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Interventions and Management

1. Somatosensory Discrimination Intervention Improves Body Position Sense and Motor Performance in Children With Hemiplegic Cerebral Palsy.

McLean B, Taylor S, Blair E, Valentine J, Carey L, Elliott C.

Am J Occup Ther. 2017 May/Jun;71(3):7103190060p1-7103190060p9. doi: 10.5014/ajot.2016.024968.

OBJECTIVE: This study examined the use of the adult neuroscience-based Sense© intervention with children with hemiplegic cerebral palsy (HCP) to improve upper-limb somatosensory discrimination, motor function, and goal performance. **METHOD:** Seventeen children with HCP (9 boys, 8 girls; mean age = 10.2 yr) participated in this pilot matched-pairs trial with random allocation and 6-mo follow-up (intervention, n = 7; control, n = 10). The intervention group received Sense training 3×/wk for 6 wk (18 hr). Outcome measures included Goal Attainment Scaling, Sense_assess© Kids, and the Assisting Hand Assessment. **RESULTS:** The intervention group improved in goal performance, proprioception, and bimanual hand use and maintained improvement at 6-mo follow-up. The control group improved in occupational performance by 6-mo follow-up. **CONCLUSION:** This study established the feasibility of using the Sense intervention in a pediatric setting and adds preliminary evidence to suggest that improving somatosensory function can improve motor function and goal performance among children with HCP.

[PMID: 28422632](#)

2. Feasibility of Pediatric Game-Based Neurorehabilitation Using Telehealth Technologies: A Case Report.

Reifenberg G, Gabrosek G, Tanner K, Harpster K, Proffitt R, Persch A.

Am J Occup Ther. 2017 May/Jun;71(3):7103190040p1-7103190040p8. doi: 10.5014/ajot.2017.024976.

This case report is the first in a series of reports designed to determine the feasibility of implementing game-based neurorehabilitation using telehealth technologies (GbN+TT) for children with cerebral palsy, evaluate the responsiveness of relevant outcome measures to changes in motor impairment and activity participation after intervention, and identify technological challenges associated with implementation of GbN+TT. The participant completed more than 56 hr of game-based neurorehabilitation over 8 wk using the Timocco platform in his home. The primary measures of motor impairment (Bruininks-Oseretsky Test of Motor Proficiency, Second Edition) and function (Pediatric Motor Activity Log) were both sensitive to change. Results indicate that it is feasible to administer GbN+TT to a child with cerebral palsy and monitor outcomes using standardized assessments.

[PMID: 28422630](#)

3. Scoliosis in Patients with Severe Cerebral Palsy: Three Different Courses in Adolescents.

Oda Y, Takigawa T, Sugimoto Y, Tanaka M, Akazawa H, Ozaki T.

Acta Med Okayama. 2017 Apr;71(2):119-126. doi: 10.18926/AMO/54980.

Patients with cerebral palsy (CP) frequently present with scoliosis; however, the pattern of curve progression is difficult to predict. We aimed to clarify the natural course of the progression of scoliosis and to identify scoliosis predictors. This was a retrospective, single-center, observational study. Total of 92 CP patients from Asahikawasou Ryouiku Iryou Center in Okayama, Japan were retrospectively analyzed. Cobb angle, presence of hip dislocation and pelvic obliquity, and Gross Motor Function Classification System (GMFCS) were investigated. Severe CP was defined as GMFCS level IV or V. The mean observation period was 10.7 years. Thirtyfour severe CP patients presented with scoliosis and were divided into 3 groups based on their clinical courses: severe, moderate and mild. The mean Cobb angles at the final follow-up were 129°, 53°, and 13° in the severe, moderate, and mild groups, respectively. The average progressions from 18 to 25 years were 2.7°/year, 0.7°/year, and 0.1°/year in the severe, moderate, and mild curve groups, respectively. We observed the natural course of scoliosis and identified 3 courses based on the Cobb angle at 15 and 18 years of age. This method of classification may help clinicians predict the patients' disease progression.

[PMID: 28420893](#)

4. Reliability of four models for clinical gait analysis.

Kainz H, Graham D, Edwards J, Walsh HPJ, Maine S, Boyd RN, Lloyd DG, Modenese L, Carty CP.

Gait Posture. 2017 Apr 3;54:325-331. doi: 10.1016/j.gaitpost.2017.04.001. [Epub ahead of print]

Three-dimensional gait analysis (3DGA) has become a common clinical tool for treatment planning in children with cerebral palsy (CP). Many clinical gait laboratories use the conventional gait analysis model (e.g. Plug-in-Gait model), which uses Direct Kinematics (DK) for joint kinematic calculations, whereas, musculoskeletal models, mainly used for research, use Inverse Kinematics (IK). Musculoskeletal IK models have the advantage of enabling additional analyses which might improve the clinical decision-making in children with CP. Before any new model can be used in a clinical setting, its reliability has to be evaluated and compared to a commonly used clinical gait model (e.g. Plug-in-Gait model) which was the purpose of this study. Two testers performed 3DGA in eleven CP and seven typically developing participants on two occasions. Intra- and inter-tester standard deviations (SD) and standard error of measurement (SEM) were used to compare the reliability of two DK models (Plug-in-Gait and a six degrees-of-freedom model solved using Vicon software) and two IK models (two modifications of 'gait2392' solved using OpenSim). All models showed good reliability (mean SEM of 3.0° over all analysed models and joint angles). Variations in joint kinetics were less in typically developed than in CP participants. The modified 'gait2392' model which included all the joint rotations commonly reported in clinical 3DGA, showed reasonable reliable joint kinematic and kinetic estimates, and allows additional musculoskeletal analysis on surgically adjustable parameters, e.g. muscle-tendon lengths, and, therefore, is a suitable model for clinical gait analysis.

[PMID: 28411552](#)

5. Electromagnetic Tracking for Femoral Derotation Osteotomy - An in vivo study.

Geisbüsch A, Auer C, Dickhaus H, Putz C, Dreher T.

J Orthop Res. 2017 Apr 17. doi: 10.1002/jor.23579. [Epub ahead of print]

Femoral derotation osteotomy delivers good to excellent results in the treatment of rotational gait abnormalities and especially in internal rotation gait. The outcome of the procedure has been evaluated in numerous short and long term studies. Although reasons for recurrence and over-/under-correction have been unveiled in earlier studies the mechanisms are still not fully understood. False intra-operative assessment of the derotation angle may contribute to imprecise outcomes. In a recent saw-bone study we evaluated an electromagnetic tracking system in comparison to conventional goniometer measurement and a CT reference measurement and found it to be extremely accurate, whereas the use of a conventional goniometer for derotation measurement showed a high inter- and intra-rater variability. The current study evaluates the electromagnetic tracking system for continuous intraoperative derotation control under real OR conditions. Adults (age: 18-40 years) with the diagnosis of

internal rotation gait, independent of the underlying pathology, undergoing a supracondylar derotation osteotomy were included. A rotational CT scan was conducted before and in close proximity after surgery and the difference served as reference for the electromagnetic tracking results. The results showed a mean deviation of 2.6° (1.2° - 5.5°) in comparison to the reference measurement of the pre- and post-operative CT scans. The system proved to be stable under OR conditions with a good usability and a small technical footprint. Electromagnetic tracking delivers a precise, reliable and independent assessment of intraoperative derotation angles in femoral derotation osteotomies. This article is protected by copyright. All rights reserved.

[PMID: 28419537](#)

6. Assessment of anthropometric indicators in children with cerebral palsy according to the type of motor dysfunction and reference standard.

García Iñiguez JA, Vásquez-Garibay EM, García Contreras A, Romero-Velarde E, Troyo Sanromán R.

Nutr Hosp. 2017 Mar 30;34(2):315-322. doi: 10.20960/nh.353.

AIM: The study aimed to demonstrate that the assessment of the anthropomorphic measurements of children with cerebral palsy (CP) varies according to the type of motor dysfunction and reference standard used for comparison. METHOD: In a cross-sectional design, 108 children 2 to 16 years were classified according to the type of motor dysfunction by gender and age group. Weight, mid-upper-arm-circumference (MUAC), and alternative measures for height were performed. Height/age and weight/age indexes and BMI were evaluated with percentiles and/or Z-scores with reference to a number of previously published references of growth, including those of the World Health Organization (WHO). RESULTS: Fifty-three (49.1%) were females and 55 (50.9%) males. Spastic type was predominant (73.1%) and 26.9% were other types of dysfunction. Most of the children were located on level IV (14.6%) and level V (73.1%) of the Gross Motor Function Classification System (GMFCS). Significant differences were found, suggesting that weight ($p = 0.002$), height ($p = 0.001$), and MUAC ($p = 0.05$) are higher in the spastic group than in other groups. CONCLUSIONS: The anthropometric indicators were significantly higher in the spastic group than in other groups. Upper-arm length (UAL) seemed less appropriate than knee height (KH) and lower-leg length (LLL) for measuring height. The WHO reference standard was not useful to evaluate the majority of anthropometric indexes in children with CP, other references as the growth charts of Day and Brooks have been more suitable.

[PMID: 28421784](#)

7. Clown-care reduces pain in children with cerebral palsy undergoing recurrent botulinum toxin injections- A quasi-randomized controlled crossover study.

Ben-Pazi H, Cohen A, Kroyzer N, Lotem-Ophir R, Shvili Y, Winter G, Deutsch L, Pollak Y.

PLoS One. 2017 Apr 17;12(4):e0175028. doi: 10.1371/journal.pone.0175028. eCollection 2017.

OBJECTIVE: We investigated the impact of clown-care on pain in 45 children with cerebral palsy who underwent recurrent Botulinum-toxin injections (age 7.04 ± 4.68 years). Participants were randomized to receive either clown ($n = 20$) or standard ($n = 25$) -care. METHODS: Pain Visual-Analogue-Scale (range 1-5) was reported before and after procedures. Pain assessment was lower for children undergoing Botulinum-toxin injections with clown-care (2.89 ± 1.36) compared to standard-care (3.85 ± 1.39 ; $p = 0.036$) even though pain anticipated prior to procedures was similar (~ 3). FINDINGS: Children who underwent the first procedure with clown-care reported lower pain even after they crossed-over to the following procedure which was standard ($p = 0.048$). Carryover effect was more prominent in injection-naïve children ($p = 0.019$) and during multiple procedures ($p = 0.009$). Prior pain experience correlated with pain in subsequent procedures only when first experience was standard-care ($p = 0.001$). CONCLUSIONS: Clown-care alleviated pain sensation during Botulinum-toxin injections and initial clown-care experience reduced pain during subsequent injections even though clowns were not present.

[PMID: 28414728](#)

8. Relationship of cognitive functions and gross motor abilities in children with spastic diplegic cerebral palsy.

Al-Nemr A, Abdelazeim F.

Appl Neuropsychol Child. 2017 Apr 18:1-9. doi: 10.1080/21622965.2017.1312402. [Epub ahead of print]

Spastic diplegic cerebral palsy can be accompanied by a myriad of symptoms affecting other body systems including cognitive dysfunction. The purpose of this study was to determine whether a relationship exists between cognitive functions in the form of selective attention and figural memory domains with standing and walking motor abilities in children with diplegic cerebral palsy. The research design was a correlational study. Tasks assessing cognitive function and gross motor abilities were carried out with a sample of 50 children. The data demonstrated the presence of correlation between selective attention and figural memory domains of cognitive function with standing, walking running, and jumping subscales of the Gross Motor Function Measure (GMFM) scale at different ages, and this correlation was significant between selective attention domain and gross motor abilities. The outcome measurements of the current study provide original evidence based on the necessity of including cognitive and physical impairments in the examination and evaluation of children with diplegic cerebral palsy in research and clinical settings.

[PMID: 28418729](#)

9. Pediatric Oral Motor Feeding Assessments: A Systematic Review.

Barton C, Bickell M, Fucile S.

Phys Occup Ther Pediatr. 2017 Apr 21:1-20. doi: 10.1080/01942638.2017.1290734. [Epub ahead of print]

AIM: To describe the clinical properties and psychometric soundness of pediatric oral motor feeding assessments. METHODS: A systematic search was conducted using Medline, CINAHL, EMBASE, PsycInfo, and HAPI databases. Assessments were analyzed for their clinical and psychometric characteristics. RESULTS: 12 assessment tools were identified to meet the inclusion/exclusion criteria. Clinical properties varied from assessments evaluating oral-motor deficits, screening to identify feeding problems, and monitoring feeding progress. Most assessments were designed for children with developmental disabilities or cerebral palsy. Eleven assessments had psychometric evidence, of these nine had reliability and validity testing (Ability for Basic Feeding and Swallowing Scale for Children, Behavioral Assessment Scale of Oral Functions in Feeding, Dysphagia Disorder Survey, Functional Feeding Assessment-modified, Gisel Video Assessment, Montreal Children's Hospital Feeding Scale, Oral Motor Assessment Scale, Schedule for Oral Motor Assessment, and Screening Tool of Feeding Problems Applied to Children). The Brief Assessment of Motor Function-Oral Motor Deglutition and the Pediatric Assessment Scale for Severe Feeding Problems had reliability testing only. The Slurp Test was not tested for any psychometric properties. Overall, psychometric evidence was inconsistent and inadequate for the evaluative tools.

[PMID: 28430014](#)

10. Reproductive healthcare experiences of women with cerebral palsy.

Hayward K, Chen AY, Forbes E, Byrne R, Greenberg MB, Fowler EG.

Disabil Health J. 2017 Apr 5. pii: S1936-6574(17)30063-8. doi: 10.1016/j.dhjo.2017.03.015. [Epub ahead of print]

BACKGROUND: Little is known about pregnancy rates in women with disabilities in general and even less is known about women with child-onset disabilities such as cerebral palsy (CP). HYPOTHESIS: We hypothesized that discussions about pregnancy with healthcare providers and pregnancy rates for woman with CP would be related to their functional levels. METHODS: Survey methodology was used to gather information about demographics, function, whether women were asked about their desire for children, pregnancy outcomes, and services offered during pregnancy and postpartum. RESULTS: Of the 375 women with CP who participated in the survey, 76 (20%) reported 149 pregnancies resulting in 100 live births. Using Chi square statistics, mobility, manual dexterity, and communication function were significantly higher in women who were queried about or who experienced pregnancy. More than half of the women experienced a loss of mobility during pregnancy but few received referrals for physical or occupational therapy. Few reported screening for postpartum depression. A higher rate of Cesarean sections (50.4%), preterm births (12.1%), low birth weight infants (15.7%), and very low birth weight infants

(7.1%) was reported by women with CP compared to national statistics. CONCLUSIONS: Pregnancy rates and discussions were related to functional levels. As 20% of women with CP surveyed experienced pregnancy, there is a need to increase awareness, education, support, and advocacy for achievement of optimal reproductive health. More research is needed to identify factors contributing to maternal and infant health in women with CP.

[PMID: 28428111](#)

11. Long-term deterioration of perceived health and functioning in adults with cerebral palsy.

Benner JL, Hilberink SR, Veenis T, Stam HJ, van der Slot WMA, Roebroek ME.

Arch Phys Med Rehabil. 2017 Apr 17. pii: S0003-9993(17)30237-X. doi: 10.1016/j.apmr.2017.03.013. [Epub ahead of print]

OBJECTIVE: To describe longitudinal change in perceived health, presence of health issues and functional level in adults with cerebral palsy (CP). DESIGN: Prospective cohort study. SETTING: Participants who completed baseline assessments in 1996 or 2000 were invited for a long-term follow-up in 2010. PARTICIPANTS: Forty-nine Dutch adults with CP (age 35-45 years, 55% male, 75% spastic) formerly known in pediatric rehabilitation care. INTERVENTIONS: Not applicable. MAIN OUTCOME MEASURES: Postal questionnaires were completed by the adults or their proxies (n=9). Health outcomes included perceived health (adapted from SF-36), presence of health issues such as pain, severe fatigue (dichotomized), and functional level (Barthel Index; walking performance). RESULTS: Over a 10-year period, the percentage of adults with CP worrying about their health increased (29 to 54%, p=0.008) and those indicating that health problems limit their activities increased (19 to 45%, p=0.002). In the same period the majority continued to report good general health (93 to 86%, p=0.148). Presence of some health issues increased over time, such as pain; severe fatigue was a common health issue at follow-up (32%). Over a 14-year period, mobility and self-care deteriorated (Barthel Index 17.1 (SD 4.8) to 16.3 (SD 5.6), p=0.007). Walking performance, specifically indoors declined (83 to 71%, p=0.010). CONCLUSIONS: Adults with CP experienced deterioration in health outcomes in the long-term. Most notably, perceived health and functional level decreased. Pain and severe fatigue were the most common health issues in adult CP. More research is required to explore the mechanisms at work in the process of aging among persons with CP. Systematic follow-up of adults with CP appears necessary to timely detect and intervene on health problems and functional decline.

[PMID: 28427924](#)

12. Describing heterogeneity of unmet needs among adults with a developmental disability: An examination of the 2012 Canadian Survey on Disability.

Zwicker J, Zaresani A, Emery JCH.

Res Dev Disabil. 2017 Apr 13;65:1-11. doi: 10.1016/j.ridd.2017.04.003. [Epub ahead of print]

BACKGROUND: As a signatory to the UN Convention on the Rights of Persons with Disabilities, Canada has committed to protect the rights and dignity of persons with developmental disabilities (DD), which means that labour markets, education, and training opportunities should be inclusive and accessible. PURPOSE: Describe the unmet employment, education and daily needs of adults with DD, with a sub analysis of persons with autism spectrum disorder (ASD) and cerebral palsy (CP) in Canada, to inform efficient and equitable policy development. METHODS AND PROCEDURES: Secondary analysis of 2012 Canadian Survey on Disability was used to study a sample including working age (15-64 years old) individuals with self-reported DD, CP and ASD. Persons with DD reported on their met and unmet needs in term of activities of daily living, education and employment. OUTCOMES AND RESULTS: Labour force participation is the lowest for those with DD compared to any other disability. Individuals with CP and ASD report a high level of unmet needs that differ in terms of educational, vocational and daily living supports. CONCLUSIONS AND IMPLICATIONS: Improving labour force participation to be inclusive and accessible requires policy that considers the range of unmet needs that exist for persons with DD.

[PMID: 28412577](#)

13. Stakeholders' views of the introduction of assistive technology in the classroom: How family-centred is Australian practice for students with cerebral palsy?

Karlsson P, Johnston C, Barker K.

Child Care Health Dev. 2017 Apr 17. doi: 10.1111/cch.12468. [Epub ahead of print]

BACKGROUND: With family-centred care widely recognized as a cornerstone for effective assistive technology service provision, the current study was undertaken to investigate to what extent such approaches were used by schools when assistive technology assessments and implementation occurred in the classroom. **METHOD:** In this cross-sectional study, we compare survey results from parents (n = 76), school staff (n = 33) and allied health professionals (n = 65) with experience in the use of high-tech assistive technology. Demographic characteristics and the stakeholders' perceived helpfulness and frequency attending assessment and set-up sessions were captured. To evaluate how family-centred the assistive technology services were perceived to be, the parents filled out the Measure of Processes of Care for Caregivers, and the professionals completed the Measure of Processes of Care for Service Providers. Descriptive statistics and one-way analysis of variance were used to conduct the data analysis. **RESULTS:** Findings show that parents are more involved during the assessment stage than during the implementation and that classroom teachers are often not involved in the initial stage. Speech pathologists in particular are seen to be to a great extent helpful when implementing assistive technology in the classroom. This study found that family-centred service is not yet fully achieved in schools despite being endorsed in early intervention and disability services for over 20 years. No statistically significant differences were found with respect to school staff and allied health professionals' roles, their years of experience working with students with cerebral palsy and the scales in the Measure of Processes of Care for Service Providers. **CONCLUSION:** To enhance the way technology is matched to the student and successfully implemented, classroom teachers need to be fully involved in the whole assistive technology process. The findings also point to the significance of parents' involvement, with the support of allied health professionals, in the process of selecting and implementing assistive technology in the classroom.

[PMID: 28419501](#)

Prevention and Cure

14. Brain Lesions in Children with Unilateral Spastic Cerebral Palsy.

Hadzagic-Catibusic F, Avdagic E, Zubcevic S, Uzicanin S.

Med Arch. 2017 Feb;71(1):7-11. doi: 10.5455/medarh.2017.71.7-11. Epub 2017 Feb 5.

INTRODUCTION: Unilateral spastic cerebral palsy (US CP) is the second most common subtype of cerebral palsy. **AIM:** The aim of the study was to analyze neuroimaging findings in children with unilateral spastic cerebral palsy. **MATERIAL AND METHODS:** The study was hospital based, which has included 106 patients with US CP (boys 72/girls 34, term 82/preterm 24). Neuroimaging findings were classified into 5 groups: Brain maldevelopment, predominant white matter injury, predominant gray matter injury, non specific findings and normal neuroimaging findings. **RESULTS:** Predominant white matter lesions were the most frequent (48/106, 45.28%; term 35/preterm 13), without statistically significant difference between term and preterm born children ($\chi^2=0.4357$; $p=0.490517$). Predominant gray matter lesions had 32/106 children, 30.19%; (term 25/preterm 7, without statistically significant difference between term and preterm born children ($\chi^2=0.902$; $p=0.9862$). Brain malformations had 10/106 children, 9.43%, and all of them were term born. Other finding had 2/106 children, 1.89%, both of them were term born. Normal neuroimaging findings were present in 14/106 patients (13.21%). **CONCLUSION:** Neuroimaging may help to understand morphological background of motor impairment in children with US CP. Periventricular white matter lesions were the most frequent, then gray matter lesions.

[PMID: 28428665](#)

15. Segmental Diffusion Properties of the Corticospinal Tract and Motor Outcome in Hemiparetic Children With Perinatal Stroke.

Hodge J, Goodyear B, Carlson H, Wei XC, Kirton A.

J Child Neurol. 2017 May;32(6):550-559. doi: 10.1177/0883073817696815. Epub 2017 Mar 22.

Perinatal stroke injures developing motor systems, resulting in hemiparetic cerebral palsy. Diffusion tensor imaging can explore structural connectivity. We used diffusion tensor imaging to assess corticospinal tract diffusion in hemiparetic children with perinatal stroke. Twenty-eight children (6-18 years) with unilateral stroke underwent diffusion tensor imaging. Four corticospinal tract assessments included full tract, partial tract, minittract and region of interest. Diffusion characteristics (fractional anisotropy, mean, axial, and radial diffusivity) were calculated. Ratios (lesioned/nonlesioned) were compared across segments and to validated long-term motor outcomes (Pediatric Stroke Outcome Measure, Assisting Hand Assessment, Melbourne Assessment). Fractional anisotropy and radial diffusivity ratios decreased as tract size decreased, while mean diffusivity showed consistent symmetry. Poor motor outcomes were associated with lower fractional anisotropy in all segments and radial diffusivity correlated with both Assisting Hand Assessment and Melbourne Assessment. Diffusion imaging of segmented corticospinal tracts is feasible in hemiparetic children with perinatal stroke. Correlations with disability support clinical relevance and utility in model development for personalized rehabilitation.

[PMID: 28424004](#)

16. Cerebral Autoregulation, Brain Injury, and the Transitioning Premature Infant.

Vesoulis ZA, Mathur AM.

Front Pediatr. 2017 Apr 3;5:64. doi: 10.3389/fped.2017.00064. eCollection 2017.

Improvements in clinical management of the preterm infant have reduced the rates of the two most common forms of brain injury, such as severe intraventricular hemorrhage and white matter injury, both of which are contributory factors in the development of cerebral palsy. Nonetheless, they remain a persistent challenge and are associated with a significant increase in the risk of adverse neurodevelopment outcomes. Repeated episodes of ischemia-reperfusion represent a common pathway for both forms of injury, arising from discordance between systemic blood flow and the innate regulation of cerebral blood flow in the germinal matrix and periventricular white matter. Nevertheless, establishing firm hemodynamic boundaries, as a part of neuroprotective strategy, has challenged researchers. Existing measures either demonstrate inconsistent relationships with injury, as in the case of mean arterial blood pressure, or are not feasible for long-term monitoring, such as cardiac output estimated by echocardiography. These challenges have led some researchers to focus on the mechanisms that control blood flow to the brain, known as cerebrovascular autoregulation. Historically, the function of the cerebrovascular autoregulatory system has been difficult to quantify; however, the evolution of bedside monitoring devices, particularly near-infrared spectroscopy, has enabled new insights into these mechanisms and how impairment of blood flow regulation may contribute to catastrophic injury. In this review, we first seek to examine how technological advancement has changed the assessment of cerebrovascular autoregulation in premature infants. Next, we explore how clinical factors, including hypotension, vasoactive medications, acute and chronic hypoxia, and ventilation, alter the hemodynamic state of the preterm infant. Additionally, we examine how developmentally linked or acquired dysfunction in cerebral autoregulation contributes to preterm brain injury. In conclusion, we address exciting new approaches to the measurement of autoregulation and discuss the feasibility of translation to the bedside.

[PMID: 28421173](#)