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Interventions and Management

1. The potential of an automated system to identify the upper limb component of a controlled sitting posture.

Sánchez MB, Loram I, Darby J, Holmes P, Butler PB.

Gait Posture. 2017 Aug 8;58:223-228. doi: 10.1016/j.gaitpost.2017.08.002. [Epub ahead of print]

Full trunk control in sitting is demonstrated only when the head-trunk are aligned and upper limbs remain free of contact from mechanical support. These components represent a Controlled Kinetic Chain and can be evaluated in people with neuromotor disability using the Segmental Assessment of Trunk Control (SATCo) when a therapist provides manual trunk support at different segmental levels. However, the SATCo, as with other clinical assessments of control, is subjective. The SATCo was translated to objective rules relating the position of the hands and elbows to the head-trunk and then tested to determine the extent to which this automated objective method replicated the clinical judgement. Clinical evaluation used video to determine whether the upper limb was free of mechanical support while the objective evaluation used 3D motion capture of the trunk and upper limbs with a classification rule. The agreement between clinical and objective classification was calculated for three conditions of a distance-from-support-surface threshold parameter in five healthy adults and five children with cerebral palsy. The unfitted (zero-threshold values) method replicated the clinical judgement in part (68.26%±15.7, adults, 48.3%±33.9 children). The fitted (level-of-support determined) agreement showed that the process could be refined using trial specific parameters (88.32%±5.3 adults, 89.84%±10.2 children). The fixed-values agreement showed high values when using general group parameters (80.80%±3.1 adults, 74.31%±21.5 children). This objective classification of the upper limb component of trunk control largely captures the clinical evaluation. It provides the first stages in development of a clinically-friendly fully automated method.

[PMID: 28806711](#)

2. Effect of feedback from a socially interactive humanoid robot on reaching kinematics in children with and without cerebral palsy: A pilot study.

Chen Y, Garcia-Vergara S, Howard AM.

Dev Neurorehabil. 2017 Aug 17:1-7. doi: 10.1080/17518423.2017.1360962. [Epub ahead of print]

PURPOSE: To examine whether children with or without cerebral palsy (CP) would follow a humanoid robot's (i.e., Darwin) feedback to move their arm faster when playing virtual reality (VR) games. **METHODS:** Seven children with mild CP and 10 able-bodied children participated. Real-time reaching was evaluated by playing the Super Pop VRTM system, including 2-game baseline, 3-game acquisition, and another 2-game extinction. During acquisition, Darwin provided verbal feedback to direct the child to reach a kinematically defined target goal (i.e., 80% of average movement time in baseline). Outcome variables included the percentage of successful reaches ("% successful reaches"), movement time (MT), average speed, path, and number of movement units. **RESULTS:** All games during acquisition and extinction had larger "%successful reaches," faster speeds, and faster MTs than the 2 games during baseline ($p < .05$). **CONCLUSION:** Children with and without CP

could follow the robot's feedback for changing their reaching kinematics when playing VR games.

[PMID: 28816558](#)

3. Integration of serious games and wearable haptic interfaces for Neuro Rehabilitation of children with movement disorders: A feasibility study.

Bortone I, Leonardis D, Solazzi M, Procopio C, Crecchi A, Bonfiglio L, Frisoli A.

IEEE Int Conf Rehabil Robot. 2017 Jul;2017:1094-1099. doi: 10.1109/ICORR.2017.8009395.

The past decade has seen the emergence of rehabilitation treatments using virtual reality environments. One of the advantages in using this technology is the potential to create positive motivation, by means of engaging environments and tasks shaped in the form of serious games. In this work, we propose a novel Neuro Rehabilitation System for children with movement disorders, that is based on serious games in immersive virtual reality with haptic feedback. The system design aims to enhance involvement and engagement of patients, to provide congruent multi-sensory afferent feedback during motor exercises, and to benefit from the flexibility of virtual reality in adapting exercises to the patient's needs. We present a feasibility study of the method conducted through an experimental rehabilitation session in a group of 4 children with Cerebral Palsy and Developmental Dyspraxia, 4 Typically Developing children and 4 healthy adults. Subjects and patients were able to accomplish the proposed rehabilitation session and average performance of the motor exercises in patients were lower, although comparable, to healthy subjects. Together with positive comments reported by children after the rehabilitation session, results are encouraging for application of the method in a prolonged rehabilitation treatment.

[PMID: 28813967](#)

4. Exergaming with a pediatric exoskeleton: Facilitating rehabilitation and research in children with cerebral palsy.

Bulea TC, Lerner ZF, Gravunder AJ, Damiano DL.

IEEE Int Conf Rehabil Robot. 2017 Jul;2017:1087-1093. doi: 10.1109/ICORR.2017.8009394.

Effective rehabilitation of children with cerebral palsy (CP) requires intensive task-specific exercise but many in this population lack the motor capabilities to complete the desired training tasks. Providing robotic assistance is a potential solution yet the effects of this assistance are unclear. We combined a novel exoskeleton and exercise video game (exergame) to create a new rehabilitation paradigm for children with CP. We incorporated high density electroencephalography (EEG) to assess cortical activity. Movement to targets in the game was controlled by knee extension while standing. The distance between targets was the same with and without the exoskeleton to isolate the effect of robotic assistance. Our results show that children with CP maintain or increase knee extensor muscle activity during knee extension in the presence of synergistic robotic assistance. Our EEG findings also demonstrate that participants remained engaged in the exercise with robotic assistance. Interestingly we observed a developmental trajectory of sensorimotor mu rhythm in children with CP similar, though delayed, to those reported in typically developing children. While not the goal here, the exoskeleton significantly increased knee extension in 3/6 participants during use. Future work will focus on utilizing the exoskeleton to enhance volitional knee extension capability and in combination with EMG and EEG to study sensorimotor cortex response to progressive exercise in children with CP.

[PMID: 28813966](#)

5. Robotic learning from demonstration of therapist's time-varying assistance to a patient in trajectory-following tasks.

Najafi M, Adams K, Tavakoli M.

IEEE Int Conf Rehabil Robot. 2017 Jul;2017:888-894. doi: 10.1109/ICORR.2017.8009361.

The number of people with physical disabilities and impaired motion control is increasing. Consequently, there is a growing demand for intelligent assistive robotic systems to cooperate with people with disability and help them carry out different tasks. To this end, our group has pioneered the use of robot learning from demonstration (RLfD) techniques, which eliminate the

need for task-specific robot programming, in robotic rehabilitation and assistive technologies settings. First, in the demonstration phase, the therapist (or in general, a helper) provides an intervention (typically assistance) and cooperatively performs a task with a patient several times. The demonstrated motion is modelled by a statistical RLfD algorithm, which will later be used in the robot controllers to reproduce a similar intervention robotically. In this paper, by proposing a Tangential-Normal Varying-Impedance Controller (TNVIC), the robotic manipulator not only follows the therapist's demonstrated motion, but also mimics his/her interaction impedance during the therapeutic/assistive intervention. The feasibility and efficacy of the proposed framework are evaluated by conducting an experiment involving a healthy adult with cerebral palsy symptoms being induced using transcutaneous electrical nerve stimulation.

[PMID: 28813933](#)

6. Therapeutic effects of anti-gravity treadmill (AlterG) training on reflex hyper-excitability, corticospinal tract activities, and muscle stiffness in children with cerebral palsy.

Parvin S, Taghiloo A, Irani A, Mirbagheri MM.

IEEE Int Conf Rehabil Robot. 2017 Jul;2017:485-490. doi: 10.1109/ICORR.2017.8009295.

We aimed to study therapeutic effects of antigravity treadmill (AlterG) training on reflex hyper-excitability, muscle stiffness, and corticospinal tract (CST) function in children with spastic hemiplegic cerebral palsy (CP). Three children received AlterG training 3 days per week for 8 weeks as experimental group. Each session lasted 45 minutes. One child as control group received typical occupational therapy for the same amount of time. We evaluated hyper-excitability of lower limb muscles by H-reflex response. We quantified muscle stiffness by sonoelastography images of the affected muscles. We quantified CST activity by transcranial magnetic stimulation (TMS). We performed the evaluations before and after training for both groups. H response latency and maximum M-wave amplitude were improved in experimental group after training compared to control group. Two children of experimental group had TMS response. Major parameters of TMS (i.e. peak-to-peak amplitude of motor evoked potential (MEP), latency of MEP, cortical silent period, and intensity of pulse) improved for both of them. Three parameters of texture analysis of sonoelastography images were improved for experimental group (i.e. contrast, entropy, and shear wave velocity). These findings indicate that AlterG training can improve reflexes, muscle stiffness, and CST activity in children with spastic hemiplegic CP and can be considered as a therapeutic tool to improve neuromuscular abnormalities occurring secondary to CP.

[PMID: 28813867](#)

7. Therapeutic effects of an anti-gravity treadmill (AlterG) training on gait and lower limbs kinematics and kinetics in children with cerebral palsy.

Lotfian M, Kharazi MR, Mirbagheri A, Dadashi F, Nourian R, Mirbagheri MM.

IEEE Int Conf Rehabil Robot. 2017 Jul;2017:170-174. doi: 10.1109/ICORR.2017.8009241.

We aimed to investigate the effects of the lower body weight support treadmill (AlterG) training on kinetics and kinematics of the lower extremities in children with cerebral palsy (CP). We provided a 45-minute training program, 3 times a week for 8 weeks. AlterG can support the subject's weight up to 70% so that the subject will be able to walk more comfortably to reach a more correct walking pattern. The kinematics and kinetics were evaluated using an isokinetic dynamometer. The locomotion parameters were assessed in the gait laboratory. Subjects performance was evaluated at four time points: baseline (prior to training), 1 and 2 months after the beginning of training, and one month after the end of the training (as a follow-up evaluation). The results showed that the major gait, kinematic, and kinetic parameters improved after the AlterG training and were persistent. These findings suggest that the AlterG training can be considered as a therapeutic tool for improving the lower limb performance and locomotion in children with CP.

[PMID: 28813813](#)

8. How multi segmental patterns deviate in spastic diplegia from typical developed.

Zago M, Sforza C, Bona A, Cimolin V, Costici PF, Condoluci C, Galli M.

Clin Biomech (Bristol, Avon). 2017 Aug 8;48:103-109. doi: 10.1016/j.clinbiomech.2017.07.016. [Epub ahead of print]

BACKGROUND: The relationship between gait features and coordination in children with Cerebral Palsy is not sufficiently analyzed yet. Principal Component Analysis can help in understanding motion patterns decomposing movement into its fundamental components (Principal Movements). This study aims at quantitatively characterizing the functional connections between multi-joint gait patterns in Cerebral Palsy. **METHODS:** 65 children with spastic diplegia aged 10.6 (SD 3.7) years participated in standardized gait analysis trials; 31 typically developing adolescents aged 13.6 (4.4) years were also tested. To determine if posture affects gait patterns, patients were split into Crouch and knee Hyperextension group according to knee flexion angle at standing. 3D coordinates of hips, knees, ankles, metatarsal joints, pelvis and shoulders were submitted to Principal Component Analysis. **FINDINGS:** Four Principal Movements accounted for 99% of global variance; components 1-3 explained major sagittal patterns, components 4-5 referred to movements on frontal plane and component 6 to additional movement refinements. Dimensionality was higher in patients than in controls ($p < 0.01$), and the Crouch group significantly differed from controls in the application of components 1 and 4-6 ($p < 0.05$), while the knee Hyperextension group in components 1-2 and 5 ($p < 0.05$). **INTERPRETATION:** Compensatory strategies of children with Cerebral Palsy (interactions between main and secondary movement patterns), were objectively determined. Principal Movements can reduce the effort in interpreting gait reports, providing an immediate and quantitative picture of the connections between movement components.

[PMID: 28806590](#)

9. To what extent can soft-tissue releases improve hip displacement in cerebral palsy?

Terjesen T.

Acta Orthop. 2017 Aug 16:1-6. doi: 10.1080/17453674.2017.1365471. [Epub ahead of print]

Background and purpose - Hip displacement is frequent in nonambulatory children with cerebral palsy (CP) and treatment is controversial. This prospective study assesses the effectiveness of soft-tissue releases to treat hip subluxation, analyses prognostic factors for outcome, and identifies time to failure in hips with poor outcome. **Patients and methods -** 37 children (16 girls) with hip subluxation were recruited from the population-based screening program for children with CP in Norway. They had consecutively undergone soft-tissue releases (bilateral tenotomies of adductors and iliopsoas) at a mean age of 5.0 (2.8-7.2) years. Functional classification was Gross Motor Function Classification System (GMFCS) level III in 9 children, level IV in 10, and level V in 18 children. The outcome was termed good if the patient had not undergone further hip surgery and if the migration percentage (MP) of the worst hip at the latest follow-up was $< 50\%$. The mean follow-up time was 7.3 (5.1-9.8) years. **Results -** The outcome was good in all the ambulatory children and in 17 of 28 of the nonambulatory children. The only independent preoperative risk factor for poor outcome was $MP \geq 50\%$. The mean time to failure was 2.2 (1-5) years postoperatively and the reasons for failure were insufficient initial correction and later deterioration of displacement. **Interpretation -** Bilateral soft-tissue release is recommended in both ambulatory and nonambulatory children with hip subluxation. The operation should be performed before the hip displacement reaches 50%.

[PMID: 28812397](#)

10. Therapeutic effects of an anti-gravity locomotor training (AlterG) on postural balance and cerebellum structure in children with Cerebral Palsy.

Rasooli AH, Birgani PM, Azizi S, Shahrokhi A, Mirbagheri MM.

IEEE Int Conf Rehabil Robot. 2017 Jul;2017:101-105. doi: 10.1109/ICORR.2017.8009229.

We evaluated the therapeutic effects of anti-gravity locomotor treadmill (AlterG) training on postural stability in children with Cerebral Palsy (CP) and spasticity, particularly in the lower extremity. AlterG can facilitate walking by reducing the weight of CP children by up to 80%; it can also help subjects maintain an appropriate posture during the locomotor AlterG training. Thus, we hypothesized that AlterG training, for a sufficient period of time, has a potential to produce cerebellum neuroplasticity, and consequently result in an effective permanent postural stability. AlterG training was given for 45 minutes, three times a week for two months. Postural balance was evaluated using posturography. The parameters of the Romberg based posturography

were extracted to quantify the Center of Balance (CoP). The neuroplasticity of Cerebellum was evaluated using a Diffusion Tensor Imaging (DTI). The evaluations were done pre- and post-training. The Fractional Anisotropy (FA) feature was used for quantifying structural changes in the cerebellum. The results showed that AlterG training resulted in an increase in average FA value of the cerebellum white matter following the training. The results of the posturography evaluations showed a consistent improvement in postural stability. These results were consistent in all subjects. Our findings indicated that the improvement in the posture was accompanied with the enhancement of the cerebellum white matter structure. The clinical implication is that AlterG training can be considered a therapeutic tool for an effective and permanent improvement of postural stability in CP children.

[PMID: 28813801](#)

11. Relationship between assistive torque and knee biomechanics during exoskeleton walking in individuals with crouch gait.

Lerner ZF, Damiano DL, Bulea TC.

IEEE Int Conf Rehabil Robot. 2017 Jul;2017:491-497. doi: 10.1109/ICORR.2017.8009296.

Crouch or "flexed knee" gait is a pathological gait pattern affecting many individuals with cerebral palsy. One proposed method to alleviate crouch is to provide robotic assistance to knee extension during walking. The purpose of this study was to evaluate how the magnitude of knee extensor torque affects knee kinematics, kinetics, and muscle activity. Motion capture, ground reaction force and electromyography data were collected while four participants with crouch gait from cerebral palsy walked with assistance from a novel robotic exoskeleton on an instrumented treadmill. Different magnitudes of knee extensor torque were provided during the stance (range: 0.09-0.38 Nm/kg) and swing (range: 0.09-0.29 Nm/kg) phases of the gait cycle. Using a linear regression analysis, we found that greater torque from the exoskeleton was positively associated with increased knee extension (reduction in crouch) at foot contact and mid-stance, negatively associated with the biological knee extensor moment, and positively associated with knee flexor muscle activity. Determining the relationships between exoskeleton assistance and knee kinematics and kinetics will benefit the continued investigation of robotic treatment strategies for treating crouch gait. Our findings indicate the importance of properly tuned robotic control strategies for gait rehabilitation.

[PMID: 28813868](#)

12. Factors influencing outcomes after medial hamstring lengthening with semitendinosus transfer in patients with cerebral palsy.

Sung KH, Lee J, Chung CY, Lee KM, Cho BC, Moon SJ, Kim J, Park MS.

J Neuroeng Rehabil. 2017 Aug 14;14(1):83. doi: 10.1186/s12984-017-0296-0.

BACKGROUND: Although several studies have investigated the outcomes after distal hamstring lengthening (DHL), no study has undertaken an approach that included all or most of the important factors that could influence the results. This study was performed to evaluate the outcomes after DHL and analyze the factors that influence the improvement and serial change in knee motion after surgery in patients with cerebral palsy (CP), using a linear mixed model (LMM). **METHODS:** The study included 314 ambulatory CP patients (594 limbs) with spastic diplegia who were followed up after undergoing DHL as part of a single-event multilevel surgery and who underwent preoperative and postoperative 3-dimensional (3D) gait analyses. Relevant kinematic values, including knee flexion at initial contact, minimum knee flexion in the stance phase, knee range of motion (ROM), mean pelvic tilt and gait deviation index (GDI) score, were the outcome measures. Changes in knee motion and the GDI score were adjusted for multiple factors, such as sex, the Gross Motor Function Classification System (GMFCS) level, and concomitant surgeries as fixed effects, and follow-up duration, laterality, and each subject as random effects, using a LMM. **RESULTS:** We found significant improvements in knee flexion at initial contact, minimum knee flexion in the stance phase, knee ROM, and GDI score 2 years after DHL. In patients with GMFCS level I and II, improvement in all sagittal knee kinematics was maintained during follow-up. In addition, GDI score, which represents overall gait pathology, consistently improved throughout the follow-up duration (1.2 per year, $p = 0.008$). **CONCLUSION:** Medial hamstring lengthening with semitendinosus transfer, as a part of a SEMLS, was effective procedure in treating flexed knee gait with regard to sagittal knee kinematics and GDI score in spastic CP with flexed knee gait.

[PMID: 28806980](#)

13. Improved Walking Capacity and Muscle Strength After Functional Power-Training in Young Children With Cerebral Palsy.

van Vulpen LF, de Groot S, Rameckers E, Becher JG, Dallmeijer AJ.

Neurorehabil Neural Repair. 2017 Aug 1:1545968317723750. doi: 10.1177/1545968317723750. [Epub ahead of print]

BACKGROUND: Strength training programs for children with cerebral palsy (CP) showed inconclusive evidence for improving walking, despite improvements in strength. Recent studies have suggested that strength training with high movement velocity is more effective for improving walking than traditional resistance training. **OBJECTIVE:** The purpose of this study was to evaluate the effect of functional high-velocity resistance training (power-training) to improve muscle strength and walking capacity of children with CP. **METHOD:** Twenty-two children with spastic CP participated (13 bilateral, Gross Motor Function Classification System [GMFCS] level I [n = 10] and II [n = 12], 7.5 years [SD 1.8, range 4-10 years]). Within-subjects changes in a 14-weeks usual care period were compared with changes in a 14-week functional power-training period (in groups, 3×/wk). Outcome measures were the muscle power sprint test (MPST), 1-minute walk test (1MWT), 10-m shuttle run test (SRT), gross motor function (GMFM-66), isometric strength of lower-limb muscles and dynamic ankle plantar flexor strength. **RESULTS:** Changes during the training period were significantly larger than changes in the usual care period for all outcome measures ($P < .05$). Large improvements were found during the training period for walking capacity (Δ MPST [mean]: 27.6 W [95%CI 15.84-39.46, 83% increase], Δ 1MWT: 9.4 m [95% CI 4.17-14.68, 13%], Δ SRT: 4.2 [95%CI 2.57-5.83, 56%], Δ GMFM-66: 5.5 [95% CI 3.33-7.74, 7%]) and muscle strength (18%-128%), while outcomes remained stable in the usual care period. **CONCLUSIONS:** The results indicate that functional power-training is an effective training for improving walking capacity in young children with cerebral palsy.

[PMID: 28786309](#)

14. Understanding frames: A UK survey of parents and professionals regarding the use of standing frames for children with cerebral palsy.

Goodwin J, Colver A, Basu A, Crombie S, Howel D, Parr JR, McColl E, Kolehmainen N, Roberts A, Lecouturier J, Smith J, Miller K, Cadwgan J.

Child Care Health Dev. 2017 Aug 15. doi: 10.1111/cch.12505. [Epub ahead of print]

BACKGROUND: Standing frames are used for children with cerebral palsy (CP). They may improve body structure and function (e.g., reducing risk of hip subluxation, and improving bladder and bowel function), improving activity (e.g., motor abilities) and participation (e.g., interaction with peers), but there is little evidence that they do. We aimed to identify current UK standing frame practice for children with CP and to understand stakeholder views regarding their clinical benefits and challenges to use. **METHOD:** Three populations were sampled: clinicians prescribing standing frames for children with CP (n = 305), professionals (health and education) working with children with CP who use standing frames (n = 155), and parents of children with CP who have used standing frames (n = 91). Questionnaires were developed by the co-applicant group and piloted with other professionals and parents of children with CP. They were distributed online via clinical and parent networks across the UK. **RESULTS:** Prescribing practice was consistent, but achieving the prescribed use was not always possible. Respondents in all groups reported the perceived benefits of frames, which include many domains of the International Classification of Functioning Disability and Health for Children and Youth. Challenges of use are related to physical space and child-reported pain. **CONCLUSIONS:** These survey findings provide information from key stakeholders regarding current UK standing frame practice.

[PMID: 28809057](#)

15. Identification and measurement of dystonia in cerebral palsy.

Rice J, Skuza P, Baker F, Russo R, Fehlings D.

Dev Med Child Neurol. 2017 Aug 8. doi: 10.1111/dmcn.13502. [Epub ahead of print]

AIM: To establish the prevalence and severity of dystonia in a population of children with cerebral palsy (CP) with hypertonia assessment and measurement tools. **METHOD:** A cross-sectional study of 151 children (84 males, 67 females) with CP who were assessed with the Hypertonia Assessment Tool (HAT) and Barry-Albright Dystonia scale (BAD) for identification and

measurement of severity of dystonia. HAT dystonia items were assessed for construct and convergent validity. RESULTS: Distribution by predominant motor type (PMT) was: 85% spastic, 14% dyskinetic, and 1% ataxic. Spastic and dyskinetic groups showed widespread evidence of dystonia according to HAT profiles and BAD scores. The dyskinetic PMT group had a higher mean BAD score than the spastic group (difference of 13 units, 95% CI 9.1-16.4). Dystonia severity (BAD score) increased linearly across gross motor ($p<0.001$), manual ability ($p<0.001$) and communication functional levels ($p<0.001$). Divergence was noted in how HAT item six identified dystonia compared to items one and two. INTERPRETATION: The HAT provided an estimate of the prevalence of both spasticity and dystonia in a large CP population, beyond predominant motor type. Dystonia is a common finding in the spastic PMT group, and its severity increases as motor function worsens.

[PMID: 28786476](#)

16. Recent developments in clinical trials of botulinum neurotoxins.

Cocco A, Albanese A.

Toxicon. 2017 Aug 14. pii: S0041-0101(17)30250-7. doi: 10.1016/j.toxicon.2017.08.014. [Epub ahead of print]

Botulinum neurotoxins (BoNTs) are increasingly used in clinical practice for several indications. Following the pioneering years of discoveries, the recent years have witnessed an increase of new indications and new toxin brands. We review here the clinical trials on BoNTs performed since 2014 and put them into perspective. We also review the ongoing trials listed by the National Institutes of Health registry (Clinicaltrials.gov). The following indications are reviewed here: blepharospasm, cervical dystonia, spasticity, cerebral palsy, urinary incontinence, headache, topical formulations, postoperative cardiac arrhythmia, keloids and scars. For each of these indications the latest trials are reviewed and commented.

[PMID: 28818530](#)

17. Nurse Practitioner Lead Pediatric Baclofen Pump Program: Impact on Safety and Quality of Care.

Buxton K, Morgan A, Rogers J.

J Neurosci Nurs. 2017 Aug 16. doi: 10.1097/JNN.0000000000000310. [Epub ahead of print]

Children with cerebral palsy experience spasticity that can be debilitating and cause significant pain and contractures. Intrathecal baclofen (ITB) therapy can help relieve this spasticity and improve the quality of life for these patients, but it comes with risk. Withdrawal from the medication in case of abrupt discontinuation of delivery can be life-threatening. Regular maintenance of the system is mandatory. Having a program in place to manage the device and support patients helps to ensure their safety. Toward this end, we developed a program with a nurse practitioner (NP) leader to secure the safety and quality of care for patients using ITB therapy. As the program grew, the NP role as an expert in the care and management of ITB pumps became essential to the safety and care of these patients. In addition to the basic outpatient and inpatient management of the baclofen pump, the NP developed a detailed educational program for the patients and leads the quality and safety initiative for the program. The NP is also in a unique position to have intimate knowledge of the patient's condition and build a strong relationship with the patient/family. The NP is able to use this knowledge and relationship as concerns arise that could be related to the ITB therapy. This has greatly improved the safety and quality of care for patients using ITB therapy at our institution.

[PMID: 28817499](#)

18. Long-term outcomes after selective dorsal rhizotomy: a retrospective matched cohort study.

Munger ME, Aldahondo N, Krach LE, Novacheck TF, Schwartz MH.

Dev Med Child Neurol. 2017 Aug 8. doi: 10.1111/dmcn.13500. [Epub ahead of print]

AIM: To examine long-term outcomes of selective dorsal rhizotomy (SDR) 10 to 17 years after surgery. METHOD: Participants who underwent SDR had spastic diplegic cerebral palsy (CP), completed baseline gait analysis, and were 16 to 25

years old at follow-up. Non-SDR participants (i.e. controls) were matched on important clinical parameters at baseline but did not undergo SDR. All study participants completed six surveys assessing pain, quality of life, participation, function, and mobility. Treatment history for lower extremity surgery and antispasticity injections was tabulated. A subset of each study group returned for three-dimensional gait analysis, including kinematics, metabolic energy cost, and physical examination. Gait Deviation Index (GDI) was calculated to measure gait quality. RESULTS: The study cohort had 24 participants with SDR and 11 without SDR. Of these, 13 patients with SDR (five males, eight females; median [IQR] age 17y 2mo [16y 8mo-17y 9mo]) and eight without SDR (three males, five females; median [IQR] age 19y 2mo [17y 3mo-21y 11mo]) completed baseline and follow-up gait analysis. Spasticity significantly decreased in those with SDR ($p < 0.05$). Gait Deviation Index improved more in participants without SDR than those with SDR ($\Delta_{\text{non-SDR}} = 12.8$ vs $\Delta_{\text{SDR}} = 9.1$; $p = 0.01$). Compared with the SDR group, participants without SDR underwent significantly more subsequent interventions ($p < 0.05$). INTERPRETATION: Patients in both the SDR and non-SDR groups showed improved gait quality more than 10 years after surgery. Participants without SDR had a larger improvement in gait pathology but underwent significantly more intervention. There were no differences between groups in survey measures. These results suggest differing treatment courses provide similar outcomes into early adulthood.

[PMID: 28786493](#)

19. Functional electrical stimulation of the ankle dorsiflexors during walking in spastic cerebral palsy: a systematic review.

Moll I, Vles JSH, Soudant DLHM, Witlox AMA, Staal HM, Speth LAWM, Janssen-Potten YJM, Coenen M, Koudijs SM, Vermeulen RJ.

Dev Med Child Neurol. 2017 Aug 17. doi: 10.1111/dmcn.13501. [Epub ahead of print]

AIM: To assess the effect of functional electrical stimulation (FES) of ankle dorsiflexors in children and adolescents with spastic cerebral palsy (CP) during walking. METHOD: A systematic review was performed using the American Academy of Cerebral Palsy and Developmental Medicine methodology and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Six databases were searched for studies applying interventions to patients aged younger than 20 years. Outcomes were classified according to the International Classification of Functioning, Disability and Health (ICF). RESULTS: Seven hundred and eighty abstracts were found, 35 articles were fully screened, and 14 articles were used for analysis. Only five articles (three studies) were of level I to III evidence. At ICF participation and activity level, there is limited evidence for a decrease in self-reported frequency of toe-drag and falls. At ICF body structure and function level, there is clear evidence (I-III) that FES increased (active) ankle dorsiflexion angle, strength, and improved selective motor control, balance, and gait kinematics, but decreased walking speed. Adverse events include skin irritation, toleration, and acceptance issues. INTERPRETATION: There are insufficient data supporting functional gain by FES on activity and participation level. However, evidence points towards a role for FES as an alternative to orthoses in children with spastic CP.

[PMID: 28815571](#)

20. Efficacy and Safety of Letibotulinum Toxin A for the Treatment of Dynamic Equinus Foot Deformity in Children with Cerebral Palsy: A Randomized Controlled Trial.

Chang HJ, Hong BY, Lee SJ, Lee S, Park JH, Kwon JY.

Toxins (Basel). 2017 Aug 18;9(8). pii: E252. doi: 10.3390/toxins9080252.

The objective of this clinical trial was to compare the efficacy and safety of letibotulinum toxin A and onabotulinum toxin A for improving dynamic equinus foot deformity in children with cerebral palsy (CP). In total, 144 children with spastic CP who had dynamic equinus foot deformity were assigned randomly to the Botulax group (injection of letibotulinum toxin A) or the Botox group (injection of onabotulinum toxin A). The Physician's Rating Scale (PRS), ankle plantar flexor spasticity using the Modified Tardieu Scale, the Gross Motor Function Measure (GMFM)-88, and the GMFM-66 were completed before injection and at 6, 12, and 24 weeks after injection. The PRS responder rate was 60.27% in the Botulax group and 61.43% in the Botox group at 12 weeks after treatment, and the lower limit of the 95% confidence interval for the between-group difference in responder rates was -17.16%, higher than the non-inferiority margin of -24.00%. The clinical efficacy and the safety profiles of the groups did not significantly differ. The results suggest that injection of letibotulinum toxin A is as effective and safe as that of onabotulinum toxin A for the treatment of dynamic equinus foot deformity in children with spastic CP.

[PMID: 28820439](#)

21. Clinical presentation and management of dyskinetic cerebral palsy.

Monbaliu E, Himmelmann K, Lin JP, Ortibus E, Bonouvrié L, Feys H, Vermeulen RJ, Dan B.

Lancet Neurol. 2017 Sep;16(9):741-749. doi: 10.1016/S1474-4422(17)30252-1.

Cerebral palsy is the most frequent cause of severe physical disability in childhood. Dyskinetic cerebral palsy (DCP) is the second most common type of cerebral palsy after spastic forms. DCP is typically caused by non-progressive lesions to the basal ganglia or thalamus, or both, and is characterised by abnormal postures or movements associated with impaired tone regulation or movement coordination. In DCP, two major movement disorders, dystonia and choreoathetosis, are present together most of the time. Dystonia is often more pronounced and severe than choreoathetosis, with a major effect on daily activity, quality of life, and societal participation. The pathophysiology of both movement disorders is largely unknown. Some emerging hypotheses are an imbalance between indirect and direct basal ganglia pathways, disturbed sensory processing, and impaired plasticity in the basal ganglia. Rehabilitation strategies are typically multidisciplinary. Use of oral drugs to provide symptomatic relief of the movement disorders is limited by adverse effects and the scarcity of evidence that the drugs are effective. Neuromodulation interventions, such as intrathecal baclofen and deep brain stimulation, are promising options.

[PMID: 28816119](#)

22. Effects of a conductive education course in young children with cerebral palsy: A randomized controlled trial.

Myrhaug HT, Odgaard-Jensen J, Østensjø S, Vøllestad NK, Jahnsen R.

Dev Neurorehabil. 2017 Aug 17:1-9. doi: 10.1080/17518423.2017.1360961. [Epub ahead of print]

PURPOSE: To evaluate the effects of a conductive education (CE) course followed by conventional practice, on gross motor function, other functional skills, quality of life, and parents' experiences of family-centered services in young children with cerebral palsy (CP). **METHODS:** Twenty-one children with CP, 3-6 years old, were randomized to one 3-week CE course followed by conventional practice or conventional practice on a waiting list. Outcomes were measured 4 months after baseline. A web-based log collected data on the conventional practice. **RESULTS:** No additional improvements in the children's outcome were found. However, parents in the CE group reported that they received more information than parents in the waiting list group ($p = 0.01$). Children in both groups performed high amount of conventional practice at home. **CONCLUSIONS:** A 3-week CE course did not add any improvements in the children's functioning, possibly explained by the large amount of conventional practice reported of both groups.

[PMID: 28816582](#)

23. Profile of children with developmental disabilities attending a complex pain clinic of a children's hospital in Australia.

Garg P, Haynes N, De Lima J, Collins JJ.

J Paediatr Child Health. 2017 Aug 8. doi: 10.1111/jpc.13633. [Epub ahead of print]

AIM: To document the profile and management of children with developmental disabilities (DD) attending an outpatient complex pain clinic at a Children's Hospital in Sydney, Australia. **METHODS:** Children with DD from 2011 to 2014 were identified from a clinic database, and pain relevant data was collected. **RESULTS:** A total of 107 (19.6%) of 544 children were identified with DD, and accounted for one-third of clinic attendances. The median age was 14 years (interquartile range: 11-16) and females were slightly over-represented (62, 57.9%). About one-third of children had cerebral palsy (CP) from a variety of prenatal, natal and post-neonatal causes. The lower limb was the most common site for pain in children with CP, while back pain was more frequent in children with other disabilities. Comorbid emotional disorders were significantly associated with the non-CP disabilities. Children who required more than four clinic attendances were more likely to have comorbid anxiety/depression and to be reviewed by multiple specialists. **CONCLUSIONS:** Long-term persistent pain in children with DD forms a significant cohort of children requiring tertiary level paediatric pain services. Multisystem comorbidities and emotional disorders predict greater service utilisation. Further research into the effectiveness of multidisciplinary pain teams and interventions in this cohort of children is required.

[PMID: 28786141](#)

24. Spatial Characteristics of Jaw Movements During Chewing in Children with Cerebral Palsy: A Pilot Study.

Nip ISB, Wilson EM, Kearney L.

Dysphagia. 2017 Aug 9. doi: 10.1007/s00455-017-9830-2. [Epub ahead of print]

This study compared jaw motion between children with cerebral palsy (CP) and their typically-developing (TD) peers during chewing. The jaw movements of 11 children with spastic CP (GMFCS levels II-V) all of whom were exclusively oral feeders with no reported clinical issues with feeding [mean age = 7.49 (2.30) years; 7 males, 4 females] and 11 age- and sex-matched TD peers [mean age = 7.54 (2.35) years] were recorded using optical motion capture. Participants chewed five trials of three different consistencies, including puree, mechanical soft, and solid. For each chewing sequence, the path distance (total amount of distance traveled by the jaw), average jaw speed, and working space (total 3-dimensional size of the jaw movements during chewing) were calculated. The CP group had greater path distances for mechanical soft and solids ($p < 0.001$) and larger working spaces ($p < 0.001$) than the TD group. Consistency differences were also found with path distances increasing for both groups with increased bolus consistency ($p < 0.001$). Puree was chewed most slowly for both groups ($p = 0.05$) and was associated with smaller working space than the other consistencies for both groups ($p < 0.001$). The TD group demonstrated slower speeds for mechanical soft as compared to solids ($p = 0.05$), a finding which was not observed in the CP group. The results suggest children with CP showed jaw movement differences during chewing despite being exclusive oral eaters with no reports of clinical feeding or deglutition disorders. Food consistency also influenced jaw movements in both children with CP and their TD peers.

[PMID: 28795229](#)

25. ParticiPate CP: a protocol of a randomised waitlist controlled trial of a motivational and behaviour change therapy intervention to increase physical activity through meaningful participation in children with cerebral palsy.

Reedman SE, Boyd RN, Elliott C, Sakzewski L.

BMJ Open. 2017 Aug 7;7(8):e015918. doi: 10.1136/bmjopen-2017-015918.

INTRODUCTION: Children with cerebral palsy (CP) participate in leisure-time physical activities (PA) less often, with less intensity and reduced diversity than their typically developing peers. Participation in leisure-time physical activities may be an important source of habitual physical activity (HPA) for children with CP, who as a group have lower levels of HPA and increased sedentary time compared with their typically developing peers. The proposed study aims to compare the efficacy of a participation focused therapy (ParticiPate CP) to usual care in a pragmatic, randomised waitlist controlled trial. **METHODS AND ANALYSIS:** Thirty-six children with CP (18 in each group), classified as Gross Motor Function Classification System levels I to III, aged between 8 and 12 years will be recruited across South East Queensland, Australia. Children will be randomised to receive either ParticiPate CP or waitlist usual care using concealed allocation. ParticiPate CP is an individually tailored, goal-directed intervention model of pragmatic participation-focused therapy using a toolbox of evidence-based strategies in the treatment of children with CP. This will include goal-setting; identification of barriers and facilitators to participation goals, strategy formation and planning and communication guided by principles of Self-Determination Theory using strategies of Motivational Interviewing. The intervention comprises 8 weekly sessions of 1 hour duration conducted by a physiotherapist in the child's home or community.

[PMID: 28790038](#)

26. Central Precocious Puberty and Response to GnRHa Therapy in Children with Cerebral Palsy and Moderate to Severe Motor Impairment: Data from a Longitudinal, Case-Control, Multicentre, Italian Study.

Bruzzi P, Messina MF, Bartoli A, Predieri B, Lucaccioni L, Madeo SF, Verrotti A, De Luca F, Iughetti L.

Int J Endocrinol. 2017;2017:4807163. doi: 10.1155/2017/4807163. Epub 2017 Jul 16.

BACKGROUND: Children affected by neurodevelopmental disability could experience early pubertal changes at least 20 times more than the general population. Limited data about central precocious puberty (CPP) among children affected by cerebral palsy (CP) are available. **METHODS:** This is a longitudinal, observational, retrospective, case-control study involving 22 children affected by CPP and CP (group A), 22 paired with CP but without CPP (group B), and 22 children with CPP without CP. Auxological, biochemical, and instrumental data were collected at diagnosis of CPP and at 2 follow-up visits.

RESULTS: No differences were detected between groups A (at baseline) and B. At diagnosis of CPP, height SDS adjusted for target height (H-TH SDS) was significantly reduced in A than in C (-0.63 ± 1.94 versus 1.56 ± 1.38), while basal LH and oestradiol levels were significantly elevated in A than in C. During follow-up, despite an effective treatment, growth impairment deteriorated in A than in C (Δ H-SDS from diagnosis of CPP to last follow-up: -0.49 ± 0.91 versus 0.21 ± 0.33 , $p = 0.023$). **CONCLUSIONS:** Diagnosis of CPP could be partially misled in CP due to growth failure that got worse during follow-up despite therapy. CPP in CP seems to progress rapidly along time supporting the hypothesis of a more intense activation of hypothalamic-pituitary-gonadal-axis in these patients.

[PMID: 28791047](#)

27. Comparing emergency department presentations among children with cerebral palsy with general childhood presentations: a data linkage study.

Meehan E, Williams K, Reid SM, Freed GL, Babl FE, Sewell JR, Vidmar S, Donath S, Reddihough DS.

Dev Med Child Neurol. 2017 Aug 8. doi: 10.1111/dmcn.13518. [Epub ahead of print]

AIM: The aims of this study were to estimate the proportion of emergency department presentations attributable to children with cerebral palsy (CP), investigate the frequency of emergency department presentations in a CP cohort, and compare emergency department presentations among children with CP with those of other children. **METHOD:** This was a retrospective cohort study. The Victorian Cerebral Palsy Register was linked to the Victorian Emergency Minimum Dataset. Data on emergency department presentations for the CP cohort occurring between 2007 and 2014 and population control data were obtained. **RESULTS:** The CP cohort ($n=1748$) had 7015 emergency department presentations during the 7-year period, accounting for 0.4% of the 1.69 million age-specific presentations during that time. The number of annual presentations per 1000 children rose with increasing CP severity. Compared with presentations among the general population, higher proportions of presentations among the CP cohort were preceded by ambulance arrivals (27% vs 8%), triaged as urgent (66% vs 32%), and required hospital admission (38% vs 12%). **INTERPRETATION:** The marked differences in presentations between the CP cohort and the general population in the proportions that were urgent and required ambulance arrivals and hospital admissions was an important finding. Strategies to ensure appropriate use of services, including encouragement to seek earlier assistance from primary care providers, may prevent problems escalating to the need for urgent care.

[PMID: 28786475](#)

Prevention and Cure

28. Antenatal and intrapartum interventions for preventing cerebral palsy: an overview of Cochrane systematic reviews.

Shepherd E, Salam RA, Middleton P, Makrides M, McIntyre S, Badawi N, Crowther CA.

Cochrane Database Syst Rev. 2017 Aug 8;8:CD012077. doi: 10.1002/14651858.CD012077.pub2. [Epub ahead of print]

BACKGROUND: Cerebral palsy is an umbrella term encompassing disorders of movement and posture, attributed to non-progressive disturbances occurring in the developing fetal or infant brain. As there are diverse risk factors and causes, no one strategy will prevent all cerebral palsy. Therefore, there is a need to systematically consider all potentially relevant interventions for their contribution to prevention. **OBJECTIVES:** To summarise the evidence from Cochrane reviews regarding the effects of antenatal and intrapartum interventions for preventing cerebral palsy. **METHODS:** We searched the Cochrane Database of Systematic Reviews on 7 August 2016, for reviews of antenatal or intrapartum interventions reporting on cerebral palsy. Two authors assessed reviews for inclusion, extracted data, assessed review quality, using AMSTAR and ROBIS, and quality of the evidence, using the GRADE approach. We organised reviews by topic, and summarised findings in text and tables. We categorised interventions as effective (high-quality evidence of effectiveness); possibly effective (moderate-quality evidence of effectiveness); ineffective (high-quality evidence of harm or of lack of effectiveness); probably ineffective (moderate-quality evidence of harm or of lack of effectiveness); and no conclusions possible (low- to very low-quality evidence). **MAIN RESULTS:** We included 15 Cochrane reviews. A further 62 reviews pre-specified the outcome cerebral palsy in their methods, but none of the included randomised controlled trials (RCTs) reported this outcome. The included reviews were high quality and at low risk of bias. They included 279 RCTs; data for cerebral palsy were available from 27

(10%) RCTs, involving 32,490 children. They considered interventions for: treating mild to moderate hypertension (two) and pre-eclampsia (two); diagnosing and preventing fetal compromise in labour (one); preventing preterm birth (four); preterm fetal maturation or neuroprotection (five); and managing preterm fetal compromise (one). Quality of evidence ranged from very low to high. Effective interventions: high-quality evidence of effectiveness There was a reduction in cerebral palsy in children born to women at risk of preterm birth who received magnesium sulphate for neuroprotection of the fetus compared with placebo (risk ratio (RR) 0.68, 95% confidence interval (CI) 0.54 to 0.87; five RCTs; 6145 children). Probably ineffective interventions: moderate-quality evidence of harm There was an increase in cerebral palsy in children born to mothers in preterm labour with intact membranes who received any prophylactic antibiotics versus no antibiotics (RR 1.82, 95% CI 0.99 to 3.34; one RCT; 3173 children). There was an increase in cerebral palsy in children, who as preterm babies with suspected fetal compromise, were born immediately compared with those for whom birth was deferred (RR 5.88, 95% CI 1.33 to 26.02; one RCT; 507 children). Probably ineffective interventions: moderate-quality evidence of lack of effectiveness There was no clear difference in the presence of cerebral palsy in children born to women at risk of preterm birth who received repeat doses of corticosteroids compared with a single course (RR 1.03, 95% CI 0.71 to 1.50; four RCTs; 3800 children). No conclusions possible: low- to very low-quality evidence Low-quality evidence found there was a possible reduction in cerebral palsy for children born to women at risk of preterm birth who received antenatal corticosteroids for accelerating fetal lung maturation compared with placebo (RR 0.60, 95% CI 0.34 to 1.03; five RCTs; 904 children). There was no clear difference in the presence of cerebral palsy with interventionist care for severe pre-eclampsia versus expectant care (RR 6.01, 95% CI 0.75 to 48.14; one RCT; 262 children); magnesium sulphate for pre-eclampsia versus placebo (RR 0.34, 95% CI 0.09 to 1.26; one RCT; 2895 children); continuous cardiotocography for fetal assessment during labour versus intermittent auscultation (average RR 1.75, 95% CI 0.84 to 3.63; two RCTs; 13,252 children); prenatal progesterone for prevention of preterm birth versus placebo (RR 0.14, 95% CI 0.01 to 3.48; one RCT; 274 children); and betamimetics for inhibiting preterm labour versus placebo (RR 0.19, 95% CI 0.02 to 1.63; one RCT; 246 children). Very low-quality found no clear difference for the presence of cerebral palsy with any antihypertensive drug (oral beta-blockers) for treatment of mild to moderate hypertension versus placebo (RR 0.33, 95% CI 0.01 to 8.01; one RCT; 110 children); magnesium sulphate for prevention of preterm birth versus other tocolytic agents (RR 0.13, 95% CI 0.01 to 2.51; one RCT; 106 children); and vitamin K and phenobarbital prior to preterm birth for prevention of neonatal periventricular haemorrhage versus placebo (RR 0.77, 95% CI 0.33 to 1.76; one RCT; 299 children). **AUTHORS' CONCLUSIONS:** This overview summarises evidence from Cochrane reviews on the effects of antenatal and intrapartum interventions on cerebral palsy, and can be used by researchers, funding bodies, policy makers, clinicians and consumers to aid decision-making and evidence translation. We recommend that readers consult the included Cochrane reviews to formally assess other benefits or harms of included interventions, including impacts on risk factors for cerebral palsy (such as the reduction in intraventricular haemorrhage for preterm babies following exposure to antenatal corticosteroids). Magnesium sulphate for women at risk of preterm birth for fetal neuroprotection can prevent cerebral palsy. Prophylactic antibiotics for women in preterm labour with intact membranes, and immediate rather than deferred birth of preterm babies with suspected fetal compromise, may increase the risk of cerebral palsy. Repeat doses compared with a single course of antenatal corticosteroids for women at risk of preterm birth do not clearly impact the risk of cerebral palsy. Cerebral palsy is rarely diagnosed at birth, has diverse risk factors and causes, and is diagnosed in approximately one in 500 children. To date, only a small proportion of Cochrane reviews assessing antenatal and intrapartum interventions have been able to report on this outcome. There is an urgent need for long-term follow-up of RCTs of interventions addressing risk factors for cerebral palsy, and consideration of the use of relatively new interim assessments (including the General Movements Assessment). Such RCTs must be rigorous in their design, and aim for consistency in cerebral palsy outcome measurement and reporting to facilitate pooling of data, to focus research efforts on prevention.

[PMID: 28786098](#)

29. Neurodevelopmental outcome at 2 years for preterm children born at 22 to 34 weeks' gestation in France in 2011: EPIPAGE-2 cohort study.

Pierrat V, Marchand-Martin L, Arnaud C, Kaminski M, Resche-Rigon M, Lebeaux C, Bodeau-Livinec F, Morgan AS, Goffinet F, Marret S, Ancel PY; and the EPIPAGE-2 writing group.

BMJ. 2017 Aug 16;358:j3448. doi: 10.1136/bmj.j3448.

Objectives To describe neurodevelopmental outcomes at 2 years corrected age for children born alive at 22-26, 27-31, and 32-34 weeks' gestation in 2011, and to evaluate changes since 1997. **Design** Population based cohort studies, EPIPAGE and EPIPAGE-2. **Setting** France. **Participants** 5567 neonates born alive in 2011 at 22-34 completed weeks' gestation, with 4199 survivors at 2 years corrected age included in follow-up. **Comparison** of outcomes reported for 3334 (1997) and 2418 (2011) neonates born alive in the nine regions participating in both studies. **Main outcome measures** Survival; cerebral palsy (2000 European consensus definition); scores below threshold on the neurodevelopmental Ages and Stages Questionnaire (ASQ; at least one of five domains below threshold) if completed between 22 and 26 months corrected age, in children without cerebral palsy, blindness, or deafness; and survival without severe or moderate neuromotor or sensory disabilities (cerebral palsy with

Gross Motor Function Classification System levels 2-5, unilateral or bilateral blindness or deafness). Results are given as percentage of outcome measures with 95% confidence intervals. Results Among 5170 liveborn neonates with parental consent, survival at 2 years corrected age was 51.7% (95% confidence interval 48.6% to 54.7%) at 22-26 weeks' gestation, 93.1% (92.1% to 94.0%) at 27-31 weeks' gestation, and 98.6% (97.8% to 99.2%) at 32-34 weeks' gestation. Only one infant born at 22-23 weeks survived. Data on cerebral palsy were available for 3599 infants (81.0% of the eligible population). The overall rate of cerebral palsy at 24-26, 27-31, and 32-34 weeks' gestation was 6.9% (4.7% to 9.6%), 4.3% (3.5% to 5.2%), and 1.0% (0.5% to 1.9%), respectively. Responses to the ASQ were analysed for 2506 children (56.4% of the eligible population). The proportion of children with an ASQ result below threshold at 24-26, 27-31, and 32-34 weeks' gestation were 50.2% (44.5% to 55.8%), 40.7% (38.3% to 43.2%), and 36.2% (32.4% to 40.1%), respectively. Survival without severe or moderate neuromotor or sensory disabilities among live births increased between 1997 and 2011, from 45.5% (39.2% to 51.8%) to 62.3% (57.1% to 67.5%) at 25-26 weeks' gestation, but no change was observed at 22-24 weeks' gestation. At 32-34 weeks' gestation, there was a non-statistically significant increase in survival without severe or moderate neuromotor or sensory disabilities ($P=0.61$), but the proportion of survivors with cerebral palsy declined ($P=0.01$). Conclusions In this large cohort of preterm infants, rates of survival and survival without severe or moderate neuromotor or sensory disabilities have increased during the past two decades, but these children remain at high risk of developmental delay.

[PMID: 28814566](#)

30. Changing Neurodevelopment at 8 Years in Children Born Extremely Preterm Since the 1990s.

Cheong JLY, Anderson PJ, Burnett AC, Roberts G, Davis N, Hickey L, Carse E, Doyle LW; Victorian Infant Collaborative Study Group.

Pediatrics. 2017 Jun;139(6). pii: e20164086. doi: 10.1542/peds.2016-4086.

BACKGROUND AND OBJECTIVE: Survival of extremely preterm (EP; <28 weeks' gestation) infants has increased over the last 2 decades. Equivalent reductions in developmental morbidity in early childhood have not been consistently reported. The aim of this study was to determine trends in neurodevelopmental outcomes at 8 years of age of children born EP (22-27 completed weeks' gestation) over the past 2 decades. **METHODS:** Population-based cohorts of all EP survivors born in the state of Victoria, Australia in 1991-1992, 1997, and 2005 were recruited at birth. At 8 years of age, general intelligence (IQ), academic achievement, and neurosensory status were assessed. Major neurosensory disability was defined as any of moderate or severe cerebral palsy, IQ <-2 SD relative to term controls, blindness, or deafness. **RESULTS:** Rates of major neurosensory disability were similar in all eras (1991-1992, 18%; 1997, 15%; 2005, 18%), as were rates of IQ <-2 SD, cerebral palsy, blindness, and deafness. Mean z scores for IQ were similar across eras, but there was some evidence that scores for academic achievement were lower in 2005 than in 1997, and the odds of having academic problems were higher in 2005 than in both earlier eras. These outcomes were not explained by differences in known perinatal care or sociodemographic variables between eras. **CONCLUSIONS:** Contrary to expectations, rates of major neurosensory disability have not improved, and academic performance is poorer at early school age in 2005 than in earlier eras for EP children born in the state of Victoria, Australia.

[PMID: 28814550](#)

31. Chorioamnionitis in the Development of Cerebral Palsy: A Meta-analysis and Systematic Review.

Shi Z, Ma L, Luo K, Bajaj M, Chawla S, Natarajan G, Hagberg H, Tan S.

Pediatrics. 2017 Jun;139(6). pii: e20163781. doi: 10.1542/peds.2016-3781.

CONTEXT: Chorioamnionitis (CA) has often been linked etiologically to cerebral palsy (CP). **OBJECTIVES:** To differentiate association from risk of CA in the development of CP. **DATA SOURCES:** PubMed, Cochrane Library, Embase, and bibliographies of original studies were searched by using the keywords (chorioamnionitis) AND ((cerebral palsy) OR brain). **STUDY SELECTION:** Included studies had to have: (1) controls, (2) criteria for diagnoses, and (3) neurologic follow-up. Studies were categorized based on: (1) finding incidence of CP in a CA population, or risk of CP; and (2) incidence of CA in CP or association with CP. **DATA EXTRACTION:** Two reviewers independently verified study inclusion and extracted data. **RESULTS:** Seventeen studies (125 256 CA patients and 5 994 722 controls) reported CP in CA. There was significantly increased CP in preterm histologic chorioamnionitis (HCA; risk ratio [RR] = 1.34, $P < .01$), but not in clinical CA (CCA). Twenty-two studies (2513 CP patients and 8135 controls) reported CA in CP. There was increased CCA (RR = 1.43, $P < .01$), but no increase in HCA in preterm CP. Increased HCA was found (RR = 4.26, $P < .05$), as well as CCA in term/near-term CP (RR = 3.06, $P < .01$). **CONCLUSIONS:** The evidence for a causal or associative role of CA in CP is weak. Preterm HCA may

be a risk factor for CP, whereas CCA is not. An association with term and preterm CP was found for CCA, but only with term CP for HCA.

[PMID: 28814548](#)

32. Systematic review seeking erythropoietin role for neuroprotection in neonates with Hypoxic ischemic encephalopathy: presently where do we stand.

Deep Garg B, Sharma D, Bansal A.

J Matern Fetal Neonatal Med. 2017 Aug 10:1-28. doi: 10.1080/14767058.2017.1366982. [Epub ahead of print]

BACKGROUND: Hypoxic ischemic encephalopathy (HIE) is one of the leading causes of neonatal mortality in developing countries and leads to some form of neuro-developmental disability in latter part of life. **AIMS:** To evaluate the role of erythropoietin (EPO) in neuro-protection for term newborn having HIE. **METHOD:** The literature search was done for various trials by searching the Cochrane Central Register of Controlled Trials (CENTRAL), PubMed, EMBASE, Web of science, Scopus, Index Copernicus, and other data base. **RESULTS:** Total of nine studies fulfilled inclusion criteria. EPO has shown to cause reduction in death and disability, better long term neuro-developmental outcome, improvement in EEG, and reduction in risk of cerebral palsy. **CONCLUSION:** EPO treatment has neuroprotective effects against moderate/severe HIE and improves long-term behavioral neurological developments in neonates.

[PMID: 28797191](#)

33. Long-term outcomes of twins based on gestational age at delivery.

Stern E, Cohen N, Odom E, Stroustrup A, Gupta S, Saltzman DH, Rebarber A, Fox NS.

J Matern Fetal Neonatal Med. 2017 Aug 7:1-18. doi: 10.1080/14767058.2017.1364725. [Epub ahead of print]

OBJECTIVE: Prematurity is associated with adverse outcomes. However, there are less data regarding long-term outcomes of twins, based on gestational age at delivery. Our objective was to identify the association between gestational age at delivery and long-term outcomes in twins. **STUDY DESIGN:** All patients with a twin pregnancy ≥ 24 weeks delivered by a single Maternal Fetal Medicine practice from 2005-2014 were surveyed regarding pediatric outcomes at or after 2 years of life. We excluded twins with aneuploidy or major fetal anomalies. The survey was mail-based, with phone follow-up for nonresponses or for clarification. Using logistic regression analysis we compared long term outcomes between twins born in four gestational age groups: 24-27-6/7 weeks, 28-31-6/7 weeks, 32-35-6/7 weeks, and 36 weeks or later. **RESULTS:** Six hundred fifty-three twin deliveries met inclusion criteria and 425 (65.1%) mothers responded. Mean age at the time of survey completion was 6.0 +/- 2.4 years. Earlier gestational age was significantly associated with neonatal death (14, 2, 0, and 0% in the four groups respectively, $p < 0.001$). Prematurity was associated with a composite of major adverse outcomes (death; cerebral palsy; necrotizing enterocolitis; chronic renal, heart, or lung disease) (14, 7, 4, and 2% in the four groups, $p = 0.036$), as well as minor adverse outcomes (learning disability; need for speech, occupational, or physical therapy) (83, 69, 54, and 38%, $p < 0.001$).

[PMID: 28783997](#)

34. Experimental and clinical evidence of differential effects of magnesium sulfate on neuroprotection and angiogenesis in the fetal brain.

Lecuyer M, Rubio M, Chollat C, Lecointre M, Jégou S, Leroux P, Cleren C, Leroux-Nicollet I, Marpeau L, Vivien D, Marret S, Gonzalez BJ.

Pharmacol Res Perspect. 2017 Aug;5(4). doi: 10.1002/prp2.315.

Clinical studies showed beneficial effects of magnesium sulfate regarding the risk of cerebral palsy. However, regimen protocols fluctuate worldwide and risks of adverse effects impacting the vascular system have been reported for human neonates, keeping open the question of the optimal dosing. Using clinically relevant concentrations and doses of magnesium sulfate, experiments consisted of characterizing, respectively, ex vivo and in vivo, the effects of magnesium sulfate on the

nervous and vascular systems of mouse neonates by targeting neuroprotection, angiogenesis, and hemodynamic factors and in measuring, in human fetuses, the impact of a 4-g neuroprotective loading dose of magnesium sulfate on brain hemodynamic parameters. Preclinical experiments using cultured cortical slices from mouse neonates showed that the lowest and highest tested concentrations of magnesium sulfate were equally potent to prevent excitotoxic-induced cell death, cell edema, cell burst, and intracellular calcium increase, whereas no side effects were found regarding apoptosis. In contrast, *in vivo* data revealed that magnesium sulfate exerted dose-dependent vascular effects on the fetal brain. In particular, it induced brain hypoperfusion, stabilization of Hif-1 α , long-term upregulation of VEGF-R2 expression, impaired endothelial viability, and altered cortical angiogenesis. Clinically, in contrast to 6-g loading doses used in some protocols, a 4-g bolus of magnesium sulfate did not alter fetal brain hemodynamic parameters. In conclusion, these data provide the first mechanistic evidence of double-sword and dose-dependent actions of magnesium sulfate on nervous and vascular systems. They strongly support the clinical use of neuroprotection protocols validated for the lowest (4-g) loading dose of magnesium sulfate.

[PMID: 28805973](#)

35. [Results of a clinical and genealogical analysis of pedigrees of children with cerebral palsy in the population of Rostov region].

[Article in Russian; Abstract available in Russian from the publisher]

Tupikov VA, Kolmakova TS, Shamik VB, Tupikov MV, Churilov NM.

Zh Nevrol Psikhiatr Im S S Korsakova. 2017;117(7):80-85. doi: 10.17116/jnevro20171177180-85.

AIM: To perform clinical and genealogical pedigree analysis and determine the proportion of hereditary factors in the etiopathogenesis of cerebral palsy (CP) in children in the Rostov Region. MATERIAL AND METHODS: Pedigrees and the prevalence of CP, congenital malformations and other related diseases among relatives of I, II and III degrees of kinship of 229 probands with CP were studied. RESULTS AND CONCLUSION: The family concentration of the disease was detected in 15 (6.6%) cases. There were 96 (41.9%) pedigrees with probands with a family history and 118 (51.5%) without family history of CP. The frequency of CP was by 19.2 times higher in the relatives of probands in the families with a history of disease and 2.2 times higher in the siblings compared to the population frequency. The frequency of congenital malformations in the relatives of probands in this group was 23.8 times higher, while in the group of probands with a family history 14.9 times higher than the expected value. Miscarriages and stillbirths preceded the birth of children with CP in 29.2-33.3% of the mothers, and percentage of unrealized pregnancies ranged from 16.7 to 18.7%. CP in 51.5% of cases can be considered as a sporadic disease, and in 48.5% of cases it was genetically determined and can be attributed to a group of multifactorial diseases with polygenic determination of genetic predisposition components.

[PMID: 28805766](#)

36. Tetrahydrobiopterin in antenatal brain hypoxia-ischemia-induced motor impairments and cerebral palsy.

Vasquez-Vivar J, Shi Z, Luo K, Thirugnanam K, Tan S.

Redox Biol. 2017 Aug 3;13:594-599. doi: 10.1016/j.redox.2017.08.002. [Epub ahead of print]

Antenatal brain hypoxia-ischemia, which occurs in cerebral palsy, is considered a significant cause of motor impairments in children. The mechanisms by which antenatal hypoxia-ischemia causes brain injury and motor deficits still need to be elucidated. Tetrahydrobiopterin is an important enzyme cofactor that is necessary to produce neurotransmitters and to maintain the redox status of the brain. A genetic deficiency of this cofactor from mutations of biosynthetic or recycling enzymes is a well-recognized factor in the development of childhood neurological disorders characterized by motor impairments, developmental delay, and encephalopathy. Experimental hypoxia-ischemia causes a decline in the availability of tetrahydrobiopterin in the immature brain. This decline coincides with the loss of brain function, suggesting this occurrence contributes to neuronal dysfunction and motor impairments. One possible mechanism linking tetrahydrobiopterin deficiency, hypoxia-ischemia, and neuronal injury is oxidative injury. Evidence of the central role of the developmental biology of tetrahydrobiopterin in response to hypoxic ischemic brain injury, especially the development of motor deficits, is discussed.

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