Cerebral palsy research news

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Interventions and Management

1. Swan-Neck Correction by FDS Tenodesis and Dynamic Lateral Band Volar Relocation in the Setting of Cerebral Palsy

William Alexander, Damon Thomas, Sara Atkins, Bruce Johnstone

J Hand Surg Asian Pac Vol. 2023 Sep 25. doi: 10.1142/S2424835523710066. Online ahead of print.

While there are many proposed surgical treatment options for the correction of swan-neck deformities, none are perfect. We describe a partial flexor digitorum superficialis tenodesis that combines both a static volar plate with a dynamic oblique retinacular ligament vector reconstruction. This is performed through a single, short mid-lateral incision and requires no tendon grafts. The protected early active exercises are encouraged postoperatively, and our long-term results have been promising. The technique was designed for children with cerebral palsy, but the indications have since expanded. Level of Evidence: Level V (Therapeutic).

PMID: 37758494

2. Effect of Adaptive Seating Systems on Postural Control and Activity Performance: A Systematic Review

Bishnu Dutta Acharya, Arpita Karki, Saipin Prasertsukdee, Darren Reed, Lal Rawal, Prem Laxmi Baniya, Roslyn N Boyd

Pediatr Phys Ther. 2023 Oct 1;35(4):397-410. doi: 10.1097/PEP.0000000000001042.

Purpose: To systematically review the effectiveness of adaptive seating systems on sitting posture, postural control, and seated activity performance in children with cerebral palsy (CP). Summary of key points: From 5 databases, 3 of 21 (14%) articles were of good quality based on the Downs and Black checklist. Commercial modular contoured seating and paper-based low-cost, and contoured foam seating were effective at improving sitting posture, postural control, and seated activity performance. Parents and service providers reported that seating systems reduced stress, burden and psychosocial well-being, and quality of life in children with CP. Conclusion: Limited evidence demonstrated that adaptive seating systems were effective at improving sitting ability and postural control. Randomized controlled trials with objective outcome measures of seating performance in children with CP are needed to evaluate effectiveness. Recommendations for clinical practice: Adaptive seating devices are preferred by parents and therapists for children with CP; however, objective measures of seating outcomes are needed.

PMID: 37747975

3. The indication of fusion to the pelvis in neuromuscular scoliosis is based on the underlying disease rather than on pelvic obliquity

Florian Geiger, Johanna Eberl, André Wirries, Andreas Forth, Ahmed Hammad

Eur Spine J. 2023 Sep 26. doi: 10.1007/s00586-023-07943-7. Online ahead of print.

Introduction: The decision to instrument to L5 or ilium, in NMS, is usually based on radiologic factors, including pelvic obliquity (PO) > 15°, apex of curvature < L3, and Cobb angle > 60°. Since scoliosis in these patients is caused by a neurologic disease, we based our decision to stop at L5 on the presence of spasticity or flaccidity. Patients & methods: The senior author did 109 primary fusions in NMS. Of those with DMD or SMA only 16% were instrumented to the ilium. The main factor for our decision was the correction potential of the truncal shift and PO in the supine traction radiographs and the absence of severe spasticity. Results: The 57 patients with DMD/SMA had a mean preoperative curvature of 68°, PO of 17°, and truncal shift of 20°. 74% should have been instrumented to the pelvis, but only 16% were. Those instrumented shorter as the rule, were corrected from 74° to 26° and had a postoperative PO of 8°. There was no significant difference in postoperative correction and PO compared to those instrumented to L5 on standard protocol. Subsequent extension to the pelvis was needed in 1 CP patient. There were no significant changes after 2 years. Of the 20 patients instrumented to the pelvis 11 had cerebral palsy and a preop curvature of 89°, a PO of 21° and a truncal shift of 25°. Discussion: The decision on instrumentation length should take flexibility and disease into consideration. If the trunk is centred over the pelvis, deterioration will not occur in absence of spasticity.

PMID: 37750950

4. The gait pattern and not the femoral morphology is the main contributor to asymmetric hip joint loading

Willi Koller, Arnold Baca, Hans Kainz

PLoS One. 2023 Sep 26;18(9):e0291789. doi: 10.1371/journal.pone.0291789. eCollection 2023.

Gait asymmetry and skeletal deformities are common in many children with cerebral palsy (CP). Changes of the hip joint loading, i.e. hip joint contact force (HJCF), can lead to pathological femoral growth. A child's gait pattern and femoral morphology affect HJCFs. The twofold aim of this study was to (1) evaluate if the asymmetry in HJCFs is higher in children with CP compared to typically developing (TD) children and (2) identify if the bony morphology or the subject-specific gait pattern is the main contributor to asymmetric HJCFs. Magnetic resonance images (MRI) and three-dimensional gait analysis data of twelve children with CP and fifteen TD children were used to create subject-specific musculoskeletal models and calculate HJCF using OpenSim. Root-mean-square-differences between left and right HJCF magnitude and orientation were computed and compared between participant groups (CP versus TD). Additionally, the influence on HJCF asymmetries solely due to the femoral morphology and solely due to the gait pattern was quantified. Our findings demonstrate that the gait pattern is the main contributor to asymmetric HJCFs in CP and TD children. Children with CP have higher HJCF asymmetries which is probably the result of larger asymmetries in their gait pattern compared to TD children. The gained insights from our study highlight that clinical interventions should focus on normalizing the gait pattern and therefore the hip joint loading to avoid the development of femoral deformities.

PMID: 37751435

5. Walking further. How surgery can help the cerebral palsy child

A Syed, O Htwe, M S Naicker, A H A Rashid, B S Yuliawiratman, A S Naicker

Med J Malaysia. 2023 Sep;78(5):566-569.

Introduction: The prevalence of cerebral palsy (CP) in Malaysia is estimated at 2.6 per 1000 live births which is comparable to that of Australian and European data with ranges of 2.3- 4.21,2. Surgical intervention for the improvement of gait function and mobility in CP is a common practice, however scarce literature of its outcomes is available in Southeast Asia. This paper aims to address and compare outcomes of surgical interventions in our centre with other countries. Material and methods: Patients with Spastic CP with Gross Motor Function Classification System (GMFCS) I-III that underwent lower limb surgical intervention in our centre from 2008-2018 were retrospectively reviewed for The Spinal Alignment and Range of Motion Measure ROM subscale (SAROMM) scores and Functional Mobility Scale (FMS) 18 months after surgery. Changes in SAROMM, FMS scores and minimal clinically important difference (MCID) were determined. Results: 19 patients were included in the study with mean age of 12.58. All patients underwent muscle tendon procedures. Box plot analysis of SAROMM showed reduction of median scores at 6(26.3%) and 12(47.4%) months which plateaus at 18 months post-surgery. Repeated measure ANOVA analysis showed there was a statistically significant effect of time on SAROMM scores ($p < 0.001$) with MCID of 13.4. Improvement of FMS scores was the most at 50m with 13 children ($p < 0.05$), one at 5m and five at 500m. None reported worsening of FMS scores at 18 months. There were no changes of GMFCS levels by the end of 18 months. Conclusion: Surgeries performed on GMFCS I-III patients with the aim of gait improvement translates into improved mobility with results comparable to other countries.

PMID: 37775480

6. Effectiveness of Neurodevelopmental Treatment and Sensory Integration Therapy on Gross Motor Function, Balance and Gait Parameters in Children With Spastic Diplegia

Anushka Raipure, Rakesh Krishna Kovela, Pallavi Harjpal

Cureus. 2023 Aug 21;15(8):e43876. doi: 10.7759/cureus.43876. eCollection 2023 Aug.

Background Spastic diplegic cerebral palsy is the type that is most frequently seen in clinical settings. Spastic diplegic children have trouble maintaining their balance, gait, and gross motor function. This study investigated the effects of the Neurodevelopmental Technique (NDT) and Sensory Integration Technique (SIT) on balance, gross motor function, and gait characteristics in children with spastic diplegia. Method The study's participants were 8 to 12 years old, with spastic diplegia, categorized into stages I to III of the Gross Motor Function Classification System. While individuals in group B underwent sensory integration therapy, group A's subjects received NDT for 45 minutes. Both groups received traditional physiotherapy for 15 minutes. The protocol was given for five days a week, continuously for four weeks. All 40 subjects underwent pre- and post-treatment assessments using the Gross Motor Function Measure-88 (GMFM-88), Paediatric Balance Scale, Gait Parameters, and Gross Motor Function Classification System. Results The trial involved 40 children, divided into two groups of 20 each. Statistical analysis demonstrated a substantial improvement in group B post-intervention ($P>0.0001$). The study's findings were drawn using the Chi-Square test, paired and unpaired t-tests, and SPSS Statistics for Windows, version 27.0 (IBM Corp., Armonk, USA).A $p<0.05$ and the GraphPad Prism version 7.0 (GraphPad Software, Boston, USA) were used. A total of 40 children completed the entire duration of treatment for a month. 20 subjects participated in group A (age range 8-12 years; mean age 10.3 years) and 20 subjects in group B (age range 8-12 years; mean age 10.25 years). The GMFM-88, which assesses motor function, reveals that the between-group comparison indicates a substantial difference of 7.95 (6.04-9.86) in favor of Group B, with a p-value of 0.0001, signifying statistical significance. Similarly, the Pediatric Balance Scale (PBS) outcomes significantly enhanced in both groups post-intervention. The comparison between groups yields a difference of 1.85 (1.11-2.59) in favor of Group B, with a p-value of 0.0001. Conclusion The study concluded that SIT has a positive impact on gait metrics, balance, and gross motor function in children with spastic diplegia.

PMID: 37746405

7. No Evidence to Support Aquatic Therapy for Children With Cerebral Palsy, But Do Their Experiences Matter More?

Eric Williamson

Pediatr Phys Ther. 2023 Oct 1;35(4):386. doi: 10.1097/PEP.0000000000001045.

No abstract available

PMID: 37747973

8. Commentary on "Effect of Active Motor Learning Interventions on Gross Motor Function and Mobility in Children Aged 2 to 6 Years With Bilateral Cerebral Palsy: A Systematic Review and Meta-analysis"

Kaitlyn Bigner, Kelly Greve, Betsey McCamish

Pediatr Phys Ther. 2023 Oct 1;35(4):429. doi: 10.1097/PEP.0000000000001050.

No abstract available

PMID: 37747977

9. Organized physical activity and sedentary behaviors in children and adolescents with autism spectrum disorder, cerebral palsy, and intellectual disability

Amin Nakhostin-Ansari, Monir Shayestehfar, Alireza Hasanzadeh, Fateme Gorgani, Amirhossein Memari

World J Psychiatry. 2023 Sep 19;13(9):685-697. doi: 10.5498/wjp.v13.i9.685.

Background: There is little data on physical activity (PA), organized PA (OPA), and sedentary behaviors in autism spectrum disorders (ASD) and other neurodevelopmental disorders in developing countries. Aim: To examine OPA, non-OPA, and sedentary behaviors and their associated factors in children and adolescents with ASD, cerebral palsy (CP), and intellectual disability (ID). Methods: A total of 1020 children and adolescents with ASD, CP, and ID were assessed regarding the child and family information as well as the Children's Leisure Activities Study Survey. Results: The results showed that the OPA level was significantly lower than non-OPA in all groups. Furthermore, the OPA level was significantly lower in the CP group

compared to ASD and ID groups (P < 0.001). Also, moderate (P < 0.001), vigorous (P < 0.05), and total (P < 0.001) physical activity levels were significantly different between all three groups, with the values being higher in the ASD group compared to the other two. The mean of the total sedentary behavior duration in the ASD group (1819.4 min/week, SD: 1680) was significantly lower than in the CP group (2687 min/week, SD: 2673) (P = 0.007) but not ID group (2176 min/week, SD: 2168.9) (P = 0.525). Conclusion: Our findings remark on the participation rate of PA, OPA, and sedentary behaviors of children and adolescents with ASD, CP, and ID in a developing country. In contrast, the need for developing standards of PA/OPA participation in neurodevelopmental disorders is discussed.

PMID: 37771640

10. The Journey to Sustainable Participation in Physical Activity for Adolescents Living with Cerebral Palsy

Gaela Kilgour, Ngaire Susan Stott, Michael Steele, Brooke Adair, Amy Hogan, Christine Imms

Children (Basel). 2023 Sep 10;10(9):1533. doi: 10.3390/children10091533.

Purpose: To understand adolescents' and their parents' perspectives on 'being active', this study explored the experience of participation in physical activity (PA), the role of long-term participation in PA, and the importance of remaining active for life. Methods: Eight ambulant adolescents with CP (aged 11-16 years, seven male) participated in a high-level mobility programme twice per week for 12 weeks. Guided using interpretive description, adolescents and 12 of their parents were interviewed before, after and nine months following the programme. Thirty-eight interviews were coded, analysed, and interpreted, informed by audit information, reflective journaling, and team discussions. Results: Adolescents and their parents highly value being active now and into adulthood. Sustainable participation in PA requires adolescents and families to navigate complex environments (interpersonal, organisational, community, and policy). Core themes were: 'Just Doing it', 'Getting the Mix Right' (right people, right place, right time), 'Balancing the Continua' and 'Navigating the Systems'. The continua involved balancing intra-personal attributes: 'I will try anything' through to 'I will do it if I want to' and 'It's OK to be different' through to 'It sucks being disabled'. Conclusions: The journey to sustainable participation was complex and dynamic. Experiences of successful journeys are needed to help adolescents with CP "stay on track" to sustainable participation.

PMID: 37761494

11. Adenotonsillectomy for obstructive sleep apnea in children with cerebral palsy: Risks and benefits

Nikolaus E Wolter, Patrick Scheffler, Chantal Li, Christopher End, Nicole K McKinnon, Indra Narang, Reshma Amin, Jackie Chiang, Clyde Matava, Evan J Propst

Int J Pediatr Otorhinolaryngol. 2023 Sep 21;174:111743. doi: 10.1016/j.ijporl.2023.111743. Online ahead of print.

Objectives: To determine outcomes following adenotonsillectomy for obstructive sleep apnea (OSA) and the impact of motor and swallowing impairment on respiratory complications in children with Cerebral Palsy (CP). Methods: A retrospective review of children with CP and sleep disordered breathing (SDB) who underwent adenotonsillectomy (2003-2021) was performed. Children with CP were age-matched to children without CP. Motor and swallowing function was assessed using the Gross Motor Functional Classification System (GMFCS) and the Eating and Drinking Ability Classification System (EDACS). The primary outcome was postoperative obstructive apnea-hypopnea index (OAHI). Secondary outcomes were cure rate, complications, and need for additional interventions. Results: Ninety-seven children with CP were assessed for SDB, and 74 underwent polysomnography. Moderate or severe OSA was found in 49% (36/74). Adenotonsillectomy was performed in 30% (29/97). All children who underwent adenotonsillectomy experienced an initial reduction in OAHI (31.7/h to 2.9/h, p < 0.0001). Children with CP were less likely to achieve an OAHI<1 compared with children without CP (62.5% vs 81.8%, p = 0.23). Children with CP had more postoperative complications (43.5% vs. 8.7%) and greater odds of respiratory complications compared with children without CP (OR 8.9 95% CI 2.1-37.9). Children with CP and a GMFCS score of 5 and EDACS score between 3 and 5 had more respiratory complications post-adenotonsillectomy compared to those with GMFCS<5 (p = 0.002) and EDACS<3 (p = 0.031). Conclusion: Children with CP had an improved OAHI initially following adenotonsillectomy but had higher rates of post-adenotonsillectomy complications. Respiratory complications after adenotonsillectomy were more common in children with motor and swallowing impairment. Findings may provide better preoperative planning for caregivers.

PMID: 37748322

12. Working Memory Training in Norwegian Children with Cerebral Palsy (CP) Show Minimal Evidence of Near and No Far Transfer Effects

Harald Beneventi, Gro Cc Løhaugen, Guro L Andersen, Cato Sundberg, Heidi Furre Østgård, Ellen Bakkan, Geir Walther, Torstein Vik, Jon Skranes

Dev Neurorehabil. 2023 Sep 23;1-7. doi: 10.1080/17518423.2023.2259985. Online ahead of print.

In children with cerebral palsy (CP), learning disabilities are well documented, and impairments in executive functions, such as attention, inhibition, shifting and working memory, represent significant burdens on patients, their families and the society. The aim of this study was to evaluate whether Cogmed RM working memory training could improve working memory in children with CP and investigate whether increased working memory capacity would generalize to other cognitive functions. Twenty-eight children completed the training and the results were compared to a waitlist control group (n = 32). The results yielded three main findings. First, children with CP improved with practice on trained working memory tasks. Second, the intervention group showed minimal near transfer effects to non-trained working memory tasks. Third, no effects on cognitive and behavioral far transfer measures were found.

PMID: 37740724

13. Clinical actionability of genetic findings in cerebral palsy

Sara A Lewis, Maya Chopra, Julie S Cohen, Jennifer Bain, Bhooma Aravamuthan, Jason B Carmel, Michael C Fahey, Reeval Segel, Richard F Wintle, Michael Zech, Halie May, Nahla Haque, Darcy Fehlings, Siddharth Srivastava, Michael C Kruer

medRxiv. 2023 Sep 11;2023.09.08.23295195. doi: 10.1101/2023.09.08.23295195. Preprint

Background and objectives: Single gene mutations are increasingly recognized as causes of cerebral palsy (CP) phenotypes, yet there is currently no standardized framework for measuring their clinical impact. We evaluated Pathogenic/Likely Pathogenic (P/LP) variants identified in individuals with CP to determine how frequently genetic testing results would prompt changes in care. Methods: We analyzed published P/LP variants in OMIM genes identified in clinical (n = 1,345 individuals) or research (n = 496) cohorts using exome sequencing of CP patients. We established a working group of clinical and research geneticists, developmental pediatricians, genetic counselors, and neurologists and performed a systematic review of existing literature for evidence of clinical management approaches linked to genetic disorders. Scoring rubrics were adapted, and a modified Delphi approach was used to build consensus and establish the anticipated impact on patient care. Overall clinical utility was calculated from metrics assessing outcome severity if left untreated, safety/practicality of the intervention, and anticipated intervention efficacy. Results: We found 140/1,841 (8%) of individuals in published CP cohorts had a genetic diagnosis classified as actionable , defined as prompting a change in clinical management based on knowledge related to the genetic etiology. 58/243 genes with P/LP variants were classified as actionable; 16 had treatment options targeting the primary disease mechanism , 16 had specific prevention strategies , and 26 had specific symptom management recommendations. The level of evidence was also graded according to ClinGen criteria; 44.6% of interventions had evidence class "D" or below. The potential interventions have clinical utility with 97% of outcomes being moderate-high severity if left untreated and 62% of interventions predicted to be of moderate-high efficacy . Most interventions (71%) were considered moderate-high safety/ practicality. Discussion: Our findings indicate that actionable genetic findings occur in 8% of individuals referred for genetic testing with CP. Evaluation of potential efficacy , outcome severity , and intervention safety / practicality indicates moderate-high clinical utility of these genetic findings. Thus, genetic sequencing to identify these individuals for precision medicine interventions could improve outcomes and provide clinical benefit to individuals with CP. The relatively limited evidence base for most interventions underscores the need for additional research.

PMID: 37745357

14. Risk factors and outcome of epilepsy in adults with cerebral palsy or intellectual disability

Isabel Fernández Pérez, Tamara Biedermann Villagra, Joan Jiménez-Balado, Jordi Jiménez Redondo, Bernat Bertran Recasens

Epilepsy Behav. 2023 Sep 26;147:109450. doi: 10.1016/j.yebeh.2023.109450. Online ahead of print.

Introduction: Epilepsy is found in 10-60% of individuals with cerebral palsy (CP) and 5.5-35% with intellectual disability (ID). However, little is known about the long-term evolution of epilepsy among adults. The aim of the study is to describe the factors associated with epilepsy and its outcome in a population of adults with CP or ID. Methods: This retrospective study reviewed the medical records of 306 individuals with CP/ID. All individuals underwent neurological, psychiatric, and neuropsychological follow-ups. Results: In the cohort, 72.5% of the individuals had a CP diagnosis, with a mean age of 36.4 years (IQR 24.0-46.0). Epilepsy was present in 55.6% of the individuals and was associated with CP ($p < 0.01$), spastic subtype ($p < 0.01$), a higher degree of ID ($p < 0.01$), hemorrhagic and congenital malformation etiologies (p 0.011), abnormal neuroimaging ($p < 0.01$), and worse scores on motor and communication scales ($p < 0.01$). Drug-resistant epilepsy (DRE) (22.4%) was associated with higher scores on motor scales ($p < 0.01$). Additionally, 42.3% of the individuals who attempted antiseizure medication (ASM) withdrawal experienced recurrence, which was associated with epileptic activity on the electroencephalogram (EEG) (p 0.004). Conclusions: Epilepsy is a common comorbidity in adults with CP or ID and is associated with greater brain damage and a more severe phenotype. Seizure recurrence after ASM withdrawal occurred in half of the individuals and was associated with epileptic activity on the EEG.

PMID: 37769423

15. Designing an Informative App for Neurorehabilitation: A Feasibility and Satisfaction Study by Physiotherapists

María Teresa Sánchez-Rodríguez, Mónica Yamile Pinzón-Bernal, Carmen Jiménez-Antona, Sofía Laguarta-Val, Patricia Sánchez-Herrera-Baeza, Pilar Fernández-González, Roberto Cano-de-la-Cuerda

Healthcare (Basel). 2023 Sep 14;11(18):2549. doi: 10.3390/healthcare11182549.

Background: New technologies have gained popularity, especially the use of mobile phone applications, in neurorehabilitation. The aim of this paper was (1) to develop a free mobile application (NeurorehAPP) that provides information about and helps to select the appropriate mobile application related to a list of neurological disorders (cognitive impairment, Alzheimer's disease, Parkinson's disease, multiple sclerosis, traumatic brain injury, stroke, cerebral palsy, muscular dystrophy, spina bifida, and facial paralysis), based on different objectives such as healthy habits, information, assessment, and treatment; and (2) to assess the feasibility, acceptability, and degree of satisfaction by physiotherapists after using NeurorehAPP for a minimum of three months. Methods: A free application was created to work with the Android® operating system. The degree of satisfaction and acceptance with the application was assessed with an adaptation of the Customer Satisfaction Questionnaire through a survey via email applied to physiotherapists from hospitals and neurological rehabilitation centers in Spain after using the application. Results: NeurorehAPP includes a total of 131 apps. A total of 121 physiotherapists completed a satisfaction survey. The total sample showed 85.41% satisfaction with the service provided by the app and 86.41% overall satisfaction with NeurorehAPP. Conclusions: NeurorehAPP is a free, intuitive, and friendly app used with the Android® operating system that allows the selection of the most appropriate app according to the type of user, neurological disorder, objective, and FDA criteria. Physiotherapists showed a high degree of satisfaction and acceptance with NeurorehAPP.

PMID: 37761746

16. The Impact of COVID-19 on Multidisciplinary Care Delivery to Children with Cerebral Palsy and Other Neuromuscular Complex Chronic Conditions

Hillary Brenda Nguyen, Neha Mulpuri, Danielle Cook, Michael Greenberg, M Wade Shrader, Ryan Sanborn, Kishore Mulpuri, Benjamin J Shore

Children (Basel). 2023 Sep 15;10(9):1555. doi: 10.3390/children10091555.

The COVID-19 pandemic has caused unprecedented challenges in the care of children with cerebral palsy (CP) and other neuromuscular complex chronic conditions (NCCCs). The purpose of this study is to explore the direct impact of the COVID-19 pandemic on healthcare delivery. From May to August 2020, medical professionals caring for CP and NCCC patients across multiple countries and disciplines completed a self-administered cross-sectional survey comparing practices before and during the COVID-19 pandemic. Of the 79 healthcare workers from eight countries who participated-predominantly pediatric orthopedic surgeons (32%), pediatricians (30%), and pediatric physiatrists (23%)-most of them felt that caring for NCCC patients during the pandemic presented unique difficulties, and they reported a significant decrease in the in-person NCCC clinic volume ($p < 0.001$), multidisciplinary appointments ($p < 0.001$), surgical cases ($p = 0.008$), and botulinum toxin/phenol injections. Most providers affirmed that institutional guidelines for perioperative emergent/urgent and elective procedures, workplace settings, and technology were modified to accommodate the ongoing public health crisis. The usage of telemedicine significantly increased for NCCC patient visits ($p < 0.001$). During the COVID-19 pandemic, many children with NCCCs lost access to routine, multidisciplinary care. Telemedicine became an integral part of communication and management. In the setting of the COVID-19 pandemic and with the threat of future healthcare disruptions, these data lay the foundation for trending the evolution of healthcare delivery and accelerating best practice guidelines for children with CP and NCCCs.

PMID: 37761516

17. Reasons for Encounters and Comorbidities in Adolescents with Intellectual Disability in General Practice: A Retrospective Analysis of Data from the Ask Study

Menghuan Song, Tran T A Le, Simon Denny, Nicholas G Lennox, Lyn McPherson, Robert S Ware, David Harley

Children (Basel). 2023 Aug 25;10(9):1450. doi: 10.3390/children10091450.

Adolescents with intellectual disability have substantial health needs. This retrospective analysis of data from the Ask Study describes reasons for primary care encounters and the prevalence and incidence of chronic physical and mental conditions among a cohort of community-dwelling adolescents with intellectual disability. Participants attended secondary schools in southern Queensland, Australia. Primary care data were extracted from primary care records. Demographic and health information was collected using carer-completed questionnaires. Reasons for primary care encounters, disease prevalence at age 16 years, and disease incidence through adolescence were reported. Data were obtained for 432 adolescents with intellectual disability (median follow-up: 4.1 years). Skin problems (29.4 per 100 encounters) were the most common reason patients presented for primary care, followed by psychological and behavioural problems (14.4 per 100 encounters) and musculoskeletal problems (13.8 per 100 encounters). Conditions with the highest prevalence were autism spectrum disorder

(18.6%) and asthma (18.1%). The prevalence of epilepsy, visual impairment, and cerebral palsy were 14.7, 11.1, and 8.0%, respectively. Gastroesophageal reflux had the highest incidence (9.4 cases per 1000 person-years). Adolescents with intellectual disability have significant healthcare needs, which general practitioners need to be aware of and address. Study findings should inform the development of training programs for general practitioners.

PMID: 37761411

18. Ultrasound Doppler Findings in Fetal Vascular Malperfusion Due to Umbilical Cord Abnormalities: A Pilot Case Predictive for Cerebral Palsy

Shota Saji, Junichi Hasegawa, Junki Koike, Misato Takatsuki, Natsumi Furuya, Nao Suzuki

Diagnostics (Basel). 2023 Sep 18;13(18):2977. doi: 10.3390/diagnostics13182977.

Fetal Vascular Malperfusion (FVM), a pathologic condition in the feto-placental circulation, is a chronic vaso-occlusive disorder in the umbilical venous blood flow. Microthrombi are caused by the umbilical cord's blood flow deficiency in a congested umbilical vein, which also causes microvascular damage to fetal organs, especially the brain, resulting in cerebral palsy. Thrombo-occlusive events also adversely affect the upstream chorionic or stem vessels in the placenta, resulting in fetal growth restriction and fetal hypoxia. An umbilical cord structural anomaly or multiple entanglements may involve FVM. In the present report, we demonstrate a case of FVM caused by multiple umbilical cord abnormalities obtained from antenatal ultrasound Doppler findings, and we also discuss FVM, which is chronically associated with CP, comparing the ultrasonographic findings to the pathologic findings.

PMID: 37761344

19. Adults with Cerebral Palsy: Navigating the Complexities of Aging

Devina S Kumar, Gabriel Perez, Kathleen M Friel

Review Brain Sci. 2023 Sep 8;13(9):1296. doi: 10.3390/brainsci13091296.

The goal of this narrative review is to highlight the healthcare challenges faced by adults with cerebral palsy, including the management of long-term motor deficits, difficulty finding clinicians with expertise in these long-term impairments, and scarcity of rehabilitation options. Additionally, this narrative review seeks to examine potential methods for maintaining functional independence, promoting social integration, and community participation. Although the brain lesion that causes the movement disorder is non-progressive, the neurodevelopmental disorder worsens from secondary complications of existing sensory, motor, and cognitive impairments. Therefore, maintaining the continuum of care across one's lifespan is of utmost importance. Advancements in healthcare services over the past decade have resulted in lower mortality rates and increased the average life expectancy of people with cerebral palsy. However, once they transition from adolescence to adulthood, limited federal and community resources, and health care professionals' lack of expertise present significant obstacles to achieving quality healthcare and long-term benefits. This paper highlights the common impairments seen in adults with cerebral palsy. Additionally, it underscores the critical role of long-term healthcare and management to prevent functional decline and enhance quality of life across physical, cognitive, and social domains.

PMID: 37759897

20. Identification of novel homozygous variants in FOXE3 and AP4M1 underlying congenital syndromic anophthalmia and microphthalmia

Warda Akbar, Asmat Ullah, Nighat Haider, Sufyan Suleman, Fati Ullah Khan, Abid Ali Shah, Muhammad Atif Sikandar, Sulman Basit, Wasim Ahmad

J Gene Med. 2023 Sep 27;e3601. doi: 10.1002/jgm.3601. Online ahead of print.

Background: Anophthalmia and microphthalmia are severe developmental ocular disorders that affect the size of the ocular globe and can be unilateral or bilateral. The disease is found in syndromic as well as non-syndromic forms. It is genetically caused by chromosomal aberrations, copy number variations and single gene mutations, along with non-genetic factors such as viral infections, deficiency of vitamin A and an exposure to alcohol or drugs during pregnancy. To date, more than 30 genes having different modes of inheritance patterns are identified as causing anophthalmia and microphthalmia. Methods: In the present study, a clinical and genetic analysis was performed of six patients with anophthalmia and microphthalmia and/or additional phenotypes of intellectual disability, developmental delay and cerebral palsy from a large consanguineous Pakistani family. Whole exome sequencing followed by data analysis for variants prioritization and validation through Sanger sequencing was performed to identify the disease causing variant(s). American College of Medical Genetics and Genomics (ACMG) guidelines were applied to classify clinical interpretation of the prioritized variants. Results: Clinical investigations

revealed that the affected individuals are afflicted with anophthalmia. Three of the patients showed additional phenotype of intellectual disability, developmental delays and other neurological symptoms. Whole exome sequencing of the DNA samples of the affected members in the family identified a novel homozygous stop gain mutation (NM_012186: c.106G>T: p.Glu36*) in Forkhead Box E3 (FOXE3) gene shared by all affected individuals. Moreover, patients segregating additional phenotypes of spastic paraplegia, intellectual disability, hearing loss and microcephaly showed an additional homozygous sequence variant (NM_004722: c.953G>A: p.Arg318Gln) in AP4M1. Sanger sequencing validated the correct segregation of the identified variants in the affected family. ACMG guidelines predicted the variants to be pathogenic. Conclusions: We have investigated first case of syndromic anophthalmia caused by variants in the FOXE3 and AP4M1. The present findings are helpful for understanding pathological role of the mutations of the genes in syndromic forms of anophthalmia. Furthermore, the study signifies searching for the identification of second variant in families with patients exhibiting variable phenotypes. In addition, the findings will help clinical geneticists, genetic counselors and the affected family with respect to prenatal testing, family planning and genetic counseling.

PMID: 37758467

21. Limitations of Multigene Next-Generation Sequencing Panel for "Cerebral Palsy" Phenotype and Other Complex Movement Disorders

Marina Eskandar, Laura Tochen, Mi Ran Shin, Bennett Lavenstein, Meira Meltzer, Andrea Gropman, Kuntal Sen

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In the past couple of decades, literature in pediatric neurology and clinical genetics has identified hundreds of monogenic disorders that can masquerade as infantile cerebral palsy (CP). Accurate and prompt diagnosis in such cases may be challenging due to several reasons. There are commercial multigene CP panels, but their diagnostic yield is often limited compared with exome sequencing because of diverse etiologies that may mimic CP. We report one such case where a patient with spastic hemiplegia underwent a long diagnostic journey before genetic diagnosis was established with exome sequencing and appropriate management was started. TTC19-related mitochondrial complex III deficiency is an ultrarare disorder of energy metabolism that presents with bilateral lesions in the basal ganglia and a degenerative neuropsychiatric phenotype.

PMID: 37757660

22. Implementing Parent Coaching in Hospital-Based Pediatric Occupational Therapy: A Multisite Quality Improvement Project

Kelly Tanner, Sara O'Rourke, Kristin Cunningham, Valerie Duffin, Nathalie Maitre

Multicenter Study Am J Occup Ther. 2023 Sep 1;77(5):7705205120. doi: 10.5014/ajot.2023.050243.

Importance: Parent coaching (PC) is a best practice for young children with, or at high risk for, cerebral palsy (CP). Occupational therapy practitioners in outpatient settings encounter barriers to implementing PC. Objective: To increase the documented use of PC in outpatient occupational therapy visits for children younger than age 2 yr with, or at high risk for, CP from 0% to 80%. Design: Multicenter quality improvement (QI) initiative with a time-series design. Setting: Three pediatric tertiary-care institutions, each with multiple outpatient occupational therapy clinics. Participants: Practitioners in the outpatient clinics and patients <2 yr old with, or at high risk for, cerebral palsy. Intervention: Plan-do-study-act cycles included interventions packaged as a toolkit: education sessions, quick references, electronic medical record (EMR) supports, and site-specific strategies. Outcomes and measures: The primary outcome measure was the use of PC in outpatient sessions. Process measures included pre- and posteducation practitioner knowledge scores and an EMR checklist. Balancing measures (ensuring that changes do not cause problems in other areas) of parent satisfaction/experience and practitioner productivity were measured pre- and postintervention. Results: The primary outcome measure goal (80% documented use of PC in sessions) was attained in the seventh month of the study, sustained for 4 mo, and settled at 79.1% for the remaining 6 mo. Practitioner knowledge scores increased from 83.1% to 87.9% after initial education sessions, t[56] = 3.289, p = .001. Parent satisfaction/experience and practitioner productivity scores did not change. Conclusions and relevance: QI methodology can support PC implementation in pediatric outpatient practice. What This Article Adds: This multisite QI initiative shows that outpatient occupational therapy practitioners can implement PC as a best practice with the use of a toolkit. Results suggest that education alone does not result in changes to practitioner behavior and that QI methods can help when implementing best practices in a clinical setting.

PMID: 37756516

23. PROSPECTIVE SINGLE CENTER ANALYSIS OF OUTCOME STEM CELLS TRANSPLANTS IN PATIENTS WITH CEREBRAL PALSY

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Pol Merkur Lekarski. 2023;51(4):339-345. doi: 10.36740/Merkur202304107.

Objective: Aim: To evaluate efficacy and safety of autologous bone marrow-derived mononuclear stem cell transplantation intrathecal in children with cerebral palsy. Patients and methods: Materials and Methods: 35 children have levels I-V cerebral palsy aged 8-months to 8-years-old were enrolled from September (2021-2022) at Iraqi private hospital. Gross Motor Function was assessed by a pediatrician and neurologist specialist, 5 mcg/kg/day of G-CSF subcutaneous single injection daily for three consecutive days. Bone marrow harvested from posterior iliac crest under light general anesthesia. Bone marrow mononuclear cells (BMMNCs) separation was performed using density gradient centrifugation with Ficoll, the cell viability checked by propidium iodide dye in a TALI machine (Invitrogen) in average 98%. The viable BMMNCs injected intrathecal in L4-L5 over a period of 5-10 min. Results: Results: Males accounted for 57.14% (20/35) while female 42.86% (15/35), and main neurological symptoms included spastic disorder spastic disorder (quadriplegia 24 (68.6), tetraplegia 2 (5.7), diplegia 5 (14.28), hemiplegia4 (11.42)). Gross Motor Function Classification System and Gross Motor Function Measure-66 (GMFM-66) showed II 10 (28.58), III 11(31.42) and IV 14 (40). On mean follow-up of 3 months post-stem cell transplant improvement was observed in 80% cases. The improvement showed in gross motor function (6/8) p=0.01, and speech (2/4) p=0.04, neck holding (5/5) p=0.0003, sitting balance (4/4) p=0.04, postural tone (5/5) p=0.0003, as well as significant reduction in seizure frequency (2/3) p=0.04 and improvement in cognition (6/7) p=0.01 were observed. Conclusion: Stem cell therapy for cerebral palsy shows a significant positive effect on the gross motor function, without long adverse effects.

PMID: 37756453

24. Effect of virtual reality combined with repetitive transcranial magnetic stimulation on musculoskeletal pain and motor development in children with spastic cerebral palsy: a protocol for a randomized controlled clinical trial

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BMC Neurol. 2023 Sep 26;23(1):339. doi: 10.1186/s12883-023-03359-4.

Purpose: This trial aims to investigate the efficacy and safety of virtual reality (VR) combined with repetitive transcranial magnetic stimulation (rTMS) for improving musculoskeletal pain and motor development in children with unilateral spastic cerebral palsy (CP). Methods: This study protocol is for a randomized controlled trial consisting of 2 treatment sessions (3 days/week for 4 weeks in each session, with a 1-week interval between sessions). We will recruit children aged 3-10 years with unilateral spastic CP (Gross Motor Function Classification System level I or II). Participants will be randomly divided into 3 groups: the VR + rTMS group (immersive VR intervention, rTMS and routine rehabilitation therapy), rTMS group (rTMS and routine rehabilitation therapy), and control group (sham rTMS and routine rehabilitation therapy). VR therapy will involve a daily 40-minute movement training session in a fully immersive environment. rTMS will be applied at 1 Hz over the primary motor cortex for 20 min on the contralateral side. The stimulation intensity will be set at 90% of the resting motor threshold, with 1200 pulses applied. A daily 60-minute routine rehabilitation therapy session including motor training and training in activities of daily living will be administered to all participants. The primary outcome will be pain intensity, assessed by the Revised Face, Legs, Activity, Cry, and Consolability Scale (R-FLACC). The secondary outcomes will include motor development, evaluated by the 66-item version of the Gross Motor Function Measure (GMFM-66) and Fine Motor Function Measure (FMFM); balance capacity, measured by the interactive balance system; activities of daily living; and quality of life, measured by the Barthel index and the Chinese version of the Cerebral Palsy Quality of Life scale for Children (C-CP QOL-Child). Safety will be monitored, and adverse events will be recorded during and after treatment. Discussion: Combined application of VR therapy and rTMS may reveal additive effects on pain management and motor development in children with spastic CP, but further high-quality research is needed. The results of this trial may indicate whether VR therapy combined with rTMS achieves a better analgesic effect and improves the motor development of children with spastic CP.

PMID: 37752420

25. [A series of 22 cases of perinatal arterial ischaemic stroke: risk factors, clinical management and neurological sequelae] [Article in Spanish; Abstract in English, Spanish]

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Observational Study Rev Neurol. 2023 Oct 1;77(7):151-158. doi: 10.33588/rn.7707.2023158.

Introduction: Perinatal arterial ischaemic stroke (PAIS) is almost as common as in adulthood and causes significant neurological sequelae. Aim: The aim is to describe the risk situations surrounding these neonates, the clinical manifestations, the management, the cost-effectiveness of diagnostic tests and the neurological sequelae. Patients and methods: We conducted an observational study of a cohort of patients consisting of neonates with a gestational age = 35 weeks diagnosed with PAIS in our hospital between 2010 and 2021. Results: Twenty-two cases of PAIS were included, and the incidence in our centre was 1/1,869 live newborns. The data showed that 81.8% had some intrapartum risk factor and 40.9% had a combination of several risk factors. It started with seizures (mean age 27.3 hours) in 77.3% of cases. Patients with a stroke in the left hemisphere had

more sequelae (77.8%) than those with a stroke on the right-hand side (16.6%) (p = 0.041), with the exception of infantile cerebral palsy (p = 0.04), while we found no difference between hemispheres in the frequency of language impairment (p = 0.06). The mean follow-up time was 6.13 ± 3.06 years. A total of 63.6% of infants had neurological sequelae: infantile cerebral palsy (40.9%), language disorders (22.7%) and intellectual disability (9%). Moreover, 18.2% developed epilepsy (between 0.25 and 1.8 years) and antiseizure treatment was maintained after discharge in 37.5% of cases in the last years of the study. Conclusions: If a newborn infant presents seizures, it is necessary to rule out the possibility of a stroke. PAIS causes neurological sequelae in over 60% of cases. Early identification is essential to improve the neurological prognosis and avoid the prolonged use of antiseizure drugs where possible.

PMID: 37750545

26. Autocrine positive feedback of tumor necrosis factor from activated microglia proposed to be of widespread relevance in chronic neurological disease

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Review Pharmacol Res Perspect. 2023 Oct;11(5):e01136. doi: 10.1002/prp2.1136.

Over a decade's experience of post-stroke rehabilitation by administering the specific anti-TNF biological, etanercept, by the novel perispinal route, is consistent with a wide range of chronically diminished neurological function having been caused by persistent excessive cerebral levels of TNF. We propose that this TNF persistence, and cerebral disease chronicity, largely arises from a positive autocrine feedback loop of this cytokine, allowing the persistence of microglial activation caused by the excess TNF that these cells produce. It appears that many of these observations have never been exploited to construct a broad understanding and treatment of certain chronic, yet reversible, neurological illnesses. We propose that this treatment allows these chronically activated microglia to revert to their normal quiescent state, rather than simply neutralizing the direct harmful effects of this cytokine after its release from microglia. Logically, this also applies to the chronic cerebral aspects of various other neurological conditions characterized by activated microglia. These include long COVID, Lyme disease, post-stroke syndromes, traumatic brain injury, chronic traumatic encephalopathy, post-chemotherapy, post-irradiation cerebral dysfunction, cerebral palsy, fetal alcohol syndrome, hepatic encephalopathy, the antinociceptive state of morphine tolerance, and neurogenic pain. In addition, certain psychiatric states, in isolation or as sequelae of infectious diseases such as Lyme disease and long COVID, are candidates for being understood through this approach and treated accordingly. Perispinal etanercept provides the prospect of being able to treat various chronic central nervous system illnesses, whether they are of infectious or non-infectious origin, through reversing excess TNF generation by microglia.

PMID: 37750203

27. Commentary on "Fidelity of Delivery in a Multisite Randomized Clinical Trial of Intervention Efficacy for Infants With Unilateral Cerebral Palsy"

Emily J Quinn, Bethany M Sloane, Elvira Manelyuk, Will Waldon

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No abstract available

PMID: 37747983

28. Fidelity of Delivery in a Multisite Randomized Clinical Trial of Intervention Efficacy for Infants With Unilateral Cerebral Palsy

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Randomized Controlled Trial Pediatr Phys Ther. 2023 Oct 1;35(4):458-466. doi: 10.1097/PEP.0000000000001038.

Purpose: To investigate the reliability of a measure of fidelity of therapist delivery, quantify fidelity of delivery, and determine factors impacting fidelity in the Rehabilitation EArly for Congenital Hemiplegia (REACH) clinical trial. Methods: Ninety-five infants (aged 3-9 months) with unilateral cerebral palsy participated in the REACH clinical trial. The Therapist Fidelity Checklist (TFC) evaluated key intervention components. Video-recorded intervention sessions were scored using the TFC. Results: Inter- and intrarater reliability was percentage agreement 77% to 100%. Fidelity of delivery was high for 88.9% of sessions and moderate for 11.1% of sessions. Sessions with moderate scores included infants receiving infant-friendly bimanual therapy and occurred at the intervention midpoint or later. No significant relationships were found for TFC scores and infant age, manual ability, or parent engagement. Conclusions: Fidelity of delivery was high for the REACH trial in most intervention sessions. Standardized therapist training with intervention manuals and monthly peer-to-peer support likely contributed to these results.

PMID: 37747982

29. Pediatric pulmonary infection caused by oral obligate anaerobes: Case Series

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Case Reports Front Pediatr. 2023 Sep 1;11:1226706. doi: 10.3389/fped.2023.1226706. eCollection 2023.

Background: Pneumonia is quite common in people with chronic bedridden, severe malnutrition and underlying diseases of cerebral palsy. Although poor oral hygiene and inadequate airway protection are risk factors, case reports of childhood pneumonia caused by oral obligate anaerobes are rare. Introduction: We reported 4 cases of oral anaerobic pneumonia and empyema diagnosed by the pediatric intensive care unit (PICU) of our hospital. Discussion: No bacteria were detected in sputum bacterial culture, pleural water bacterial culture and blood culture of the four children. Considering that multiple sputum cultures were negative, the pleural effusion and bronchoalveolar lavage fluid were subjected to next-generation sequencing (NGS) to identify the pathogen causing pneumonia. The results found oral obligate anaerobes represented by Parvimonas micra and Porphyromonas gingivalis. After identifying the pathogenic bacteria, we changed to piperacillin tazobactam combined with metronidazole for anti-infection treatment, and the pneumonia in the above patients was improved. In addition, all four patients had different basic medical histories, and long-term bed rest, severe malnutrition, poor oral hygiene and insufficient airway protection were all high risk factors for oral anaerobic pneumonia in these children. Conclusion: Oral obligate anaerobes are one of the pathogens to consider for pneumonia in the elderly, but they may be easily overlooked in pediatric groups. Therefore, when receiving children with high-risk factors, we should be alert to the possibility of oral obligate anaerobic bacteria infection. Educating family members to pay attention to children's oral hygiene plays an important role in preventing oral obligatory anaerobic bacteria pneumonia. NGS can be used as a rapid diagnostic method when sputum culture cannot distinguish between pathogens.

PMID: 37744449

30. Characteristics of Changes in Intrathecal Baclofen Dosage over Time due to Causative Disease

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Neurol Med Chir (Tokyo). 2023 Sep 23. doi: 10.2176/jns-nmc.2022-0359. Online ahead of print.

Intrathecal baclofen (ITB) therapy effectively treats spasticity caused by brain or spinal cord lesions. However, only a few studies compare the course of treatment for different diseases. We investigated the change in daily dose of baclofen per year and its associated adverse events in patients presenting with the three most common etiologies at our institute: hereditary spastic paraplegia, cerebral palsy, and spinal cord injury. The ITB pumps were implanted from July 2007 to August 2019, with a mean follow-up period of 70 months. In patients with hereditary spastic paraplegia, baclofen dosage was reduced after eight years following ITB introduction, and the treatment was terminated in one patient owing to disease progression. In patients with cerebral palsy, the dosage increased gradually, and became constant in the 11th year. Patients with spinal cord injury gradually increased their baclofen dosage throughout the entire observation period. Severity and adverse event rates were higher in patients with cerebral palsy than in others. The degree and progression of spasticity varied depending on the causative disease. Understanding the characteristics and natural history of each disease is important when continuing ITB treatment.

PMID: 37743509

31. It's easier to relearn gross motor skills than learn them for the first time after injury: Empirical evidence informing the age at injury debate

Thomas B Atkinson, Rob J Forsyth

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The effect of age at injury on outcomes after brain injury has long been debated. Many have argued that the greater plasticity of the immature brain aids in its recovery from trauma, but others (notably Donald Hebb) have argued that early injury can impair the future ability of the brain to acquire new capabilities. This is difficult to assess empirically due to the presence of many age-dependent confounders. We performed Item Response Theory (IRT) analyses of two datasets of Gross Motor Function Measure (GMFM) observations, one in children with cerebral palsy (CP) and one in children with acquired brain injury (ABI) sustained at later ages. We used IRT to derive independent estimates of test item difficulty in the two populations. Additionally, where comparison between GMFM items and items in the Denver II Developmental Screening Test battery was possible we used the latter to obtain the ages at which these abilities are acquired in typically developing children. Item difficulty estimates for the two populations are highly correlated (adjusted $r2=0.89$, $p<0.0005$), but demonstrate significant bias with harder items

(typically acquired at later ages) being more readily achieved by children with ABI compared to CP. These results support the Hebbian perspective that (when considering gross motor function) it is easier to maintain or recover previously established functions than to learn them for the first time in an injured brain. This argues for a more cautious outcome prognosis in injury at very young ages.

PMID: 37741169

Prevention and Cure

32. Neuroprotective effect of magnesium sulfate in premature infants. Analysis after establishing an antenatal administration protocol in a tertiary care hospital

Belén Fernández Monteagudo, Sonia Villar Castro, Paula Carrascosa García, Susana Zeballos Sarrato, Manuel Sánchez Luna

An Pediatr (Engl Ed). 2023 Sep 21;S2341-2879(23)00214-4. doi: 10.1016/j.anpede.2023.07.007. Online ahead of print.

Introduction: In 2016, a protocol was developed in our hospital for the antenatal administration of magnesium sulfate in pregnant women at risk of imminent preterm birth as a method to reduce the risk of cerebral palsy (CP). Material and methods: We conducted a retrospective observational study in a level IIIC hospital with the primary objective of comparing the incidence of CP before and after the implementation of this protocol. Among the secondary outcomes, we ought to highlight the incidence of cognitive deficits and necrotizing enterocolitis and the mortality in both groups. The sample consisted of preterm newborns delivered before 32 weeks of gestation in 2011-2012 (prior to the implementation of the protocol) and in 2016-2018 (after the implementation of the protocol, whose mothers had received magnesium sulfate for neuroprotection). The clinical and epidemiological characteristics of both groups were comparable. Results: We collected data for a total of 523 patients, 263 and 260 in each group. As regards the primary outcome, we did not find statistically significant differences between groups. We observed a statistically significant reduction in mortality and the risk of severe necrotizing enterocolitis in the group of patients born in the 2016-2018 period and between 26+0 and 27+6 weeks of gestation, whose mothers had received magnesium sulfate. Conclusions: In our study, the administration of magnesium sulfate to mothers at risk of preterm birth did not decrease the risk of developing CP.

PMID: 37741767