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Interventions and Management

1. Methodological Considerations to Investigate Dosage Parameters of Intensive Upper Limb Rehabilitation in Children with Unilateral Spastic Cerebral Palsy: A Scoping Review of RCTs.

Ravault L, Darbois N, Pinsault N.

Dev Neurorehabil. 2019 Nov 11:1-12. doi: 10.1080/17518423.2019.1687599. [Epub ahead of print]

Purposes: To identify and synthesize RCTs on the isolated effect of dosage parameters of upper limb Intensive Motor Rehabilitation Treatments (IMRT) of children with Unilateral Spastic Cerebral Palsy (USCP); to identify the most frequent methodological weaknesses. **Methods:** Searches were conducted until September 2018 in gray and published literature databases and supplemented by exploring the identified studies' references. Inclusion criteria applied: RCT; children aged 1.5 to 19 years with USCP; upper limb IMRT differing only from $\geq 1/4$ dosage parameters between groups. Literature analyses conducted: qualitative and descriptive. **Results:** We identified 461 studies. Seventeen were included: three presented a rehabilitation dosage distinction between groups in Frequency-Time, four in Intensity-Progressivity, three in Intensity-Restraint, two in Intensity-Environment and five presented ≥ 3 distinctions above. **Conclusions:** Inconsistencies were noted between USCP lifelong issues, and the short follow-ups and lack of participation assessments. Confounding factors and misstatements in Intent To Treat (ITT) analyses were identified. A meta-analysis was considered irrelevant. **Abbreviations:** USCP, CP: Unilateral Spastic Cerebral Palsy, Cerebral Palsy; RCT: Randomized Controlled Trial; IMRT: Intensive Motor Rehabilitation Treatment.

PMID: [31710245](#)

2. Abnormal Gray Matter Structural Covariance Networks in Children With Bilateral Cerebral Palsy.

Liu H, Jiang H, Bi W, Huang B, Li X, Wang M, Wang X, Zhao H, Cheng Y, Tao X, Liu C, Huang T, Jin C, Zhang T, Yang J.

Front Hum Neurosci. 2019 Oct 11;13:343. doi: 10.3389/fnhum.2019.00343. eCollection 2019.

Bilateral cerebral palsy (BCP) is a common movement disorder in children, which often results in lifelong motor disability. One main symptom of BCP is the limitation of hand function in everyday activities. However, the neuroanatomical basis of this prominent hand impairment is yet to discover. Recent advances mainly focus on the lesions of BCP, but the views on the atypical development of cortical parcellations are extremely lacking. Here, in our study, neuroimaging with network analysis was employed to evaluate the changes of structural covariance networks (SCNs) in BCP children. We aimed to elucidate the alteration of SCNs based on cortical thickness (CT), and to reveal the relationship of CT and hand function in the participants with BCP. SCNs were constructed using covariance between regional CT, which was acquired from T1-weighted images of 19 children with BCP and 19 demographically matched healthy controls (HCs). Compared with HCs, BCP children showed increased CT in several regions involving the bilateral areas (lateral occipital, lingual, and fusiform) and right areas (cuneus, pericalcarine, inferior temporal, middle temporal, superior temporal, and insula). Decreased CT was found in the left superior temporal and right superior parietal cortices. Global network analyses revealed significantly decreased normalized clustering and small-worldness in the BCP network. The area under the curve (AUC) of global network measures varied slightly between the BCP and HC networks. The resistance of the both SCNs to the target and random attack showed no significant

difference. Also, the BCP foci (right superior temporal and subtemporal cortex) showed a significantly negative correlation between the CT and manual ability. In this work, we identified the CT-based SCNs changes in children with BCP. The abnormal topological organization of SCNs was revealed, indicating abnormal CT, incongruous development of structural wiring, destructive nodal profiles of betweenness, and moved hub distribution in BCP children. This may provide a neuroanatomical hallmark of BCP in the developing brain. Therefore, our results may not only reflect neurodevelopmental aberrations but also compensatory mechanisms.

PMID: [31708758](#)

3. Effects of dual tasking on postural and gait performances in children with cerebral palsy and healthy children.

Palluel E, Chauvel G, Bourg V, Commare MC, Prado C, Farigoule V, Nougier V, Olivier I.

Int J Dev Neurosci. 2019 Nov 10. pii: S0736-5748(19)30128-5. doi: 10.1016/j.ijdevneu.2019.10.008. [Epub ahead of print]

Simultaneous execution of motor and cognitive tasks is embedded in the daily life of children. 53 children of 7-12 years and 22 adults (study 1), 20 healthy children and 20 children of 7-12 years with cerebral palsy (study 2) performed a Stroop-animal task simultaneously with a standing or a walking task in order to determine the attentional demand of postural control and locomotion. Dual-task cost decreased with advancing age in healthy children during balance. CP and healthy children were similarly affected by dual-task constraints during standing and walking. Children with diplegia were more affected by the DT during the postural task than children with hemiplegia. We found that adults could benefit from dual-tasking for standing. The integrated model of task prioritization might explain our results regarding postural reserve of each population.

PMID: [31722225](#)

4. Scoliosis in Non-Ambulatory Cerebral Palsy: Challenges and Management.

Weigl DM.

Isr Med Assoc J. 2019 Nov;21(11):752-755.

In non-ambulatory patients with cerebral palsy, the presence of scoliosis has a major impact on health and quality of life. The aim of this review is to raise awareness of caregivers from various professions to the extent of the problem, to explain the natural history of neuromuscular scoliosis and its pathophysiology, and to describe up-to-date optional conservative and surgical treatments.

PMID: [31713365](#)

5. Mid-term clinical result of femoral varus osteotomy combined with Pemberton osteotomy in treating spastic hip subluxation.

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

J Pediatr Orthop B. 2019 Nov 12. doi: 10.1097/BPB.0000000000000695. [Epub ahead of print]

Hip subluxation in ambulant children with cerebral palsy may lead to limited walking and pain. This study aimed to introduce the indications and methods of femoral varus osteotomy combined with Pemberton osteotomy in treating spastic hip subluxation to evaluate the interim clinical result and outcome and to discuss its corrective mechanism and orthopedic effect. A total of 23 children with spastic hip subluxation, who underwent femoral varus osteotomy combined with Pemberton osteotomy were selected. The clinical effects were evaluated according to the migration percentage, acetabular index, proximal femur neck shaft angle (NSA), and Melbourne Cerebral Palsy Hip Classification System (MCPHCS). The median migration percentage was 55 (50, 75) before operation, 20 (0, 30) at postoperative 1 year, and 22 (5, 32) at last follow-up. The median acetabular index was 30° (25°, 40°) before operation, 20° (15°, 26°) at postoperative 1 year, and 20° (15°, 25°) at last follow-up. The median NSA was 145 (138, 153) before operation, 117 (107, 126) at postoperative 1 year, and 118 (110, 125) at last follow-up. The MCPHCS grade 4 counts 23 (100%) before operation, grade 3 counts 20 (87.0%), grade 2 counts 2 (8.7%) and grade 1 counts 1 (4.3%) at postoperative 1 year, and grade 4 counts 1 (4.3%), grade 3 counts 21 (91.3%) and grade 1 counts 1 (4.3%)

at last follow-up. Femoral varus osteotomy combined with Pemberton osteotomy is a good surgical treatment for children with Gross Motor Function Classification System levels I and II and migration percentage greater than 50%.

PMID: [31725535](#)

6. The Relationship between Parent-reported PEDI-CAT Mobility and Gross Motor Function in Children with Cerebral Palsy: Brief Report.

Lewis J, Scott K, Pan X, Heathcock J.

Dev Neurorehabil. 2019 Nov 14;1-5. doi: 10.1080/17518423.2019.1687601. [Epub ahead of print]

Purpose: The PEDI-CAT mobility domain (PEDI-mob) is a parent-reported measure of mobility for children up to 21 years of age. The purpose of this research is to investigate the relationship between the PEDI-mob and Gross Motor Function Measure (GMFM)-66 and Gross Motor Function Classification Scale (GMFCS) levels. **Methods:** Fifty-seven children (N = 57), ages 2-8.8 years participated. PEDI-mob and GMFM were administered and GMFCS was confirmed during the same session. A Pearson correlation coefficient was calculated for PEDI-mob and GMFM-66 scores to evaluate the association between these two measures. An ANOVA was used to analyze PEDI-mob across GMFCS levels. **Results:** Large, statistically significant correlation was found between PEDI-mob and GMFM-66 scores ($r = 0.894$, $p\text{-value} < 0.001$). Differences in PEDI-mob scores were found across GMFCS levels ($p\text{-value} < 0.001$), where patients with higher GMFCS levels had lower PEDI-mob scores. **Conclusion:** These results support a strong relationship between parent-reported and clinically measured motor function.

PMID: [31726912](#)

7. Selective Dorsal Rhizotomy for the Treatment of Gait Dysfunction in Cerebral Palsy: A Critical Analysis Review.

Po-Jung Chen B, Wang KK, Novacheck TF.

JBJS Rev. 2019 Nov 12. doi: 10.2106/JBJS.RVW.19.00020. [Epub ahead of print]

PMID: [31725025](#)

8. Motor Function Improvement in Children with Ataxia Receiving Interval Rehabilitation, Including Vibration-Assisted Hometraining: A Retrospective Study.

Martakis K, Stark C, Alberg E, Bossier C, Semler O, Schönau E, Duran I.

Klin Padiatr. 2019 Nov;231(6):304-312. doi: 10.1055/a-1001-2284. Epub 2019 Nov 13.

BACKGROUND: Physiotherapy, including vibration-assisted therapy, has been proven to be effective for patients with ataxic cerebral palsy. Herewith, we studied the effect of a functional, goal-oriented interval rehabilitation program, including vibration-assisted home-training on the motor function of children with congenital ataxias. **PATIENTS:** 45 children (mean age 7.7 years, SD 4.70) with ataxia, having received a 6-month home-based side-alternating vibration-assisted therapy combined with intensive, goal-oriented, functional rehabilitation intervals, were included in the study, classified according to the progressive or non-progressive ataxia character. **METHOD:** Retrospective analysis of the prospectively collected data of the registry of the Cologne rehabilitation program "Auf die Beine". Motor abilities have been assessed prior to the intervention (M0), after 6 months of home-training (M6) as well as in a follow-up 6 months later (M12). We performed a gait analysis, a 1-minute walking test (1-MWT), and the Gross Motor Function Measure (GMFM-66). **RESULTS:** The GMFM-66 improvement (M6-M0 vs. M12-M6) was statistically significant with median improvement of 2.4 points (non-progressive) and 2.9 points (progressive) respectively, and clinically relevant. The 1-MWT improvement was statistically significant and clinically relevant for non-progressive ataxia. **CONCLUSION:** The intensive training, including vibration-assisted therapy significantly improved the motor function of children with ataxia. Six months later the skills were preserved in children with progressive ataxia and could be further developed in non-progressive forms.

PMID: [31724139](#)

9. Contralateral seventh cervical nerve transfer can affect the pennation angle of the lower limb in spastic hemiplegia patients: An observational case series study.

Yu BF, Chen LW, Qiu YQ^{2,3}, Xu J, Yin HW, Li QY, Xu WD.

Brain Behav. 2019 Nov 13:e01460. doi: 10.1002/brb3.1460. [Epub ahead of print]

INTRODUCTION: We previously reported transferring seventh cervical (C7) nerve from unaffected side to affected side in patients with spastic hemiplegia due to chronic cerebral injury, to improve function and reduce spasticity of paralyzed upper limb. In the clinics, some patients also reported changes of spasticity in their lower limb, which could not be detected by routine physical examinations. Pennation angle of muscle can indirectly reflect the condition of spasticity. The purpose of this study was to evaluate whether this upper limb procedure may affect spasticity of lower limb, using ultrasonography to detect changes of muscle pennation angle (PA). **METHODS:** Twelve spastic hemiplegia patients due to cerebral injury including stroke, cerebral palsy, and traumatic brain injury, who underwent C7 nerve transfer procedure, participated in this study. B-mode ultrasonography was used to measure PA of the gastrocnemius medialis (GM) muscle at rest preoperatively and postoperatively. The plantar load distribution of the lower limbs was evaluated using a Zebris FDM platform preoperatively and postoperatively. **RESULTS:** The PA of the GM was significantly smaller on the affected side than that of unaffected side before surgery. On the affected side, the postoperative PA was significantly larger than preoperative PA. On the unaffected side, the postoperative PA was not significantly different compared to preoperative PA. The postoperative plantar load distribution of the affected forefoot was significantly smaller than preoperative load distribution, which was consistent with ultrasonography results. **CONCLUSIONS:** This study indicates that C7 nerve transfer surgery for improving upper limb function can also affect muscle properties of lower limb in spastic hemiplegia patients, which reveals a link between the upper and lower limbs. The interlimb interactions should be considered in rehabilitation physiotherapy, and the regular pattern and mechanism need to be further studied.

PMID: [31721481](#)

10. Safety and immediate effects of Hybrid Assistive Limb in children with cerebral palsy: A pilot study.

Nakagawa S, Mutsuzaki H, Mataka Y, Endo Y, Matsuda M, Yoskikawa K, Kamada H, Iwasaki N, Yamazaki M.

Brain Dev. 2019 Nov 5. pii: S0387-7604(19)30399-7. doi: 10.1016/j.braindev.2019.10.003. [Epub ahead of print]

PURPOSE: Early intervention is effective for developing motor ability and preventing contractures and deformities in patients with cerebral palsy (CP). Gait training using the newly developed Hybrid Assistive Limb (HAL) shows promise as an intervention to prevent deterioration in walking ability and deformities in pediatric CP patients. The purpose of this pilot study was to examine the safety and immediate effects on walking ability after gait training using the HAL in pediatric CP patients. **METHODS:** Nineteen patients (six females, 13 males; mean age 8.5 years; mean height 120.5 cm; mean weight 23.2 kg) were enrolled. The Gross Motor Functional Classification Scale level was I in two patients, II in two, III in eight, and IV in seven. The HAL was used for a single session of gait training. The primary outcome was safety of the HAL for use in pediatric CP patients. The secondary outcome was the immediate effect after gait training with HAL, evaluated by passive range of motion (ROM) and gait parameters, including gait speed (m/s), step length (cm), and cadence (step/min). **RESULTS:** All 19 patients were able to carry out the gait training without any severe adverse events. Significant improvements were observed for mean internal/external rotation and abduction angles of the hip joint, and ankle dorsiflexion angles (n = 19). Significant improvements were observed for mean gait speed and step length based on expansion of the hip flexion-extension range (n = 11). **CONCLUSION:** Gait training using the HAL is safe and can produce immediate improvements in ROM and walking ability in pediatric patients with CP.

PMID: [31704189](#)

11. Movement-based interventions for preschool-age children with, or at risk of, motor impairment: a systematic review.

Cameron KL, Albeshier RA¹, McGinley JL, Allison K, Cheong JLY, Spittle AJ.

Dev Med Child Neurol. 2019 Nov 12. doi: 10.1111/dmcn.14394. [Epub ahead of print]

AIM: To explore the efficacy of movement-based interventions to improve motor skills in preschool-age children with, or at risk of, motor impairment, including those with a diagnosis of cerebral palsy, autism spectrum disorder, and developmental coordination disorder. **METHOD:** Relevant electronic databases were searched for randomized or quasi-randomized controlled trials. Outcomes were classified using domains of the International Classification of Functioning, Disability and Health: Children & Youth version. Quality was assessed using the Physiotherapy Evidence Database scale. Risk of bias was assessed using the Cochrane Risk of Bias tool. Effect sizes were calculated using Cohen's d. **RESULTS:** Seventeen articles exploring a heterogeneity of intervention types, population groups, and outcome measures met the inclusion criteria. Movement-based interventions did not significantly improve outcomes in either the body structure and function or activity domains in most studies. No studies used a participation outcome measure. **INTERPRETATION:** There is a paucity of evidence exploring movement-based interventions in the preschool-age group. Although movement-based interventions showed potential for improving body structure and function and activity outcomes for children with motor impairment, results were mostly not significant. Small sample sizes, variable study quality, and risk of bias limit confidence in the results. **WHAT THIS PAPER ADDS:** The evidence is inconclusive to support movement-based interventions in this group. No studies used outcome measures assessing participation. Variability in intervention type and study quality limit confidence in results.

PMID: [31713851](#)

12. The relationship between special needs and dental trauma. a systematic review and meta analysis.

Nogueira de Miranda E Silva Silveira AL, Magno MB, Rodrigues Campos Soares T.

Dent Traumatol. 2019 Nov 14. doi: 10.1111/edt.12527. [Epub ahead of print]

BACKGROUND/AIMS: Understanding the risk factors for dental injuries are essential to develop prevention strategies. The aim of this study was to perform a systematic review and meta-analysis to determine whether people with special needs (SN) have a higher incidence of traumatic dental injury (TDI). **MATERIALS AND METHODS:** Electronic searches were performed with no language or date restrictions in the following databases: PubMed, Lilacs, BBO, Scopus, Web of Science, Cochrane Library and Open Gray. According to the PECOS strategy, observational studies that investigated subjects with and without SN and its association with TDI episodes, were included. Quality assessment and bias control were carried out according to Fowkes and Fulton guidelines. A meta-analysis was performed by subgrouping studies according to the type of SN, with the odds ratio (OR) also being calculated ($p \leq 0.05$). The evidence was quality tested using the GRADE approach. **RESULTS:** After titles and abstracts were examined, and full texts were read, 28 studies were included in the qualitative synthesis and 27 in the meta-analysis. Three studies were classified with high methodological quality, the others had methodological problems. No associations were determined between TDI and autism spectrum disorder, epilepsy and mental disability (OR 1.12 [0.70, 1.78], OR 1.28 [0.13, 12.27] and OR 1.04 [0.20, 5.35], respectively, $p > 0.05$). A positive association ($p < 0.05$) was found between TDI and attention-deficit hyperactivity disorder, cerebral palsy, 21 trisomy, various conditions of SN and in pooled results (OR 2.67 [1.22, 5.87], OR 1.89 [1.06, 3.37], OR 6.18 [2.24, 17.05], OR 1.69 [1.18, 2.41], OR 1.61 [1.16; 2.22], respectively). The certainty of evidence ranged from very low to low. **CONCLUSIONS:** In general, people with SN had a higher chance of having TDI with very low certainty of evidence. People with ADHD and cerebral palsy had a higher chance of TDI.

PMID: [31724811](#)

13. Dermatoglyphics as a Noninvasive Tool for Predicting Dental Caries in Cerebral Palsy and Healthy Children: An In Vivo Study.

Somani R, Gupta MP, Jaidka S, Singh DJ, Puri V, Kumar D.

Int J Clin Pediatr Dent. 2019 May-Jun;12(3):237-242. doi: 10.5005/jp-journals-10005-1630.

AIM: To find the association of dermatoglyphics and dental caries in normal and cerebral palsy (CP) children. **MATERIALS AND METHODS:** A total of 150 children of age group 6-12 years were selected and divided into three equal groups. Group I constituted of 50 CP caries-active children, group II constituted of 50 healthy caries active children, and group III consisted of 50 healthy caries-free children. World Health Organization (WHO) criteria were used for diagnosis and recording of decayed, missing, filled teeth (DMFT)/deft scores. Fingerprints of both hands were taken using a stamp pad and analyzed using the Cummin and Midlo method. **RESULTS:** The results were statistically analyzed using one-way analysis of variance (ANOVA)

and post hoc Tukey's honestly significant difference (HSD). The data for the entire study were calculated using statistical package for social sciences (SPSS) statistical software 19.0 version. The mean DMFT/deft score was the highest for the CP caries-active group compared to the healthy caries-active and healthy caries-free children. Dermatoglyphic pattern distribution in the CP caries-active group showed more whorls and that in the healthy caries-free group showed more arches. Intergroup comparisons for DMFT/deft and dermatoglyphic patterns were significant except between CP caries-active children and healthy caries-active children. **CONCLUSION:** Association of dermatoglyphics and dental caries was observed among CP caries-active children, healthy caries-active children, and healthy caries-free children. This association can be helpful in identifying the possible genetic predisposition and early prediction of dental caries in CP children, so as to initiate oral health measures at an early stage. **CLINICAL SIGNIFICANCE:** Maintaining oral hygiene has always been a challenge in children because of many difficulties like behavior management and lack of dexterity, and it becomes all the more difficult in the case of children with special needs. Dermatoglyphics can be proven to be a very useful, noninvasive, and economical tool for the preliminary diagnosis of diseases of suspected genetic origin like dental caries and CP. **HOW TO CITE THIS ARTICLE:** Somani R, Gupta MP, et al. Dermatoglyphics as a Noninvasive Tool for Predicting Dental Caries in Cerebral Palsy and Healthy Children: An In Vivo Study. *Int J Clin Pediatr Dent* 2019;12(3):237-242.

PMID: [31708622](#)

14. Management of gastroesophageal reflux disease in pediatric patients with cerebral palsy.

Fernando T, Goldman RD.

Can Fam Physician. 2019 Nov;65(11):796-798.

Question As a family physician who provides care to a large pediatric population in the community, I see children with various neurologic impairments, many with cerebral palsy (CP), presenting with gastroesophageal reflux disease (GERD). What are the current recommendations to manage GERD in pediatric patients with CP? **Answer** A variety of lifestyle modifications can be used to manage GERD in pediatric patients with CP, including raising the head of the patient's bed, reducing patient weight, limiting exposure to smoke, and avoiding caffeine, spicy foods, fatty foods, and chocolate. The primary pharmacologic treatments currently recommended are histamine-2 receptor antagonists and proton pump inhibitors. Surgical treatments for GERD, like the Nissen fundoplication, might result in complications, so there is ongoing research looking at the benefits of using high-pectin diets, baclofen, and prokinetic agents like mosapride instead.

PMID: [31722910](#)

15. Topography of behavior problems among children with neurodevelopmental conditions: Profile differences and overlaps.

Gardiner E, Miller AR, Lach LM.

Child Care Health Dev. 2019 Nov 12. doi: 10.1111/cch.12720. [Epub ahead of print]

BACKGROUND: This exploratory proof of principle study examined the extent to which behavior problems represent a functional characteristic that crosses diagnostic boundaries. **METHODS:** This cross-sectional study pertains to 179 caregivers of children, aged 4-13 years ($M = 8.27$) with cerebral palsy ($n = 77$), autism spectrum disorder ($n = 58$), and global developmental delay/intellectual disability ($n = 44$). Caregivers completed the Strengths and Difficulties Questionnaire, which provides a measure of conduct problems, emotional symptoms, hyperactivity-inattention, peer problems, as well as total difficulties. **RESULTS:** Behavior problem severity differed across diagnostic groups ($p < .001$). Visual examination of box plots indicated substantial overlap within Strengths and Difficulties Questionnaire subscales across children with autism spectrum disorder, cerebral palsy, and global developmental delay/intellectual disability. Children within each condition demonstrated matching profile topographies, such that hyperactivity-inattention difficulties were most severe. Repeated measures analysis of variances confirmed that children within each group received significantly higher ratings on the hyperactivity-inattention subscale (all $p < .001$). **CONCLUSIONS:** The approach adopted to examine the data and findings have the potential to inform how we conceptualize and study behavior problems among children with neurodevelopmental conditions. Importantly, children with particular conditions did not demonstrate unique constellations of difficulties. Clinicians must therefore be attuned to the possibility of commonality in behavior problems across children with disparate diagnoses, irrespective of syndrome-specific expectations.

PMID: [31714607](#)

16. A systematic review on quality of life assessment in adults with cerebral palsy: Challenging issues and a call for research.

Alves-Nogueira AC, Silva N, McConachie H, Carona C.

Res Dev Disabil. 2019 Nov 6;96:103514. doi: 10.1016/j.ridd.2019.103514. [Epub ahead of print]

BACKGROUND AND AIMS: Little is known about the quality of life (QoL) of adults with cerebral palsy (CP). This systematic review aimed to examine the extent to which methodological best practices have been applied to achieve valid and informative QoL assessments for this population. **METHODS AND PROCEDURES:** Systematic search identified 1097 non-duplicated, quantitative articles assessing self- and/or proxy-reported QoL in samples of adults with CP. Eighteen studies were included and data extraction was conducted for sampling characteristics, selection of informants (self- and proxy-reports), adequacy of administered measures, and examination of age-related specificities. **OUTCOMES AND RESULTS:** The results revealed discrepancies between conceptual definitions of QoL and their measurement approaches in CP. Most papers relied on self-reports. Most studies were cross-sectional and often based on relatively small samples; the variable of age was considered inconsistently in statistical analyses. **CONCLUSIONS AND IMPLICATIONS:** Future strategies to improve the validity and applicability of QoL assessments of adults with CP would include: using a clear definition of QoL aligned with the measurement employed; considering proxy-reports whenever appropriate, to encompass larger samples and a wider range of ability; and using age-stratified analyses, in order to deepen understanding of potentially modifiable variables and paths linked to QoL outcomes.

PMID: [31706133](#)

17. Accessible digital assessments of temporal, spatial, or movement concepts for profoundly motor impaired and non-verbal individuals: a pilot study.

Moseley M, Howat L, McLoughlin L, Gilling S, Lewis D.

Disabil Rehabil Assist Technol. 2019 Nov 15:1-11. doi: 10.1080/17483107.2019.1683240. [Epub ahead of print]

Purpose: Here we present a study of two new Assistive Technology (AT) accessible digital assessments which were developed to address the current paucity of (English) spoken language comprehension assessments accessible to individuals who are both non-verbal and have profound motor impairments. Such individuals may rely heavily upon AT for communication and control. However, many assessments require that responses are given either verbally, by physical pointing or manipulating physical objects. A further problem with many assessments is their reliance upon static images to represent language components involving temporal, spatial or movement concepts. These new assessments aim to address some of these issues. **Materials and methods:** The assessments were used with 2 young people who are non-verbal and have profound motor impairments (GMFCS level IV/V) and who use eye gaze as their primary method of communication and access. One assessment uses static images and the other short video clips to represent concepts containing temporal, spatial or movement elements. The assessments were carried out with each participant, both before and after an intervention, as part of a larger study. **Results:** The assessments were accessible using AT (eye gaze) for both participants, although assessment scores varied. The design of the assessments particularly suited one participant who scored near maximum, but they appeared less suitable for the other participant. **Conclusions:** Making assessments AT accessible removes a barrier to assessing aspects of the spoken language comprehension abilities of some. Video may be a better medium for representing certain concepts within assessments compared with static images. **IMPLICATIONS FOR REHABILITATION** The new assessments provided a deeper understanding of two members of a group who are traditionally difficult to assess, using two alternative physically accessible methods of assessing the spoken language comprehension of the target group; Accessible assessments are important for assessing complex individuals in order to identify knowledge limitations and set therapy (and education) goals; The alternative access features of communication software can provide a "wrapper" for providing accessibility features to assessments; Video clips may be a better means of representing certain concepts in assessments compared to their static equivalents; Ensuring that assessments are physically accessible is sufficient for the assessment of some individuals, but for some "cognitive" accessibility also needs to be considered.

PMID: [31729265](#)

18. BCI controlled robotic arm as assistance to the rehabilitation of neurologically disabled patients.

Casey A, Azhar H, Grzes M, Sakel M.

Disabil Rehabil Assist Technol. 2019 Nov 11:1-13. doi: 10.1080/17483107.2019.1683239. [Epub ahead of print]

Purpose: Brain-computer interface (BCI)-controlled assistive robotic systems have been developed with increasing success with the aim to rehabilitation of patients after brain injury to increase independence and quality of life. While such systems may use surgically implanted invasive sensors, non-invasive alternatives can be better suited due to the ease of use, reduced cost, improvements in accuracy and reliability with the advancement of the technology and practicality of use. The consumer-grade BCI devices are often capable of integrating multiple types of signals, including Electroencephalogram (EEG) and Electromyogram (EMG) signals. **Materials and Methods:** This paper summarizes the development of a portable and cost-efficient BCI-controlled assistive technology using a non-invasive BCI headset "OpenBCI" and an open source robotic arm, U-Arm, to accomplish tasks related to rehabilitation, such as access to resources, adaptability or home use. The resulting system used a combination of EEG and EMG sensor readings to control the arm. To avoid risks of injury while the device is being used in clinical settings, appropriate measures were incorporated into the software control of the arm. A short survey was used following the system usability scale (SUS), to measure the usability of the technology to be trialed in clinical settings. **Results:** From the experimental results, it was found that EMG is a very reliable method for assistive technology control, provided that the user specific EMG calibration is done. With the EEG, even though the results were promising, due to insufficient detection of the signal, the controller was not adequate to be used within a neurorehabilitation environment. The survey indicated that the usability of the system is not a barrier for moving the system into clinical trials. **Implication on rehabilitation** For the rehabilitation of patients suffering from neurological disabilities (particularly those suffering from varying degrees of paralysis), it is necessary to develop technology that bypasses the limitations of their condition. For example, if a patient is unable to walk due to the unresponsiveness in their motor neurons, technology can be developed that used an alternate input to move an exoskeleton, which enables the patient to walk again with the assistance of the exoskeleton. This research focuses on neuro-rehabilitation within the framework of the NHS at the Kent and Canterbury Hospital in UK. The hospital currently does not have any system in place for self-driven rehabilitation and instead relies on traditional rehabilitation methods through assistance from physicians and exercise regimens to maintain muscle movement. This paper summarises the development of a portable and cost-efficient BCI controlled assistive technology using a non-invasive BCI headset "OpenBCI" and an open source robotic arm, U-Arm, to accomplish tasks related to rehabilitation, such as access to resources, adaptability or home use. The resulting system used a combination of EEG and EMG sensor readings to control the arm, which could perform a number of different tasks such as picking/placing objects or assist users in eating.

PMID: [31711336](#)

19. Cerebral Palsy in Children With Congenital Zika Syndrome: A 2-Year Neurodevelopmental Follow-up.

Carvalho AL, Ventura P, Taguchi T, Brandi I, Brites C, Lucena R.

J Child Neurol. 2019 Nov 13:883073819885724. doi: 10.1177/0883073819885724. [Epub ahead of print]

OBJECTIVE: To describe the 2-year neurodevelopmental outcome in children with cerebral palsy associated with congenital Zika (CZ) and explore variables associated with a more severe presentation. **METHODS:** Data on 69 children with cerebral palsy associated with CZ, followed in a neurorehabilitation hospital, who consecutively attended the neurodevelopmental assessment at 2 years of age, were collected. Bayley III Scales of Infant and Toddler Development, Hammersmith Infant Neurological Examination, and Gross Motor Function Classification System were used for the outcome evaluation. Descriptive and inferential statistical analysis were performed. **RESULTS:** The median age at follow-up was of 24.0 (23-32) months. Only 3 (4.3%) children were not microcephalic. The majority presented with bilateral (94.2%), spastic (100.0%), Gross Motor Function Classification System grade IV or V (92.8%) cerebral palsy, epilepsy (73.1%), extremely low performances on cognitive (94.2%), language (95.7%), and motor (95.7%) Bayley-III Scales of Infant and Toddler Development Test scores. The median Hammersmith Infant Neurological Examination score was of 21.0 (range 9-75). There was a correlation between birth head circumference with the cognitive ($r = 0.3$, $P < .01$), language ($r = 0.3$, $P < .01$), and motor ($r = 0.3$, $P < .01$) Bayley-III Scales of Infant and Toddler Development Test scores, as well as with the Hammersmith Infant Neurological Examination score ($r = 0.2$, $P < .03$). An association was observed between an inferior median Hammersmith Infant Neurological Examination score with congenital microcephaly ($P = .04$), arthrogryposis ($P = .02$), and epilepsy in the first year ($P < .01$). **CONCLUSION:** Cerebral palsy related to CZ presents with a severe global impairment at a 2-year follow-up. Birth head circumference, arthrogryposis, and early epilepsy are associated with a worse outcome and may be considered as prognostic markers. These findings are important for the neurorehabilitation planning, parents' guiding, and future prognostic studies.

PMID: [31718421](#)

20. Childhood Disability and Nutrition: Findings from a Population-Based Case Control Study in Rural Bangladesh.

Jahan I, Karim T, Al Imam MH, Das MC, Ali KM, Muhit M, Khandaker G.

Nutrients. 2019 Nov 11;11(11). pii: E2728. doi: 10.3390/nu11112728.

BACKGROUND: Evidence regarding the complex relationship between childhood disability and malnutrition is limited in low and middle income countries. We aimed to measure the association between childhood disability and malnutrition in rural Bangladesh. **METHOD:** We conducted a population-based case control study among children aged <18 years in a rural sub-district (i.e., Shahjhadpur) in Bangladesh. Children with permanent disability (i.e., Cases) and their age/sex-matched peers (i.e., Controls) were identified from the local community utilizing the key informant method. Socioeconomic, anthropometric, and educational information was collected using a pre-tested questionnaire. Only Cases underwent detailed medical assessment for clinical and rehabilitation information. Descriptive and bivariate analyses were performed. **RESULTS:** Between October 2017 and February 2018, 1274 Cases and 1303 Controls were assessed. Cases had 6.6 times and 11.8 times higher odds of being severely underweight and severely stunted respectively than Controls. Although epileptic children had the highest overall prevalence of malnutrition, the age/sex-adjusted odds of malnutrition were significantly higher among children with physical impairments. Underweight and/or stunting among children with disability was significantly associated with parental educational qualification, socioeconomic status and mainstream school attendance. **CONCLUSION:** The significantly high proportion of severe malnutrition among children with disability calls for urgent action and implementation of inclusive nutrition intervention programs in rural Bangladesh.

PMID: [31717926](#)**21. Low-Trauma Fracture Increases 12-Month Incidence of Cardiovascular Disease for Adults With Cerebral Palsy.**

Whitney DG, Whitney RT, Prisby RD, Jepsen KJ.

J Orthop Res. 2019 Nov 11. doi: 10.1002/jor.24515. [Epub ahead of print]

Individuals with cerebral palsy (CP) have poor skeletal and cardiovascular health. However, no studies have examined if skeletal fragility enhances cardiovascular disease (CVD) risk for this population. The purpose of this study was to determine whether adults with CP have higher 12-month CVD incidence following a low-trauma fracture compared with adults without CP. Data, from the Optum Clinformatics® Data Mart, were extracted from adults (18+ years) that sustained a low-trauma fracture between 01/01/2012 and 12/31/2016. The primary outcome measure was incident CVD within 12 months following a low-trauma fracture. Cox proportional hazards regression models were used to compare 12-month incident CVD with adjustment for sociodemographics and chronic disease comorbidities. Mean age (SD) at baseline was 54.7 (18.9) for adults with CP (n = 1,025, 43.3% men) and 60.4 (19.7) for adults without CP (n = 460,504, 33.7% men). During the follow-up, 121 adults with CP (11.8%, mean age [SD] = 63.9 [16.3]) and 45,330 adults without CP (9.8%, mean age [SD] = 74.5 [11.9]) developed CVD. In the fully adjusted model, adults with CP had higher 12-month post-fracture CVD incidence (hazard ratio [HR] = 1.63; 95% confidence interval [CI] = 1.37-1.95). When the outcome was stratified by CVD subtype, adults with CP had higher 12-month post-fracture incidence of ischemic heart disease (HR = 1.45; 95% CI = 1.09-1.92), heart failure (HR = 1.68; 95% CI = 1.22-2.31), and cerebrovascular disease (HR = 1.96; 95% CI = 1.54-2.50). Study findings suggest that among adults with CP, low-trauma fracture may enhance 12-month CVD incidence compared with adults without CP. © 2019 Orthopaedic Research Society. Published by Wiley Periodicals, Inc. J Orthop Res.

PMID: [31710380](#)**22. MRI safety and imaging artifacts evaluated for a cannulated screw used for guided growth surgery.**

Thompson RM, Fowler E, Culo B, Shellock FG.

Magn Reson Imaging. 2019 Nov 5. pii: S0730-725X(19)30371-6. doi: 10.1016/j.mri.2019.11.005. [Epub ahead of print]

OBJECTIVE: Percutaneously-placed cannulated screws are the implant of choice for treatment of skeletal deformity associated with growing children that have spastic cerebral palsy (CP). These patients often require MRI examinations throughout their childhood to evaluate associated comorbidities and frequently for research protocols. There are concerns related to the use of MRI when metallic implants are present. Therefore, this study characterized MRI safety and imaging artifacts for a cannulated screw commonly used for guided growth. **METHODS:** Standardized and well-accepted in vitro techniques were used to evaluate a cannulated screw (4.5 mm diameter x 50 mm length, 316 L stainless steel) for MRI issues. Static magnetic field

interactions (i.e., translational attraction and torque) and artifacts were tested at 3-Tesla. Radiofrequency-related heating was assessed at 1.5-Tesla/64-MHz and 3-Tesla/128-MHz using relatively high levels of RF energy (whole-body averaged specific absorption rates of 2.7 W/kg and 2.9-W/kg, respectively). Artifacts were determined using T1-weighted, spin echo and gradient echo pulse sequences. RESULTS: The cannulated screw exhibited minor magnetic field interactions (14° deflection angle, no torque). The highest temperature changes at 1.5-Tesla/64-MHz and 3-Tesla/128-MHz MRI were 2.1 °C and 2.4 °C, respectively. The maximum artifact size on a gradient echo sequence extended 20 mm relative to the dimensions of the implant. CONCLUSIONS: The in vitro tests performed on the cannulated screw indicated that there were no substantial concerns with respect to the use of 1.5- and 3-Tesla MRI. Therefore, a patient with this cannulated screw can safely undergo MRI by following specific conditions to ensure safety.

PMID: [31704394](#)

23. Early prediction of unilateral cerebral palsy in infants at risk: MRI versus the hand assessment for infants.

Wagenaar N, Verhage CH, de Vries LS, van Gasselt BPL, Koopman C, Leemans A, Groenendaal F, Benders MJNL, van der Aa NE.

Pediatr Res. 2019 Nov 13. doi: 10.1038/s41390-019-0664-5. [Epub ahead of print]

INTRODUCTION: Neonates with unilateral perinatal brain injury (UPBI) are at risk for developing unilateral spastic cerebral palsy (USCP). This study compares several predictors for USCP later in life. METHODS: Twenty-one preterm and 24 term born infants with UPBI were included, with an MRI scan including diffusion tensor imaging (DTI) performed at term equivalent age or around 3 months after birth, respectively. T2-weighted images and DTI-based tractography were used to measure the surface area, diameter, and fractional anisotropy (FA) of both corticospinal tracts (CSTs). The hand assessment for infants (HAI) was performed before 5, between 5 and 8 and between 8 and 12 months of (corrected) age. Asymmetry indices were derived from all techniques and related to USCP at ≥ 2 years of age. RESULTS: MRI measures and HAI scores were significantly lower for the affected compared to the unaffected side. Before 5 months of age, FA asymmetry on DTI yielded the highest area under the curve compared to conventional MRI and HAI. CONCLUSIONS: Prediction of USCP after UPBI is reliable using asymmetry of the CST on MRI, as well as clinical hand assessment. Before 5 months of age, DTI tractography provides strongest predictive information, while HAI specifically aids to prognosis of USCP at later age points.

PMID: [31722367](#)

24. The Predictive Accuracy of the General Movement Assessment for Cerebral Palsy: A Prospective, Observational Study of High-Risk Infants in a Clinical Follow-Up Setting.

Støen R, Boswell L, de Regnier RA, Fjørtoft T, Gaebler-Spira D, Ihlen E, Labori C, Loennecken M, Msall M, Möinichen, Peyton C, Russow A, Schreiber MD, Silberg IE, Songstad NT, Vågen R, Øberg GK, Adde L.

J Clin Med. 2019 Oct 25;8(11). pii: E1790. doi: 10.3390/jcm8111790.

BACKGROUND: Early prediction of cerebral palsy (CP) using the General Movement Assessment (GMA) during the fidgety movements (FM) period has been recommended as standard of care in high-risk infants. The aim of this study was to determine the accuracy of GMA, alone or in combination with neonatal imaging, in predicting cerebral palsy (CP). METHODS: Infants with increased risk of perinatal brain injury were prospectively enrolled from 2009-2014 in this multi-center, observational study. FM were classified by two certified GMA observers blinded to the clinical history. Abnormal GMA was defined as absent or sporadic FM. CP-status was determined by clinicians unaware of GMA results. RESULTS: Of 450 infants enrolled, 405 had scorable video and follow-up data until at least 18-24 months. CP was confirmed in 42 (10.4%) children at mean age 3 years 1 month. Sensitivity, specificity, positive and negative predictive values, and accuracy of absent/sporadic FM for CP were 76.2, 82.4, 33.3, 96.8, and 81.7%, respectively. Only three (8.1%) of 37 infants with sporadic FM developed CP. The highest accuracy (95.3%) was achieved by a combination of absent FM and abnormal neonatal imaging. CONCLUSION: In infants with a broad range of neonatal risk factors, accuracy of early CP prediction was lower for GMA than previously reported but increased when combined with neonatal imaging. Sporadic FM did not predict CP in this study.

PMID: [31717717](#)

25. Periventricular Hemorrhagic Infarction in Very Preterm Infants: Characteristic Sonographic Findings and Association with Neurodevelopmental Outcome at Age 2 Years.

Cizmeci MN, de Vries LS, Ly LG, van Haastert IC, Groenendaal F, Kelly EN, Traubici J, Whyte H, Leijser LM.

J Pediatr. 2019 Nov 6. pii: S0022-3476(19)31319-8. doi: 10.1016/j.jpeds.2019.09.081. [Epub ahead of print]

OBJECTIVE: To describe the sonographic characteristics of periventricular hemorrhagic infarction (PVHI) and their association with mortality and neurodevelopmental disability in very preterm infants born in 2008-2013. **STUDY DESIGN:** Retrospective multicenter observational cohort study. Diagonal PVHI size was measured and severity score assessed. PVHI characteristics were scored and temporal trends were assessed. Neurodevelopmental outcome at 2 years of corrected age was assessed using either the Bayley Scales of Infant and Toddler Development, Third Edition or the Griffiths Mental Development Scales. Multigroup analyses were applied as appropriate. **RESULTS:** We enrolled 160 infants with median gestational age of 26.6 weeks. PVHI was mostly unilateral (90%), associated with an ipsilateral grade III intraventricular hemorrhage (84%), and located in the parietal lobe (51%). Sixty-four (40%) infants with PVHI died in the neonatal period. Of the survivors assessed at 2 years of corrected age, 65% had normal cognitive and 69% had normal motor outcomes. The cerebral palsy rate was 42%. The composite outcome of death or severe neurodevelopmental disability was observed in 58%, with no trends over the study period ($P = .6$). Increasing PVHI severity score was associated with death ($P < .001$). Increasing PVHI size and severity score were negatively associated with gross motor scores ($P = .01$ and $.03$, respectively). Trigone involvement was associated with cerebral palsy (41% vs 14%; $P = .004$). Associated posthemorrhagic ventricular dilation (36%) was an independent risk factor for poorer cognitive and motor outcomes ($P < .001$ for both). **CONCLUSIONS:** Increasing PVHI size and severity score were predictive of less optimal gross motor outcome and death in very preterm infants.

PMID: [31706634](#)

26. Infantile Onset of Spinocerebellar Ataxia Type 5 (SCA-5) in a 6 Month Old with Ataxic Cerebral Palsy.

Rea G, Tirupathi S, Williams J, Clouston P, Morrison PJ.

Cerebellum. 2019 Nov 12. doi: 10.1007/s12311-019-01085-7. [Epub ahead of print]

Spinocerebellar ataxia type 5 (SCA-5) is a predominantly slowly progressive adult onset ataxia. We describe a child with a presentation of ataxic cerebral palsy (CP) and developmental delay at 6 months of age. Genetic testing confirmed a c.812C>T p.(Thr271Ile) mutation within the SPTBN2 gene. Seven previous cases of infantile onset SCA-5 are reported in the literature, four of which had a CP presentation. Early onset of SCA-5 presents with ataxic CP and is a rare cause of cerebral palsy.

PMID: [31721007](#)

27. The Effect of Botulinum Toxin Injections on Gross Motor Function for Lower Limb Spasticity in Children with Cerebral Palsy.

Choi JY, Kim SK, Park ES.

Toxins (Basel). 2019 Nov 8;11(11). pii: E651. doi: 10.3390/toxins11110651.

The aim of this study was to investigate the use of botulinum toxin type A (BoNT-A) injections and their efficacy on gross motor function for lower limb spasticity in children with spastic cerebral palsy (CP). This retrospective study included 919 injection occasions from 591 children with CP who received a lower limb BoNT-A injection between 2006 and 2016. The Gross Motor Function Measure (GMFM-88), the Modified Ashworth Scale, and the Modified Tardieu Scale were administered before and after injections. Injections were predominantly administered to children under the age of 6 years. The most common muscle injection site was the calf muscle for dynamic foot deformity. The second most commonly injected muscle was the hip adductor among 2-3 year olds and the hamstring muscle among 4-6 year olds. Distal injections were predominantly administered to high-functioning children, whereas proximal injections were typically administered to low-functioning children. Multilevel injections were mostly administered to midfunctioning children. GMFM-88 scores significantly increased post-injection for both high- and low-functioning groups. Younger age at injection and distal injection type were associated

with larger improvements on the GMFM-88 at both short- and midterm follow-up. The target muscles for injection varied depending on gross motor functioning and age. Younger age at injection and distal injection type were significantly related with greater gain in gross motor function.

PMID: [31717282](#)

28. Growth disorders in children and adolescents affected by syndromes or diseases associated with neurodysfunction.

Perenc L, Guzik A, Podgórska-Bednarz J, Drużbicki M.

Sci Rep. 2019 Nov 11;9(1):16436. doi: 10.1038/s41598-019-52918-8.

We have observed that one in three patients admitted to the Neurological Rehabilitation Ward for Children and Adolescents due to a syndrome or disease associated with neurodysfunction is short of stature for their age. In order to identify the relationship between growth defects (short stature) and syndromes or diseases associated with neurodysfunction, we analyzed data collected during admission to the Neurological Rehabilitation Ward for Children and Adolescents. The study applied a retrospective analysis of data collected during hospitalization of 327 children and adolescents, aged 4-18 years, affected by congenital disorders of the nervous system and/or neurological syndromes associated with a minimum of one neurodysfunction. Two assessment systems were taken into account - one system traditionally applied, and another one in accordance with indications approved by the Food and Drug Administration, related to diagnosing short stature. The findings show more frequent co-occurrence of, as well as statistically significant correlations between, short stature in certain groups: operated myelomeningocele with hydrocephalus in the subgroup of neural tube defects ($p = 0.029$), tetraplegia in the subgroup of spastic cerebral palsy ($p < 0.001$), and hypothyroidism ($p = 0.04$) in the entire study group.

PMID: [31712660](#)

29. A Rare Cause of Septic Shock in the Emergency Department in an Intellectually-Disabled Child.

Ravi C, Glass NE, Josyabhatla R, Monteiro I, Sinha V, Kondamudi N.

J Emerg Med. 2019 Nov 7. pii: S0736-4679(19)30814-5. doi: 10.1016/j.jemermed.2019.09.031. [Epub ahead of print]

BACKGROUND: Sepsis in older children is often associated with the presence of developmental abnormalities and cerebral palsy. While relatively uncommon, surgical abdomen in these patients is associated with a high rate of mortality. Few reports have been described of sepsis caused by isolated cecal necrosis. **CASE REPORT:** We report a 13-year-old child with cerebral palsy and global developmental delay who presented to the emergency department with acute worsening abdominal distention that the mother attributed to chronic constipation. Clinical evaluation revealed that she was in severe septic shock and needed immediate stabilization after which she underwent an exploratory laparotomy. Operative findings revealed cecal necrosis that necessitated an ileocecectomy. **WHY SHOULD AN EMERGENCY PHYSICIAN BE AWARE OF THIS?:** Children with intellectual disabilities presenting with sepsis to the emergency department can be particularly challenging given the communication barriers and the time-sensitive nature of the condition. When evaluating these patients, a thorough history and examination are often the only tools that assist in the early identification of the infectious source, leading to improved clinical outcomes. © 2019 Elsevier Inc.

PMID: [31708322](#)

Prevention and Cure

30. Comparative Efficacy and Safety of Neuroprotective Therapies for Neonates With Hypoxic Ischemic Encephalopathy: A Network Meta-Analysis.

Lee CYZ, Chakranon P, Lee SWH.

Front Pharmacol. 2019 Oct 25;10:1221. doi: 10.3389/fphar.2019.01221. eCollection 2019.

Context: Several interventions are available for the management of hypoxic ischemic encephalopathy (HIE), but no studies

have compared their relative efficacy in a single analysis. This study aims to compare and determine the effectiveness of available interventions for HIE using direct and indirect data. Methods: Large randomized trials were identified from PubMed, EMBASE, CINAHL Plus, AMED, and Cochrane Library of Clinical Trials database from inception until June 30, 2018. Two independent reviewers extracted study data and performed quality assessment. Direct and network meta-analysis of randomized controlled trials was performed to obtain pooled results comparing the effectiveness of different therapies used in HIE on mortality, neurodevelopmental delay at 18 months, as well as adverse events. Their probability of having the highest efficacy and safety was estimated and ranked. The certainty of evidence for the primary outcomes of mortality and mortality or neurodevelopmental delay at 18 months was evaluated using GRADE criteria. Results: Fifteen studies comparing five interventions were included in the network meta-analysis. Whole body cooling [Odds ratio: 0.62 (95% credible interval: 0.46-0.83); 8 trials, high certainty of evidence] was the most effective treatment in reducing the risk of mortality, followed by selective head cooling (0.73; 0.48-1.11; 2 trials, moderate certainty of evidence) and use of magnesium sulfate (0.79; 0.20-3.06; 2 trials, low certainty of evidence). Whole body hypothermia (0.48; 0.33-0.71; 5 trials), selective head hypothermia (0.54; 0.32-0.89; 2 trials), and erythropoietin (0.36; 0.19-0.66; 2 trials) were more effective for reducing the risk of mortality and neurodevelopmental delay at 18 months (moderate to high certainty). Among neonates treated for HIE, the use of erythropoietin (0.36; 0.18-0.74, 2 trials) and whole body hypothermia (0.61; 0.45-0.83; 7 trials) were associated with lower rates of cerebral palsy. Similarly, there were lower rates of seizures among neonates treated with erythropoietin (0.35; 0.13-0.94; 1 trial) and whole body hypothermia (0.64; 0.46-0.87, 7 trials). Conclusion: The findings support current guidelines using therapeutic hypothermia in neonates with HIE. However, more trials are needed to determine the role of adjuvant therapy to hypothermia in reducing the risk of mortality and/or neurodevelopmental delay.

PMID: [31708771](#)