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Interventions and Management

1. Efficacy of Armeo® Robotic Therapy versus Conventional Therapy on Upper Extremity Function in Children with Hemiplegic Cerebral Palsy.

El-Shamy SM.

Am J Phys Med Rehabil. 2017 Oct 21. doi: 10.1097/PHM.0000000000000852. [Epub ahead of print]

OBJECTIVE: The aim of this study was to examine the efficacy of Armeo® robotic therapy, compared to conventional therapy, on upper extremity function in children with hemiplegic cerebral palsy. **DESIGN:** Thirty children with hemiplegic cerebral palsy, with ages ranging from 6 to 8 years, were selected for this randomized controlled study and randomly assigned to two groups. The study group (n=15) received 12 weeks of Armeo robotic therapy (45 min/session, 3 days/week) and the control group (n=15) received conventional therapy for the same time period. The measured outcomes were the Modified Ashworth Scale (MAS) and the Quality of Upper Extremity Skills Test (QUEST), measured at baseline and after 12 weeks of intervention. **RESULTS:** Children in the study group showed significant improvement in the mean values of all the measured variables, compared to those in the control group ($P < 0.05$). Post-intervention MAS scores for the study and control groups were 1.6 (0.3) and 2 (0.5), respectively. Post-interventional QUEST total scores for the study and control groups were 84.6 (2.7) and 79.1 (2), respectively. **CONCLUSIONS:** Armeo robotic therapy is significantly more effective than conventional therapy in improving the upper extremity quality of movement in children with hemiplegic cerebral palsy.

[PMID: 29059068](#)

2. Towards a wearable hand exoskeleton with embedded synergies.

Burns MK, Van Orden K, Patel V, Vinjamuri R.

Conf Proc IEEE Eng Med Biol Soc. 2017 Jul;2017:213-216. doi: 10.1109/EMBC.2017.8036800.

Numerous hand exoskeletons have been proposed in the literature with the aim of assisting or rehabilitating victims of stroke, brain/spinal cord injury, or other causes of hand paralysis. In this paper a new 3D printed soft hand exoskeleton, HEXOES (Hand Exoskeleton with Embedded Synergies), is introduced and mechanically characterized. Metacarpophalangeal (MCP) and proximal interphalangeal/interphalangeal (PIP/IP) joints had measured maximum flexion angles of $53.7 \pm 16.9^\circ$ and $39.9 \pm 13.4^\circ$, respectively; and maximum MCP and PIP angular velocities of 94.5 ± 41.9 degrees/s and 74.6 ± 67.3 degrees/s, respectively. These estimates indicate that the mechanical design has range of motion and angular velocity characteristics that meet the requirements for synergy-based control. When coupled with the proposed control loop, HEXOES can be used in the future as a test-bed for synergy-based clinical hand rehabilitation.

[PMID: 29059848](#)

3. Motor planning in children with cerebral palsy: A longitudinal perspective.

Lust JM, Spruijt S, Wilson PH, Steenbergen B.

J Clin Exp Neuropsychol. 2017 Oct 23;1-8. doi: 10.1080/13803395.2017.1387645. [Epub ahead of print]

INTRODUCTION: Motor planning is important for daily functioning. Deficits in motor planning can result in slow, inefficient, and clumsy motor behavior and are linked to disruptions in performance of activities of daily living in children with cerebral palsy (CP). However, the evidence in CP is primarily based on cross-sectional data. **METHOD:** Data are presented on the development of motor planning in children with CP using a longitudinal design with three measurement occasions, each separated by 1 year. Twenty-two children with CP (9 boys, 13 girls; age in years;months, M = 7;1, SD = 1;2) and 22 age-matched controls (10 boys, 12 girls, M = 7;1, SD = 1;3) participated. Children performed a bar transport task in which some conditions ("critical angles") required participants to sacrifice initial posture comfort in order to achieve end-state comfort. Performance on critical trials was analyzed using linear growth curve modeling. **RESULTS:** In general, children with CP showed poor end-state planning for critical angles. Importantly, unlike in controls, motor planning ability did not improve across the three measurement occasions in children with CP. **CONCLUSION:** These longitudinal results show that motor planning issues in CP do not resolve with development over childhood. Strategies to enhance motor planning are suggested for intervention.

[PMID: 29061082](#)

4. Low gait efficiency is the primary reason for the increased metabolic demand during gait in children with cerebral palsy.

Ries AJ, Schwartz MH.

Hum Mov Sci. 2017 Oct 21. pii: S0167-9457(17)30280-4. doi: 10.1016/j.humov.2017.10.004. [Epub ahead of print]

Children diagnosed with cerebral palsy (CP) use two to three times more metabolic energy to walk than their typically developing (TD) peers. The primary cause of the metabolic increase remains unknown. In this study, we analyzed metabolic energy, center of mass (COM) work, and gait efficiency for a large group of children diagnosed with diplegic CP in order to better understand the source of the excessive metabolic demand. Our primary hypothesis is that metabolic demand is increased in CP due to low efficiency conversion of metabolic energy into useful COM work. Results show that, on average, individuals with CP produce 27% more COM work, but have 99% higher metabolic demand than their TD peers. This causes individuals with CP to have a gait efficiency that is 31% lower than the gait efficiency of TD individuals. Therefore, low efficiency is responsible for nearly three quarters of the increase in metabolic demand. These results show that the high metabolic demands in CP are largely a result of low gait efficiency, not excessive COM work. Further work is needed to identify the specific neurological and biomechanical mechanisms underlying low gait efficiency in CP.

[PMID: 29066191](#)

5. The impact of an anti-gravity treadmill (AlterG) training on walking capacity and corticospinal tract structure in children with cerebral palsy.

Azizi S, Marzbani H, Raminfard S, Birgani PM, Rasooli AH, Mirbagheri MM.

Conf Proc IEEE Eng Med Biol Soc. 2017 Jul;2017:1150-1153. doi: 10.1109/EMBC.2017.8037033.

We studied the effects of an anti-gravity treadmill (AlterG) training on walking capacity and corticospinal tract structure in children with Cerebral Palsy (CP). AlterG can help CP children walk on the treadmill by reducing their weights up to 80% and maintain their balance during locomotion. AlterG training thus has the potential to improve walking capacity permanently as it can provide systematic and intense locomotor training for sufficiently long period of time and produce brain neuroplasticity. AlterG training was given for 45 minutes, three times a week for two months. The neuroplasticity of corticospinal tract was evaluated using Diffusion Tensor Imaging (DTI). The fractional Anisotropy (FA) feature was extracted to quantify structural changes of the corticospinal tract. Walking capacity was evaluated using popular clinical measurements of gait; i.e., walking speed, mobility and balance. The evaluations were done before and after training. Our results revealed that AlterG training resulted in an increase in average FA value of the corticospinal tract following the training. The outcome measures of clinical assessments of gait presented enhanced walking capacity of the CP subjects. Our findings indicated that the improved walking capacity was concurrent with the enhancement of the corticospinal tract structure. The clinical implication is that AlterG training may be considered as a therapeutic tool for permanent gait improvement in CP children.

[PMID: 29060079](#)

6. Antagonist thigh-muscle activity in 6-to-8-year-old children assessed by surface EMG during walking.

Di Nardo F, Strazza A, Mengarelli A, Ercolani S, Burattini L, Fioretti S.

Conf Proc IEEE Eng Med Biol Soc. 2017 Jul;2017:3469-3472. doi: 10.1109/EMBC.2017.8037603.

Analysis of muscle co-contractions seems to be relevant in the characterization of children pathologies such as spastic cerebral palsy. The aim of the study was the quantification of thigh-muscle co-contractions during walking in healthy children. To this aim, the Statistical Gait Analysis, a recent methodology providing a statistical characterization of gait, was performed on surface EMG signals from Vastus Medialis (VM) and Lateral Hamstrings (LH) in 30 healthy 6-to-8-year-old children. Muscular co-contraction was assessed as the overlapping period between activation intervals of agonist and antagonist muscles. As in adults, VM activity occurring from terminal swing to the following loading response superimposed LH activity in the same percentage of the gait cycle. This co-contraction occurred in order to control knee joint stability during weight acceptance. It was acknowledged in the totality (100 %) of the considered strides. Concomitant activity of VM and LH was detected also in the second half of stance phase in 17.1 ± 4.8 % of the considered strides. Working VM and LH on different joints, this concomitant activity of antagonist muscles should not be considered as an actual co-contraction. Present findings provide new information on the variability of the reciprocal role of VM and LH during child walking, useful for comparison between normal and pathological walking in the clinical context and for designing future studies on maturation of gait..

[PMID: 29060644](#)

7. Estimating medial gastrocnemius muscle volume in children with spastic cerebral palsy: a cross-sectional investigation.

Schless SH, Hanssen B, Cenni F, Bar-On L, Aertbeliën E, Molenaers G, Desloovere K.

Dev Med Child Neurol. 2017 Oct 24. doi: 10.1111/dmcn.13597. [Epub ahead of print]

AIM: This cross-sectional investigation evaluates the reliability of estimating medial gastrocnemius anatomical cross-sectional area (aCSA) in typically developing and spastic cerebral palsy (SCP) cohorts. It verifies whether muscle volume estimations based on aCSA improve when aCSA is multiplied by muscle-tendon unit (MTU) or muscle length, and whether the resulting errors in volume estimations are smaller than changes after intervention. METHOD: Fifteen typically developing children (mean age 8y 2mo [SD 1y 5mo], six males, nine females) and 30 children with SCP (mean age 9y 2mo [SD 2y 5mo], 22 males, eight females, Gross Motor Function Classification System [GMFCS] level I=15, II=15) participated in the investigation. The SCP cohort was divided according to GMFCS level. A three-dimensional freehand ultrasound technique was used to estimate medial gastrocnemius aCSA, muscle volume, MTU, and muscle length. Estimated muscle volume (aCSA×MTU or muscle length) was compared with the measured muscle volume. RESULTS: Anatomical cross-sectional area, muscle volume, and muscle length significantly differed between the typically developing and two SCP cohorts ($p \leq 0.050$). aCSA multiplied by either MTU or muscle length improved estimations of medial gastrocnemius volume. Leave-one-out cross-validation revealed an absolute difference with measured muscle volume of 3.77 ml (SD 2.90). INTERPRETATION: This investigation revealed that medial gastrocnemius muscle volume can be reliably estimated in a clinically feasible manner in typically developing children and those with SCP. WHAT THIS PAPER ADDS: Medial gastrocnemius anatomical cross-sectional area (aCSA) can be reliably estimated in children with spastic cerebral palsy. The location of the anatomical cross-section should be taken with respect to muscle and not bone length. Medial gastrocnemius volume can be reliably estimated by multiplying aCSA and muscle length. The errors in volume estimations are smaller than reported differences after interventions.

[PMID: 29067675](#)

8. Comparison of seating, powered characteristics and functions and costs of electrically powered wheelchairs in a general population of users.

Dolan MJ, Bolton MJ, Henderson GI.

Disabil Rehabil Assist Technol. 2017 Oct 26:1-6. doi: 10.1080/17483107.2017.1393701. [Epub ahead of print]

PURPOSE: To profile and compare the seating and powered characteristics and functions of electrically powered wheelchairs (EPWs) in a general user population including equipment costs. METHOD: Case notes of adult EPW users of a regional NHS service were reviewed retrospectively. Seating equipment complexity and type were categorized using the Edinburgh

classification. Powered characteristics and functions, including control device type, were recorded. RESULTS: 482 cases were included; 53.9% female; mean duration EPW use 8.1 years (SD 7.4); rear wheel drive 88.0%; hand joystick 94.8%. Seating complexity: low 73.2%, medium 18.0%, high 8.7%. Most prevalent diagnoses: multiple sclerosis (MS) 25.3%, cerebral palsy (CP) 18.7%, muscular dystrophy (8.5%). Compared to CP users, MS users were significantly older at first use, less experienced, more likely to have mid-wheel drive and less complex seating. Additional costs for muscular dystrophy and spinal cord injury users were 3-4 times stroke users. CONCLUSIONS: This is the first large study of a general EPW user population using a seating classification. Significant differences were found between diagnostic groups; nevertheless, there was also high diversity within each group. The differences in provision and the equipment costs across diagnostic groups can be used to improve service planning. Implications for Rehabilitation At a service planning level, knowledge of a population's diagnostic group and age distribution can be used to inform decisions about the number of required EPWs and equipment costs and specialised seating (including review) clinics. At a user level, purchasing decisions about powered characteristics and functions of EPWs and specialised seating equipment need to be taken on a case by case basis because of the diversity of users' needs within diagnostic and age groups. The additional equipment costs for SCI and MD users are several times those of stroke users and add between 60 and 70% of the cost of basic provision. Compared to CP users, it is more important for MS users to be regularly reviewed for both specialist seating and EPW control ability. This is due to the progressive nature of the condition.

[PMID: 29072545](#)

9. Skeletal muscle mechanics, energetics and plasticity.

Lieber RL, Roberts TJ, Blemker SS, Lee SSM, Herzog W.

J Neuroeng Rehabil. 2017 Oct 23;14(1):108. doi: 10.1186/s12984-017-0318-y.

The following papers by Richard Lieber (Skeletal Muscle as an Actuator), Thomas Roberts (Elastic Mechanisms and Muscle Function), Silvia Blemker (Skeletal Muscle has a Mind of its Own: a Computational Framework to Model the Complex Process of Muscle Adaptation) and Sabrina Lee (Muscle Properties of Spastic Muscle (Stroke and CP) are summaries of their representative contributions for the session on skeletal muscle mechanics, energetics and plasticity at the 2016 Biomechanics and Neural Control of Movement Conference (BANCOM 2016). Dr. Lieber revisits the topic of sarcomere length as a fundamental property of skeletal muscle contraction. Specifically, problems associated with sarcomere length non-uniformity and the role of sarcomerogenesis in diseases such as cerebral palsy are critically discussed. Dr. Roberts then makes us aware of the (often neglected) role of the passive tissues in muscles and discusses the properties of parallel elasticity and series elasticity, and their role in muscle function. Specifically, he identifies the merits of analyzing muscle deformations in three dimensions (rather than just two), because of the potential decoupling of the parallel elastic element length from the contractile element length, and reviews the associated implications for the architectural gear ratio of skeletal muscle contraction. Dr. Blemker then tackles muscle adaptation using a novel way of looking at adaptive processes and what might drive adaptation. She argues that cells do not have pre-programmed behaviors that are controlled by the nervous system. Rather, the adaptive responses of muscle fibers are determined by sub-cellular signaling pathways that are affected by mechanical and biochemical stimuli; an exciting framework with lots of potential. Finally, Dr. Lee takes on the challenging task of determining human muscle properties in vivo. She identifies the dilemma of how we can demonstrate the effectiveness of a treatment, specifically in cases of muscle spasticity following stroke or in children with cerebral palsy. She then discusses the merits of ultrasound based elastography, and the clinical possibilities this technique might hold. Overall, we are treated to a vast array of basic and clinical problems in skeletal muscle mechanics and physiology, with some solutions, and many suggestions for future research.

[PMID: 29058612](#)

10. Cerebral palsy in under 25 s: assessment and management (NICE Guideline NG62).

Shaunak M, Kelly VB.

Arch Dis Child Educ Pract Ed. 2017 Oct 22. pii: edpract-2017-312970. doi: 10.1136/archdischild-2017-312970. [Epub ahead of print]

Cerebral palsy is the most common cause of physical disability in children and young people in high-income countries, with a prevalence of 2.0–2.5 cases per 1000 live births. The physical manifestations of disability vary depending on the location and extent of underlying brain damage and may change over time. There is no cure for cerebral palsy. Management focuses on optimising functional ability, decreasing secondary musculoskeletal deformity and managing comorbidities.

The current guideline

In January 2017, the National Institute for Health and Care Excellence (NICE) published guidance entitled, 'Cerebral palsy in under 25 s: assessment and management'. The guideline aims to standardise the assessment and management of developmental and clinical comorbidities associated with cerebral palsy, from birth up to the age of 25 years. It is intended to be used in conjunction with, 'Spasticity in under 19 s: management', a NICE guideline published in 2012, which provides recommendations for optimising movement and posture in cerebral palsy. Here, we summarise the new guidance for healthcare professionals and discuss its relevance to clinical practice.

[PMID: 29056589](#)

11. Mechanical Insufflation-Exsufflation Versus Conventional Chest Physiotherapy in Children With Cerebral Palsy.

Siriwat R, Deerojanawong J, Sritippayawan S, Hantragool S, Cheanprapai P.

Respir Care. 2017 Oct 24. pii: respcare.05663. doi: 10.4187/respcare.05663. [Epub ahead of print]

BACKGROUND: The cough mechanism is often impaired in children with quadriplegic spastic cerebral palsy, accounting for the high prevalence of pneumonia and atelectasis requiring prolonged hospitalization. Conventional chest physiotherapy (CPT) is a current technique recommended at the onset of lower-respiratory infections in cerebral palsy. Previous studies have demonstrated the usefulness of mechanical insufflation-exsufflation (MI-E) in children with neuromuscular disease. To date, there has been no study of MI-E in children with quadriplegic spastic cerebral palsy. The objective of the study is to compare the efficacy in reducing hospital stay and improvement of atelectasis between MI-E and CPT in children with quadriplegic spastic cerebral palsy with lower-respiratory infections. **METHODS:** This study is a randomized controlled trial. Children with quadriplegic spastic cerebral palsy, age 6 months to 18 y, admitted for lower-respiratory infections and/or atelectasis at King Chulalongkorn Memorial Hospital between June 1, 2014, and March 31, 2015, were recruited. Those with pneumothorax, severe pneumonia, active tuberculosis, and shock were excluded. Children were randomized into the MI-E or CPT group. The MI-E group received MI-E (3 therapies/d), and the CPT group received CPT (1 therapy/d). Vital signs per protocol and chest radiograph as needed were recorded. **RESULTS:** There were 22 children enrolled in the study, 11 in the MI-E and 11 in the CPT group. Demographic data were comparable in both groups. The length of hospital stay was similar in both groups (MI-E 4-24 d vs CPT 6-42 d, $P = .15$). There were 17 subjects with atelectasis (MI-E [$n = 9$] versus CPT [$n = 8$]). In this atelectasis subgroup, MI-E had shortened therapy time when compared with CPT (2.9 ± 0.8 d vs 3.9 ± 0.6 d, $P = .01$). No complications were observed. **CONCLUSIONS:** MI-E is proven to be beneficial in shortening the duration of airway clearance in children with quadriplegic spastic cerebral palsy presenting with lower-respiratory infections and atelectasis. MI-E is a safe and efficient intervention for airway clearance.

[PMID: 29066586](#)

12. Does L-Tryptophan supplementation reduce chewing deficits in an experimental model of cerebral palsy?

Lacerda DC, Manhães-de-Castro R, Ferraz-Pereira KN, Toscano AE.

Nutr Neurosci. 2017 Oct 23:1-2. doi: 10.1080/1028415X.2017.1391934. [Epub ahead of print]

Children with cerebral palsy commonly present with feeding difficulties that result from multiple orofacial sequelae, especially deficits in mastication. A previous study demonstrated that perinatal protein undernutrition accentuated the chewing impact in an experimental model of cerebral palsy. Therefore, the present study investigated whether nutritional manipulation reversed or minimized the chewing sequelae in cerebral palsy. We emphasized the relevance of evaluating the therapeutic potential of nutrients, especially tryptophan supplementation, to reduce the chewing deficits that are typical of this syndrome. Clarification of the role of nutrients may help in the development of new treatment strategies for these children.

[PMID: 29058562](#)

13. Dental caries and related risk factors in Saudi cerebral palsy children.

Wyne AH, Al-Hammad NS, Splieth CH.

Neurosciences (Riyadh). 2017 Oct;22(4):282-286. doi: 10.17712/nsj.2017.4.20170191.

OBJECTIVE: To determine caries experience and related risk factors in cerebral palsy (CP) children. **METHODS:** Random sample of CP children was examined for dental caries and oral hygiene. Questionnaire was utilized for information about caries risk factors. This cross-sectional study was conducted in Riyadh from December 2014 to May 2015. **RESULTS:** Fifty-two CP children were examined with mean age of 6.3+/-2.7 years. Only one (1.9%) child out of the 52 had no clinical caries. Combined (dmft plus DMFT) mean caries score among study sample was 9.98+/-3.99. Older children had significantly higher mean caries scores (11.5+/-3.34) than younger children (8.86+/-4.1, p=0.017). The CP children with good oral hygiene had lowest mean caries score (5.8+/-7.32) as compared to those with fair (9.72+/-3.3) and poor (11.55+/-3.05) oral hygiene (p=0.012). Those children whose first dental visit was for routine check-up had significantly (p=0.02) lower mean caries scores (7.33+/-4.65) than those who made their first visit due to dental problem (11.57+/-4.15). Similarly, those who had topical fluoride applications by dentist had significantly (p=0.003) lower mean caries scores (8.67+/-4.14) than those with no topical fluoride application (11.9+/-2.89). **CONCLUSION:** The studied CP children had very high caries experience and poor oral hygiene. There was strong association between the high caries experience and poor oral hygiene.

[PMID: 29057853](#)

14. [The Therapeutic Effect of Acupuncture on Cerebral Palsy in Children with Language Retardation Using the Midnight-noon Ebb-flow Method Combined with Syndrome Differentiation].

[Article in Chinese]

Du X, Chen J, Jiang K, Wu ZF, Liang S.

Zhen Ci Yan Jiu. 2017 Aug 25;42(4):346-9.

OBJECTIVE: To determine the clinical effect of acupuncture treatment on cerebral palsy in children with language retardation using the Midnight-noon Ebb-flow method combined with syndrome differentiation. **METHODS:** One hundred and thirty-six children with cerebral palsy and language retardation were randomly divided into control group and treatment group. The control group received routine treatment for language rehabilitation, while the treatment group received acupuncture treatment using the Midnight-noon Ebb-flow method combined with syndrome differentiation for 3 months based on language rehabilitation. The children were assessed by sign-significate relations for language comprehension and language expression before and after treatment. **RESULTS:** After treatment, the development quotient scores for language comprehension and language expression were (60.37±4.64) and (51.13±3.81) in the control group, and (73.54±4.73) and (64.08±3.93) in the treatment group, and the differences were statistically significant compared with those before treatment in the same one group, respectively (P<0.05, P<0.01). The effects of the treatment group were statistically better than those of the control group (P<0.05). **CONCLUSIONS:** Acupuncture treatment using the Midnight-noon Ebb-flow method combined with syndrome differentiation has a better therapeutic effect in improving language comprehension and language expression, and promoting language development in children with cerebral palsy.

[PMID: 29072018](#)

15. Comparing parent and child reports of health-related quality of life and their relationship with leisure participation in children and adolescents with Cerebral Palsy.

Longo E, Badia M, Begoña Orgaz M, Gómez-Vela M.

Res Dev Disabil. 2017 Oct 17;71:214-222. doi: 10.1016/j.ridd.2017.09.020. [Epub ahead of print]

The aim of this study was to examine the level of agreement between reports of health-related quality of life (HR-QoL) obtained from children and adolescents with cerebral palsy (CP) and their parents. We also examined the relationships between child and parent perception of the different domains of HR-QoL and participation dimensions. Sixty-nine children and adolescents with CP and their parents separately completed parallel forms of the KIDSCREEN questionnaire. The Spanish version of the Children's Assessment of Participation and Enjoyment (CAPE) was completed by the child/adolescent.

Concordance between the children's and the parents' HR-QoL scores was analyzed via Pearson and intraclass correlations. Differences in means were tested using paired Student's t-tests. Chi-square tests were used to assess the incidence of personal variables in the agreement and disagreement of children-parents' responses. The relationships between HR-QoL and leisure participation was confirmed with Pearson's correlation coefficients. Correlations between child and parent HR-QoL scores were small in 7 domains, medium in 2 and large in the Social Support & Peers domain. Children reported significantly better HR-QoL than their parents did. Participation was positively associated with specific domains of HR-QoL, but only weakly, and there were discrepancies between parent and child reports of HR-QoL. These findings provide interesting information about the importance of hearing the voices of children and adolescents with CP to promote HR-QoL and leisure participation.

[PMID: 29055241](#)

16. Longitudinal study showed that the quality of life of Finnish adolescents with cerebral palsy continued to be relatively good.

Böling S, Varho T, Haataja L.

Acta Paediatr. 2017 Oct 20. doi: 10.1111/apa.14123. [Epub ahead of print]

AIM: This longitudinal study examined what perceptions paediatric patients with cerebral palsy (CP) and their caregivers had of the patient's quality of life (QoL). It examined changing trends as children with CP became adolescents and examined the feasibility of the Finnish version of the CP QOL-Teen questionnaire. **METHODS:** Carried out in autumn 2015, this study formed part of the multi-centre Finnish national CP project and aimed to validate the CP QOL-Teen questionnaire, which was posted to 54 adolescents and their caregivers. They included 24 who had responded to CP QOL-Child questionnaire in 2013. **RESULTS:** The questionnaires were returned by 27 pairs of adolescents and caregivers and one extra caregiver also responded. Of these, 24 pairs had taken part in the 2013 survey. The internal consistencies of the sum variables were found to be acceptable in all cases. Overall QoL showed an average score of 81.8 on a scale from 0-100. Adolescents reported significantly higher QoL than their caregivers. There were no significant differences between the responses of the children and adolescents. **CONCLUSION:** We showed that QoL was relatively good in childhood and adolescence. The Finnish version of the CP QOL-Teen questionnaire was an appropriate clinical tool for assessing QoL. This article is protected by copyright. All rights reserved.

[PMID: 29055066](#)

17. Body pose estimation in depth images for infant motion analysis.

Hesse N, Schroder AS, Muller-Felber W, Bodensteiner C, Arens M, Hofmann UG.

Conf Proc IEEE Eng Med Biol Soc. 2017 Jul;2017:1909-1912. doi: 10.1109/EMBC.2017.8037221.

Motion analysis of infants is used for early detection of movement disorders like cerebral palsy. For the development of automated methods, capturing the infant's pose accurately is crucial. Our system for predicting 3D joint positions is based on a recently introduced pixelwise body part classifier using random ferns, to which we propose multiple enhancements. We apply a feature selection step before training random ferns to avoid the inclusion of redundant features. We introduce a kinematic chain reweighting scheme to identify and to correct misclassified pixels, and we achieve rotation invariance by performing PCA on the input depth image. The proposed methods improve pose estimation accuracy by a large margin on multiple recordings of infants. We demonstrate the suitability of the approach for motion analysis by comparing predicted knee angles to ground truth angles.

[PMID: 29060265](#)

18. A video/IMU hybrid system for movement estimation in infants.

Machireddy A, van Santen J, Wilson JL, Myers J, Hadders-Algra M, Xubo Song.

Conf Proc IEEE Eng Med Biol Soc. 2017 Jul;2017:730-733. doi: 10.1109/EMBC.2017.8036928.

Cerebral palsy is a non-progressive neurological disorder occurring in early childhood affecting body movement and muscle control. Early identification can help improve outcome through therapy-based interventions. Absence of so-called "fidgety

movements" is a strong predictor of cerebral palsy. Currently, infant limb movements captured through either video cameras or accelerometers are analyzed to identify fidgety movements. However both modalities have their limitations. Video cameras do not have the high temporal resolution needed to capture subtle movements. Accelerometers have low spatial resolution and capture only relative movement. In order to overcome these limitations, we have developed a system to combine measurements from both camera and sensors to estimate the true underlying motion using extended Kalman filter. The estimated motion achieved 84% classification accuracy in identifying fidgety movements using Support Vector Machine.

[PMID: 29059976](#)

19. Characteristics of general movements in preterm infants assessed by computer-based video analysis.

Adde L, Yang H, Sæther R, Jensenius AR, Ihlen E, Cao JY, Støen R.

Physiother Theory Pract. 2017 Oct 24:1-7. doi: 10.1080/09593985.2017.1391908. [Epub ahead of print]

BACKGROUND: Previous evidence suggests that the variability of the spatial center of infant movements, calculated by computer-based video analysis software, can identify fidgety general movements (GMs) and predict cerebral palsy. **AIM:** To evaluate whether computer-based video analysis quantifies specific characteristics of normal fidgety movements as opposed to writhing general movements. **METHODS:** A longitudinal study design was applied. Twenty-seven low-to moderate-risk preterm infants (20 boys, 7 girls; mean gestational age 32 [SD 2.7, range 27-36] weeks, mean birth weight 1790 grams [SD 430g, range 1185-2700g]) were videotaped at the ages of 3-5 weeks (period of writhing GMs) and 10-15 weeks (period of fidgety GMs) post term. GMs were classified according to Prechtl's general movement assessment method (GMA) and by computer-based video analysis. The variability of the centroid of motion (CSD), derived from differences between subsequent video frames, was calculated by means of computer-based video analysis software; group mean differences between GM periods were reported. **RESULTS:** The mean variability of the centroid of motion (CSD) determined by computer-based video analysis was 7.5% lower during the period of fidgety GMs than during the period of writhing GMs ($p = 0.004$). **CONCLUSION:** Our findings support that the variability of the centroid of motion reflects small and variable movements evenly distributed across the body, and hence shows that computer-based video analysis qualifies for assessment of direction and amplitude of FMs in young infants.

[PMID: 29064734](#)

Prevention and Cure

20. Risk Factors for Cerebral Palsy in Children in Botswana.

Monokwane B, Johnson A, Gambrah-Sampaney C, Khurana E, Baier J, Baranov E, Westmoreland KD, Mazhani L, Steenhoff AP, Bearden DR.

Pediatr Neurol. 2017 Aug 3. pii: S0887-8994(17)30473-3. doi: 10.1016/j.pediatrneurol.2017.07.014. [Epub ahead of print]

BACKGROUND: Although cerebral palsy is reported to have a higher prevalence in low-resource settings, there are few studies describing risk factors for cerebral palsy in these settings. A better understanding of the unique risk factors affecting children with cerebral palsy in low-resource settings could optimize both resource allocation and preventative strategies. **METHODS:** A case-control study comparing children with cerebral palsy at ages two to 18 years with age-matched healthy control subjects was conducted between 2013 and 2014 at a referral center in Gaborone, Botswana. Study participants were enrolled from inpatient and outpatient settings, and data were collected through caregiver interviews, review of medical records, and physical examination of subjects. Risk factors were evaluated using conditional logistic regression models. **RESULTS:** We studied 56 subjects with cerebral palsy and 56 age-matched control subjects. Significant risk factors for cerebral palsy included a history of serious neonatal infection (odds ratio 15.0, $P = 0.009$), complications during delivery (odds ratio 13.5, $P < 0.001$), and maternal human immunodeficiency virus (HIV) infection (odds ratio 3.5, $P = 0.03$). Maternal HIV infection remained a significant risk factor after adjusting for potential confounders and covariates (adjusted odds ratio 13.2, $P = 0.05$). **CONCLUSIONS:** Major risk factors for cerebral palsy in Botswana differ from those described in high-resource settings. Modifiable risk factors such as maternal HIV infection should be targeted as a potential strategy to reduce the incidence of cerebral palsy in Botswana. Further studies are necessary to determine optimal preventative and treatment strategies in this population.

[PMID: 29074060](#)

21. Learning from the patient safety errors of the past.

Tingle J.

Br J Nurs. 2017 Oct 26;26(19):1078-1079. doi: 10.12968/bjon.2017.26.19.1078.

John Tingle, Associate Professor (Teaching and Scholarship), Nottingham Trent University, discusses NHS Resolution's thematic review report analysing 5 years of cerebral palsy legal claims.

[PMID: 29068732](#)

22. Congenital anomalies and cerebral palsy: cause or comorbidity?

Williams J.

Dev Med Child Neurol. 2017 Nov;59(11):1108. doi: 10.1111/dmcn.13559.

[This commentary is on the original article by Jystad et al.]

[PMID: 29064099](#)

23. Neurodevelopmental outcome in survivors of hypoxic ischemic encephalopathy without cerebral palsy.

Hayes BC, Doherty E, Grehan A, Madigan C, McGarvey C, Mulvany S, Matthews TG, King MD.

Eur J Pediatr. 2017 Oct 24. doi: 10.1007/s00431-017-3028-3. [Epub ahead of print]

To assess outcome following hypoxic ischemic encephalopathy (HIE), survivors without cerebral palsy were invited for formal developmental assessment. Children aged ≥ 42 months were assessed using the NEPSY-2, Movement Assessment Battery for Children 2 (Movement ABC-2), Behavior Rating Inventory of Executive Function, and the Child Behavior Checklist. Children aged < 42 months were assessed using the Bayley Scales of Infant and Toddler Development, Third Edition (BSITD-3). One hundred forty-six children attended for assessments [Grade 1 (112), Grade 2 (33), and Grade 3 (1)]. BSITD-3 did not identify significant rates of impairment on cognitive, motor, or language subtests. A significant proportion of children scored < 3 rd percentile on the adaptive behavior scale. In older age groups, difficulties were seen in 16/24 NEPSY-2 subtests and on timed assessments using Movement ABC-2. Difficulties arose especially in the "control" aspects of cognition and behavior. Behavioral difficulties were common with internalizing problems predominating. There was a graded effect with grade 2 cases differing significantly from grade 1 cases. CONCLUSION: Following HIE, children may experience attention, memory, and behavior difficulties which are not always evident at a young age. The adaptive behavior questionnaire may be a useful tool to select children requiring developmental surveillance beyond 2 years of age. What is known: • Diversity of outcome across grades of HIE is reported and few studies have looked at the milder consequences of HIE at school age. What is new: • Following HIE children may experience attention, memory, and behavior difficulties which are not always evident at a young age. • The adaptive behavior questionnaire may be a useful tool to select children requiring developmental surveillance beyond 2 years of age.

[PMID: 29063960](#)

24. Late (> 7 days) systemic postnatal corticosteroids for prevention of bronchopulmonary dysplasia in preterm infants.

Doyle LW, Cheong JL, Ehrenkranz RA, Halliday HL.

Cochrane Database Syst Rev. 2017 Oct 24;10:CD001145. doi: 10.1002/14651858.CD001145.pub4. [Epub ahead of print]

BACKGROUND: Many preterm infants who survive go on to develop bronchopulmonary dysplasia, probably as the result of persistent inflammation in the lungs. Corticosteroids have powerful anti-inflammatory effects and have been used to treat individuals with established bronchopulmonary dysplasia. However, it is unclear whether any beneficial effects outweigh the adverse effects of these drugs. OBJECTIVES: To examine the relative benefits and adverse effects of late systemic postnatal

corticosteroid treatment (> 7 days) for preterm infants with evolving or established bronchopulmonary dysplasia. **SEARCH METHODS:** For the 2017 update, we used the standard search strategy of Cochrane Neonatal to search the Cochrane Central Register of Controlled Trials (CENTRAL; 2017, Issue 1); MEDLINE via PubMed (January 2013 to 21 February 2017); Embase (January 2013 to 21 February 2017); and the Cumulative Index to Nursing and Allied Health Literature (CINAHL; January 2013 to 21 February 2017). We also searched clinical trials databases, conference proceedings, and reference lists of retrieved articles for randomised controlled trials and quasi-randomised trials. **SELECTION CRITERIA:** We selected for inclusion in this review randomised controlled trials (RCTs) comparing systemic postnatal corticosteroid treatment versus placebo or nothing initiated more than seven days after birth for preterm infants with evolving or established bronchopulmonary dysplasia. **DATA COLLECTION AND ANALYSIS:** We used the GRADE approach to assess the quality of evidence. We extracted and analysed data regarding clinical outcomes including mortality, bronchopulmonary dysplasia, death or bronchopulmonary dysplasia, failure to extubate, complications during primary hospitalisation, and long-term health outcomes. **MAIN RESULTS:** Twenty-one RCTs enrolling a total of 1424 participants were eligible for this review. All were RCTs, but methods used for random allocation were not always clear. Allocation concealment, blinding of the intervention, and blinding of outcome assessments most often were satisfactory. Late steroid treatment was associated with a reduction in neonatal mortality (at 28 days) but no reduction in mortality at 36 weeks, at discharge, or at latest reported age. Benefits of delayed steroid treatment included reductions in failure to extubate by 3, 7, or 28 days; bronchopulmonary dysplasia both at 28 days of life and at 36 weeks' postmenstrual age; need for late rescue treatment with dexamethasone; discharge on home oxygen; and death or bronchopulmonary dysplasia both at 28 days of life and at 36 weeks' postmenstrual age. Data revealed a trend towards increased risk of infection and gastrointestinal bleeding but no increase in risk of necrotising enterocolitis. Short-term adverse affects included hyperglycaemia, glycosuria, and hypertension. Investigators reported an increase in severe retinopathy of prematurity but no significant increase in blindness. Trial results showed a trend towards reduction in severe intraventricular haemorrhage, but only five studies enrolling 247 infants reported this outcome. Trends towards an increase in cerebral palsy or abnormal neurological examination findings were partly offset by a trend in the opposite direction involving death before late follow-up. The combined rate of death or cerebral palsy was not significantly different between steroid and control groups. Major neurosensory disability and the combined rate of death or major neurosensory disability were not significantly different between steroid and control groups. There were no substantial differences between groups for other outcomes in later childhood, including respiratory health or function, blood pressure, or growth, although there were fewer participants with a clinically important reduction in forced expired volume in one second (FEV1) on respiratory function testing in the dexamethasone group. GRADE findings were high for all major outcomes considered, but review authors degraded the quality of evidence by one level because we found evidence of publication bias (bronchopulmonary dysplasia at 36 weeks). **AUTHORS' CONCLUSIONS:** Benefits of late corticosteroid therapy may not outweigh actual or potential adverse effects. This review of postnatal systemic corticosteroid treatment for bronchopulmonary dysplasia initiated after seven days of age suggests that late therapy may reduce neonatal mortality without significantly increasing the risk of adverse long-term neurodevelopmental outcomes. However, the methodological quality of studies determining long-term outcomes is limited in some cases (some studies assessed surviving children only before school age, when some important neurological outcomes cannot be determined with certainty), and no studies were sufficiently powered to detect increased rates of important adverse long-term neurosensory outcomes. Evidence showing both benefits and harms of treatment and limitations of available evidence suggests that it may be prudent to reserve the use of late corticosteroids for infants who cannot be weaned from mechanical ventilation, and to minimise both dose and duration for any course of treatment.

[PMID: 29063594](#)

25. Early (< 8 days) systemic postnatal corticosteroids for prevention of bronchopulmonary dysplasia in preterm infants.

Doyle LW, Cheong JL, Ehrenkranz RA, Halliday HL.

Cochrane Database Syst Rev. 2017 Oct 24;10:CD001146. doi: 10.1002/14651858.CD001146.pub5. [Epub ahead of print]

BACKGROUND: Bronchopulmonary dysplasia remains a major problem in neonatal intensive care units. Persistent inflammation in the lungs is the most likely underlying pathogenesis. Corticosteroids have been used to prevent or treat bronchopulmonary dysplasia because of their potent anti-inflammatory effects. **OBJECTIVES:** To examine the relative benefits and adverse effects of systemic postnatal corticosteroids commenced within the first seven days of life for preterm infants at risk of developing bronchopulmonary dysplasia. **SEARCH METHODS:** For the 2017 update, we used the standard search strategy of Cochrane Neonatal to search the Cochrane Central Register of Controlled Trials (CENTRAL; 2017, Issue 1); MEDLINE via PubMed (January 2013 to 21 February 2017); Embase (January 2013 to 21 February 2017); and the Cumulative Index to Nursing and Allied Health Literature (CINAHL) (January 2013 to 21 February 2017). We also searched clinical trials databases, conference proceedings, and reference lists of retrieved articles for randomised controlled trials (RCTs) and quasi-randomised trials. **SELECTION CRITERIA:** For this review, we selected RCTs examining systemic postnatal corticosteroid treatment within the first seven days of life (early) in high-risk preterm infants. Most studies evaluated the use of dexamethasone, but we also included studies that assessed hydrocortisone, even when used primarily for management of hypotension. **DATA COLLECTION AND ANALYSIS:** We used the GRADE approach to assess the quality of evidence. We¹⁰

extracted and analysed data regarding clinical outcomes that included mortality, bronchopulmonary dysplasia, death or bronchopulmonary dysplasia, failure to extubate, complications during primary hospitalisation, and long-term health outcomes. **MAIN RESULTS:** We included 32 RCTs enrolling a total of 4395 participants. The overall risk of bias of included studies was probably low, as all were RCTs, and most trials used rigorous methods. Investigators reported significant benefits for the following outcomes overall: lower rates of failure to extubate, decreased risks of bronchopulmonary dysplasia both at 28 days of life and at 36 weeks' postmenstrual age, death or bronchopulmonary dysplasia at 28 days of life and at 36 weeks' postmenstrual age, patent ductus arteriosus, and retinopathy of prematurity (ROP), including severe ROP. Researchers found no significant differences in rates of neonatal or subsequent mortality; they noted that gastrointestinal bleeding and intestinal perforation were important adverse effects, and that risks of hyperglycaemia, hypertension, hypertrophic cardiomyopathy, and growth failure were increased. The 13 trials that reported late outcomes described several adverse neurological effects at follow-up examination, including cerebral palsy. However, study authors indicated that major neurosensory disability was not significantly increased, either overall in the eight studies for which this outcome could be determined, or in the two individual studies in which rates of cerebral palsy or abnormal neurological examination were significantly increased. Moreover, data show that rates of the combined outcomes of death or cerebral palsy, or of death or major neurosensory disability, were not significantly increased. Two-thirds of studies used dexamethasone (n = 21). Subgroup analyses by type of corticosteroid revealed that most of the beneficial and harmful effects of treatment were attributable to dexamethasone. However, as with dexamethasone, hydrocortisone was associated with reduced rates of patent ductus arteriosus, mortality, and the combined outcome of mortality or chronic lung disease, but with increased occurrence of intestinal perforation. Results showed that hydrocortisone was not associated with obvious longer-term problems. Use of the GRADE approach revealed that the quality of evidence was high for the major outcomes considered, but review authors downgraded quality one level for several outcomes (mortality at latest age, bronchopulmonary dysplasia at 36 weeks, and death or bronchopulmonary dysplasia at 36 weeks) because of weak evidence of publication bias or moderate heterogeneity (death or cerebral palsy). **AUTHORS' CONCLUSIONS:** Benefits of early postnatal corticosteroid treatment (≤ 7 days), particularly dexamethasone, may not outweigh adverse effects associated with this treatment. Although early corticosteroid treatment facilitates extubation and reduces risk of bronchopulmonary dysplasia and patent ductus arteriosus, it causes short-term adverse effects including gastrointestinal bleeding, intestinal perforation, hyperglycaemia, hypertension, hypertrophic cardiomyopathy, and growth failure. Long-term follow-up studies report increased risk of abnormal findings on neurological examination and increased risk of cerebral palsy. However, the methodological quality of studies examining long-term outcomes is limited in some cases: Surviving children have been assessed predominantly before school age; no study has been sufficiently powered to detect important adverse long-term neurosensory outcomes; and no study has been designed with survival free of adverse long-term neurodevelopmental disability as the primary outcome. There is a compelling need for long-term follow-up and reporting of late outcomes, especially neurological and developmental outcomes, among surviving infants who participated in all randomised trials of early postnatal corticosteroid treatment. Hydrocortisone reduced rates of patent ductus arteriosus, of mortality, and of the combined outcome of mortality or bronchopulmonary dysplasia, without causing any obvious long-term harm. However, gastrointestinal perforation was more frequent in the hydrocortisone group. Longer-term follow-up into late childhood is vital for assessment of important effects or other effects that cannot be assessed in early childhood, such as effects of early hydrocortisone treatment on higher-order neurological functions, including cognitive function, academic performance, behaviour, mental health, and motor function. Further randomised controlled trials of early hydrocortisone should include longer-term survival free of neurodevelopmental disability as the main outcome.

[PMID: 29063585](#)

26. Altered regional and circuit resting-state activity in patients with occult spastic diplegic cerebral palsy.

Mu X, Wang Z, Nie B, Duan S, Ma Q, Dai G, Wu C, Dong Y, Shan B, Ma L.

Pediatr Neonatol. 2017 Oct 7. pii: S1875-9572(17)30142-0. doi: 10.1016/j.pedneo.2017.10.003. [Epub ahead of print]

BACKGROUND: Very few studies have been made to investigate functional activity changes in occult spastic diplegic cerebral palsy (SDCP). The purpose of this study was to analyze whole-brain resting state regional brain activity and functional connectivity (FC) changes in patients with SDCP. **METHODS:** We examined 12 occult SDCP and 14 healthy control subjects using resting-state functional magnetic resonance imaging. The data were analyzed using Resting-State fMRI Data Analysis Toolkit (REST) software. The regional homogeneity (ReHo), amplitude of low-frequency fluctuations (ALFF), and whole brain FC of the motor cortex and thalamus were analyzed and compared between the occult SDCP and control groups. **RESULTS:** Compared with the control group, the occult SDCP group showed decreased ReHo regions, including the bilateral frontal, parietal, and temporal lobes, the cerebellum, right cingulate gyrus, and right lenticular nucleus, whereas an increased ReHo value was observed in the left precuneus, calcarine, fusiform gyrus, and right precuneus. Compared with the control group, no significant differences in ALFF were noted in the occult SDCP group. With the motor cortex as the region of interest, the occult SDCP group showed decreased connectivity regions in the bilateral fusiform and lingual gyrus, but increased connectivity regions in the contralateral precentral and postcentral gyrus, supplementary motor area, and the ipsilateral

postcentral gyrus. With the thalamus being regarded as the region of interest, the occult SDCP group showed decreased connectivity regions in the bilateral basal ganglia, cingulate, and prefrontal cortex, but increased connectivity regions in the bilateral precentral gyrus, the contralateral cerebellum, and inferior temporal gyrus. CONCLUSIONS: Resting-state regional brain activities and FC changes in the patients with occult SDCP exhibited a special distribution pattern, which is consistent with the pathology of the disease.

[PMID: 29066071](#)