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Interventions and Management

1. Clinical assessment and three-dimensional movement analysis: An integrated approach for upper limb evaluation in children with unilateral cerebral palsy.

Mailleux L, Jaspers E, Ortibus E, Simon-Martinez C, Desloovere K, Molenaers G, Klingels K, Feys H.

PLoS One. 2017 Jul 3;12(7):e0180196. doi: 10.1371/journal.pone.0180196. eCollection 2017.

INTRODUCTION: The clinical application of upper limb (UL) three-dimensional movement analysis (3DMA) in children with unilateral cerebral palsy (uCP) remains challenging, despite its benefits compared to conventional clinical scales. Moreover, knowledge on UL movement pathology and how this relates to clinical parameters remains scarce. Therefore, we investigated UL kinematics across different manual ability classification system (MACS) levels and explored the relation between clinical and kinematic parameters in children with uCP. **PATIENTS AND METHODS:** Fifty children (MACS: I = 15, II = 26, III = 9) underwent an UL evaluation of sensorimotor impairments (grip force, muscle strength, muscle tone, two-point discrimination, stereognosis), bimanual performance (Assisting Hand Assessment, AHA), unimanual capacity (Melbourne Assessment 2, MA2) and UL-3DMA during hand-to-head, hand-to-mouth and reach-to-grasp tasks. Global parameters (Arm Profile Score (APS), duration, (timing of) maximum velocity, trajectory straightness) and joint specific parameters (angles at task endpoint, ROM and Arm Variable Scores (AVS)) were extracted. The APS and AVS refer respectively to the total amount of movement pathology and movement deviations of wrist, elbow, shoulder, scapula and trunk. **RESULTS:** Longer movement durations and increased APS were found with higher MACS-levels ($p < 0.001$). Increased APS was also associated with more severe sensorimotor impairments ($r = -0.30$ - (-0.73)) and with lower AHA and MA2-scores ($r = -0.50$ - (-0.86)). For the joint specific parameters, stronger movement deviations distally were significantly associated with increased muscle weakness ($r = -0.32$ - (-0.74)) and muscle tone ($r = 0.33$ - (-0.61)); proximal movement deviations correlated only with muscle weakness ($r = -0.35$ - 0.59). Regression analysis exposed grip force as the most important predictor for the variability in APS ($p < 0.002$). **CONCLUSION:** We found increased movement pathology with increasing MACS-levels and demonstrated the adverse impact of especially muscle weakness. The lower correlations suggest that 3DMA provides additional information regarding UL motor function, particularly for the proximal joints. Integrating both methods seems clinically meaningful to obtain a comprehensive representation of all aspects of a child's UL functioning.

[PMID: 28671953](#)

2. Classification of upper limb disability levels of children with spastic unilateral cerebral palsy using K-means algorithm.

Raouafi S, Achiche S, Begon M, Sarcher A, Raison M.

Med Biol Eng Comput. 2017 Jul 1. doi: 10.1007/s11517-017-1678-y. [Epub ahead of print]

Treatment for cerebral palsy depends upon the severity of the child's condition and requires knowledge about upper limb disability. The aim of this study was to develop a systematic quantitative classification method of the upper limb disability

levels for children with spastic unilateral cerebral palsy based on upper limb movements and muscle activation. Thirteen children with spastic unilateral cerebral palsy and six typically developing children participated in this study. Patients were matched on age and manual ability classification system levels I to III. Twenty-three kinematic and electromyographic variables were collected from two tasks. Discriminative analysis and K-means clustering algorithm were applied using 23 kinematic and EMG variables of each participant. Among the 23 kinematic and electromyographic variables, only two variables containing the most relevant information for the prediction of the four levels of severity of spastic unilateral cerebral palsy, which are fixed by manual ability classification system, were identified by discriminant analysis: (1) the Falconer index (CAI E) which represents the ratio of biceps to triceps brachii activity during extension and (2) the maximal angle extension (0 Extension,max). A good correlation (Kendall Rank correlation coefficient = -0.53, $p = 0.01$) was found between levels fixed by manual ability classification system and the obtained classes. These findings suggest that the cost and effort needed to assess and characterize the disability level of a child can be further reduced.

[PMID: 28667591](#)

3. Usability testing of a developed assistive robotic system with virtual assistance for individuals with cerebral palsy: a case study.

Jafari N, Adams K, Tavakoli M, Wiebe S, Janz H.

Disabil Rehabil Assist Technol. 2017 Jul 4:1-6. doi: 10.1080/17483107.2017.1344884. [Epub ahead of print]

This paper presents a novel application of an assistive robotic system with virtual assistance to enhance manual performance of individuals with cerebral palsy. Cerebral palsy affects one's voluntary motor movements resulting in limited opportunities to actively engage in physical manipulative activities that require fine motor movements and coordination. Lack of object manipulation and environmental exploration can result in further impairments such as cognitive and social delays. The proposed assistive robotic system has been developed to enhance hand movements of people with disabilities when performing a functional task colouring. This paper presents the usability testing of the effectiveness of the developed system with an individual with cerebral palsy in a set of colouring tasks. Assisted and unassisted approaches were compared and analysed through quantitative and qualitative measures. The robotic-based approach was further compared with the participant's typical alternate access method to perform the same proposed tasks. The robotic system with virtual assistance was clinically validated to be significantly more effective, compared to both unassisted and typical approaches, by increasing the hand controllability, reducing the physical load and increasing the easiness of maintaining movements within the lines. Future studies will inform the use of the system for children with disabilities to provide them with assisted play for functional and playful activities. Implications for rehabilitation Robotic system can enhance manual performance in individuals with disabilities. Participating in a robot-mediated play activity could increase children's motivation and engagement. The developed robotic system can contribute to a basis for clinical and home-based implementation of the technology to promote manual play activities for children with disabilities.

[PMID: 28673115](#)

4. Correlation of the torsion values measured by rotational profile, kinematics, and CT study in CP patients.

Kim HY, Cha YH, Chun YS, Shin HS.

Gait Posture. 2017 Jun 22;57:241-245. doi: 10.1016/j.gaitpost.2017.06.014. [Epub ahead of print]

BACKGROUND: The purpose of study was to analyze correlations between bony torsions measured by Staheli's rotation profile, computed tomography (CT) torsional study, and gait analysis in patients with cerebral palsy (CP). **MATERIALS & METHOD:** The study group comprised of 26 children with CP (spastic diplegia, Gross Motor Function Classification System (GMFCS) 1-2, mean age 12.6 years) with torsional deformities. All subjects were assessed by examining: 1) rotational profile [internal rotation (IR) and external rotation (ER)], 2) CT torsional profile [femoral anteversion (FAV) and tibial torsion (TT)], and 3) gait analysis [mean hip rotation (HR) and mean knee rotation (KR)]. Statistical analysis was performed using the Pearson correlation test. **RESULTS:** In the femur, there was good correlation between FAV and Staheli's rotational profile of IR and ER (Pearson correlation coefficient (PC)=0.69, 0.52, $p < 0.05$). ER correlated very strongly with mean HR during gait (PC=0.8, $p < 0.05$). There was, however, poor correlation between HR and IR ($p > 0.05$), and between HR and FAV ($p > 0.05$). In the tibia, mean KR correlated well with thigh-foot angle (TFA) (PC=0.72) and CT tibia torsion (TT) (PC=0.62). TT also correlated with TFA (PC=0.62). **CONCLUSION:** Gait analysis and Staheli's rotational profile reflect both static and dynamic factors of gait abnormalities. However, CT study reflect static factor primarily. Dynamic factors tend to influence the

measurements of the femoral torsion only due to large rotational arc of hip joint. In surgical planning, it must be considered that HR sometimes does not correlate with CT anteversion angle. Similarly, it must also be considered that KR correlates well with TFA and CT TT angle.

[PMID: 28668738](#)

5. AAPT Diagnostic Criteria for Central Neuropathic Pain.

Widerstrom-Noga E, Loeser JD, Jensen TS, Finnerup NB.

J Pain. 2017 Jun 27. pii: S1526-5900(17)30626-0. doi: 10.1016/j.jpain.2017.06.003. [Epub ahead of print]

Central neuropathic pain, which is pain caused by a lesion or disease of the central somatosensory nervous system, is a serious consequence of spinal cord injury, stroke, multiple sclerosis and other conditions affecting the central nervous system. A collaborative effort between the Analgesic, Anesthetic, and Addiction Clinical Trial Translations, Innovations, Opportunities, and Networks (ACTTION) public-private partnership and the American Pain Society (APS), the ACTTION-APS Pain Taxonomy (AAPT) initiative, invited a working group to develop diagnostic criteria for central neuropathic pain. The criteria for central neuropathic pain that were developed expand upon existing criteria for neuropathic pain and the ICD11 draft criteria in order to ensure consistency. This article focuses on central neuropathic pain associated with spinal cord injury, stroke, and multiple sclerosis, but the AAPT framework can be extended to central pain due to other causes such as traumatic brain injury. The classification of central neuropathic pain is organized according to the AAPT multidimensional framework, specifically (1) core diagnostic criteria; (2) common features; (3) common medical and psychiatric comorbidities; (4) neurobiological, psychosocial, and functional consequences; and (5) putative neurobiological and psychosocial mechanisms, risk factors, and protective factors. PERSPECTIVE: The AAPT chronic central neuropathic pain taxonomy provides a classification for central pain associated with spinal cord injury, stroke and multiple sclerosis. The diagnostic criteria are organized according to the AAPT multidimensional framework, specifically (1) core diagnostic criteria; (2) common features; (3) common medical and psychiatric comorbidities; (4) neurobiological, psychosocial, and functional consequences; and (5) putative neurobiological and psychosocial mechanisms, risk factors, and protective factors.

[PMID: 28666966](#)

6. Effect of Functional Chewing Training on tongue thrust and drooling in children with cerebral palsy: A randomised controlled trial.

Inal Ö, Serel Arslan S, Demir N, Yilmaz ÖT, Karaduman AA.

J Oral Rehabil. 2017 Jul 6. doi: 10.1111/joor.12544. [Epub ahead of print]

BACKGROUND: Tongue thrust which is an oral reflex associated with sucking behaviour may cause problems in swallowing, speech, orofacial development, and also drooling. OBJECTIVE: We aimed to examine the effect of Functional Chewing Training(FuCT) on tongue thrust and drooling in children with cerebral palsy (CP). METHODS: The study included 32 children with a mean age of 58.25±9.58 months who had tongue thrust. Children were divided into two groups: The FuCT group and control group receiving classical oral motor exercises. Each group received training for 12 weeks. Oral motor assessment was performed. Chewing performance level was determined with the Karaduman Chewing Performance Scale (KCPS). Tongue thrust severity was evaluated with the Tongue Thrust Rating Scale(TTRS). The Drooling Severity and Frequency Scale(DSFS) was used to evaluate drooling severity and frequency. The evaluations were performed before and after treatment. RESULTS: Groups were well-matched in age, gender, and oral motor assessment. No significant difference was found between groups in terms of pre-treatment chewing function, tongue thrust severity, drooling severity and frequency ($p>0.05$). The FuCT group showed improvement in chewing performance($p=0.001$), tongue thrust severity($p=0.046$), and drooling severity($p=0.002$), but no improvement was found in terms of drooling frequency($p=0.082$) after treatment. There was no improvement in chewing performance, tongue thrust, drooling severity and frequency in the control group. A significant difference was found between groups in favour of FuCT group in tongue thrust severity($p = 0.043$). CONCLUSION: This study showed that the FuCT is an effective approach on the severity of tongue thrust and drooling in children with CP. This article is protected by copyright. All rights reserved.

[PMID: 28681387](#)

7. Oral sucking habits among children with Down syndrome and cerebral palsy.

Carneiro NCR, Monteiro LR, Pordeus IA, Borges-Oliveira AC.

Spec Care Dentist. 2017 Jul;37(4):176-180. doi: 10.1111/scd.12231.

AIMS: Identify factors associated with the presence of oral sucking habits among children with Down syndrome (DS) and cerebral palsy (CP). METHODS: The sample consisted of 181 children with DS or CP from two public healthcare institutions that treat children with special needs in the city of Rio de Janeiro, Brazil. The children's mothers answered a questionnaire about the individual and behavioral characteristics and the medical history of their children. The study was approved by the Research Ethics Committee of Universidade Federal de Minas Gerais. RESULTS: The presence of oral sucking habits (bottle feeding and pacifier/finger sucking) was observed in 83.0% of children. Children with artificial sucking habits had a 3.42 times greater chance of having a history of throat infection during the previous 6 months (5.61 to 48). A mother in the group of children with oral sucking habits had a 10.28 chance of not having breastfed her child (2.86 to 36.93). CONCLUSION: The history of throat infections in the preceding 6 months and the lack of breastfeeding were associated with the presence of oral sucking habits in children with DS and CP.

[PMID: 28677883](#)

8. Parents' Assessments of Disability in Their Children Using World Health Organization International Classification of Functioning, Disability and Health, Child and Youth Version Joined Body Functions and Activity Codes Related to Everyday Life.

Illum NO, Gradel KO.

Clin Med Insights Pediatr. 2017 Jun 19;11:1179556517715037. doi: 10.1177/1179556517715037. eCollection 2017.

AIM: To help parents assess disability in their own children using World Health Organization (WHO) International Classification of Functioning, Disability and Health, Child and Youth Version (ICF-CY) code qualifier scoring and to assess the validity and reliability of the data sets obtained. METHOD: Parents of 162 children with spina bifida, spinal muscular atrophy, muscular disorders, cerebral palsy, visual impairment, hearing impairment, mental disability, or disability following brain tumours performed scoring for 26 body functions qualifiers (b codes) and activities and participation qualifiers (d codes). Scoring was repeated after 6 months. Psychometric and Rasch data analysis was undertaken. RESULTS: The initial and repeated data had Cronbach α of 0.96 and 0.97, respectively. Inter-code correlation was 0.54 (range: 0.23-0.91) and 0.76 (range: 0.20-0.92). The corrected code-total correlations were 0.72 (range: 0.49-0.83) and 0.75 (range: 0.50-0.87). When repeated, the ICF-CY code qualifier scoring showed a correlation R of 0.90. Rasch analysis of the selected ICF-CY code data demonstrated a mean measure of 0.00 and 0.00, respectively. Code qualifier infit mean square (MNSQ) had a mean of 1.01 and 1.00. The mean corresponding outfit MNSQ was 1.05 and 1.01. The ICF-CY code τ thresholds and category measures were continuous when assessed and reassessed by parents. Participating children had a mean of 56 codes scores (range: 26-130) before and a mean of 55.9 scores (range: 25-125) after repeat. Corresponding measures were -1.10 (range: -5.31 to 5.25) and -1.11 (range: -5.42 to 5.36), respectively. Based on measures obtained at the 2 occasions, the correlation coefficient R was 0.84. The child code map showed coherence of ICF-CY codes at each level. There was continuity in covering the range across disabilities. And, first and foremost, the distribution of codes reflexed a true continuity in disability with codes for motor functions activated first, then codes for cognitive functions, and, finally, codes for more complex functions. CONCLUSIONS: Parents can assess their own children in a valid and reliable way, and if the WHO ICF-CY second-level code data set is functioning in a clinically sound way, it can be employed as a tool for identifying the severity of disabilities and for monitoring changes in those disabilities over time. The ICF-CY codes selected in this study might be one cornerstone in forming a national or even international generic set of ICF-CY codes for the benefit of children with disabilities, their parents, and caregivers and for the whole community supporting with children with disabilities on a daily and perpetual basis.

[PMID: 28680270](#)

Prevention and Cure

9. Uptake of dendrimer-drug by different cell types in the hippocampus after hypoxic-ischemic insult in neonatal mice: Effects of injury, microglial activation and hypothermia.

Nemeth CL, Drummond GT, Mishra MK, Zhang F, Carr P, Garcia MS, Doman S, Fatemi A, Johnston MV, Kannan RM, Kannan S, Wilson MA.

Nanomedicine. 2017 Jun 30. pii: S1549-9634(17)30122-3. doi: 10.1016/j.nano.2017.06.014. [Epub ahead of print]

Perinatal hypoxic-ischemic encephalopathy (HIE) can result in neurodevelopmental disability, including cerebral palsy. The only treatment, hypothermia, provides incomplete neuroprotection. Hydroxyl polyamidoamine (PAMAM) dendrimers are being explored for targeted delivery of therapy for HIE. Understanding the biodistribution of dendrimer-conjugated drugs into microglia, neurons and astrocytes after brain injury is essential for optimizing drug delivery. We conjugated N-acetyl-L-cysteine to Cy5-labeled PAMAM dendrimer (Cy5-D-NAC) and used a mouse model of perinatal HIE to study effects of timing of administration, hypothermia, brain injury, and microglial activation on uptake. Dendrimer conjugation delivered therapy most effectively to activated microglia but also targeted some astrocytes and injured neurons. Cy5-D-NAC uptake was correlated with brain injury in all cell types and with activated morphology in microglia. Uptake was not inhibited by hypothermia, except in CD68+ microglia. Thus, dendrimer-conjugated drug delivery can target microglia, astrocytes and neurons and can be used in combination with hypothermia for treatment of HIE.

[PMID: 28669854](#)

10. Classification of caesarean section and normal vaginal deliveries using foetal heart rate signals and advanced machine learning algorithms.

Fergus P, Hussain A, Al-Jumeily D, Huang DS, Bouguila N.

Biomed Eng Online. 2017 Jul 6;16(1):89. doi: 10.1186/s12938-017-0378-z.

BACKGROUND: Visual inspection of cardiotocography traces by obstetricians and midwives is the gold standard for monitoring the wellbeing of the foetus during antenatal care. However, inter- and intra-observer variability is high with only a 30% positive predictive value for the classification of pathological outcomes. This has a significant negative impact on the perinatal foetus and often results in cardio-pulmonary arrest, brain and vital organ damage, cerebral palsy, hearing, visual and cognitive defects and in severe cases, death. This paper shows that using machine learning and foetal heart rate signals provides direct information about the foetal state and helps to filter the subjective opinions of medical practitioners when used as a decision support tool. The primary aim is to provide a proof-of-concept that demonstrates how machine learning can be used to objectively determine when medical intervention, such as caesarean section, is required and help avoid preventable perinatal deaths. **METHODS:** This is evidenced using an open dataset that comprises 506 controls (normal virginal deliveries) and 46 cases (caesarean due to $\text{pH} \leq 7.20$ -acidosis, $n = 18$; $\text{pH} > 7.20$ and $\text{pH} < 7.25$ -foetal deterioration, $n = 4$; or clinical decision without evidence of pathological outcome measures, $n = 24$). Several machine-learning algorithms are trained, and validated, using binary classifier performance measures. **RESULTS:** The findings show that deep learning classification achieves sensitivity = 94%, specificity = 91%, Area under the curve = 99%, F-score = 100%, and mean square error = 1%. **CONCLUSIONS:** The results demonstrate that machine learning significantly improves the efficiency for the detection of caesarean section and normal vaginal deliveries using foetal heart rate signals compared with obstetrician and midwife predictions and systems reported in previous studies.

[PMID: 28679415](#)

11. GNAO1-related movement disorder with life-threatening exacerbations: movement phenomenology and response to DBS.

Waak M, Mohammad SS, Coman D, Sinclair K, Copeland L, Silburn P, Coyne T, McGill J, O'Regan M, Selway R, Symonds J, Grattan-Smith P, Lin JP, Dale RC, Malone S.

J Neurol Neurosurg Psychiatry. 2017 Jul 1. pii: jnnp-2017-315653. doi: 10.1136/jnnp-2017-315653. [Epub ahead of print]

Background: GNAO1 (OMIM 139311) encodes a $\text{G}\alpha\text{O}$ CNS protein responsible for regulation of GABA-B and $\alpha 2$ -receptors, and neurotransmitter release. Mutations of GNAO1 are reported in patients with epileptic encephalopathy (EE) at times with a

movement disorder (MD); some display severe hyperkinetic movements without EE, three underwent Deep Brain Stimulation (DBS) with reduction in exacerbations. Methods: We describe the MD phenomenology and course in three patients identified from neurology services in Brisbane and Glasgow with GNAO1-related MD, highlighting effectiveness of DBS in exacerbations. Informed consent was obtained. Four MD specialists reviewed videos (baseline, exacerbations, post-DBS) using a Proforma (SI) and reached a consensus on movement phenomenology. Results: All patients had global delay, central hypotonia and MD noted in early life (see online supplementary table 1, patient synopsis, SI). Patient 3 initially showed bradykinesia, rigidity and dystonia; patient 1 resting tremor. All had been diagnosed with dyskinetic Cerebral Palsy (CP), without substantive MRI findings. Medication for baseline MD had variable efficacy (see online supplementary table 2, SI). MRI demonstrated mild progressive atrophy over 6 years in two patients (see online supplementary figure 1, SI). MRI during an exacerbation revealed restricted diffusion in the internal capsules and splenium (corpus callosum) in one (figure 1). Whole exome sequencing identified de novo heterozygous mutations in the GNAO1 gene in all three patients, confirmed with Sanger sequencing.

[PMID: 28668776](#)