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Interventions and Management

1. Res Dev Disabil. 2012 Oct 31;34(1):588-595. doi: 10.1016/j.ridd.2012.09.019. [Epub ahead of print]

Determinants of inclusive education of 8-12 year-old children with cerebral palsy in 9 European regions.

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The principle of inclusive education has been increasingly recognised over recent decades and most countries officially support schooling of children with disabilities in mainstream settings. The SPARCLE study offers the opportunity to report on the schooling practices for children with cerebral palsy according to the nature and severity of their impairments and the schooling policy in European regions. The aim of this paper is to describe the type of schooling of children with cerebral palsy in various European regions after controlling for relevant individual factors. Children aged 8-12 years with cerebral palsy from 9 European regions and their families were interviewed. Our findings support the hypothesis that between-region variations in the type of schooling are still significant after adjustment for individual factors; and that motor function and intellectual ability have different effects on inclusion in mainstream school, depending on the region.

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2. Am J Clin Nutr. 2012 Nov 7. [Epub ahead of print]

Energy requirements in preschool-age children with cerebral palsy.

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BACKGROUND: There is a paucity of data concerning the energy requirements (ERs) of preschool-age children with cerebral palsy (CP), the knowledge of which is essential for early nutritional management. **OBJECTIVE:** We

aimed to determine the ERs for preschool-age children with CP in relation to functional ability, motor type, and distribution and compared with typically developing children (TDC) and published estimation equations. DESIGN: Thirty-two children with CP (63% male) of all functional abilities, motor types, and distributions and 16 TDC (63% male) aged 2.9-4.4 y participated in this study. The doubly labeled water method was used to determine ERs. Statistical analyses were conducted by 1-factor ANOVA and post hoc Tukey honestly significant difference tests, independent and paired t tests, Bland and Altman analyses, correlations, and multivariable regressions. RESULTS: As a population, children with CP had significantly lower ERs than did TDC ($P < 0.05$). No significant difference in ERs was found between ambulant children and TDC. Marginally ambulant and nonambulant children had ERs that were ~18% lower than those of ambulant children and 31% lower than those of TDC. A trend toward lower ERs with greater numbers of limbs involved was observed. The influence of motor type could not be determined statistically. Published equations substantially underestimated ERs in the nonambulant children by ~22%. CONCLUSIONS: In preschool-age children with CP, ERs decreased as ambulatory status declined and more limbs were involved. The greatest predictor of ERs was fat-free mass, then ambulatory status. Future research should build on the information presented to expand the knowledge base regarding ERs in children with CP. This trial was registered with the Australian New Zealand Clinical Trials Registry as ACTRN 12612000686808.

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3. Clin Nutr. 2012 Oct 11. pii: S0261-5614(12)00220-8. doi: 10.1016/j.clnu.2012.10.005. [Epub ahead of print]

The use of bioelectrical impedance analysis to estimate total body water in young children with cerebral palsy.

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BACKGROUND & AIMS: Body composition assessment is an essential component of nutritional evaluation in children with cerebral palsy. This study aimed to validate bioelectrical impedance to estimate total body water in young children with cerebral palsy and determine best electrode placement in unilateral impairment. METHODS: 55 young children with cerebral palsy across all functional ability levels were included. Height/length was measured or estimated from knee height. Total body water was estimated using a Bodystat 1500MDD and three equations, and measured using the gold standard, deuterium dilution technique. Comparisons were made using Bland Altman analysis. RESULTS: For children with bilateral impairment, the Fjeld equation estimated total body water with the least bias (limits of agreement): 0.0 L (-1.4 L to 1.5 L); the Pencharz equation produced the greatest: 2.7 L (0.6 L-4.8 L). For children with unilateral impairment, differences between measured and estimated total body water were lowest on the unimpaired side using the Fjeld equation 0.1 L (-1.5 L to 1.6 L)) and greatest for the Pencharz equation. CONCLUSIONS: The ability of bioelectrical impedance to estimate total body water depends on the equation chosen. The Fjeld equation was the most accurate for the group, however, individual results varied by up to 18%. A population specific equation was developed and may enhance the accuracy of estimates. Australian New Zealand Clinical Trials Registry (ANZCTR) number: ACTRN12611000616976.

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4. Spine (Phila Pa 1976). 2012 Nov 5. [Epub ahead of print]

Cervical myelopathy in patients with athetoid cerebral palsy.

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Study Design. Retrospective clinical study. **Objective.** To report the surgical outcomes of patients with cervical myelopathy associated with athetoid cerebral palsy (CP) and to assess whether a halo vest is necessary for postoperative external immobilization. **Summary of Background Data.** Although a halo vest has remained the first choice for postoperative external immobilization of patients with cervical myelopathy associated with CP, simplification of this method has been attempted in recent years. Studies focusing on postoperative external immobilization are rare. **Methods.** Since 2001, 20 patients underwent surgery with posterior instrumented fusion or posterior fixation and anterior decompression with fusion with a year or longer follow-up. Before 2004, all patients were given a halo vest for postoperative external immobilization. After 2004, halo vests were not used, and when abnormal involuntary neck movements were severe, an intramuscular injection of botulinum toxin was administered before and after surgery. **Surgical outcomes, surgical methods and complications** were compared between the group that used a halo vest and the group that did not use a halo vest. **Results.** In the halo vest group, the average Japanese Orthopedic Association (JOA) score was 6.9 points before surgery and 9.3 points at one-year follow-up. The average recovery rate was 25.0%. In the group without halo vest use, the average JOA score was 5.8 points before surgery and 9.9 points at one-year follow-up. The average recovery rate was 35.7%. The group without halo vest use achieved outcomes equal to those achieved in the group with halo vest use. The frequency of complications was less without halo vest use than with halo vest use. **Conclusion.** No inferiority in clinical outcomes was seen if postoperative halo vest use was omitted. Progress in surgical instrumentation and injection of botulinum toxin may explain this result.

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5. Res Dev Disabil. 2012 Oct 31;34(1):554-561. doi: 10.1016/j.ridd.2012.09.020. [Epub ahead of print]

Managing lower extremity muscle tone and function in children with cerebral palsy via eight-week repetitive passive knee movement intervention.

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This study used a repeated measures design to assess the effect of an eight-week repetitive passive movement (RPM) intervention on lower extremity muscle tone and function in children with cerebral palsy (CP). Eighteen children (aged 9.5±2.1 years) with spastic CP were randomly assigned to a knee RPM intervention condition of 3 times a week for 8 weeks or a control condition. The 8 weeks were followed by 4 weeks of washout period, after which the participants were crossed over to the other group. In the RPM condition, each subject's knees were intervened with continuous passive motion device (at a velocity of 15°/s) for 20min. The subjects were evaluated via variables measuring range-of-motion, muscle tone, and ambulatory function before, after, 1 day after, and 3 days after each intervention. Repeated-measures statistical analyses found significant differences between condition variable on active range-of-motion of the knee (AROM, increased), relaxation index (RI, increased), Modified Ashworth Scale (MAS, decreased), timed up-and-go (TUG, decreased), 6-min walk test (6MWT, increased); and significant differences among time variable including RI, MAS, and 6MWT. No difference was found in passive range-of-motion measurements. Repetitive passive movement reduced lower extremity spastic hypertonia in children with cerebral palsy, and it also improved ambulatory function in terms of walking speed. Effects of this treatment protocol on ambulation lasted up to 3 days post intervention. Findings of this study provide clinicians and patients an alternative, effective and efficient strategy for spastic control and ambulatory improvement.

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6. J Neurophysiol. 2012 Nov 7. [Epub ahead of print]**Failure of normal development of central drive to ankle dorsiflexors relates to gait deficits in children with cerebral palsy.**

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Neurophysiological markers of the central control of gait in children with cerebral palsy (CP) are used to assess developmental response to therapy. Here we measure the central common drive to a leg muscle in children with CP. We recorded EMGs from the Tibialis Anterior (TA) muscle of 40 children with hemiplegic CP and 42 typically-developing age-matched controls during static dorsiflexion of the ankle and during the swing phase of treadmill walking. The common drive to TA motoneurons was identified through time and frequency domain cross-correlation methods. In control subjects, the common drive consists of frequencies between 1 and 60 Hz with peaks at beta (15-25 Hz) and gamma (30-45 Hz) frequencies known to be caused by activity within sensori-motor cortex networks: this drive to motoneurons strengthens during childhood. Similar to control subjects, this drive to the least affected TA in the CP children tended to strengthen with age, although compared to the control subjects it was slightly weaker. For CP subjects' of all ages the most affected TA muscle common drive was markedly reduced compared both to their least affected muscle and to controls. These differences between the least and most affected TA muscles were unrelated to differences in the magnitude of EMG in the two muscles but positively correlated with ankle dorsiflexion velocity and joint angle during gait. Time and frequency domain analysis of on-going EMG recruited during behaviourally relevant lower limb tasks provides a non-invasive and important measure of the central drive to motoneurons in subjects with CP.

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7. Phys Ther. 2012 Nov 8. [Epub ahead of print]**Reliability and Responsiveness of the Gross Motor Function Measure-88 in Children With Cerebral Palsy.**

Ko J, Kim M.

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BACKGROUND: The "Gross Motor Function Measure" (GMFM-88) is a commonly used measure for evaluating gross motor function in children with cerebral palsy (CP). The relative reliability of GMFM-88 has been assessed in children with CP. However, little information is available about the absolute reliability or responsiveness of GMFM-88. **OBJECTIVE:** The objective of this research was to determine the absolute and relative reliability and responsiveness of the GMFM-88 in evaluating gross motor function in children with CP. **DESIGN:** A clinical measurement design. **METHODS:** Ten raters scored GMFM-88 of 84 children from video records across all GMFCS levels to establish inter-rater reliability. Two raters participated to assess intra-rater reliability. Responsiveness was determined from three additional assessments after the baseline assessment. The inter- and intra-rater intraclass correlation coefficient (ICC) with 95% confidence intervals, standard error of measurement (SEM), smallest real difference (SRD), effect size (ES), and standardized response mean (SRM) were calculated. **RESULTS:** The relative reliabilities of the GMFM were excellent (ICCs = 0.986-1.000). The SEM and SRD for total score of the GMFM were acceptable (1.60 and 3.14, respectively). Additionally, the goal total scores of the ES and SRM increased gradually in the three follow-up assessments (GMFCS level I-II: ES = 0.5, 0.6, and 0.8, SRM = 1.3, 1.8, and 2.0; GMFCS III-V: ES = 0.4, 0.7, and 0.9, SRM = 1.5, 1.7, and 2.0). **LIMITATIONS:** Children over 10 years of age with CP were not included in this study, so the results should not be generalized to all children with CP. **CONCLUSIONS:** This study indicates that both reliability and responsiveness of the GMFM-88 are reasonable for measuring gross motor function in children with CP.

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Prevention and Cure

8. *Dev Med Child Neurol.* 2012 Nov 2. doi: 10.1111/dmcn.12016. [Epub ahead of print]

The association of cerebral palsy with birth asphyxia: a definitional quagmire.

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Aim: The aim of this study was to investigate whether current literature provides a useful body of evidence reflecting the proportion of cerebral palsy (CP) that is attributable to birth asphyxia. **Method:** We identified 23 studies conducted between 1986 and 2010 that provided data on intrapartum risks of CP. **Results:** The proportion of CP with birth asphyxia as a precursor (case exposure rate) varied from less than 3% to over 50% in the 23 studies reviewed. The studies were heterogeneous in many regards, including the definitions for birth asphyxia and the outcome of CP. **Interpretations:** Current data do not support the belief, widely held in the medical and legal communities, that birth asphyxia can be recognized reliably and specifically, or that much of CP is due to birth asphyxia. The very high case exposure rates linking birth asphyxia to CP can probably be attributed to several factors: the fact that the clinical picture at birth cannot specifically identify birth asphyxia; the definition of CP employed; and confusion of proximal effects - results - with causes. Further research is needed.

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9. *Dev Med Child Neurol.* 2012 Nov 2. doi: 10.1111/dmcn.12013. [Epub ahead of print]

Brain magnetic resonance imaging, and motor and intellectual functioning in 86 patients born at term with spastic diplegia.

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Aim: To investigate the association between magnetic resonance imaging (MRI) patterns and motor function, epileptic episodes, and IQ or developmental quotient in patients born at term with spastic diplegia. **Method:** Eighty-six patients born at term with cerebral palsy (CP) and spastic diplegia (54 males, 32 females; median age 20y, range 7-42y) among 829 patients with CP underwent brain MRI between 1990 and 2008. The MRI and clinical findings were analysed retrospectively. Intellectual disability was classified according to the Enjoji developmental test or the Wechsler Intelligence Scale for Children (3rd edition). **Results:** The median ages at diagnosis of CP, assignment of Gross Motor Function Classification System (GMFCS) level, cognitive assessment, and MRI were 2 years (range 5mo-8y), 6 years (2y 8mo-19y), 6 years (1y 4mo-19y), and 7 years (10mo-30y) respectively. MRI included normal findings (41.9%), periventricular leukomalacia, hypomyelination, and porencephaly/periventricular venous infarction. The frequency of patients in GMFCS levels III to V and intellectual disability did not differ between those with normal and abnormal MRI findings. Patients with normal MRI findings had significantly fewer epileptic episodes than those with abnormal ones ($p=0.001$). **Interpretation:** Varied MRI findings, as well as the presence of severe motor dysfunction and intellectual disability (despite normal MRI), suggest that patients born at term with spastic diplegia had heterogeneous and unidentified pathophysiology.

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10. J Physiol. 2012 Nov 5. [Epub ahead of print]**Generation of striatal projection neurons extends into the neonatal period in the rat brain.**

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Substantial advances have been made in the last decade on our understanding of the basic physiology underlying neurogenesis in the postnatal mammalian brain. The bulk of the work in this area has been based on analysis of the adult brain. Relatively less is known about the capacity for neurogenesis in specific structures within the neonatal brain. Here we report that the production of medium spiny striatal projection neurons extends into the early neonatal period under normal physiological conditions in the rat brain. Birth-dating of newborn cells with bromo-deoxy-uridine at postnatal days 0, 2 and 5 showed a peak production close to birth, which sharply declined at the later time-points. Additionally, there was a low-level but stable contribution of neurons with interneuron identity over the same time-period. Importantly, retroviral labeling of new striatal projection neurons with green fluorescent protein showed long term survival and terminal differentiation with characteristic morphology, including highly elaborated spiny dendrites, and appropriate axonal targeting of the globus pallidus and midbrain. This latent period of striatal neurogenesis in the early neonatal brain represents an interesting target for regenerative approaches aimed at restoring striatal circuitry in perinatal pathologies, such as hypoxic and ischemic damage associated with cerebral palsy.

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11. J Rehabil Med. 2012 Nov 9. doi: 10.2340/16501977-1081. [Epub ahead of print]**Asymmetric skull deformity in children with cerebral palsy: frequency and correlation with postural abnormalities and deformities.**

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Objective: Asymmetrical skull deformity is frequently seen in children with cerebral palsy, and may contribute to postural abnormalities and deformities. The aim of this cross-sectional- survey was to determine the frequency of asymmetrical skull deformity and its correlation with clinical parameters. **Methods:** A 10-item checklist for asymmetrical skull deformity, postural abnormalities, and deformities was developed, and its inter-rater reliability was tested. A total of 110 participants aged 1-18 years (mean age 9.3 years (standard deviation 4.7)) was assessed using the checklist. The frequency of asymmetrical skull deformity was analysed and related to the Gross Motor Function Classification System (GMFCS), postural abnormalities, and deformities. **Results:** The reliability of the checklist was satisfactory ($\kappa > 0.8$). Asymmetrical skull deformity was observed in 44 children, 24 showing right and 20 showing left flat occipital deformity. Its frequency was significantly related to GMFCS and with the patterns of asymmetrical posture and deformities ($p < 0.05$). Children with right flat occipital asymmetrical skull deformity showed predominantly rightward facial direction and right-side-dominant asymmetrical tonic neck reflex, left convex scoliosis, right-side-elevated pelvic obliquity, and left-sided hip dislocation. Those with left flat occipital asymmetrical skull deformity demonstrated the reverse tendency. **Conclusion:** Asymmetrical skull deformity is frequent in cerebral palsy and closely related to asymmetrical posture and deformities. This information will be useful to manage these problems.

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