

Monday 11 June 2012

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## Interventions and Management

**1. J Biomech. 2012 May 31. [Epub ahead of print]**

**Validity and reliability of shoulder kinematics in typically developing children and children with hemiplegic cerebral palsy.**

Lempereur M, Brochard S, Mao L, Rémy-Néris O.

Laboratoire de Traitement de l'Information Médicale INSERM U1101, Brest, France; Université de Bretagne Occidentale, Brest, France; CHRU de Brest, Hôpital Morvan, service de médecine physique et de réadaptation, Brest, France.

Shoulder motion has been mainly analysed in children based on thoraco-humeral (TH) joint kinematics, excluding the scapula-thoracic (ST) and gleno-humeral (GH) joints. In order to measure 3D scapulo-humeral motion using an optoelectronic system, we propose a protocol based on an acromion marker cluster (AMC), a functional method to determine the gleno-humeral rotation centre and different Euler sequences. This study investigated the validity of the AMC compared to the palpation of anatomical landmarks with a scapula locator, assessed the intra-session repeatability and the ability to discriminate differences of such a protocol in 10 typically developing children (TD) and 10 children with hemiplegic cerebral palsy (HCP) during 6 different tasks (flexion, abduction, horizontal abduction, hand to head, hand to contralateral shoulder and hand to back pocket). For both populations, the AMC method showed an overall Root Mean Square Error (RMSE) of 5.5°. The AMC method under-estimated the protraction/retraction of the scapula during abduction. The within-session reliability was good to excellent for all tasks except the hand to back pocket task. The YXY recommended Euler sequence for TH and GH joints resulted in gimbal lock for most of the tasks whereas the XZY sequence could be used for most of the tasks and most of the children.

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[PMID: 22658078](https://pubmed.ncbi.nlm.nih.gov/22658078/) [PubMed - as supplied by publisher]

**2. Neurorehabil Neural Repair. 2012 Jun 6. [Epub ahead of print]****Neuroradiology Can Predict the Development of Hand Function in Children With Unilateral Cerebral Palsy.**

Holmefur M, Kits A, Bergström J, Krumlinde-Sundholm L, Flodmark O, Forssberg H, Eliasson AC.

**BACKGROUND:** Much variation is found in the development of hand function in children with unilateral cerebral palsy (CP). **OBJECTIVE:** To explore how anatomic brain abnormalities can be used to predict the development of hand function. **METHODS:** A total of 32 children with unilateral CP (16 boys and 16 girls) were evaluated at least once a year by the Assisting Hand Assessment (AHA). The data collection covered an age range from 18 months to 8 years (mean time in study, 4 years and 6 months). Computerized tomography or magnetic resonance imaging of the brain were assessed for patterns of brain damage, including the location of gray and extent of white-matter damage. The children were divided into groups according to lesion characteristics, and a series of univariate models were analyzed with a nonlinear mixed-effects model. The rate and maximum limit of development were calculated. **RESULTS:** The highest predictive power of better development of hand function was the absence of a concurrent lesion to the basal ganglia and thalamus, independent of the basic type of brain lesion. This model predicted both the rate of increasing ability and hand function at age 8 years. Hand function was also predicted by the basic pattern of damage and by the extent of white-matter damage. The presence of unilateral or bilateral damage had no predictive value. **CONCLUSIONS:** Neuroradiological findings can be used to make a crude prediction of the future development of the use of the affected hand in young children with unilateral CP.

[PMID: 22677505](#) [PubMed - as supplied by publisher]

**3. Clin Orthop Surg. 2012 Jun;4(2):149-55. Epub 2012 May 17.****Pitfalls and important issues in testing reliability using intraclass correlation coefficients in orthopaedic research.**

Lee KM, Lee J, Chung CY, Ahn S, Sung KH, Kim TW, Lee HJ, Park MS.

Department of Orthopedic Surgery, Seoul National University Bundang Hospital, Seongnam, Korea.

**BACKGROUND:** Intra-class correlation coefficients (ICCs) provide a statistical means of testing the reliability. However, their interpretation is not well documented in the orthopedic field. The purpose of this study was to investigate the use of ICCs in the orthopedic literature and to demonstrate pitfalls regarding their use. **METHODS:** First, orthopedic articles that used ICCs were retrieved from the Pubmed database, and journal demography, ICC models and concurrent statistics used were evaluated. Second, reliability test was performed on three common physical examinations in cerebral palsy, namely, the Thomas test, the Staheli test, and popliteal angle measurement. Thirty patients were assessed by three orthopedic surgeons to explore the statistical methods testing reliability. Third, the factors affecting the ICC values were examined by simulating the data sets based on the physical examination data where the ranges, slopes, and interobserver variability were modified. **RESULTS:** Of the 92 orthopedic articles identified, 58 articles (63%) did not clarify the ICC model used, and only 5 articles (5%) described all models, types, and measures. In reliability testing, although the popliteal angle showed a larger mean absolute difference than the Thomas test and the Staheli test, the ICC of popliteal angle was higher, which was believed to be contrary to the context of measurement. In addition, the ICC values were affected by the model, type, and measures used. In simulated data sets, the ICC showed higher values when the range of data sets were larger, the slopes of the data sets were parallel, and the interobserver variability was smaller. **CONCLUSIONS:** Care should be taken when interpreting the absolute ICC values, i.e., a higher ICC does not necessarily mean less variability because the ICC values can also be affected by various factors. The authors recommend that researchers clarify ICC models used and ICC values are interpreted in the context of measurement.

[PMID: 22662301](#) [PubMed - in process] [PMCID: PMC3360188](#)

#### 4. Acta Orthop Traumatol Turc. 2012;46(3):196-200.

##### **Intraobserver reliability of modified Ashworth scale and modified Tardieu scale in the assessment of spasticity in children with cerebral palsy.**

Numanoglu A, Günel MK.

Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, Hacettepe University, Ankara, Turkey.

**OBJECTIVE:** The aim of this study was to analyze the intraobserver reliability of the Modified Ashworth Scale (MAS) and Modified Tardieu Scale (MTS) in the assessment of spasticity in children with cerebral palsy (CP). **METHODS:** Elbow flexor muscles, wrist flexor muscles, hip adductors, hamstrings, gastrocnemius and soleus muscles of 37 children (mean age: 8.97±4.41) with spastic CP were evaluated using the MAS and MTS according to the severity of spasticity. **RESULTS:** Intraobserver reliability of MAS was significant for all assessments ( $p < 0.01$ ) and reliability ranged from 'low' to 'average'. The reliability of MTS was significant for all assessments ( $p < 0.01$ ) and intraobserver reliability ranged among 'average', 'good' and 'excellent'. **CONCLUSION:** Although the high intraobserver reliability for MTS to assess spasticity level in muscles of children with CP will improve usage of this scale, new research testing the intraobserver reliability of this scale is needed.

[PMID: 22659636](#) [PubMed - in process]

#### 5. Clin Orthop Surg. 2012 Jun;4(2):139-48. Epub 2012 May 17.

##### **Early results of one-stage correction for hip instability in cerebral palsy.**

Kim HT, Jang JH, Ahn JM, Lee JS, Kang DJ.

Department of Orthopaedic Surgery, Pusan National University Hospital, Busan, Korea.

**BACKGROUND:** We evaluated the clinical and radiological results of one-stage correction for cerebral palsy patients. **METHODS:** We reviewed clinical outcomes and radiologic indices of 32 dysplastic hips in 23 children with cerebral palsy (13 males, 10 females; mean age, 8.6 years). Ten hips had dislocation, while 22 had subluxation. Preoperative Gross Motor Function Classification System (GMFCS) scores of the patients were as follows; level V (13 patients), level IV (9), and level III (1). Acetabular deficiency was anterior in 5 hips, superolateral in 7, posterior in 11 and mixed in 9, according to 3 dimensional computed tomography. The combined surgery included open reduction of the femoral head, release of contracted muscles, femoral shortening varus derotation osteotomy and the modified Dega osteotomy. Hip range of motion, GMFCS level, acetabular index, center-edge angle and migration percentage were measured before and after surgery. The mean follow-up period was 28.1 months. **RESULTS:** Hip abduction (median, 40°), sitting comfort and GMFCS level were improved after surgery, and pain was decreased. There were two cases of femoral head avascular necrosis, but no infection, nonunion, resubluxation or redislocation. All radiologic indices showed improvement after surgery. **CONCLUSIONS:** A single event multilevel surgery including soft tissue, pelvic and femoral side correction is effective in treating spastic dislocation of the hip in cerebral palsy.

[PMID: 22662300](#) [PubMed - in process] [PMCID: PMC3360187](#)

#### 6. Am J Phys Med Rehabil. 2012 May 31. [Epub ahead of print]

##### **Quantitative Analysis of Gait Coordination Based on Gait Events in Children with Cerebral Palsy.**

Chen L, Wang J, Gao L, Hassan E, Li H, Li S, Liao F.

From the Key Laboratory of Biomedical Information Engineering, Ministry of Education, Xi'an Jiaotong University, Xi'an, Shaanxi, PR China (LC, JW, LG, EH); Shaanxi Boai Hospital, Xi'an, Shaanxi, PR China (HL, SL); and Department of Rehabilitation Sciences, University of Oklahoma Health Sciences Center (FL).

**OBJECTIVE:** The objective of this study was to quantify gait coordination of the lower limbs in children with cerebral palsy (CP) based on gait events. **DESIGN:** The kinematic data of 50 children with typical development and

26 children with CP prerehabilitation and postrehabilitation were recorded. The hip and knee joint angles in the sagittal plane on both sides were obtained at six gait events. Then a gait coordination index (GCI) model was established based on the gait features extracted from the joint angles of the children with typical development using kernel-based principal component analysis, which was then used to calculate the GCI of children with CP. One-way analysis of variance was used to compare GCI and joint angles at each gait event. Intraclass correlation coefficient was calculated to evaluate the reliability of GCI in two trials separated by a day. RESULTS: GCI in children with CP postrehabilitation was significantly higher than that in the children with typical development ( $P < 0.05$ ) but significantly lower than that in children with CP prerehabilitation ( $P < 0.05$ ). There are significant differences in GCI for children with CP prerehabilitation between level I, level II, and level III ( $P < 0.05$ ). The results of intraclass correlation coefficients ( $>0.8$ ) indicated that the obtained GCIs were reliable. CONCLUSIONS: GCI can reflect gait coordination of lower limbs in children with CP and may be a useful tool for rehabilitation assessment.

[PMID: 22660366](#) [PubMed - as supplied by publisher]

## 7. NeuroRehabilitation. 2012 Jan 1;30(4):277-86.

### Neurorehabilitation with versus without resistance training after botulinum toxin treatment in children with cerebral palsy: A randomized pilot study.

Bandholm T, Jensen BR, Nielsen LM, Rasmussen H, Bencke J, Curtis D, Pedersen SA, Sonne-Holm S.

Gait Analysis Laboratory, Department of Orthopedic Surgery, Copenhagen University Hospital, Hvidovre, Denmark  
Department of Physical Therapy, Copenhagen University Hospital, Hvidovre, Denmark  
Clinical Research Center, Copenhagen University Hospital, Hvidovre, Denmark.

Objective: To compare the effects of physical rehabilitation with (PRT) and without (CON) progressive resistance training following treatment of spastic plantarflexors with botulinum toxin type A (BoNT) in children with cerebral palsy (CP). Methods: Fourteen children with CP performed supervised PRT ( $n=7$ ) or CON ( $n=7$ ) two times per week for 12 weeks, following the BoNT-treatment. Outcome measurements were performed at baseline (pre BoNT), and 4 and 12 weeks post BoNT. They consisted of: ankle muscle function (maximal torque and submaximal torque steadiness of isometric ankle dorsi- and plantarflexion and associated ankle muscle [EMG] activity), gait function (3-dimensional gait analysis), balance function (sway analysis), gross motor function (GMFM-66), and spasticity (modified Ashworth). Results: Submaximal torque control (torque steadiness) of isometric dorsiflexion improved similarly in the two groups, and the improvement was related to the reduction in antagonist (soleus) co-activity ( $P < 0.05$ ). Maximal plantarflexion torque increased after PRT, whereas a reduction was seen after CON ( $P < 0.05$ ). No changes in function were observed. Conclusions: Both types of physical rehabilitation in combination with BoNT-treatment improved antagonist (ankle dorsiflexion) torque-control to the same extent - which was related to the reduction in antagonist co-activity - but only rehabilitation with PRT increased maximal plantarflexion torque.

[PMID: 22672941](#) [PubMed - in process]

## 8. Dev Neurorehabil. 2012 Jun 6. [Epub ahead of print]

### Feasibility and preliminary effectiveness of a novel mobility training intervention in infants and toddlers with cerebral palsy.

Prosser LA, Ohlrich LB, Curatalo LA, Alter KE, Damiano DL.

Division of Rehabilitation Medicine, The Children's Hospital of Philadelphia, PA, USA.

Objective: To design a novel mobility training intervention incorporating infant motor learning and neurorehabilitation principles and investigate its feasibility, tolerability and effect on motor development in toddlers with cerebral palsy (CP). Methods: A single-subject research design with repeated measures during 6-week baseline and intervention phases and after treatment withdrawal was used. Five participants attended therapy utilizing novel dynamic weight assistance technology, which allowed practice of motor skills beyond participants' current abilities. Results: Average attendance and engagement rates exceeded 90%. Gains in gross motor function were observed after treatment that exceeded the expected rate in four of the five participants. Rates of motor development during treatment were 10.8, 3.8, 7.0, 15.1, and 0.3 times greater than during baseline for the five

participants, respectively. Conclusions: This intervention was tolerated and demonstrated the potential to alter the trajectory of motor development in CP, providing proof of concept for further investigation.

[PMID: 22670679](#) [PubMed - as supplied by publisher]

## **9. Am J Phys Med Rehabil. 2012 May 31. [Epub ahead of print]**

### **Virtual Electric Power Wheelchair Driving Performance of Individuals with Spastic Cerebral Palsy.**

Dicianno BE, Mahajan H, Guirand AS, Cooper RA.

From the Human Engineering Research Laboratories, Rehabilitation Research and Development Service, Department of Veterans Affairs, Pittsburgh, PA (BED, HM, ASG, RAC); Department of Rehabilitation Science and Technology, University of Pittsburgh, Pittsburgh, PA (BED, HM, RAC); and Department of Physical Medicine and Rehabilitation, University of Pittsburgh Medical Center, Pittsburgh PA (BED, ASG, RAC).

**OBJECTIVE:** Upper limb spasticity may impair the use of control interfaces such as joysticks for many individuals with disabilities such as cerebral palsy (CP). The aims of this study were to compare the driving performance of those with CP to that of control participants, to identify the impact of lead time on performance, and to compare two joystick designs, a standard movement sensing joystick and a novel isometric joystick. **DESIGN:** This study used a repeated-measures design to compare the performance of a group of participants with CP to that of participants without disabilities in a two-dimensional simulated driving task on a computer screen using the two control interfaces. The driving trials used varying "lead times," or the amount of warning time available to make movement decisions and turns. A total of 34 participants with CP and without disability were matched by age and sex into two groups. **RESULTS:** Participants with CP had lower driving performance in most variables of interest compared with controls. However, surprisingly, reducing lead time also reduced some performance errors, possibly because of more deliberate driving. The isometric joystick outperformed the movement sensing joystick in terms of performance errors but contributed to a prolonged reaction time. **CONCLUSIONS:** The isometric joystick was preferred by participants over the movement sensing joystick in this study and may be a future alternative for individuals with CP for both power mobility and computer access tasks.

[PMID: 22660370](#) [PubMed - as supplied by publisher]

## **10. Disabil Rehabil Assist Technol. 2012 Jun 5. [Epub ahead of print]**

### **The impact of switching on family caregivers of children with cerebral palsy.**

Nicolson A, Moir L, Millstead J.

Faculty of Computing, Health and Science, School of Exercise and Health Sciences, Edith Cowan University, Joondalup, Western Australia.

**Purpose:** This study aimed to enhance our knowledge and understanding of switching, as assistive technology, and how it impacts on family caregivers of children with cerebral palsy with GMFCS levels four or five. **Methods:** A qualitative method using a constructivist approach was adopted. Purposive sampling was used to recruit five caregivers to participants in this study. Framework analysis was applied to the data collection of semistructured interviews conducted with each caregiver. **Findings:** The three main themes identified were an investment in the future, resulting in joy and hope. The learning process of switching is resource intensive, time consuming and effortful for caregivers. If caregivers do not perceive this as an investment, then they may not experience the joy switching can bring to their child, and in turn the joy, hope, and caregiver satisfaction it can offer for the future. **Conclusion:** This research indicates that caregivers often have the greatest impact on whether switching will be adopted in the home. The greatest impact on caregivers is related to their perception on the competence of therapists and coordination of services provided.

[PMID: 22663015](#) [PubMed - as supplied by publisher]

**11. Appl Physiol Nutr Metab. 2012 Jun 5. [Epub ahead of print]****An exploratory study of sodium, potassium, and fluid nutrition status of tube-fed nonambulatory children with severe cerebral palsy.**

McGowan JE, Fenton TR, Wade AW, Branton JL, Robertson M.

Department of Nutrition Services, Neuroscience Program, Alberta Children's Hospital, Alberta Health Services, 2888 Shaganappi Trail NW, Calgary, AB T3B 6A8, Canada.

Children with severe cerebral palsy (CP) often have lower mineral intakes than healthy children. It is unknown if their lower nutrient intakes are adequate to meet their needs. The objective of this study was to examine the sodium, potassium, phosphate, and fluid status of primarily tube-fed nonambulatory children with severe CP. The design consisted of a cross-sectional exploratory study and a clinical trial of sodium supplementation. Nutritional status was determined among primarily tube-fed children (aged 2 to 17 years) with CP based on blood and urine samples, anthropometry, and 3-day food records. Mineral and fluid status was evaluated by a nephrologist blind to nutrient intakes. Twenty children supplied food records, blood samples, and anthropometric measurements, and 16 supplied urine samples. Six (37.5%) of those who provided urine samples were considered possibly dehydrated, as urine osmolality was  $>600$  mmol·kg<sup>-1</sup>. Six (60%) of the 10 children with satisfactory fluid status (low urine osmolality) were considered to have a possible dietary sodium deficiency based on a very low urine sodium concentration ( $<20$  mmol·L<sup>-1</sup>). Those considered to have a possible dietary sodium deficiency had a significantly lower sodium intake ( $48\% \pm 15\%$  Adequate Intake (AI)) compared with those considered sodium sufficient ( $73\% \pm 20\%$  AI) ( $p = 0.031$ ). One child was considered possibly phosphorus deficient, but none was assessed as likely potassium deficient. The conclusion was that sodium deficiencies were likely prevalent among the children. The findings from this small observational study suggest that sodium intakes for tube-fed children with CP should be maintained near the AI for their age. Hydration status of children receiving hypercaloric formulas should be monitored.

[PMID: 22667347](#) [PubMed - as supplied by publisher]

**12. Eur J Paediatr Neurol. 2012 May 30. [Epub ahead of print]****Feeding and communication impairments in infants with central grey matter lesions following perinatal hypoxic-ischaemic injury.**

Martinez-Biarge M, Diez-Sebastian J, Wusthoff CJ, Lawrence S, Aloysius A, Rutherford MA, Cowan FM.

Department of Paediatrics and Imaging Sciences, Imperial College London, Hammersmith Hospital Campus, London, United Kingdom; Department of Neonatology, La Paz University Hospital, Madrid, Spain.

**BACKGROUND:** Basal ganglia and thalamic (BGT) injury is common after acute perinatal hypoxia-ischaemia. Cerebral palsy is the most obvious consequence of BGT injury affecting 70-75% of survivors and is predictable from neonatal magnetic resonance imaging (MRI). However there is no equivalent predictive data for other specific outcomes. Feeding and communication impairments are also common in children following hypoxic-ischaemic encephalopathy (HIE) and BGT injury. **AIMS:** To describe, in infants with HIE and BGT injury, the prevalence of feeding and communication impairments; and to evaluate the accuracy of early MRI for predicting these outcomes. **METHODS:** 175 term infants with HIE and BGT injury were studied. Brain lesions were classified by site and severity from the MRI scans. Motor, feeding and communication impairments were documented at 2 years. **RESULTS:** Feeding and communication impairments occurred in 65% and 82% of 126 survivors respectively and related strongly to the severity of motor impairment. Forty-one children had a gastrostomy or long-term nasogastric tube. Injury severity in all brain regions was significantly associated with feeding and communication impairment on univariate analysis. On logistic regression analysis BGT (OR 10.9) and mesencephalic lesions (OR 3.7) were independently associated with feeding impairment; BGT (OR 10.5) and pontine lesions (OR 3.8) were associated with gastrostomy; the severity of BGT lesions (OR 20.1) was related to the severity of communication impairment. **CONCLUSIONS:** Feeding and communication impairment are very common in children with BGT and brainstem injury of neonatal origin and can be well predicted from early MRI scans.

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[PMID: 22658307](#) [PubMed - as supplied by publisher]

**13. Child Care Health Dev. 2012 Jun 8. doi: 10.1111/j.1365-2214.2012.01391.x. [Epub ahead of print]**

**Predicting leisure participation of school-aged children with cerebral palsy: longitudinal evidence of child, family and environmental factors.**

Bult MK, Verschuren O, Lindeman E, Jongmans MJ, Westers P, Claassen A, Ketelaar M.

Rudolph Magnus Institute of Neuroscience and Center of Excellence for Rehabilitation Medicine, University Medical Center Utrecht and Rehabilitation Center de Hoogstraat Partner of NetChild, Network for Childhood Disability Research in the Netherlands Department of Neonatology, Wilhelmina Children's Hospital, University Medical Center Utrecht Department of Special Education, Faculty of Social Sciences, Utrecht University Julius Center for Health Sciences and Primary Care, University Medical Center Utrecht, Utrecht, the Netherlands.

Objective: This longitudinal study aims to determine which child, family and environmental variables measured at 2 years of age predict leisure participation in formal and informal activities in school aged children with cerebral palsy (CP). Methods: Parents of 46 children with CP (mean age at baseline: 2 years 6 months, SD 0 years 1 month; at follow-up 6 years 7 months, SD 0 years 9 months; n = 26 boys, n = 20 girls; Gross Motor Classification System I = 30%, II = 7%, III = 28%, IV = 24%, V = 11%) completed the Children's Assessment of Participation and Enjoyment indicating their child's participation. Multivariate regression models were used to identify early predictors of participation. Results: Movement ability was a significant child-related predictor for formal activities (R(2) 17%, P < 0.05). Movement ability and social skills were most predictive (R(2) 62%, P < 0.00) for informal activities. The feeling of being restricted in family participation was the single most predictive factor for formal and informal activities at family level (R(2) 12%, P < 0.05, R(2) 25%, P < 0.05). Type of daycare was the only environmental variable that was predictive, and only for informal activities (R(2) 16%, P < 0.05). In the overall model movement ability was most predictive for leisure participation in formal activities (R(2) 17%, P < 0.05). Movement ability and social skills are the most important predictors for informal leisure participation (R(2) 62%, P < 0.01). Conclusions: Several variables are found to be related to formal and informal participation at age 6. Movement ability and social skills at age 2 are most predictive of leisure participation when the child is 6 years old.

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[PMID: 22676329](#) [PubMed - as supplied by publisher]

**14. Child Care Health Dev. 2012 Jun 8. doi: 10.1111/j.1365-2214.2012.01396.x. [Epub ahead of print]**

**Predictors of psychological adjustment, experienced parenting burden and chronic sorrow symptoms in parents of children with cerebral palsy.**

Whittingham K, Wee D, Sanders MR, Boyd R.

Queensland Cerebral Palsy and Rehabilitation Research Centre, the School of Medicine, Faculty of Health Sciences, the University of Queensland The School of Psychology, Faculty of Social and Behavioural Sciences, the University of Queensland Queensland Children's Medical Research Institute, Faculty of Health Sciences, the University of Queensland Parenting and Family Support Centre, School of Psychology, Faculty of Social and Behavioural Sciences, the University of Queensland, Brisbane, Qld, Australia.

Aim: To investigate the role of child behaviour, parental coping and experiential avoidance in predicting the psychological outcomes of: (i) psychological symptoms; (ii) chronic sorrow symptoms; and (iii) experienced parenting burden in parents of children with cerebral palsy (CP). Method: This study is a cross-sectional, correlational study. Ninety-four parents of children (aged 2-12 years) with CP (various levels of motor functioning GMFCS I-V) participated. Results: Together, the three predictors of child behaviour, parental coping and experiential avoidance explained 36.8% of the variance in psychological symptoms with child behavioural problems and experiential avoidance as significant unique predictors. In addition, 15.8% of the variance in chronic sorrow symptoms was explained by the three predictors with experiential avoidance alone as a significant unique predictor. Lastly, the predictors together explained 24.3% of the variance in experienced parenting burden with child behavioural problems and experiential avoidance as significant unique predictors. Conclusions: This study

demonstrates a relationship between child behavioural problems and parental psychological symptoms and experienced parenting burden as well as a relationship between experiential avoidance and parental psychological symptoms, experienced parenting burden and chronic sorrow symptoms.

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[PMID: 22676468](#) [PubMed - as supplied by publisher]

## Prevention and Cure

**15. N Engl J Med. 2012 May 31;366(22):2085-92.**

### **Childhood outcomes after hypothermia for neonatal encephalopathy.**

Shankaran S, Pappas A, McDonald SA, Vohr BR, Hintz SR, Yolton K, Gustafson KE, Leach TM, Green C, Bara R, Petrie Huitema CM, Ehrenkranz RA, Tyson JE, Das A, Hammond J, Peralta-Carcelen M, Evans PW, Heyne RJ, Wilson-Costello DE, Vaucher YE, Bauer CR, Dusick AM, Adams-Chapman I, Goldstein RF, Guillet R, Papile LA, Higgins RD; Eunice Kennedy Shriver NICHD Neonatal Research Network. Collaborators (135)

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**BACKGROUND:** We previously reported early results of a randomized trial of whole-body hypothermia for neonatal hypoxic-ischemic encephalopathy showing a significant reduction in the rate of death or moderate or severe disability at 18 to 22 months of age. Long-term outcomes are now available. **METHODS:** In the original trial, we assigned infants with moderate or severe encephalopathy to usual care (the control group) or whole-body cooling to an esophageal temperature of 33.5°C for 72 hours, followed by slow rewarming (the hypothermia group). We evaluated cognitive, attention and executive, and visuospatial function; neurologic outcomes; and physical and psychosocial health among participants at 6 to 7 years of age. The primary outcome of the present analyses was death or an IQ score below 70. **RESULTS:** Of the 208 trial participants, primary outcome data were available for 190. Of the 97 children in the hypothermia group and the 93 children in the control group, death or an IQ score below 70 occurred in 46 (47%) and 58 (62%), respectively ( $P=0.06$ ); death occurred in 27 (28%) and 41 (44%) ( $P=0.04$ ); and death or severe disability occurred in 38 (41%) and 53 (60%) ( $P=0.03$ ). Other outcome data were available for the 122 surviving children, 70 in the hypothermia group and 52 in the control group. Moderate or severe disability occurred in 24 of 69 children (35%) and 19 of 50 children (38%), respectively ( $P=0.87$ ). Attention-executive dysfunction occurred in 4% and 13%, respectively, of children receiving hypothermia and those receiving usual care ( $P=0.19$ ), and visuospatial dysfunction occurred in 4% and 3% ( $P=0.80$ ). **CONCLUSIONS:** The rate of the combined end point of death or an IQ score of less than 70 at 6 to 7 years of age was lower among children undergoing whole-body hypothermia than among those undergoing usual care, but the differences were not significant. However, hypothermia resulted in lower death rates and did not increase rates of severe disability among survivors. (Funded by the National Institutes of Health and the Eunice Kennedy Shriver NICHD Neonatal Research Network; ClinicalTrials.gov number, NCT00005772.).

[PMID: 22646631](#) [PubMed - indexed for MEDLINE]

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