Prior studies have shown that performing visually-coupled task could reduce cognitive interference associated with performing ‘two tasks at once’ in an uncoupled bimanual task. For children with USCP, who also...
present with cognitive delay, performing this type of task may allow them to process and plan their movement faster. We tested this hypothesis by examining the grip force control of 7 children with USCP during unimanual and visually-coupled bimanual tasks. Results demonstrated that despite the visual coupling, the bimanual coordination of these children remained impaired. However, there may be a potential benefit of visually-coupled task in encouraging both hands to initiate in concert. The implication of the study for children with USCP is discussed.

PMID: 31374762

3. Motion Analysis for People with Cerebral Palsy: A Vision Based Approach.
Macedo M, Candeias A, Marques M.

We propose a methodology to classify motion of subjects with cerebral palsy based on RGB image sequences and present a new dataset with 2D facial landmark trajectories from RGB images of people with and without disabilities while performing specific types of movements. Depending on these movements, parts of the face can be occluded and we are able to recover the 3D face's shape and its motion based on the Structure from Motion framework. Using the 3D structure and the motion, we propose two different motion descriptors, one is focused on describing the spatial distribution of the motion and the other on the temporal distribution. Finally, we discuss the physical meaning of these descriptors and show that they are very informative about the degree of the subjects’ disabilities. Our descriptor can classify people with and without cerebral palsy from 2D image sequences.

PMID: 31374604

McCall JV, Ludovice MC, Blaylock JA, Kamper DG.

The brain injury that results in cerebral palsy CP may adversely affect fine motor control of the hand. The degradation of manual dexterity in the fingers profoundly impacts overall functionality of the upper limb, yet research efforts to facilitate rehabilitation of finger individuation in children with CP have been limited. This study describes the development of an integrated hardware and software platform for training and evaluating finger individuation. A pneumatically actuated glove provides extension assistance or flexion resistance independently to each digit in concert with playing a virtual reality keyboard. This setup enables intensive and efficient practice of fine motor control of either or both hands. Bimanual training options range from mirror movements to fully independent motions and rhythms in each hand, thereby enabling maintenance of the proper level of challenge. Additionally, an instrument was created to provide assessment of individuated fingertip force generation in order to evaluate effectiveness of the training. Preliminary data were obtained from children both with and without CP using this tool.

PMID: 31374653

5. PEXO - A Pediatric Whole Hand Exoskeleton for Grasping Assistance in Task-Oriented Training.

Children with hand motor impairment due to cerebral palsy, traumatic brain injury, or pediatric stroke are considerably affected in their independence, development, and quality of life. Treatment conventionally includes task-oriented training in occupational therapy. While dose and intensity of hand therapy can be promoted through technology, these approaches are mostly limited to large stationary robotic devices for non-task-oriented training, or passive wearable devices for children with mild impairments. Here we present PEXO, a fully wearable actuated pediatric hand exoskeleton to cover the special needs of children (6 to 12 years of age) with strong impairments in hand function. Through three degrees of freedom, PEXO provides assistance in various grasp types needed for the execution of functional tasks. It is lightweight, water proof, and inherently interacts safely with the user. It meets mechanical requirements such as force, fast closing movement, and battery lifetime...
derived from literature and discussions with clinicians. Appealing appearance, user-friendly design, and intuitive control with visual feedback of forearm muscle activity should keep the user motivated during training in the clinic or at home. A pilot test with a 6-years old child with stroke showed that PEXO can provide assistance in grasping various objects weighing up to 0.5 kg. These are promising first results on the way to make hand exoskeletons accessible for children with neuromotor disorders.

PMID: 31374615

Chen J, Damiano DL, Lerner ZF, Bulea TC.

Advanced control strategies that can adjust assistance based volitional effort from the user may be beneficial for deploying exoskeletons for overground gait training in ambulatory populations, such as children with cerebral palsy (CP). In this study, we evaluate the ability to predict biological knee moment during stance phase of walking with an exoskeleton in two children subjects with crouch gait from CP. The predictive model characterized the knee as a rotational spring with the addition of correction factors at knee extensor moment extrema to predict the instantaneous knee moment profile from the knee angle. Our model prediction performance was comparable to previous studies for weight acceptance (WA) and mid-stance (MS) phases in both assisted (Assist) and non-assisted (Zero) modes based on normalized root mean square error (RMSE), demonstrating the feasibility of joint moment estimation during exoskeleton walking. RMSE was highest in late stance phase, likely due to the non-linear knee stiffness exhibited during this phase in one participant. Overall, our results support real-time implementation of the joint moment prediction model for control of exoskeleton knee extension assistance in children with CP.

PMID: 31374725

7. Development of a "transparent operation mode" for a lower-limb exoskeleton designed for children with cerebral palsy.
Andrade RM, Sapienza S, Bonato P.

Robot-assisted rehabilitation in children and young adults with Cerebral Palsy (CP) is expected to lead to neuroplasticity and reduce the burden of motor impairments. For a lower-limb exoskeleton to perform well in this context, it is essential that the robot be "transparent" to the user and produce torques only when voluntarily-generated motor outputs deviate significantly from the target trajectory. However, the development of transparent operation modes and assistance-as-needed control schema are still open problems with several implementation challenges. This paper presents a theoretical approach and provides a discussion of the key issues pertinent to designing a transparent operation mode for a lower-limb exoskeleton suitable for children and young adults with CP. Based on the dynamics of exoskeletons as well as friction models and human-robot interaction models, we propose a control strategy aimed to minimize human-machine interaction forces when subjects generate motor outputs that match the target trajectory. The material is presented as a conceptual framework that can be generalized to other exoskeleton systems for overground walking.

PMID: 31374681

Portinaro N, Turati M, Cometto M, Bigoni M, Davids JR, Panou A.

BACKGROUND: Progressive hip displacement is one of the most common and debilitating deformities seen in children with cerebral palsy (CP). The aim of this study was to evaluate the results of temporary medial hemiepiphysiodesis of the proximal femur (TMH-PF) using a transphyseal screw to control hip migration during growth in children with CP. METHODS: This was a retrospective study of children with CP and hip dysplasia, age 4 to 11 years and GMFCS levels III-V. There were 28 patients with 56 hips that underwent TMH-PF surgery between 2007 and 2010. Clinical and radiologic evaluation was performed preoperatively, at 6, 12, and 60 months following the index surgery. Acetabular index (AI), neck-shaft angle (NSA) and
migration percentage (MP) were measured. All complications were recorded. RESULTS: All radiographic measurements were significantly improved at the final follow-up. Positive correlations were found between NSA, MP, and AI. Multiple regression analysis revealed that MP, time from surgery, and age were influenced by the decrease of the NSA. The femoral physis grew off the screw in 9 hips within 36 months. The screw head broke during attempted screw exchange in 1 hip. The remain cases (4 hips) were treated by placing a second screw parallel to the existing one. Finally, progressive subluxation occurred in 3 hips when the physis grew off the screw and were treated by skeletal reconstruction. CONCLUSIONS: TMH-PF was effective in controlling progressive subluxation of the hip in the majority of cases, obviating the need for major reconstructive surgery in these children with CP. LEVEL OF EVIDENCE: Level IV.

PMID: 31393306


BACKGROUND: Implants are commonly used to stabilize proximal femoral osteotomies in children with cerebral palsy (CP). Removal of implants is common practice and believed to avoid infection, fracture, or pain that might be associated with retained hardware. There is little evidence to support a prophylactic strategy over a reactive approach based on symptoms. The aim of this study was to compare the outcomes of prophylactic and reactive approaches to removal of proximal femoral implants in children with CP. METHODS: An intention-to-treat model was used to compare 2 institutions that followed a prophylactic (within ∼1 y) and reactive (following complication/symptoms) approach to hardware removal, respectively. Patients with CP who had femoral implants placed at or before age 16, and had ≥2-year postsurgical follow-up were included. Demographics, surgical details, reasons for removal, and complications were recorded. χ² and t tests were used. RESULTS: Six hundred twenty-one patients (prophylactic=302, reactive=319) were followed for an average of 6 years (range, 2 to 17 y). Two hundred eighty-seven (95%) implants were removed in the prophylactic group at 1.2 years. In the reactive group, 64 (20%) implants were removed at an average of 4.2 years. Reasons for removal included pain; infection; fracture; or for repeat reconstruction. The rate of unplanned removals due to fracture or infection was higher in the reactive group (4.7% vs. 0.7%, P=0.002), but there was no difference in the rate of complications during/after removal between the 2 groups (1.7% vs. 3.1%; P=0.616). No specific risk factor associated with unplanned removal could be identified; but children under 8 years old seemed more likely to undergo later removal (odds ratio 1.98; 95% confidence interval, 0.99-3.99). CONCLUSIONS: Eighty percent of patients in the reactive removal strategy avoided surgery. This group did have a 4% higher rate of fracture or infection necessitating unplanned removal but these were successfully treated at time of removal with no difference in complication rates associated with removal between both groups. One would need to remove implants from 25 patients to avoid 1 additional complication, providing some support for a reactive approach to removal of proximal femoral implants in this population. LEVEL OF EVIDENCE: Level III-therapeutic.

PMID: 31393307


BACKGROUND: During ambulatory follow-up of patients with cerebral palsy (CP) systematic radiographic screening is required firstly to evaluate hip migration and development in the prevention of hip dislocation and secondly to analyse lower limb alignment and leg length. The Migration Percentage (MP) is a radiographic measurement used to describe the extent of femoral head lateralisation on conventional supine pelvic radiographs. Our goal was to assess the comparability of the MP measured on low radiation dose EOS® standing full-leg radiographs with that of conventional supine pelvic radiographs. METHODS: Patients presenting with CP were prospectively selected from our outpatient follow-up consultation at our institutions CP reference centre and underwent conventional supine pelvic and EOS® standing full-leg radiographs the same day for diagnostic and screening reasons. RESULTS: Out of 28 prospectively selected patients we included 21 (42 hips), of which 10 were female, with a mean age of 9.25 years and GMFCS levels of I, II and III. Seven out of 28 patients were excluded due to insufficient quality of radiographic images. The absolute differences in MP measured on both conventional supine pelvic and EOS® standing full-leg radiographs ranged between - 8 and 6% with an absolute mean difference of 0% (SD ±3.5) and were not statistically significant (p = 0.99). A Bland-Altman plot showed acceptable agreement between both measurements without proportional bias. CONCLUSION: There is no statistical significant difference between the Migration Percentage measured on conventional supine pelvic radiographs and EOS® standing full-leg radiographs in ambulant patients.
These images use lower radiation doses and contain more radiographic information. TRIAL REGISTRATION: Approved by the Medical Research Ethics committee of the University Hospitals Leuven (MP001492).

PMID: 31391039

Schwarze M, Horoba L, Block J, Putz C, Alimusaj M, Wolf SI, Dreher T.


OBJECTIVE: To date there is only limited knowledge about the wearing time of orthoses. Ankle-foot orthoses (AFOs) have not been studied with this research question. Additional influences of the orthotic design as well as weekdays and the weekend are also unknown. DESIGN: Monocentric, clinically prospective intervention study. PATIENTS: Inclusion of 10 patients with bilateral spastic cerebral palsy. METHODS: Equipment of all subjects with a dynamic ankle-foot orthosis (DAFO) and modular shank supply (MSS, dynamic elastic shank adaptation or ground reaction AFO). Integration of temperature sensors for recording the wearing time for a period of 3 months. RESULTS: The actual wearing time was below the recommendations on actually worn days as well as the average of the entire study period. In addition, the actual usage in terms of days and hours was well below the recommendations. The wearing time showed differences between weekdays and weekend. Differences between DAFO and MSS were not detectable. CONCLUSION: The actual usage behavior of ankle-foot orthoses differs from the recommendations of the prescriber. This applies to both DAFOs and modular use with shank supplies. Environmental factors may have a significant impact on wearing times on weekdays and the weekend.

PMID: 31380119


Our research team has developed two versions of an ankle robot for children with cerebral palsy. Both devices provide three degrees of freedom and are connected to an airplane video game. The child uses his/her foot as the controller for the plane and attempts to fly through a series of hoops arranged to manipulate the foot across the ankle joint. The first device is for lab-based therapy and four children have completed 20 sessions each with the device. The second device is for home-based therapy and two children have completed a 28-day trial using the device at home. Both studies were done under Institutional Review Board approval and all participants improved ankle range of motion. Further studies are ongoing to gather more data and validate the results.

PMID: 31374600

Jung SM, Lee E, Park SJ.


BACKGROUND: This prospective study aimed to determine whether the bispectral index (BIS) is a valid objective tool for differentiating adequate from inadequate deep sedation in spontaneously breathing children with cerebral palsy (CP).

METHODS: Propofol was titrated to increase the level of sedation with a continuous infusion of remifentanil at a rate of 0.05 μg/kg/min while maintaining spontaneous ventilation in 22 children with spastic CP, aged 3-18 years. The depth of sedation was assessed using the University of Michigan Sedation Scale (UMSS) and the Modified Observer's Assessment of Alertness and Sedation (MOAAS) scale. Receiver operating characteristic curve analysis was performed to determine the cutoff BIS values for deep sedation, defined as a UMSS score of 3-4 and a MOAAS score of 0-1. RESULTS: The BIS values significantly changed with the increase in the level of sedation across both the UMSS and MOAAS scores (p < 0.001). The BIS values significantly correlated with the UMSS (r = -0.795, p < 0.001) and MOAAS (r = 0.815, p < 0.001) scores. The cutoff BIS value...
to detect adequate deep sedation in children with CP was 61.5 (UMSS score: sensitivity 0.860, specificity 0.814; MOAAS score: sensitivity 0.794, specificity 0.811). CONCLUSIONS: The BIS value strongly correlates with the clinical sedation scales, such as the UMSS and MOAAS, during deep sedation in children with CP. Therefore, BIS monitoring can be used as a valid tool for assessing the level of propofol sedation in spontaneously breathing children with CP undergoing a botulinum toxin injection.

PMID: 31378054

14. Control of Walking Speed in Children With Cerebral Palsy.
Davids JR1, Cung NQ, Chen S, Sison-Williamson M, Bagley AM.


BACKGROUND: Children's ability to control the speed of gait is important for a wide range of activities. It is thought that the ability to increase the speed of gait for children with cerebral palsy (CP) is common. This study considered 3 hypotheses: (1) most ambulatory children with CP can increase gait speed, (2) the characteristics of free (self-selected) and fast walking are related to motor impairment level, and (3) the strategies used to increase gait speed are distinct among these levels.

METHODS: A retrospective review of time-distance parameters (TDPs) for 212 subjects with CP and 34 typically developing subjects walking at free and fast speeds was performed. Only children who could increase their gait speed above the minimal distance parameters (TDPs) for 212 subjects with CP and 34 typically developing subjects walking at free and fast speeds were included. Analysis of variance was used to compare TDPs of children with CP, among Gross Motor Function Classification System (GMFCS) levels, and children in typically developing group.

RESULTS: Eight-five percent of the CP group (GMFCS I, II, III; 96%, 99%, and 34%, respectively) could increase gait speed on demand. At free speed, children at GMFCS I and II were significantly faster than children at GMFCS level III. At free speed, children at GMFCS I and II had significantly greater stride length than those at GMFCS levels III. At free speed, children at GMFCS level III had significantly lower cadence than those at GMFCS I and II. There were no significant differences in cadence among GMFCS levels at fast speeds. There were no significant differences among GMFCS levels for percent change in any TDP between free and fast walking.

DISCUSSION: Almost all children with CP at GMFCS levels I and II can control the speed of gait, however, only one-third at GMFCS III level have this ability. This study suggests that children at GMFCS III level can be divided into 2 groups based on their ability to control gait speed; however, the prognostic significance of such categorization remains to be determined. LEVEL OF EVIDENCE: Diagnostic level II.

PMID: 31393305

15. SimCP: A Simulation Platform to Predict Gait Performance Following Orthopedic Intervention in Children With Cerebral Palsy.


Gait deficits in cerebral palsy (CP) are often treated with a single-event multi-level surgery (SEMLS). Selecting the treatment options (combination of bony and soft tissue corrections) for a specific patient is a complex endeavor and very often treatment outcome is not satisfying. A deterioration in 22.8% of the parameters describing gait performance has been reported and there is need for additional surgery in 11% of the patients. Computational simulations based on musculoskeletal models that allow clinicians to test the effects of different treatment options before surgery have the potential to drastically improve treatment outcome. However, to date, no such simulation and modeling method is available. Two important challenges are the development of methods to include patient-specific neuromechanical impairments into the models and to simulate the effect of different surgical procedures on post-operative gait performance. Therefore, we developed the SimCP framework that allows the evaluation of the effect of different simulated surgeries on gait performance of a specific patient and includes a graphical user interface (GUI) that enables performing virtual surgery on the models. We demonstrated the potential of our framework for two case studies. Models reflecting the patient-specific musculoskeletal geometry and muscle properties are generated based solely on data collected before the treatment. The patient's motor control is described based on muscle synergies derived from pre-operative EMG. The GUI is then used to modify the musculoskeletal properties according to the surgical plan. Since SEMLS does not affect motor control, the same motor control model is used to define gait performance pre- and post-operative. We use the capability gap (CG), i.e., the difference between the joint moments needed to perform healthy walking and the joint moments the personalized model can generate, to quantify gait performance. In both cases, the CG was smaller post- then pre-operative and this was in accordance with the measured change in gait kinematics after treatment.

PMID: 31379550

BACKGROUND: Children with developmental disabilities may need support with motor skills such as balance improvement, cognitive skills such as vocabulary learning, or social skills such as adequate interpretation of emotional expressions. Digital interactive games could support the standard treatments. We aimed to review clinical studies which investigated the application of serious games in children with developmental disabilities. 

METHOD: We searched MEDLINE and Scopus on 05 May 2019 limited to English language. We included people between two and 24 years of age who were affected by neurodevelopmental disorders who received digital serious game-based medical interventions such as any computer-based or video-based games. 

We considered any study design reporting primary data. We used title, abstract, and full-text of journal articles to build diagnostic groups, and we described some selected specific game applications. RESULTS: The majority of the 145 relevant studies reported on autism spectrum disorder (ASD), attention deficit hyperactivity disorder (ADHD), developmental coordination disorder (DCD), and disabilities affecting intellectual abilities (DAIA). 30 of the 145 studies reported a randomized design. We detailed six specific applications aimed at improving abilities in children with ASD, ADHD, cerebral palsy, and Down syndrome. We visualized the diagnostic groups by bibliographic mapping, and we limited the text to the title and abstract of journal articles. 

CONCLUSION: We identified promising results regarding anxiety reduction, stress regulation, emotion recognition, and rehabilitation. Currently, there appears to be a lack of clinical evidence that children with neurodevelopmental disorders can benefit from the application of serious games.

PMID: 31393252

17. Do the type of walking surface and the horse speed during hippotherapy modify the dynamics of sitting postural control in children with cerebral palsy? 
Flores FM, Dagnese F, Copetti F.  

BACKGROUND: Hippotherapy is described as a rehabilitation method for postural control in children with cerebral palsy. Horse's movements can be manipulated during hippotherapy's sessions with horse walking on different surfaces and at different speeds. The purpose of this study was to assess if dynamic sitting postural control in children with cerebral palsy in hippotherapy is modified when surfaces (sand or asphalt) and horse's walking speed (slow or faster) are changed. 

METHODS: Sixteen children participated in this crossover study. Eight bilateral spastic cerebral palsy children, age range (6-12 years), with Gross Motor Function Classification System levels III to IV, practicing hippotherapy and eight children with typical development (reference group), matched for age and sex. All children were evaluated during riding a horse on sand and asphalt surfaces and at slow (self-selected) and faster (30%) horse's walking speed. Center of pressure parameters were determined by a portable pressure measurement system positioned on the saddle. FINDINGS: Mediolateral displacement amplitude of the center of pressure was larger when the horse was on sand. Mediolateral and anteroposterior displacements amplitude and velocities of the center of pressure increased at horse's faster walking speed. INTERPRETATION: Our study test empirical procedures used in clinical practice and with a population widely reached by hippotherapy. In order to increase the demand for sitting postural control in children with cerebral palsy during horse riding, faster horse speed or riding on sand should be used.

PMID: 31386976

18. A Comparison of the Physiology of Sedentary Behavior and Light Physical Activity in Adults With and Without a Physical Disability. 
Balemans ACJ, Houdijk H, Koelewijn GR, Piek M, Tubbing F, Visser-Meily A, Verschuren O.  

BACKGROUND: It is questionable whether postures that are regarded as sedentary behavior in able-bodied persons evoke comparable physiological responses in adults with stroke or cerebral palsy (CP). This study aimed to compare metabolic demand and muscle activity in healthy controls, adults with stroke, and adults with CP during sedentary behavior and light physical activities. 

METHODS: Seventy-one adults (45.6 [18.9] y, range 18-86) participated in this study, of which there were 18 controls, 31 with stroke, and 22 with CP. The metabolic equivalent of task (MET) and level of muscle activation were assessed for different sedentary positions (sitting supported and unsupported) and light physical activities (standing and
walking). RESULTS: During sitting supported and unsupported, people with mild to moderate stroke and CP show comparable MET and electromyographic values as controls. While sitting unsupported, people with severe stroke show higher METs and electromyographic values (P < .001), and people with severe CP only show higher METs compared with controls (P < .05) but all below 1.5 METs. Standing increased electromyographic values in people with severe stroke or CP (P < .001) and reached values above 1.5 METs. CONCLUSIONS: Physiologic responses during sedentary behavior are comparable for controls and adults with mild to moderate stroke and CP, whereas higher metabolic demands and muscle activity (stroke only) were observed in severely affected individuals.

PMID: 31382243

19. Prevalence of Mental Health Disorders Among Adults With Cerebral Palsy.
[No authors listed]


PMID: 31382277

Whitney DG, Warschauksy SA, Ng S, Hurvitz EA, Kamdar NS, Peterson MD.


BACKGROUND: Persons with cerebral palsy (CP) have an increased risk for secondary chronic conditions during childhood, including mental health disorders. However, little is known about how these disorders affect adults with CP. OBJECTIVE: To determine the prevalence of mental health disorders among adults with CP compared with those without CP. DESIGN: Cross-sectional. SETTING: 2016 Optum Clininformatics Data Mart. PATIENTS: 8.7 million adults (including 7348 adults with CP). MEASUREMENTS: Other neurodevelopmental comorbid conditions (intellectual disabilities, autism spectrum disorders, epilepsy) and 37 mental health disorders (as 6 categories) were identified on the basis of diagnosis codes. Direct age-standardized prevalence of the mental health disorder categories was estimated by sex for adults with CP alone, adults with CP and neurodevelopmental disorders, and adults without CP. RESULTS: Men with CP alone had higher age-standardized prevalence than men without CP for schizophrenic disorders (2.8% [95% CI, 2.2% to 3.4%] vs. 0.7%), mood affective disorders (19.5% [CI, 18.0% to 21.0%] vs. 8.1%), anxiety disorders (19.5% [CI, 18.0% to 21.0%] vs. 11.1%), disorders of adult personality and behavior (1.2% [CI, 0.8% to 1.6%] vs. 0.3%), and alcohol- and opioid-related disorders (4.7% [CI, 3.9% to 5.5%] vs. 3.0%). The same pattern was observed for women. Compared with adults with CP alone, those with CP and neurodevelopmental disorders had similar or higher age-standardized prevalence of the 6 mental health disorder categories, except for the lower prevalence of alcohol- and opioid-related disorders in men. LIMITATIONS: Single claims code was used to define the cohort of interest. Information on the severity of CP was not available. CONCLUSION: Compared with adults without CP, those with CP have an elevated prevalence of mental health disorders, some of which may be more pronounced in patients with comorbid neurodevelopmental disorders. PRIMARY FUNDING SOURCE: National Institute on Disability, Independent Living, and Rehabilitation Research.

PMID: 31382276

21. Shining the Light on Mental Health in a Population at Risk: Cerebral Palsy and Other Developmental Disabilities.
Krahn G, Havercamp S.


PMID: 31382274

Barreto TM, Bento MN, Barreto TM, Jagersbacher JG, Jones NS, Lucena R, Bandeira ID.

AIM: To estimate the prevalence of mental illness in parents of children with cerebral palsy (CP). METHOD: This is a systematic review that follows the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols in the search for observational studies determining the prevalence of depression, anxiety, and substance abuse in parents of individuals with CP. The information sources used for this study were: PubMed, SciELO, Cochrane Library, Clinical Trials, and Biblioteca Virtual de Saúde. RESULTS: Fourteen articles were selected and included, investigating 1264 mothers and 105 fathers of children with CP. Data extracted for analysis were divided into three categories: study data, data about participants with CP, and data about parents. All studies included volunteer parents, of whom 95 per cent were female. INTERPRETATION: CP is related to a higher prevalence of symptoms of depression and anxiety in parents. Factors such as a child's degree of functionality and socioeconomic level may influence the frequency of mental disorders in parents. However, these studies have heterogeneous samples and applied different criteria to characterize their populations. WHAT THIS PAPER ADDS: Depression and anxiety are more prevalent for parents of children with cerebral palsy (CP) than parents of typically developing children. The child's illness severity is a risk factor for mental illness in parents of children with CP. The more time spent on child care, the higher the risk of mental illness among mothers of children with CP. There is a lack of reliable data in the literature on substance abuse in parents of children with CP.

PMID: 31381150


BACKGROUND: Quality of life (QoL) and health-related quality of life (HRQoL) measurement in low and middle-income countries of people with cerebral palsy (CP), the major cause of childhood physical disability, is essential to assess the impact of interventions and inform policies that best improve people's lives. The purpose of this study was to cross-culturally translate and psychometrically validate the Cerebral Palsy Quality of Life-Teens (CPQoL-Teens) self- and proxy-report questionnaires for application with adolescents with CP in Bangladesh. METHOD: The CPQoL-Teens questionnaires were translated to Bengali using forward and backwards cross-cultural translation protocols. The questionnaires were interviewer administered to adolescents and their primary caregivers, identified through the Bangladesh Cerebral Palsy Register. Feasibility, sensitivity, internal consistency, content, concurrent and construct validity were assessed. RESULTS: One hundred fifty four adolescents with CP (10 to 18y; mean 15y 1mo SD 1y 8mo; 31.2% female) participated. Feasibility, sensitivity and internal consistency of both self- and proxy-report questionnaires was excellent; nil missing scores except 'school wellbeing' which was associated with non-school attendance (48.4 to 74.7%); floor and ceiling effect ≤13.6%; Cronbach's alpha 0.77 to 0.94. Instrument validity was good; confirmatory factor analysis reflected five of the seven original instrument dimensions. CPQoL-Teens correlated to Kidscreen-27 on most dimensions (r = 0.176 to 0.693, p < 0.05); minimal difference in known groups was observed by mental health status (p < 0.05) although could be accounted for by homogeneity of mental health problems in the sample. CONCLUSION: The CPQoL-Teens self- and proxy report questionnaires successfully translated to Bengali and showed excellent feasibility and strong psychometric properties confirming suitability to assess indicators of HRQoL among adolescents with CP in Bangladesh.

PMID: 31375110

Reyes FI, Salemi JL, Dongarwar D, Magazine CB, Salihu HM.


AIM: This cross-sectional study characterized the prevalence, trends, sociodemographic factors, and clinical factors that are associated with a coded diagnosis of malnutrition (CDM) among hospitalized children with cerebral palsy (CP) in the USA. METHOD: We used data from the 2002 to 2015 National Inpatient Sample database and restricted the analysis to hospitalized children with CP between 2 and 17 years of age. International Classification of Diseases, Ninth Edition, Clinical Modification diagnosis codes for CP, malnutrition, and comorbidities associated with CP were used to characterize hospitalizations for this population. Logistic regression models were conducted to identify the sociodemographic factors and comorbidities associated with a diagnosis of malnutrition. RESULTS: The average documented rate of CDM among hospitalized children with CP was 7.9% and nearly doubled during the study period. The model suggests that younger age, non-white ethnicity, lower income, and non-private insurance/payer status were associated with increased odds of documented malnutrition. Concomitant inpatient diagnoses of epilepsy, dysphagia, scoliosis, reflux, and constipation were associated with higher rates of CDM. INTERPRETATION: The rate of CDM in hospitalized patients with CP is well under the estimated clinical prevalence of 30%...
Multiple sociodemographic, hospital, and clinical factors are associated with higher rates of CDM. WHAT THIS PAPER ADDS: The documented rate of malnutrition in hospitalized children with cerebral palsy (CP) averaged 7.9% yearly. For hospitalized children with CP, documentation of malnutrition nearly doubled between 2002 and 2015. Economically disadvantaged and minority ethnic groups had a greater likelihood of malnutrition documentation. Inpatient malnutrition documentation was more likely with some comorbidities indicative of greater impairments. Gastrointestinal disorders increased the likelihood of an inpatient-documented diagnosis of malnutrition.

PMID: 31378936

25. Preliminary Design of an Active Stabilization Assistive Eating Device for People Living with Movement Disorders. Turgeon P, Laliberte T, Routhier F, Campeau-Lecours A.


This paper presents the development of a new active assistive eating device, which aims to stabilize the movements of people living with movement disorders, such as spasticity and ataxia. Many people living with upper-body incapacities are unable to eat on their own, due to movement disorders (ex. tremors, spastic motions, lack of muscular tone), resulting from various ailments like Cerebral palsy, Parkinson's disease, Dystonia, Multiple sclerosis, strokes, and Muscular dystrophy. Our past work focused on the development of a purely mechanical device, which involved damping of the system via passive mechanical dampers. This paper extends said work by using active stabilization of user movements. The active assistance enables the design of intelligent algorithms that can assist human movements more efficiently. This active version has the benefits of being easily adjustable; the level of damping can be adjusted in real-time, depending on the user movement; different control modes are offered, and the guiding of user movements is also allowed. Firstly, the mechanical design of the device is presented, followed by the damping arrangement, the electronic design, the control algorithms and finally, the preliminary experiments are mentioned.

PMID: 31374633

26. Unsupervised breastfeeding was related to sudden unexpected postnatal collapse during early skin-to-skin contact in cerebral palsy cases. Miyazawa T, Itabashi K, Tamura M, Suzuki H, Ikenoue T; Prevention Recurrence Committee, Japan Obstetric Compensation System for Cerebral Palsy.


AIM: This study aimed to identify the clinical features of infants who were healthy at birth, but developed sudden unexpected collapse and were then diagnosed with cerebral palsy before five years of age. METHODS: We retrospectively analysed 1182 records from the no-fault Japan Obstetric Compensation System for Cerebral Palsy database up to 2016. This identified 45 subjects (3.8%) who were subsequently diagnosed with severe cerebral palsy due to sudden unexpected postnatal collapse (SUPC). They were all healthy at birth, based on the criteria of five-minute Apgar scores of seven or more, with normal umbilical cord blood gases and no need for neonatal resuscitation within five minutes of birth. RESULTS: The median birth weight of the 45 subjects (26 males) was 2770g (range 2006-3695g). Of these, 10 developed SUPC during early skin-to-skin contact (SSC). Medical personnel were not present in all 10 cases: nine were being breastfed at the time and eight of the mothers did not notice their infant's abnormal condition until medical staff alerted them. CONCLUSION: This national study of children with cerebral palsy who appeared healthy at birth found that unsupervised breastfeeding was a common factor in cases of SUPC during early SSC. This article is protected by copyright. All rights reserved.

PMID: 31385353

27. Brain Activity and Cerebral Oxygenation After Perinatal Arterial Ischemic Stroke Are Associated With Neurodevelopment. Wagenaar N, van den Berk DJM, Lemmers PMA, van der Aa NE, Dudink J, van Bel F, Groenendaal F, de Vries LS, Benders MJNL, Alderliesten T.

Stroke. 2019 Aug 8;STROKEAHA119025346. doi: 10.1161/STROKEAHA.119.025346. [Epub ahead of print]
Background and Purpose- In infants with perinatal arterial ischemic stroke (PAIS), early prognosis of neurodevelopmental outcome is important to adequately inform parents and caretakers. Early continuous neuromonitoring after PAIS may improve early prognosis. Our aim was to study early cerebral electrical activity and oxygenation measured by amplitude-integrated electroencephalography (aEEG) and near-infrared spectroscopy in term neonates with PAIS and relate these to the development of cerebral palsy and cognitive deficit. Methods- aEEG patterns and regional cerebral oxygen saturation (rScO2) levels of both hemispheres were studied for 120 hours from the first clinical symptoms of PAIS (ie, seizures) onward. Multivariable analyses were used to investigate the association between aEEG, near-infrared spectroscopy, clinical variables, and neurodevelopmental outcome. Results- In 52 patients with PAIS (gestational age, 40.4±1.4 weeks; birth weight, 3282±479 g), median time to a continuous background pattern was longer in the ipsilesional compared with the contralesional hemisphere (13.5 versus 10.0 hours; P<0.05). rScO2 decreased over time in both hemispheres but less in the ipsilesional one, resulting in a rScO2 asymmetry ratio of 4.5% (interquartile range, -4.3% to 5.9%; P<0.05) between hemispheres from day 3 after symptoms onward. Both time to normal background pattern and asymmetry in rScO2 were negatively affected by gestational age, size of the PAIS, use of antiepileptic drugs, and mechanical ventilation. After correction for size of the PAIS on magnetic resonance imaging, a slower recovery of background pattern on ipsilesional aEEG and increased rScO2 asymmetry between hemispheres was related with an increased risk for cognitive deficit (≤1 SD) at a median of 24.0 (interquartile range, 18.4-24.4) months of age. Conclusions- Recovery of background pattern on aEEG and cerebral oxygenation are both affected by PAIS and related to neurocognitive development. Both measurements may provide valuable early prognostic information. Additionally, monitoring cerebral activity and oxygenation may be useful in identifying infants eligible for early neuroprotective interventions and to detect early effects of these interventions.

PMID: 31390967

28. Maturation of Corticospinal Tracts in Children With Hemiplegic Cerebral Palsy Assessed by Diffusion Tensor Imaging and Transcranial Magnetic Stimulation.
Papadelis C, Kaye H, Shore B, Snyder B, Grant PE, Rotenberg A.


Aim: To assess changes in the developmental trajectory of corticospinal tracts (CST) maturation in children with hemiplegic cerebral palsy (HCP). Methods: Neuroimaging data were obtained from 36 children with HCP for both the more affected (MA) and less affected (LA) hemispheres, and, for purposes of direct comparison, between groups, 15 typically developing (TD) children. With diffusion tensor imaging (DTI), we estimated the mean fractional anisotropy (FA), axial diffusivity (AD), mean diffusivity (MD), and radial diffusivity (RD) of the corticospinal tract, parameters indicative of factors including myelination and axon density. Transcranial magnetic stimulation (TMS) was performed as a neurophysiologic measure of corticospinal tract integrity and organization. Resting motor threshold (rMT) was obtained per hemisphere, per patient. Results: We observed a significant AD and MD developmental trajectory, both of which were inversely related to age (decrease in AD and diffusivity corresponding to increased age) in both hemispheres of TD children (p < 0.001). This maturation process was absent in both MA and LA hemispheres of children with HCP. Additionally, the TMS-derived previously established rMT developmental trajectory was preserved in the LA hemisphere of children with HCP (n = 26; p < 0.0001) but this trajectory was absent in the MA hemisphere. Conclusions: Corticospinal tract maturation arrests in both hemispheres of children with HCP, possibly reflecting perinatal disruption of corticospinal tract myelination and axonal integrity.

PMID: 31396066

Pels A, Beune IM, van Wassenaer-Leemhuis AG, Limpens J, Ganzevoort W.


INTRODUCTION: Severe early-onset fetal growth restriction is an obstetric condition with significant risks of perinatal mortality, major and minor neonatal morbidity, and long-term health sequelae. The prognosis of a fetus is influenced by the extent of prematurity and fetal weight. Clinical care is individually adjusted. In literature, survival rates described vary and studies often only include live born neonates with missing rates of antenatal death. This systematic review aims to summarize the literature on mortality and morbidity. MATERIAL AND METHODS: A broad literature search was conducted in OVID MEDLINE from 2000 to 2019, April 26th to identify studies on fetal growth restriction and perinatal death. Studies were excluded when all included children were born before 2000 because (neonatal) health care has considerably improved since this period. Studies were included that described fetal growth restriction diagnosed before 32 weeks of gestation and antenatal mortality and neonatal mortality and/or morbidity as outcome. Quality of evidence was rated with the GRADE instrument. RESULTS: Of the 2604 publications identified, 25 studies, reporting 2895 pregnancies, were included in the systematic review.
Overall risk of bias in most studies was judged as low. The quality of evidence was generally rated as very low to moderate, except for three large well-designed randomized controlled trials. When combining all data on mortality, in 355 of 2895 pregnancies (12%) the fetus died antenatally, 192 died in the neonatal period (8% of live born neonates) and 2347 (81% of all pregnancies) children survived. Of the neonatal morbidities recorded, respiratory distress syndrome (34% of the live born neonates), retinopathy of prematurity (13%) and sepsis (30%) were most common. Of 476 children that underwent neurodevelopmental assessment, 58 (12% of surviving children, 9% of all pregnancies) suffered from cognitive impairment and/or cerebral palsy. CONCLUSIONS: When combining the data of 25 included studies, survival in fetal growth restriction pregnancies, diagnosed before 32 weeks of gestation was 81%. Neurodevelopmental impairment was assessed in a minority of surviving children. Individual prognostic counseling on the basis of these results is hampered by differences in patient and pregnancy characteristics within the included patient groups. This article is protected by copyright. All rights reserved.

PMID: 31376293

Hakami WS, Hundallah KJ, Tabarki BM.


Cerebral palsy is a syndrome that encompasses a large group of childhood movement and posture disorders that result from a lesion occurring in the developing brain. The clinical presentation of many metabolic and genetic conditions, particularly in highly consanguineous populations, can mimic cerebral palsy particularly at early age. The aim of this review article is to identify the clinical features that should alert the physician to the possibility of disorders that resemble cerebral palsy, the clinical and neuroimaging red flags, and highlight some metabolic and genetic conditions which may present with spasticity, ataxia and dyskinesia. In the case of metabolic or genetic disorder, making a precise diagnosis is particularly important for the possibility of treatment, accurate prognosis and genetic counseling.

PMID: 31380813