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Monday 30 May 2016

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# Interventions and Management

**1. BMC Pediatr. 2016 May 27;16(1):70. doi: 10.1186/s12887-016-0608-8.**

Minimising impairment: Protocol for a multicentre randomised controlled trial of upper limb orthoses for children with cerebral palsy.

Imms C, Wallen M, Elliott C, Hoare B, Randall M, Greaves S, Adair B, Bradshaw E, Carter R, Orsini F, Shih ST, Reddihough D.

BACKGROUND: Upper limb orthoses are frequently prescribed for children with cerebral palsy (CP) who have muscle overactivity predominantly due to spasticity, with little evidence of long-term effectiveness. Clinical consensus is that orthoses help to preserve range of movement: nevertheless, they can be complex to construct, expensive, uncomfortable and require commitment from parents and children to wear. This protocol paper describes a randomised controlled trial to evaluate whether long-term use of rigid wrist/hand orthoses (WHO) in children with CP, combined with usual multidisciplinary care, can prevent or reduce musculoskeletal impairments, including muscle stiffness/tone and loss of movement range, compared to usual multidisciplinary care alone. METHODS/DESIGN: This pragmatic, multicentre, assessor-blinded randomised controlled trial with economic analysis will recruit 194 children with CP, aged 5-15 years, who present with flexor muscle stiffness of the wrist and/or fingers/thumb (Modified Ashworth Scale score ≥1). Children, recruited from treatment centres in Victoria, New South Wales and Western Australia, will be randomised to groups (1:1 allocation) using concealed procedures. All children will receive care typically provided by their treating organisation. The treatment group will receive a custom-made serially adjustable rigid WHO, prescribed for 6 h nightly (or daily) to wear for 3 years. An application developed for mobile devices will monitor WHO wearing time and adverse events. The control group will not receive a WHO, and will cease wearing one if previously prescribed. Outcomes will be measured 6 monthly over a period of 3 years. The primary outcome is passive range of wrist extension, measured with fingers extended using a goniometer at 3 years. Secondary outcomes include muscle stiffness, spasticity, pain, grip strength and hand deformity. Activity, participation, quality of life, cost and cost-effectiveness will also be assessed. DISCUSSION: This study will provide evidence to inform clinicians, services, funding agencies and parents/carers of children with CP whether the provision of a rigid WHO to reduce upper limb impairment, in combination with usual multidisciplinary care, is worth the effort and costs.

PMID: 27230616

**2. Agri. 2016 Jan;28(1):18-24. doi: 10.5505/agri.2015.74436.**

Musculoskeletal system pain and related factors in mothers of children with cerebral palsy.

Terzi R, Tan G.

OBJECTIVES: The aim of the present study was to identify prevalence of musculoskeletal system diseases and related factors among mothers of children with cerebral palsy. METHODS: Eighty-five mothers of children with cerebral palsy were included as the treatment group, and 42 mothers of healthy children were included as the control group. Sociodemographic

characteristics of all subjects were recorded. Musculoskeletal system pain was evaluated by the standardized Nordic Musculoskeletal Questionnaire, and level of depression was evaluated according to Beck's Depression Scale. RESULTS: Musculoskeletal system pain and depression scores of the treatment group were significantly higher than those of the control group. Most frequently reported by mothers in the treatment group was low back pain (44.7%). In multiple regression analysis, number of children, age, and functional level of the child with cerebral palsy, as well as depression level of the mother were identified as independent risk factors for musculoskeletal system pain. CONCLUSION: Mothers of children with cerebral palsy are at higher risk for musculoskeletal system pain and depression. Prevalence of musculoskeletal system pain in these mothers, especially those with older children who have lower functional statuses, should be kept in mind.

PMID: 27225608

**3. Disabil Rehabil. 2016 May 23:1-12. [Epub ahead of print]**

Easy-to-use clinical measures of walking ability in children and adolescents with cerebral palsy: a systematic review.

Himuro N, Abe H, Nishibu H, Seino T, Mori M.

OBJECTIVE: The aims of this systematic review were to identify quick, simple and easy-to-use measures of walking ability currently used to assess children and adolescents with cerebral palsy (CP), and to evaluate the clinical utility and psychometric properties of these measures. DATA SOURCES: The PubMed, CINAHL, SPORTDiscus and MEDLINE databases were searched up to March 2015. REVIEW METHODS: Two independent reviewers rated the methodological quality of the identified measures using the COnsensus-based Standards for the selection of health status Measurement INstruments (COSMIN) checklist. RESULTS: The 1-Minute Walk Test, Timed Up and Go Test, ABILOCO-Kids, Gillette Functional Assessment Questionnaire and Functional Mobility Scale were identified. Each measure can be carried out within 5 min with limited equipment, and does not require examiner training. There was "limited" to "strong" evidence on the reliability and validity of these measurements, whereas evidence on measurement error and responsiveness was limited. CONCLUSION: The identified measures in this systematic review may be considered for the clinical measurement of walking ability in children and adolescents with CP in a quick, simple and easy-to-use manner. However, there is overall a lack of evidence on the psychometric properties of these tools. The lack of evidence regarding measurement error and responsiveness might limit their value in measuring change over time. Implications for Rehabilitation The ABILOCO-Kids, 1-Minute Walk Test, Timed Up and Go Test, Gillette Functional Assessment Questionnaire, Functional Mobility Scale can be performed within 5 min with limited equipment, and do not require examiner training for measuring of walking ability in children and adolescents with cerebral palsy. The clinicians should use these measurement tools carefully when assessing change over time as the available evidence on measurement error and responsiveness is limited. When clinicians use these measurement tools, the psychometric properties reported in this systematic review should be considered in the selection of tools and subsequent interpretation of results.

PMID: 27216081

**4. Vopr Kurortol Fizioter Lech Fiz Kult. 2016;93(2):17-19.**

[The effectiveness of correction of the postural problems in the patients presenting with juvenile cerebral palsy].
[Article in Russian]

Barbaeva SN, Kulishova TV.

We have studied stabilographic characteristics and their dynamics in the healthy children (n=30) and the patients suffering from juvenile cerebral palsy (JCP) in the form of spastic diplegia (n=99) after they had undergone the combined rehabilitation treatment with the use of various methods of electrical stimulation. The mean age of the children was 7.0±1.7 years. The patients with JCP included in the main group (n=45) received therapy with the application of electrical stimulation based on the AKorD apparatus while the patients with JCP comprising the group of comparison were treated with the use of the Mioritm 040 apparatus. Vertical stability of the schoolchildren was evaluated using the Stabilan-01-2 hardware system, once in the healthy children and twice (before and after the termination of rehabilitation) in the patients with JCP. A course of the rehabilitative treatment of the patients with JCP included in the main group resulted in a 24.6% and 15.8% reduction ($p<0.05$) of the statokinesiogram area in the tests with the open and closed eyes respectively. The visual control coefficient increased significantly. The patients of the comparison group experienced a marked reduction of the area of statokinesiogram in the tests with the open eyes (by 15,5% ($p<0,05$)) while the remaining characteristics of interest remained unaltered. It is concluded that the treatment of the children presenting with juvenile cerebral palsy with the use of the AKorD apparatus for electrical

stimulation is more efficient for the maintenance of the vertical posture in comparison with the treatment based on the use of the Mioritm 040 apparatus.

PMID: 27213944

**5. Clin Biomech (Bristol, Avon). 2016 May 10;36:32-39. doi: 10.1016/j.clinbiomech.2016.05.008. [Epub ahead of print]**

Contractile behavior of the medial gastrocnemius in children with bilateral spastic cerebral palsy during forward, uphill and backward-downhill gait.

Hösl M, Böhm H, Arampatzis A, Keymer A, Döderlein L.

BACKGROUND: Plantarflexor tightness due to muscle degenerations has been frequently documented in children with spastic cerebral palsy but the contractile behavior of muscles during ambulation is largely unclear. Especially the adaptability of gastrocnemius muscle contraction on sloped surface could be relevant during therapy. METHODS: Medial gastrocnemius contractions were measured during flat-forward, uphill (+12% incline) and backward-downhill (-12% decline) treadmill gait in 15 children with bilateral cerebral palsy, walking in crouch, and 17 typically developing controls (age: 7-16years) by means of ultrasound and motion analysis. Tracked fascicle and calculated series elastic element length during gait were normalized on seated rest length. Additionally electromyography of the medial gastrocnemius, soleus and tibialis anterior was collected. FINDINGS: During forward gait spastic gastrocnemii reached 10% shorter relative fascicle length, 5% shorter series elastic element length and showed 37% less concentric fascicle excursion than controls. No difference in eccentric fascicle excursion existed. Uphill gait increased concentric fascicle excursion in children with cerebral palsy and controls (by 23% and 41%) and tibialis anterior activity during swing (by 33% and 48%). Backward downhill gait more than doubled (+112%) eccentric fascicle excursion in cerebral palsy patients. INTERPRETATION: Apart from having innately shorter fascicles at rest, flat-forward walking showed that spastic gastrocnemius fascicles work at shorter relative length than those of controls. Uphill gait may be useful to concentrically train push-off skills and foot lift. During backward-downhill gait the gastrocnemius functions as a brake and displays more eccentric excursion which could potentially stimulate sarcomere-genesis in series with repeated training.

PMID: 27208665

**6. Cir Cir. 2016 May 21. pii: S0009-7411(16)30019-6. doi: 10.1016/j.circir.2016.03.007. [Epub ahead of print]**

[Submandibular gland resection for the management of sialorrhea in paediatric patients with cerebral palsy and unresponsive to type A botullinum toxin. Pilot study].

[Article in Spanish]

Hernández-Palestina MS, Cisneros-Lesser JC, Arellano-Saldaña ME, Plascencia-Nieto SE.

BACKGROUND: Sialorrhoea has a prevalence of between 10% and 58% in patients with cerebral palsy. Amongst the invasive treatments, botulinum toxin-A injections in submandibular and parotid glands and various surgical techniques are worth mentioning. There are no studies in Mexico on the usefulness of surgery to manage sialorrhoea. OBJECTIVE: To evaluate the usefulness of submandibular gland resection in improving sialorrhoea in patients with cerebral palsy and with a poor response to botulinum toxin. MATERIAL AND METHODS: Experimental, clinical, self-controlled, prospective trial was conducted to evaluate the grade of sialorrhoea before surgery, and 8, 16 and 24 weeks after. Statistical analysis was performed using a non-parametric repetitive measure assessment, considering a $p < 0.05$ as significant. Complications and changes in salivary composition were evaluated. RESULTS: Surgery was performed on 3 patients with severe sialorrhoea, and 2 with profuse sialorrhoea, with mean age of 10.8 years. The frequency and severity of sialorrhoea improved in the 5 patients, with mean of 76.7 and 87.5% improvement, respectively. The best results were seen after 6 months of surgery, with a statistically significant difference between the preoperative stage and 6 months after the procedure ($p = 0.0039$, 95% CI). No significant differences were observed in complications, increase in periodontal disease or cavities, or salivary composition. CONCLUSIONS: Submandibular gland resection is an effective technique for sialorrhoea control in paediatric patients with cerebral palsy, with a reduction in salivary flow greater than 80%. It has a low chance of producing complications compared to other techniques. It led to an obvious decrease in sialorrhoea without the need to involve other salivary glands in the procedure.

PMID: 27221328

**7. Urology. 2016 May 19. pii: S0090-4295(16)30220-5. doi: 10.1016/j.urology.2016.05.024. [Epub ahead of print]**

Urodynamic Findings in Adults with Moderate to Severe Cerebral Palsy.

Cotter KJ, Levy ME, Goldfarb RA, Liberman D, Katorski J, Myers JB, Elliott SP.

OBJECTIVES: To determine UDS findings in adult CP patients. Cerebral palsy (CP) patients may suffer from voiding dysfunction. Urodynamics (UDS) in children with CP has consistently shown an upper motor neuron bladder with detrusor-sphincter dyssynergia (DSD). METHODS: We included adult CP patients seen at Gillette Transitional Urology Clinic who underwent UDS for voiding dysfunction between 2011-2014.Descriptive statistics were used to characterize findings. RESULTS: 49/211 CP patients underwent UDS. Average age was 30 years; 55% were men. 98% had moderate to severe CP. UDS was initiated for irritative symptoms in 55%, obstructive voiding symptoms in 25%, hydronephrosis in 18%, and other reasons in 2%. Incontinence was reported in 57%. DSD was seen in 12%, detrusor overactivity (DO) in 30% and detrusor leak point pressure (DLPP) >40 cm H2O in 51%. Median compliance was 18 mL/cm H2O (0.78 - 365). Maximum cystometric capacity (MCC) was 80-1400 mL and was < 300mL in 27%. 16% had a MCC < 300mL and compliance < 20. 12% had a MCC <300 and DLPP >40. CONCLUSIONS: UDS findings in symptomatic adult CP patients are varied. 51% had upper motor neuron bladder findings, similar to that seen in the pediatric literature, but 6% had large flaccid bladders. Half of the patients had concerning findings, such as compliance <20 or DLPP >40 cm H2O. Our results emphasize the needs to thoroughly investigate voiding dysfunction in those with CP. Further characterization of this population is needed in order to correlate these UDS findings with clinical outcomes.

PMID: 27210572

**8. ran J Med Sci. 2016 May;41(3):186-190.**

Comparison of Auditory Perception in Cochlear Implanted Children with and without Additional Disabilities.

Hashemi SB Md, Monshizadeh L PhD.

BACKGROUND: The number of children with cochlear implants who have other difficulties such as attention deficiency and cerebral palsy has increased dramatically. Despite the need for information on the results of cochlear implantation in this group, the available literature is extremely limited. We, therefore, sought to compare the levels of auditory perception in children with cochlear implants with and without additional disabilities. METHODS: A spondee test comprising 20 two-syllable words was performed. The data analysis was done using SPSS, version 19. RESULTS: Thirty-one children who had received cochlear implants 2 years previously and were at an average age of 7.5 years were compared via the spondee test. From the 31 children, 15 had one or more additional disabilities. The data analysis indicated that the mean score of auditory perception in this group was approximately 30 scores below that of the children with cochlear implants who had no additional disabilities. CONCLUSION: Although there was an improvement in the auditory perception of all the children with cochlear implants, there was a noticeable difference in the level of auditory perception between those with and without additional disabilities. Deafness and additional disabilities depended the children on lip reading alongside the auditory ways of communication. In addition, the level of auditory perception in the children with cochlear implants who had more than one additional disability was significantly less than that of the other children with cochlear implants who had one additional disability.

PMID: 27217602

**9. J Bodyw Mov Ther. 2016 Apr;20(2):252-7. doi: 10.1016/j.jbmt.2015.03.007. Epub 2015 Mar 25.**

Transcranial direct current stimulation combined with integrative speech therapy in a child with cerebral palsy: A case report.

Carvalho Lima VL, Collange Grecco LA, Marques VC, Fregni F, Brandão de Ávila CR.

The aim of this study was to describe the results of the first case combining integrative speech therapy with anodal transcranial direct current stimulation (tDCS) over Broca's area in a child with cerebral palsy. The ABFW phonology test was used to analyze speech based on the Percentage of Correct Consonants (PCC) and Percentage of Correct Consonants - Revised (PCC-R). After treatment, increases were found in both PCC (Imitation: 53.63%-78.10%; Nomination: 53.19%-70.21%) and PPC-R (Imitation: 64.54%-83.63%; Nomination: 61.70%-77.65%). Moreover, reductions occurred in distortions, substitutions and improvement was found in oral performance, especially tongue mobility (AMIOFE-mobility before = 4 after = 7). The child

demonstrated a clinically important improvement in speech fluency as shown in results of imitation number of correct consonants and phonemes acquire. Based on these promising findings, continuing research in this field should be conducted with controlled clinical trials.

PMID: 27210840

# Prevention and Cure

**10. Int J Dev Neurosci. 2016 May 19. pii: S0736-5748(16)30079-X. doi: 10.1016/j.ijdevneu.2016.05.002. [Epub ahead of print]**

Effects of maternal low-protein diet on parameters of locomotor activity in a rat model of cerebral palsy.

Silva KO, Pereira SD, Portovedo M, Milanski M, Galindo LC, Guzmán-Quevedo O, Manhães-De-Castro R, Toscano AE. Children with cerebral palsy have feeding difficulties that can contribute to undernutrition. The aim of this study was to investigate the effect of early undernutrition on locomotor activity and the expression of the myofibrillar protein MuRF-1 in an experimental model of cerebral palsy (CP). In order to achieve this aim, pregnant rats were divided into two groups according to the diet provided: Normal Protein (NP, n=9) and Low Protein (LP, n=12) groups. After birth, the pups were divided into four groups: Normal Protein Sham (NPS, n=16), Normal Protein Cerebral Palsy (NPCP, n=21), Low Protein Sham (LPS, n=20) and Low Protein Cerebral Palsy (LPCP, n=18) groups. The experimental cerebral palsy protocol consisted of two episodes of anoxia at birth and during the first days of life. Each day, nitrogen flow was used (9l/min during 12min). After nitrogen exposure, sensorimotor restriction was performed 16h per day, from the 2nd to the 28th postnatal day (PND). Locomotor activity was evaluated at 8th, 14th, 17th, 21th and 28th PND. At PND 29, soleus muscles were collected to analyse myofibrillar protein MuRF-1. Our results show that CP animals decreased body weight ($p<0.001$), which were associated with alterations of various parameters of locomotor activity ($p<0.05$), compared to their control. Undernourished animals also showed a decrease ($p<0.05$) in body weight and locomotor activity parameters. Moreover, CP decreased MuRF-1 levels in nourished rats ($p=0.015$) but not in undernourished rats. In summary, perinatal undernutrition exacerbated the negative effects of cerebral palsy on locomotor activity and muscle atrophy, but it appears not be mediated by changes in MuRF-1 levels.

PMID: 27211347

**11. Paediatr Perinat Epidemiol. 2016 May 23. doi: 10.1111/ppe.12299. [Epub ahead of print]**

Prevalence of Cerebral Palsy among 8-Year-Old Children in 2010 and Preliminary Evidence of Trends in Its Relationship to Low Birthweight.

Durkin MS, Benedict RE, Christensen D, Dubois LA, Fitzgerald RT, Kirby RS, Maenner MJ, Van Naarden Braun K, Wingate MS, Yeargin-Allsopp M.

BACKGROUND: The public health objective for cerebral palsy (CP) in the United States is to reduce the percentage of children with CP who were born low birthweight (LBW, <2500 g) by 10% between 2006 and 2020. This study reports the prevalence of CP in a constant surveillance area for the years 2006, 2008, and 2010 and describes initial progress towards the CP public health objective. METHODS: Data on children with CP at age 8 years were ascertained by the Autism and Developmental Disabilities Monitoring (ADDM) Network, a population-based surveillance system that monitored CP in four areas of the United States. RESULTS: CP prevalence in 2010 was 2.9 per 1000 [95% confidence interval (CI) 2.6, 3.2], down from 3.5 (95% CI 3.2, 3.9) in the same surveillance area in 2006. Among CP cases with no documented postneonatal aetiology, 49.1% (95% CI 42.9, 55.2) were born LBW in 2010 compared with 54.3% (95% CI 48.4, 60.1) in 2006. In 2010, 28.1% (95% CI 22.9, 30.4) were born very low birthweight (VLBW, <1500 g) compared with 35.4% (95% CI 30.0, 41.2) in 2006. The relative risks for associations between CP and both LBW and VLBW also declined, though not significantly, during the study period. CONCLUSIONS: Declines in the associations between CP and LBW categories may have contributed to declines during the study period in both the prevalence of CP and the percentage of children with CP who were born LBW or VLBW. Ongoing monitoring of these trends is warranted.

PMID: 27215680

**12. Res Dev Disabil. 2016 May 20;55:218-225. doi: 10.1016/j.ridd.2016.04.010. [Epub ahead of print]**

The clinical outcomes of deep gray matter injury in children with cerebral palsy in relation with brain magnetic resonance imaging.

Choi JY, Choi YS, Rha DW, Park ES.

In the present study we investigated the nature and extent of clinical outcomes using various classifications and analyzed the relationship between brain magnetic resonance imaging (MRI) findings and the extent of clinical outcomes in children with cerebral palsy (CP) with deep gray matter injury. The deep gray matter injuries of 69 children were classified into hypoxic ischemic encephalopathy (HIE) and kernicterus patterns. HIE patterns were divided into four groups (I-IV) based on severity. Functional classification was investigated using the gross motor function classification system-expanded and revised, manual ability classification system, communication function classification system, and tests of cognitive function, and other associated problems. The severity of HIE pattern on brain MRI was strongly correlated with the severity of clinical outcomes in these various domains. Children with a kernicterus pattern showed a wide range of clinical outcomes in these areas. Children with severe HIE are at high risk of intellectual disability (ID) or epilepsy and children with a kernicterus pattern are at risk of hearing impairment and/or ID. Grading severity of HIE pattern on brain MRI is useful for predicting overall outcomes. The clinical outcomes of children with a kernicterus pattern range widely from mild to severe.
WHAT THIS PAPER ADDS:
Delineation of the clinical outcomes of children with deep gray matter injury, which are a common abnormal brain MRI finding in children with CP, is necessary. The present study provides clinical outcomes for various domains in children with deep gray matter injury on brain MRI. The deep gray matter injuries were divided into two major groups; HIE and kernicterus patterns. Our study showed that severity of HIE pattern on brain MRI was strongly associated with the severity of impairments in gross motor function, manual ability, communication function, and cognition. These findings suggest that severity of HIE pattern can be useful for predicting the severity of impairments. Conversely, children with a kernicterus pattern showed a wide range of clinical outcomes in various domains. Children with severe HIE pattern are at high risk of ID or epilepsy and children with kernicterus pattern are at risk of hearing impairment or ID. The strength of our study was the assessment of clinical outcomes after 3 years of age using standardized classification systems in various domains in children with deep gray matter injury.

PMID: 27214680