Third congress on NeuroRehabilitation and Neural Repair

Programme and Proceedings Book

From Science to Evidence-based Practice
22-23-24 May 2019 | The Netherlands
Contents

Welcome 03
Committee, Keynote speakers and Invited speakers 04
Programme schedule 05
• Wednesday 22 May 2019 06
• Thursday 23 May 2019 12
• Friday 24 May 2019 18
Sponsors 21
Social Programme 22
Floorplan 28
Scientific information 29
General information 31
Pre congress Wednesday 22 May 2019 36
Keynotes Thursday 23 May 2019 38
Keynotes Friday 24 May 2019 40
Invited lectures Thursday 23 May 2019 44
Invited lectures Friday 24 May 2019 48
Focused symposia Thursday 23 May 2019 65
Focused symposia Friday 24 May 2019 87
Young Scientist competition Thursday 23 May 2019 93
Best Poster competition Thursday 23 May 2019 102
Oral abstracts Thursday 23 May 2019 118
Oral abstracts Friday 24 May 2019 134
Lunch symposia Thursday 23 May 2019 136
Lunch symposia Friday 24 May 2019 138
Posters 233
Authors index first author 237
Notes
Welcome!

We are proud to announce the third International Congress on Neurorehabilitation and Neural Repair organized by the Dutch, Belgian and German Societies for Neurorehabilitation and the Association of Chartered Physiotherapists in Neurology in the United Kingdom which will bridge the gap between neuroscience and practice. This 3-day meeting is focused on the most recent advances in neurorehabilitation research ready for translation, providing opportunities to share knowledge, experience, and most recent developments in applying evidence-based practice.

The scientific program will include the most distinguished invited speakers in the field of neuroplasticity and neurorehabilitation, and will be dedicated to the management of most common problems such as gait and balance control, spasticity, cognitive impairments, including difficulties in implementation of evidence in the field of stroke, Parkinsons’ disease and MS. This multidisciplinary conference will be important for all professionals dedicated to neurorehabilitation such as physicians, neurologists, physical and occupational therapists, nurses, movement scientists, bioengineers as well as those who are more involved in the management of neurorehabilitation.

On behalf of the DSNR, BSNR, DGNKN and ACPIN, we wish you a warm welcome at the 3rd International Congress on Neurorehabilitation and Neural Repair in Maastricht.

Prof. Dr. Gert Kwakkel
President DSNR

Prof. Dr. Gaëtan Stoquart
President BSNR

Prof. Dr. Jan Mehrholz
President DGNKN

Prof. Dr. Jane Burridge
President ACPIN
Committee

Organizing and Scientific Committee

Prof. Dr. Alexander Geurts, vice-president of the Dutch Society for Neuro-Rehabilitation
Prof. Dr. Gert Kwakkel, president of the Dutch Society for Neuro-Rehabilitation
Prof. Dr. Jan Mehrholz, president of the German Society for Neuro-Traumatology und Clinical Neuro-Rehabilitation
Prof. Dr. Geert Verheyden, treasurer of the Belgian Society for Neurorehabilitation
Dr. Erwin van Wegen, treasurer of the Dutch Society for Neuro-Rehabilitation
Prof. Dr. Jane Burridge, president of the Association of Chartered Physiotherapists in Neurology
Mr. Jakko Brouwers, honorary chair of the Association of Chartered Physiotherapists in Neurology

Keynote speakers

Prof. Dr. Daniel Corcos, Northwestern University, USA
Prof. Dr. Theresa Jones, University of Texas, USA
Prof. Dr. Gillian Mead, University of Edinburgh, United Kingdom
Prof. Dr. Nick Ward, UCL Institute of Neurology, United Kingdom

Invited speakers

Dr. Ulrik Dalgas, Aarhus University, Denmark
Prof. Dr. Jules Dewald, Northwestern University, USA
Dr. Christian Dohle, MEDIAN Klinik Berlin-Kladow, Germany
Prof. Dr. Friedhelm Hummel, Swiss Federal Institute of Technology, Switzerland
Dr. Anna Kuppuswamy, UCL Institute of Neurology, United Kingdom
Prof. Dr. Joachim Liepert, Kliniken Schmieder, Germany
Prof. Dr. Thomas Nyffeler, University of Berg, Switzerland
Prof. Dr. Frederike van Wijck, Glasgow Caledonian University, Scotland
Wednesday 22 May 2019

Pre Congress

**ROOM 0.2/0.3 PRE CONGRESS WORKSHOP**


14.30-16.00  Cochrane Reviews in Neurorehabilitation – state of the art and future directions: J. Mehrholz, B. Elsner, G. Verheyden

**ROOM 0.4 PRE CONGRESS WORKSHOP**

13.00-14.30  Integrating musculoskeletal and neurological clinical reasoning to optimize the assessment and treatment of the post-stroke painful shoulder: L. de Baets, A. Van Bladel

14.30-16.00  Functional Electrical Stimulation (FES) for improving mobility in MS and other neurological conditions. The evidence, future trends and practical application: P. Taylor, J. Burridge

**ROOM 0.5 PRE CONGRESS WORKSHOP**

13.00-14.30  Using mixed methods in exploring the efficacy of technology and implementing self-management in stroke: L. Tedesco Triccas, S. Tino Kulnik

14.30-16.00  Moving forward: overcoming challenges to physical activity after stroke: F. van Wijck

16.00-16.30  BREAK – LOBBY

**ROOM 0.2/0.3 PRE CONGRESS WORKSHOP**

16.30-18.00  Mirror Therapy: C. Dohle

**ROOM 0.5 PRE CONGRESS WORKSHOP**

16.30-18.00  Post-stroke fatigue: behavior and physiology: A. Kuppuswamy
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<tr>
<th>Time</th>
<th>Event</th>
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<tr>
<td>09.30-10.00</td>
<td>Welcome &amp; Opening G. Kwakkel</td>
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<td>10.00-11.00</td>
<td>Changing approaches to rehabilitation of the upper limb after stroke Chair: G. Kwakkel Speaker: N. Ward</td>
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<td>11.00-11.30</td>
<td>Coffee break &amp; Exhibition ExpoFoyer</td>
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<td>11.30-13.00</td>
<td>Young Scientist Competition Chair: J. Burridge</td>
<td>S. Denissen</td>
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<tr>
<td>11.45-12.00</td>
<td>Position-cortical coherence as a marker for somatosensory integrity early post-stroke, a prospective cohort study S. Zandvliet</td>
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<tr>
<td>12.00-12.15</td>
<td>Predicting Fugl-Meyer scores from hand motion analysis J. Stuerner</td>
<td>B. Rubio Ballester</td>
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<td>12.15-12.30</td>
<td>A systematic review on kinematic assessments of upper limb movements after stroke A. Schwarz</td>
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<td>12.30-12.45</td>
<td>Is there a dose-response relationship of robotic-assisted therapy in motor rehabilitation of the upper extremity after stroke? J. Stuerner</td>
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<td>12.45-13.00</td>
<td>Longitudinal recovery of manual dexterity after stroke: brain lesion location a key predictor of poor precision grip force control G. Pennati</td>
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<td>13.00-14.00</td>
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<td>Poster Visit ExpoFoyer</td>
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<td>14.30-16.00</td>
<td>Best Poster Competition Chair: J. Mehrholz</td>
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<tr>
<td>14.30-14.40</td>
<td>Effectiveness of botulinum toxin treatment for upper limb spasticity after stroke over different ICF domains: a systematic review and meta-analysis A. Andringa</td>
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<td>14.40-14.50</td>
<td>Evoked brain responses to robotic wrist manipulations reflect the severity of sensory impairments in patients with stroke J. Kordelaar</td>
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<td>14.50-15.00</td>
<td>Effect of trunk training on body function and activity post stroke: a systematic review and meta-analysis L. Thijs</td>
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<td>15.00-15.10</td>
<td>Home-based Constraint-Induced Movement Therapy in chronic stroke patients: a pilot TMS study S. Borsato</td>
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<td>15.10-15.20</td>
<td>Minor stroke, serious balance problems? J. Roelofs</td>
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<td>15.20-15.30</td>
<td>Running-induced visuospatial memory improvement in MS: a stronger functional embedding of the hippocampus in the default-mode network? M. Huiskamp</td>
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<td>15.30-15.40</td>
<td>How does upper extremity Fugl-Meyer motor score relate to resting-state EEG in chronic stroke? A power spectral density analysis M. Saes</td>
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<td>15.40-15.50</td>
<td>Relationship between a 10m &amp; 6min walk test ratio and age in stroke patients P. Philipp</td>
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<td>15.50-16.00</td>
<td>Cortical activation during submaximal contractions of a hand muscle after mild traumatic brain injury R. Prak</td>
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<td>16.00-16.30</td>
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<td>16.30-17.30</td>
<td>When and how much rehabilitation are optimal? Interrelated questions with interrelated brain mechanisms Chair: J. Mehrholz I. Jones</td>
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<td>17.30-19.00</td>
<td>Welcome reception ExpoFoyer</td>
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# Room 0.2/0.3

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<td>Coffee break &amp; Exhibition</td>
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<td>11.30-13.00</td>
<td><strong>Focused Symposium</strong></td>
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<td></td>
<td><em>Technology for measurement of manual dexterity impairments in stroke</em></td>
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<td><em>Chair: P. Lindberg</em></td>
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<td><em>Speakers: P. Lindberg, L. Dupin, A. Roby-Brami en J. Hermsdörfer</em></td>
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<td>Poster Visit</td>
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<td>14.30-16.00</td>
<td><strong>Focused Symposium</strong></td>
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<td></td>
<td><em>Sensorimotor Impairments Post Unilateral Brain Injury</em></td>
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<td><em>Chairs: J. Dewald &amp; N. Gurari</em></td>
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<td><em>Speakers: J. Dewald, R. Sainburg, F. van der Helm, N. Guriari</em></td>
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<td>16.00-16.30</td>
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Thursday 23 May 2019
Room 0.4

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<td>Coffee break &amp; Exhibition</td>
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<td>11.30-13.00</td>
<td>Focused Symposium&lt;br&gt;Clinical effectiveness of Digital Neuro-Interventions for patients with stroke or dementia and language impairments: behaviour and brain factors explored and exploited&lt;br&gt;Chair: A. Leff&lt;br&gt;Speakers: Z. Woodhead, V. Fleming, C. Doogan, J. Crinion</td>
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<td>Lunch &amp; Exhibition</td>
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<td>Poster Visit</td>
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<td>14.30-16.00</td>
<td>Focused Symposium&lt;br&gt;Making training better: Incorporating fundamental motor control and learning principles into rehabilitation interventions&lt;br&gt;Chair: D. Piscitelli&lt;br&gt;Speakers: M. Levin, D. Piscitelli, A. Turolla</td>
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<td>16.00-16.30</td>
<td>Coffee break &amp; Exhibition</td>
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<td>17.30-19.00</td>
<td>Welcome reception</td>
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<td>19.00-20.00</td>
<td>ACPIN Annual General Meeting</td>
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<td>11.30-13.00</td>
<td>Invited Lecture and oral abstract presentations</td>
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<td><strong>Chair:</strong> P. Feys</td>
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<tr>
<td>11.30-12.00</td>
<td>Exercise and multiple sclerosis - recent advances</td>
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<td><strong>U. Dalgas</strong></td>
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<td>12.00-12.15</td>
<td>The attitudes of people with progressive MS to the use of mobile applications for symptom monitoring and sharing information with healthcare professionals</td>
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<td><strong>C. Holland</strong></td>
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<td>12.15-12.30</td>
<td>Test-retest reliability of cognitive-motor interference assessments in walking with various task complexity in persons with Multiple Sclerosis</td>
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<td><strong>R. Veldkamp</strong></td>
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<td>12.30-12.45</td>
<td>Perceptions of exercise - what moves people with multiple sclerosis to exercise?</td>
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<td><strong>M. Hensman</strong></td>
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<td>12.45-13.00</td>
<td>Boost - a self-management programme for people with multiple sclerosis</td>
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<td><strong>H. Gaskell</strong></td>
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<td>Lunch &amp; Exhibition</td>
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<td>Poster Visit</td>
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<td>14.30-16.00</td>
<td>Focused Symposium:</td>
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<td></td>
<td><strong>Trending topics in MS rehabilitation</strong></td>
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<td><strong>Chairs:</strong> P. Feys &amp; U. Dalgas</td>
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<td><strong>Speakers:</strong> L. Hvid, L. Moumdjian, F. Van Geel, J.Raats</td>
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<td>16.00-16.30</td>
<td>Coffee break &amp; Exhibition</td>
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### Thursday 23 May 2019

**Room 0.8**

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<td>11.30-13.00</td>
<td><strong>Invited Lecture and oral abstract presentations</strong></td>
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<td><em>Chair: K. Oostra</em></td>
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<tr>
<td>11.30-12.00</td>
<td><strong>Mirror therapy in neurorehabilitation</strong></td>
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<td><em>C. Dohle</em></td>
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<td>12.00-12.15</td>
<td><strong>Longitudinal changes in upper extremity kinematics during the first year post stroke</strong></td>
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<td><em>M. Murphy</em></td>
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<td>12.15-12.30</td>
<td><strong>Extending the proportional recovery rule for the upper paretic limb after stroke</strong></td>
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<td><em>R. Vliet</em></td>
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<td>12.30-12.45</td>
<td><strong>Premotor dorsal white matter integrity for the prediction of upper limb motor impairment after stroke</strong></td>
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<td><em>L. Boccuni</em></td>
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<td>12.45-13.00</td>
<td><strong>Individuals with chronic hemiparetic stroke can accurately identify elbow flexion torques within each arm</strong></td>
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<td><em>N. Cai</em></td>
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<td>Poster Visit</td>
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<td>14.30-16.00</td>
<td><strong>Invited Lecture and oral abstract presentations</strong></td>
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<td><em>Chair: J. Liepert</em></td>
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<td>14.30-15.00</td>
<td><strong>Towards patient-tailored treatment strategies to enhance stroke recovery</strong></td>
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<td><em>F. Hummel</em></td>
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<td>15.00-15.15</td>
<td><strong>Neurofeedback for central neuropathic pain treatment: mental strategies used for successful neuromodulation</strong></td>
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<td><em>K. Anil</em></td>
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<td>15.15-15.30</td>
<td><strong>The role of cerebellar transcranial direct current stimulation on balance and mobility in multiple sclerosis patients: a pilot study</strong></td>
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<td><em>A. Baroni</em></td>
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<td>15.30-15.45</td>
<td><strong>Cathodal direct current stimulation over contralesional m1 may be detrimental to leg motor control in more severely impaired chronic stroke patients</strong></td>
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<td><em>W. Staring</em></td>
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<td>15.45-16.00</td>
<td><strong>Interhemispheric functional connectivity and mirror movements in chronic hemiparetic stroke patients</strong></td>
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<td><em>P. Lindberg</em></td>
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<td>16.00-16.30</td>
<td>Coffee break &amp; Exhibition</td>
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<td>17.30-19.00</td>
<td>Welcome reception</td>
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<td>13.00-14.00</td>
<td>Lunch Symposium</td>
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<td>Neurorehabilitation and physical management in the context of spasticity</td>
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<td><em>Speakers: S. Ashtord, A. Geurts</em></td>
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<td>14.00-14.30</td>
<td>Poster Visit</td>
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<td>14.30-16.00</td>
<td>Invited lecture and oral abstract presentations</td>
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<td><em>Chair: A. Leff</em></td>
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<tr>
<td>14.30-15.00</td>
<td>Mechanisms of post-stroke fatigue</td>
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<td><em>A. Kuppuswamy</em></td>
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<td>15.00-15.15</td>
<td>The influence of psychological factors and mood on the course of participation up to four years after stroke</td>
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<td><em>J. de Graaf</em></td>
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<td>15.15-15.30</td>
<td>Prospectively classifying community walkers after stroke: who are they?</td>
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<td><em>M. Mulder</em></td>
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<td>15.30-15.45</td>
<td>Caregiver mediated exercises with e-health support for early supported discharge after stroke: conclusions of the care4stroke trial</td>
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<td><em>J. Vloothuis</em></td>
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<td>15.45-16.00</td>
<td>Aneurysmal Subarachnoid Hemorrhage: Long-term functional results</td>
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<td><em>V. Davalos Yerovi</em></td>
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<td>17.30-19.00</td>
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## Friday 24 May 2019

**Auditorium II**

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<th>Time</th>
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<tr>
<td>08.30-09.30</td>
<td><strong>The exercise prescription for Parkinson’s disease</strong>&lt;br&gt;Chair: E. van Wegen</td>
<td>Speaker: D. Corcos</td>
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<td>09.30-10.00</td>
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<td>10.00-11.30</td>
<td><strong>Focused Symposium</strong>&lt;br&gt;Is it any wonder no one ever implements evidence-based practice?&lt;br&gt;Chair: L. Connell &amp; E. Lynch&lt;br&gt;Speakers: T. Lannin, P. Logan, N. Ward</td>
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<td>13.00-14.30</td>
<td><strong>Focused Symposium</strong>&lt;br&gt;Motor and non-motor symptoms of Parkinson’s Disease: avenues for rehabilitation&lt;br&gt;Chair: A. Nieuwboer&lt;br&gt;Speakers: J. Nonnekes, A. Nieuwboer, N. de Vries-Farrouh</td>
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<td>15.00-16.00</td>
<td><strong>Treatment of post-stroke fatigue-new horizons</strong>&lt;br&gt;Chair: G. Verheyden</td>
<td>Speaker: G. Mead</td>
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<td>16.00-17.00</td>
<td><strong>Awards &amp; Closing</strong>&lt;br&gt;Luc van Calster award&lt;br&gt;Young scientist and Best Poster awards&lt;br&gt;Winner Young Scientist Competition&lt;br&gt;Winner Best Poster Competition</td>
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<td><em>Neurophysiological correlates of upper limb sensorimotor function and recovery in stroke measured by electroencephalography and magnetoencephalography</em></td>
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<td><strong>Chair:</strong> L. Tedesco Triccas  <strong>Speakers:</strong> K. Laaksonen, L. Tedesco Triccas, M. Saes, A. Guggisberg</td>
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<td><em>Managing daily life: evidence and implications for practice in neurorehabilitation</em></td>
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<td><strong>Chair:</strong> D. Kos  <strong>Speakers:</strong> D. Kos, I. Satink, A. Van Gils</td>
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<td><strong>IISART: Optimizing the use of technology in upper limb and gait rehabilitation</strong></td>
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<td><strong>Chair:</strong> F. Steenbrink</td>
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<td><strong>Speakers:</strong> A. Esquenazi, I. Jakob, F. Steenbrink</td>
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<td><strong>Brain computer interface (BCI) in Neurorehabilitation</strong></td>
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<td><strong>Chair:</strong> J. Groothuis</td>
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<td><strong>Speakers:</strong> J. Farquhar, J. Raaphorst, N. Keijsers, J. Groothuis</td>
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<td>Invited lecture and oral abstract presentations</td>
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<td>Chair: M. Levin</td>
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<td>10.00-10.30</td>
<td>Evidence for an increased dependence on contralesional corticoreticulospinal pathways: maladaptive plasticity following a unilateral brain injury?</td>
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<td>J. Dewald</td>
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<td>10.30-10.45</td>
<td>Validity and reliability of a new method for detection of spasticity in the lower limb</td>
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<td>10.45-11.00</td>
<td>Functional effects of treatment with botulinum toxin and subsequent stretching of the hip adductors in patients with hereditary spastic paraplegia</td>
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<td>11.00-11.15</td>
<td>Abobotulinumtoxina injections in shoulder muscles: results from a real world (ulis-ii) and phase iii study</td>
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<td>I. Lejeune</td>
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<td>11.15-11.30</td>
<td>Goal setting for botulinum toxin injections: impact of the upper limb international spasticity (ulis) programme</td>
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<td>Motor learning in people after stroke: different perspectives on research and clinical practice</td>
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<td>Chairs: S. Braun</td>
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<td>Speakers: M. Kleynen, L. Johnson, E. Kal, J. Franck</td>
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Friday 24 May 2019

Room 0.8

07.30-08.30  BSNR Annual general meeting

09.30-10.00  Coffee break & Exhibition  ExpoFoyer

10.00-11.30  Invited Lecture and oral abstract presentations
   Chair: T. Jones

10.00-10.30  Theta burst stimulation effects on spatial neglect and functional outcome after stroke
   S. Nyffeler

10.30-10.45  Fast but enduring improvement in the covert shift of attention task in visuospatial neglect
   H. Hildebrandt

10.45-11.00  Adaptive cueing treatment of neglect in stroke patients leads to improvements in activities of daily living: a randomized controlled, crossover trial
   N. Turgut

11.00-11.15  Neuronavigated Theta Burst Stimulation (TBS) in Chronic post-Stroke Aphasia
   A. Georgiou

11.15-11.30  Transcranial direct current stimulation (tdcs) for improving aphasia after stroke: a network meta-analysis of randomised controlled trials
   B. Elsner

11.30-12.30  Lunch & Exhibition  ExpoFoyer

12.30-13.00  Poster Visit  ExpoFoyer

13.00-14.30  Invited Lecture and oral abstract presentations
   Chair: F. Hummel

13.00-13.30  rTMS as a therapeutic tool in stroke - what is the evidence?
   J. Liepert

13.30-13.45  Classification of cortical theta activity elicited by balance perturbations provides preliminary evidence of distinct cortical representation of mediolateral balance capacity in hemiparetic chronic stroke
   I. Solis-Escalante

13.45-14.00  Motor impairment in post-stroke individuals may be related to a reduced ability of the corticospinal system to shift stretch-reflex thresholds
   J. Piscitelli

14.00-14.15  Does Transcranial Magnetic Stimulation have an added value to clinical assessment in predicting upper limb function very early after severe stroke?
   M. Hoonhorst

14.15-14.30  Acute diffusivity biomarker for prediction of language outcome in mild-to-severe stroke patients
   C. Rosso

14.30-15.00  Coffee break & Exhibition  ExpoFoyer
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<td>DSNR Annual General Meeting</td>
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<td>11.30-12.30</td>
<td>Lunch symposium&lt;br&gt;&lt;br&gt;Advanced robotics for clinical rehabilitation; challenges &amp; successes&lt;br&gt;&lt;br&gt;Speaker: V. Hömberg</td>
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<td>Invited Lecture and oral abstract presentations&lt;br&gt;&lt;br&gt;Chair: G. Mead</td>
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<td>13.00-13.30</td>
<td>Physical activity after stroke: evidence and implications&lt;br&gt;&lt;br&gt;F. van Wijck</td>
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<td>13.30-13.45</td>
<td>Determinants of activity participation and life satisfaction one year after ischemic stroke: contributions of early executive function and psychosocial characteristics&lt;br&gt;&lt;br&gt;D. Edwards</td>
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<td>13.45-14.00</td>
<td>The mini-bestest as clinical test for balance problems after minor stroke; an item-wise comparison&lt;br&gt;&lt;br&gt;A. Huisinga</td>
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<td>14.00-14.15</td>
<td>Effectiveness of an innovative upper limb programme for stroke survivors: a mixed-Methods investigation of quality-of-life outcomes&lt;br&gt;&lt;br&gt;A. Strawson</td>
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<td>14.15-14.30</td>
<td>Shaping therapy: what influences the content and time for therapy of the upper limb after stroke? a survey of uk therapists&lt;br&gt;&lt;br&gt;R. Stockley</td>
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Sponsors

The Organising Committee of the Third Congress on NeuroRehabilitation and Neural Repair gratefully acknowledges the contributions of our sponsors:

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NPI  LATER LIFE TRAINING
Neurorehabilitation and physical management in the context of spasticity

Thursday May 23rd 2019
13.00-14.00
MECC Maastricht
Level 0 – Room 09

Lunch will be provided at the entrance of the room

Speakers

Prof. dr. A.C.H. Geurts MD PhD
Radboudumc / Sint Maartenskliniek

Dr. S. Ashford PhD, FCSP
London North West University Healthcare
NHS Trust & King’s College London
Interested in a clear approach to post-CVA spasticity?

Discover it yourself at booth number 7 of Will Pharma
Social programme

Welcome reception
The welcome reception will take place in MECC Maastricht in the Expo Foyer, on Thursday the 23rd of May 2019, directly after the programme. The organising committee invites all attendees to join us and exploit this opportunity to network, meet old friends and colleagues, and to make new ones.

Date: Thursday 23 May 2019
Time: 17.30 - 19.00 hrs.
Location: Expo Foyer MECC Maastricht
Expo Foyer

**Poster topics:**

- **Topic 1:** Action observation/visuomotor imagery
- **Topic 2:** Adaptive devices
- **Topic 3:** Comprehensive rehabilitation programs
- **Topic 4:** Functional diagnostics/prognostics
- **Topic 5:** Gait analysis
- **Topic 6:** Guidelines/implementation/reimbursement
- **Topic 7:** Neuromuscular disorders/neuropathy
- **Topic 8:** Neuropsychiatry/behavioural disorders
- **Topic 9:** Neurorobotics
- **Topic 10:** Neurostimulation/modulation
- **Topic 11:** Orthotics/neuroprosthetics/FES
- **Topic 12:** Parkinson’s disease
- **Topic 13:** Self-management/empowerment
- **Topic 14:** Spasticity/dystonia
- **Topic 15:** Spinal cord injury
- **Topic 16:** Stroke
- **Topic 17:** Traumatic brain injury
- **Topic 18:** Virtual reality training
Neurologische bewegingsstoornissen zoals spasticiteit en dystonie gaan niet alleen gepaard met spierspasmen, maar vaak ook met heftige pijn en psychologische stress. Voor veel patiënten is botuline toxine de aangewezen behandeling. Bij Merz hechten wij veel belang aan een behandeling die toegesneden kan worden op de specifieke behoeften van de individuele patiënt.

De pure botuline neurotoxine
Complexerende eiwitten worden beschouwd als één van de factoren van secundair falen van de therapie.\textsuperscript{1,2} Merz heeft een botuline neurotoxine weten te ontwikkelen die vrij is van complexerende eiwitten. Op onze stand vertellen we u graag wat dit voor uw patiënt kan betekenen.


PQC BNLNL 2249 JAN19

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C-Brace
Reshaping the future

The C-Brace opens up entirely new possibilities for users with its microprocessor sensor technology. Flexing under load while sitting down, navigating slopes, walking on uneven terrain, or going down stairs step over step—all this defines a new level of mobility.

Visit our booth and see the possibilities of the C-Brace!
Complete Solution for Gait Rehabilitation

You would like to

- have the highest standard for your patients
- work economically
- achieve best results with existing resources
- implement guidelines in everyday clinical practice
- achieve satisfaction by clear therapy structures

Benefit from our expertise and experience and visit us on booth 9.
Scientific Information

**Oral presentations**
Please make sure to bring your PowerPoint presentation on USB drive to the congress and hand it in to a technician in the Speaker Preview Room (Room 1.3), upon arrival, but at least 3 hours before your presentation. Please note that you will **NOT** be able to use your own laptop or computer.

**Poster presentations**
Posters will be displayed throughout the meeting in the exhibition area in the Expo Foyer. The posters are divided per topic. Participants selected to give a poster presentation are required to attend their poster to answer questions during the poster-viewing sessions. All topics, titles and abstract numbers of the presenters are displayed on the poster boards.

**Poster set-up and removal times**
Please mount your poster before Thursday 23 May 2019, 10.00 hrs., and do not dismantle your poster before Friday 24 May 2019, 17.30 hrs. The Congress Secretariat will remove all posters which have not been removed by **18.00 hrs.**
General information

Address details
The congress takes place in the Maastricht Exhibition and Congress Centre Forum 100, 6629 GV Maastricht.

All parallel sessions will be organised in the congress centre in the Lobby, the plenary sessions will be organised in Auditorium II. The exhibition, lunch and coffee/tea breaks will be held in the Expo Foyer.

Parking
MECC Maastricht provides ample parking around the premises. Parking tickets can be purchased in the entrance hall and cost € 12,- per day, regardless of duration. The maximum vehicle height in the parking garage is 2.05 meters.

Registration desk
The registration area in the congress centre will be open for registration:
Wednesday 22 May 2019: 12.00 – 18.00 hrs.
Thursday 23 May 2019: 08.00 – 17.30 hrs.
Friday 24 May 2019: 08.00 – 17.00 hrs.

The registration fee includes:
• Admission to all scientific sessions
• Admission to the exhibition and poster area
• Congress bag
• Daily lunch
• Daily coffee breaks
• Programme/proceedings book
• Attending the Welcome reception
• Free transport in the city bus

Payment registration fee
You can pay the registration fee on-site by credit card or cash. The official currency at the congress is Euros. Cheques and foreign currency are not accepted.
WIFI
You will have WIFI access on-site in the congress centre.

Network: MECC_FREE_WIFI
Password: no password needed

Badges
For security reasons, badges must be worn throughout the congress. Be careful not to lose your badge, as the Congress Committee cannot be responsible for lost badges, tickets or other valuable items. Entrance to lecture halls, poster and exhibition area will not be allowed to any person without a badge. Your badge gives you free transport in the city bus of Maastricht. Just show your badge to the bus driver.

Certificate of attendance
All participants will receive a digital certificate of attendance by email after the congress.

Lunch and coffee breaks
Lunches and coffee breaks on Wednesday, Thursday and Friday will take place in the exhibition area in the Expo Foyer.

Wardrobe
The wardrobe is unattended and at the Trajectum.

Anything lost?
Please go to the registration desk or the information desk of the MECC at the main entrance.

Language
The official language of the congress is English.

Liability
Upon registration, participants agree that neither the Organizing Committee nor the Conference Management can be subject to any liability concerning participation related activities. Participants should, therefore, organize their own (health and travel) insurance(s).
Management of gait impairments after stroke
Prof. A. Geurts, Prof. J. Buurke, Dr. J. Nonnekes, Dr. J. Fleuren

The management of gait impairments after stroke is complex and shows a large variation across nations and institutions. Practice variation is often based on differences in (team) expertise, (team) experience, available medical-technical possibilities (e.g. functional electrical stimulation, focal spasmolysis, ankle-foot surgery), resources and reimbursement. During this interactive workshop, we will provide a profound insight into the underlying causes of gait impairments after stroke and show how this knowledge can contribute to selecting the optimal treatment strategy, taking into account patient preferences and needs. The role of instrumented gait analysis will be discussed and individual examples of treatment results will be given. Overall, a practical, hierarchical approach to the management of gait impairments after stroke will be advocated with a focus on medical-technical interventions in order to reduce variation in clinical practice and offer patients the best functional perspective.

Learning objectives workshop:
- to gain insight into the underlying causes of gait impairments after stroke
- to gain insight into how instrumented gait analysis can contribute to understand individual gait impairments
- to learn how to follow a hierarchical approach to correcting gait impairments after stroke with emphasis on medical-technical interventions

Integrating musculoskeletal and neurological clinical reasoning to optimize the assessment and treatment of the post-stroke painful shoulder
Dr. L. de Baets, Dr. A. van Bladel

In this workshop, the latest information regarding state-of-art assessment and rehabilitation of the post-stroke painful shoulder will be presented and discussed based on several case-studies. The workshop will focus on how the integration of musculoskeletal information can be of additional value in the upper extremity assessment and rehabilitation of stroke patients with shoulder pain or dysfunction.
Pre congress Wednesday 22 May 2019

Learning objectives workshop:
- to give an update on the biomechanical and neurological background of shoulder functioning
- to provide a clinical reasoning framework for integrated musculoskeletal and neurological clinical reasoning with regard to shoulder pain after stroke
- to provide participants with practical skills to perform a clinical upper extremity assessment to direct treatment goals in persons with post-stroke shoulder pain
- to provide participants with practical skills for the rehabilitation of persons with post-stroke shoulder pain

13:00 - 14:30 | Room 0.5
Using mixed Methods in exploring the efficacy of technology and implementing self-management in stroke
Dr. L. Tedesco Triccas & Dr. S. Tino Kulnik

This interactive workshop will first focus on gaining knowledge about mixed methodology involving the combination of qualitative and quantitative Methods and data and its integration into stroke clinical settings and research. An example of when mixed Methods were integrated into a randomized controlled trial involving robot therapy and non-invasive brain stimulation in stroke will be presented. Workshop participants will then be presented with a research question around implementing a team-based self-management approach in neurorehabilitation. Participants will be invited to draft a mixed-Methods study design addressing the question. We will discuss thoughts and ideas and present a completed mixed-Methods study that addressed the same question.

14:30 - 16:00 | Room 0.2/0.3
Cochrane Reviews in Neurorehabilitation – state of the art and future directions
Prof. J. Merholz, Prof. B. Elsner & Prof. G. Verheyden

This workshop held by members of the World Federation of Neurorehabilitation (WFNR), partner of Cochrane Rehabilitation (CR) shows how state-of-the-art Cochrane Reviews are conducted. It highlights issues like effective and efficient search for literature, performing step-by
step meta-analysis in Cochrane’s ReviewManager 5.3 and emerging analyses like network meta-analysis.

Learning objectives workshop:
- to explain the role of Cochrane Groups, Cochrane Rehabilitation Field (CR) and the partnership with WFNR in the field of neurorehabilitation
- to perform effective literature search
- to perform pairwise meta-analyses
- to know why, when and how conducting subgroup and sensitivity analysis
- to plan and design Network meta-analysis

14:30 - 16:00 | Room 0.4
Functional Electrical Stimulation (FES) for improving mobility in MS and other neurological conditions. The evidence, future trends and practical application
Dr. P. Taylor & Prof. J. Burridge

Functional Electrical Stimulation (FES) is a means of producing functional movement in paralysed or weak muscles for individuals with damage to the brain or spinal cord. It is most commonly used for correction of dropped foot in conditions such as multiple sclerosis and stroke and in recent years has become a standard treatment in rehabilitation. This workshop will review the evidence for FES for dropped foot and discuss developments that may improve its effectiveness. We will also introduce ACPIN’s initiative to produce best practice guidelines for the clinical provision of FES. We will demonstrate some FES applications and there will be an opportunity for participants to apply FES for correction of dropped foot, improving hip flexion or extension and other applications with each other. Please bring shorts or other suitable clothing to allow the applications of electrodes. Please be aware that people who have implanted electronic devices, are pregnant or have epilepsy should not receive FES.

Participants will gain an overview of the clinical evidence for FES in MS and other neurological conditions and its impact on its users. They will receive an Introduction to the clinical implementation of FES including selection criteria, clinical pathways and an Introduction to the different Methods that can be used to optimise its effect. They will experience the direct effect of FES, giving them an insight to the experience of the FES user.
A sedentary lifestyle is common amongst people with stroke and other long term neurological conditions (LTNC) – including those with adequate mobility. This tends to have a negative impact on health, function, activity, participation and well-being. Therefore, the goal of reducing sedentary behaviour and increasing physical activity should be central to neurorehabilitation. Supporting such behaviour change requires an in-depth understanding of each individual’s barriers and motivators, and a good knowledge of strategies to overcome these. This workshop, intended especially for practitioners, will:

- identify common barriers and facilitators to changing sedentary behaviour and physical activity in people with stroke and other LTNC,
- summarise behavioural change theory underpinning practical strategies to overcome common barriers to behaviour change,
- discuss the application of behaviour change strategies to enhancing physical activity and reducing sedentary behaviour in people with LTNC, using a number of case studies from across the care pathway.

Following this workshop, delegates will be able to:

- describe common patterns of sedentary behaviour and physical activity amongst people with stroke and other LTNC
- identify common barriers and facilitators to changing patterns of physical activity, specifically amongst people with stroke and other LTNC
- discuss, justify and apply behaviour change strategies to case studies of people with LTNC, with the aim to reduce sedentary behaviour and increase physical activity.
Mirror therapy
Dr. C. Dohle

During mirror therapy (MT) for patients with a one-sided pathology of a limb, a mirror is sagitally in the patient’s midline. Thus, the mirror image of the unaffected limb appears as if it were the affected one. MT was proposed to improve of a number of neurological conditions, most prominently (phantom) limb pain and paresis after stroke. In the workshop, the neural basis of the mirror illusion (mirrored visual feedback, MVF) will be briefly highlighted. The current state of evidence as therapy in neurorehabilitation will be explained. Participants of the course will have the chance to gain practical experience in MT. Especially, they should understand how different therapy variants may influence therapy success. In the end, they should be able to develop a first concept how to effectively integrate MT in their therapy.

Post-stroke fatigue: behavior and physiology
Dr. A. Kuppuswamy

Fatigue is a major problem in many neurological illnesses, however there is very little known about the underlying mechanisms that mediate fatigue. In this workshop I will be discussing emerging data from stroke populations that is starting to provide insights into why stroke survivors suffer from fatigue sometimes years after their stroke. I will be discussing results from behavioral studies and brain stimulation studies in non-depressed, highly functioning stroke survivors and present to you a framework within which we can understand post-stroke fatigue. I will also discuss about an ongoing neuromodulation based interventional trial for fatigue in stroke survivors.

Learning objectives workshop:
- identify and understand the presentation of fatigue in stroke survivors
- know the behavioral and neurophysiological correlates of post-stroke fatigue
- understand the mechanistic framework of post-stroke fatigue
Stroke is the leading cause of complex adult disability in the world. Recovery from stroke is often incomplete, which leaves many people dependent on others for their care. The improvement of long-term outcomes should, therefore, be a clinical and research priority. I will discuss three key areas that hold the key improving the state of stroke recovery, using upper limb rehabilitation as an example. Firstly, the current provision of upper limb rehabilitation, both in practice and pragmatic clinical trials, is woefully inadequate. I will discuss the current state of upper limb rehabilitation and describe the experiences of the Queen Square Upper Limb Neurorehabilitation Programme. Secondly, as a result of the advances in our understanding of the biological mechanisms involved in recovery and repair after stroke, therapeutic opportunities to promote recovery through manipulation of post-stroke plasticity have never been greater. This work has almost exclusively been carried out in preclinical animal models of stroke with little translation into human studies. The challenge ahead is to develop a mechanistic understanding of recovery from stroke in humans so that
When and how much rehabilitation are optimal? Interrelated questions with interrelated brain mechanisms
T. Jones

Psychology department, University of Texas, Austin, Texas, United States of America

This talk covers evidence for, putative mechanisms of, and translational hurdles surrounding timing- and dose-dependencies in the efficacy of rehabilitation. Animal models of post-stroke upper extremity impairments support that the efficacy of motor rehabilitative training (RT) can vary both with post stroke timing and quantity of task practice (“dose”). RT efficacy depends, in part, on neural plasticity mechanisms of motor skill learning, which are practice-dependent. However, skill learning mechanisms can be both subverted by stroke damage and facilitated by convergence with regenerative responses to this damage. Neural remodeling responses to stroke are neural activity-dependent and hence, experience- and practice-dependent. Animal studies support that RT efficacy is enhanced by its temporal overlap with the particularly dynamic early period of post-stroke neural remodeling. Much larger doses of RT may be required at later time points to achieve more modest gains. However, “early” is a vague therapeutic target. The process of brain remodeling after stroke is a complex multiphasic process that varies with stroke loci and severity, age and comorbidities. The specific events within this process that optimize the functional gains per dose of RT have yet to be identified. Filling this knowledge gap has the potential to replace “early” with more specific targets for optimizing RT efficacy.
Parkinson’s disease [PD] is a debilitating, progressive, neurodegenerative movement disorder. The early stages of PD are characterized by motor signs but non-motor symptoms play a larger role in reducing quality of life over time. Medication and deep brain stimulation are very effective in treating the motor signs but are much less effective at treating the non-motor symptoms. In addition, both treatments have side effects. There is now mounting evidence that exercise is therapeutically beneficial for both the motor signs, and the non-motor symptoms. Progressive resistance exercise reduces the signs of the disease, increases muscle strength, movement speed, facilitates muscle activation and improves attention and short term-memory. High intensity endurance exercise improves oxygen consumption and delays the rate at which the motor signs of Parkinson’s disease progress. Finally tai chi improves balance. Although the mechanisms by which exercise positively affects the disease are not known, potential candidates include: reductions in levels of cortisol, improved cortical vascularity, increased cortical thickness, increased brain connectivity, increased dopamine metabolism, neurogenesis, neuroplasticity, anti-inflammatory effects, improved mitochondrial function and oxidative stress, and increased levels of neurotrophic factors. Collectivity, a multimodal exercise program reduces the signs and symptoms of the disease, delays the rate at which the signs of the disease progress and also improves balance. The exercise prescription should include progressive resistance exercises 2 times per week, endurance exercise 3 times per week, and balance 2 times per week. If exercise was a pill, there would be no doubt that people would take it.
Fatigue affects around 50% of stroke survivors and often persists for many months. There are no effective treatments for post-stroke fatigue. Fatigue adversely affects quality of life and return to work. Post-stroke fatigue is a priority for research among stroke survivors, researchers and health care professionals.

Our systematic reviews and original research showed that post-stroke fatigue is associated with low mood, anxiety and low levels of physical activity-together these variables explain about 70% of the variance in post-stroke fatigue and are targets for its management. Qualitative interviews have demonstrated that fatigue is improved with good sleep and rehabilitation.

We developed a complex intervention for treating post-stroke fatigue in consultation with stroke survivors-this includes a manual, and seven telephone calls 2 weeks apart from a stroke nurse trained in the delivery of the intervention. A cognitive behavioural therapy approach is used. The goals are to increase physical activity in a graded way, improve sleep, improve low mood and symptoms of anxiety, and challenge negative thoughts. In a small observational study, the intervention improved fatigue.

We are now testing this approach in a multicentre randomised controlled trial (POSITIF -Post-Stroke Intervention Trial in Fatigue) in the UK.

I will also discuss other approaches to developing new interventions. For example, small studies have suggested that fatigue might be related to impaired corticomotor control-this might be a target for treatment. There are also small trials of modafinil (which promotes wakefulness) and other pharmacological interventions for post-stroke fatigue.
Exercise and multiple sclerosis - recent advances
Dr. U. Dalgas
Public Health, Aarhus University, Aarhus c, Denmark

Introduction / Objective: Exercise therapy is an individualized exercise prescription designed to restore health and prevent further disease or impairment, which take into account the current medical condition and provides advice regarding exercise type, intensity, duration and frequency. For years patients with multiple sclerosis (MS) were advised not to participate in physical exercise because it was reported to lead to deterioration of symptoms or fatigue. During the last decades, however, studies on exercise therapy in MS have instead shown a number of beneficial effects, and today exercise is an important part of MS rehabilitation programs, with a number of recent advances. Thus, the purpose of the presentation is to provide an overview of the most recent advances within the field of exercise and multiple sclerosis.

Methods: The lecture is based on a number of recent original research papers and and reviews.

Results: Resistance training and aerobic training has shown the most promising effects. Moreover, the potential beneficial effects include improved functional capacity such as improved walking speed and distance. Additional effects include reduced fatigue, improved balance, improved health and ultimately improved quality of life. Currently, the effects on brain health is attracting substantial attention and these may include reduced loss of brain volume and cortical thickness.

Discussion: it is proposed that exercise therapy to a larger extend should also be used as a preventive (potentially disease-modifying) tool rather than a symptomatic treatment.

Conclusion: Exercise is a safe and beneficial intervention in persons with multiple sclerosis that may have disease modifying effects, why early intervention may be crucial.
Mirror therapy in neurorehabilitation
Dr. C. Dohle
Neurological Rehabilitation, MEDIAN Kinik Berlin-Kladow, Berlin, Germany

**Introduction:** During mirror therapy (MT) for patients with a one-sided pathology of a limb, a mirror is sagitally in the patient’s midline. Thus, the mirror image of the unaffected limb appears as if it were the affected one. MT was proposed to improve a number of neurological conditions, most prominently (phantom) limb pain and paresis after stroke.

**Methods:** Review of current neuroimaging findings on the mirror illusion (mirrored visual feedback, MVF) and clinical studies on the effect of MT.

**Results:** Neuroimaging studies point at the precuneus of either hemisphere as key structure to convey lateralised visual feedback. Its activity can be modified independent from actual movement execution. Clinical studies unambiguously demonstrate an effect of MT on motor recovery after stroke. Congruently to the imaging results, this is superior to “standard therapy” only in patients who are not able to actively train with their affected limb. For moderate paresis, MT only outperforms sham therapies, not therapies with direct visual feedback of the affected limb. Different therapy variants show different effects.

**Conclusion:** Neuroimaging results help to understand the neural mechanisms of MT: MVF is integrated into visuomotor processing in exactly the same way as direct visual feedback. Thus, MT is only superior when other active forms of training with the affected limb are not possible. Differences in actual execution of MT should be considered.
Towards patient-tailored treatment strategies to enhance stroke recover
Prof. Dr. med. F. Hummel
Defitech Chair of Clinical Neuroengineering, Brain Mind Institute, SV. Centre of Neuroprosthetics (CNP), Swiss Federal Institute of Technology (EPFL), Campus Biotech, Geneva

In Europe, 3.7 million patients suffer from long-term deficits, such as motor or language deficits, after a stroke. Despite the recent developments in acute stroke therapy (e.g., thrombolysis, thrombectomy, stroke units) still less than 15% of the patients recover to a degree that they get back to normal life. This makes stroke the main course of long-term disability with a major impact on patients' life, the health systems and socio-economics. Thus, there is a strong need for novel, innovative treatment strategies to enhance significantly the magnitude of functional recovery to bring more patients back to normal life. Innovative treatment strategies, such as non-invasive brain stimulation (NIBS), robot-, VR- or BCI-based treatments, have demonstrated promising results in proof-of-principle studies (Hummel et al., 2005, Hummel & Cohen, 2006, for review Raffin & Hummel, 2017). However, the treatment responses are not satisfying yet, as their magnitude is heterogeneous, with responders and non-responders. Based on the fact that the population of stroke patients is quite heterogeneous in relation to e.g., lesion location, lesion size, course and degree of recovery, initial deficit, functional and structural pre-requisites beyond others, 'one suits all' treatment strategies seem not to be the most promising approach (Schulz et al. 2015, 2017, for review Koch & Hummel, 2017, Wessel & Hummel, 2017).

Thus, to achieve treatment effects with much larger magnitude, there might be a need for a paradigm shift from imprecision 'one suits all' treatment strategies towards patient-tailored precision medicine approaches. In the present talk, these issues will be discussed in more detail and potential approaches towards patient-tailored interventions to achieve homogenous treatment responses with maximized effects will be introduced and discussed.

References:
Mechanisms of post-stroke fatigue

Dr. A. Kuppuswamy

UCL, London, United Kingdom

Introduction / Objective: In this talk I put forward a novel active inference based, sensory attenuation model of post-stroke fatigue. I will also discuss behavioural data that potentially supports the idea of post-stroke fatigue as a disorder of sensory attenuation.

Methods: The classic force matching task without any visual feedback is used to quantify sensory attenuation in the stroke survivors with varying levels of fatigue. 4 different force levels ranging from 1 to 20 newtons is used to study the phenomenon of sensory attenuation in sensorimotor domain.

Results: here we show that greater the fatigue lesser participants attenuate, specifically in the lower force levels. Behaviourally, participants normally overshoot when trying to match a felt force, however in patients with high fatigue, there is less of an overshoot suggesting they attenuate lesser.

Discussion: lower levels of attenuation in the force matching task lends support to the theory that fatigue may arise from poor sensory attenuation. I will also discuss how poor attenuation might give rise to post-stroke fatigue.

Conclusion: poorer attenuation gives rise to fatigue after stroke.

Acknowledgments: I would like to thank the Wellcome Trust for funding this work.
Evidence for an increased dependence on contralesional corticoreticulospinal pathways: maladaptive plasticity following a unilateral brain injury?

J. Dewald

Introduction: Paretic arm and hand dysfunction is a major cause of chronic disability among unilateral stroke survivors. In addition to weakness or paralysis, the arm/hand is also affected by the flexion synergy that compromises the ability to reach and open the hand and reduces the control of grasp strength as a function of limb weight, thus compounding the stroke survivor's functional deficits [1]. The resulting loss of selective motor control is anticipated to be largely driven by an increased reliance on ipsilateral corticobulbospinal motor pathways due to the loss of contralateral corticospinal tract.

Methods: we tested this hypothesis using high-density electroencephalographic (HD-EEG), Brainstem Diffusion Tensor Imaging (DTI) or by administering a noradrenergic [2] agonist and imidazoline ligand, Tizanidine (TIZ) in moderately to severely impaired hemiparetic stroke participants.

Results: using (HD-EEG) recordings, shows an increased activation of contralesional motor cortices with increasing levels of paretic limb weight support by stroke participants [2], indicating the use of indirect corticoreticulospinal pathways based on primate research. In the same cohort, DTI shows an increase in structural tract integrity in contralesional reticulospinal tract integrity [3]. Finally, inhibiting the neuromodulatory component of the reticulospinal tract, by administering TIZ, we observed a reduction of flexion synergy expression by disfacilitating spinal motoneurons [4].

Discussion/conclusion: we interpret the progressive recruitment of contralesional cortico-reticulospinal pathways combined with an increased reticulospinal neuromodulatory input as an adaptive strategy that increases shoulder abduction strength at the cost of functional selective motor control in the paretic upper limb.


10.00 – 10.30 | Room 0.8
Theta burst stimulation effects on neglect and functional outcome after stroke: determinants of response variability
Prof. Dr. T. Nyffeler

ARTORG Center for Biomedical Engineering Research, Bern, Switzerland

Introduction / Objective: After stroke spatial neglect is a negative predictor of outcome. Non-invasive brain stimulation (NIBS) has been shown to ameliorate neglect on a group level, however a variability of the effects is observed at the individual level. We aimed to assess the determinants of the effects of NIBS in neglect.

Methods: In thirty patients with neglect, we applied continuous Theta Burst Stimulation (cTBS) over the left posterior parietal cortex (PPC) in a randomized clinical trial, either in 8 or 16 trains, or as sham stimulation. Neglect severity was measured with the Catherine Bergego Scale (CBS) and a neuropsychological test battery, at admission to and at discharge from inpatient neurorehabilitation. General functional outcome was assessed with the Functional Independent Measurement (FIM) and the Lucerne ICF-based Multidisciplinary Observation Scale (LIMOS). The impact of clinical and demographic factors was evaluated, and the influence of lesion location and extension was assessed by means of voxel-based lesion-symptom mapping (VLSM).

Results: cTBS (8 and 16 trains) significantly reduced neglect severity, at discharge and 3 months later. Furthermore, cTBS significantly improved general functional outcome. Hierarchical cluster and VLSM analyses revealed that on an individual level, the variability in the responses to cTBS is determined by the integrity of callosal parieto-parietal connections.

Discussion: In cTBS responders, in whom neglect and outcome were significantly improved, the corpus callosum was intact; this was not the case in cTBS non-responders.

Conclusion: In patients with intact interhemispheric connectivity, cTBS
over the contralesional PPC significantly improves neglect recovery and, associated with it, general functional outcome.

13.00 – 13.30 | Room 0.8
Repetitive transcranial magnetic stimulation (rtms) for treatment of motor deficits and aphasia after stroke
Prof. Dr. J. Liepert
Neurorehabilitation, Kliniken Schmieder Allensbach, Allensbach, Germany

Introduction / Objective: RTMS has been used for improvement of symptoms after stroke since approximately 15 years. Different symptoms, e.g. motor deficits, aphasia, dysphagia, visuospatial neglect, spasticity have been addressed. Despite the fact that thousands of patients have been treated, there is only limited evidence of the effectiveness of rTMS. The pathophysiological concept of rTMS effects is mostly based on the assumption of an interhemispheric rivalry with the undamaged hemisphere having a negative impact on the lesioned hemisphere.

Methods: A large number of variables has to be considered, e.g. stimulus intensity, stimulation frequency (low or high frequency), number of sessions, combination of rTMS and physiotherapy, location of the lesion (subcortical versus cortical), time since stroke (acute, subacute, chronic), severity of symptoms, type of symptoms (e.g., receptive versus expressive language).

This review will present data for rTMS treatment of motor deficits, neglect and aphasia. Recent reviews and randomized controlled trials are considered.

Results: Currently, the best evidence is available for improving motor deficits by low frequency rTMS over the contralesional motor cortex in acute/subacute patients with pure subcortical lesions. Limited evidence suggests that rTMS os more effective in patients with the lesion affecting the dominant hemisphere. Possibly, high frequency contralesional premotor cortex stimulation is more beneficial for patients with severe motor deficit.

Low frequency rTMS over contralesional parietal areas improves visuospatial neglect as by specific neglect tests.

Low frequency rTMS over the right inferior frontal gyrus seems to be effective for treatment of non-fluent aphasia.
Physical activity after stroke: evidence and implications

Prof. Dr. F. van Wijck

School of Health and Life Sciences, Glasgow Caledonian University, Glasgow, United Kingdom

Introduction / Objective: An important goal of neurorehabilitation is to improve motor function, with the assumption that improved function will automatically carry over into physical activity following discharge. But what is the evidence for this?

Methods: This talk will present the latest findings on physical activity and sedentary behaviour amongst people with stroke and other long term neurological conditions (LTNC). It will outline the impact of common fitness impairments on function, activity and participation, and present the latest evidence underpinning exercise and fitness training for people with LTNC.

Discussion: The implications arising from this evidence for neurorehabilitation - and beyond - will be discussed.

Conclusion: Distinguish between the concepts of ‘physical activity’, ‘physical fitness’, ‘physical function’ and ‘sedentary behaviour’, and describe how these can be measured.

Summarise current evidence about the effects and experiences of physical fitness training for people with stroke and other LTNC, and identify its strengths and limitations.

Discuss implications of this body of evidence for neurorehabilitation - and beyond.
Technology for measurement of manual dexterity impairments in stroke
11:30 - 13:00 | Room 0.2/0.3

Individual dexterity impairment profiles after stroke
P. Lindberg
Inserm U1266, Paris, France

Introduction / Objective: Manual dexterity is essential for grasping and manipulation of objects and is often impaired in neurological disorders limiting activities of daily living and impacting quality of life. Clinically, there is a lack of quantitative multi-dimensional measures of manual dexterity.

Methods: We developed a device and visuomotor tasks to measure:
   (i) accuracy during finger force tracking, (ii) motor sequence recall during sequential finger tapping, (iii) single-finger tapping rate and variability, and (iv) independence of finger movements during multi-finger tapping.

Results: Results from three studies in stroke and mild cognitive impairment and will be presented. First, chronic stroke patients showed less accurate finger force control, reduced tapping rate, and reduced independence of finger movements compared to controls despite lack of hand motor impairment on conventional clinical scales. Dexterity impairments did not systematically correlate to each other and individual dexterity profiles were apparent. Second, post-stroke recovery in finger force control correlated with recovery in corticospinal excitability. However, finger tapping rate and independence of finger movements showed a different time course of recovery and remained impaired at six months. Third, elderly subjects with mild cognitive decline had impaired finger tapping variability and independence of finger movements compared to cognitively intact elderly subjects.

Discussion: Corticospinal tract integrity is a major determinant of recovery in finger force control whereas additional brain structures are likely involved in recovery of more cognitive-motor impairments, such as independence of finger movements.

Conclusion: Identifying individual dexterity impairment profiles post-stroke should be useful in development of targeted treatments.
Spatial representation of hands in stroke patients with hemiparesis
L. Dupin
Institut de Psychiatrie et Neurosciences de Paris, Paris, France

Introduction / Objective: The position sense of our body parts, i.e. the ability to locate our limbs in external space in absence of movement, is critical to perform targeted movements, towards objects for instance, and therefore to properly interact with the external environment. Consequently, impaired spatial representation of body parts could be related to altered movement initiation and planning observed in stroke patients with motor impairments (hemiparesis). In this study, we focused on upper limbs and particularly on hand representation. Differentiated fingers spatial representations could be necessary to individuated fingers movements, critical for manual dexterity. Position sense is constructed through a combination of proprioceptive, tactile and visual cues forming a multisensory spatial representation of the body.

Methods: We used the localization of tactile stimulations as a measure of position sense which is based on the localization of the stimulated body part. Initially, the localization of a tactile stimulation is coded in somatotopic reference frame (S1). This reference frame does not contain spatial information on body parts in external space. The remapping between somatotopic and spatiotopic reference frame of the tactile localization can be used to evaluate the position sense of body parts and their alterations.

Results: Preliminary results show that hands representations using tactile localizations are correlated between the right and left hands for healthy subjects.

Discussion: The comparison of the representation between hands can be used to identify altered fingers representations in hemiparetic patients after stroke.

Conclusion: The localization of tactile stimulations on hands in absence of vision allows an unbiased measure of position sense.
Analysis of force exchanges during object grasping and manipulation in healthy subjects and stroke patients


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Introduction / Objective: The impairment of hand dexterity in hemiparetic patients is multifactorial. The manipulation behavior depends on the direct consequences of brain lesions (lack of individual finger control, impairment of force regulation and sensation, spasticity) and on the compensatory strategies including the use of alternative grasping configurations. We analyze hand function in healthy subjects and hemiparetic patients during various manipulation tasks with an instrumented object.

Methods: The instrumented object iBox is fitted with an Inertial Measurement Unit (IMU) and six force sensors. Two studies will be presented: i) the analyse of manipulative tasks involving object rotations in 24 healthy subjects; ii) the impact of grasping configuration on grasp-to-lift in twelve stroke patients.

Results: The results confirm the tight regulation between grasping and unloading forces during lifting, in both healthy subjects and stroke patients. They provide a precise description of the regulation of grasping forces and object stability during the sequence of sub-goals of the task and may evidence the occurrence of micro-errors. The unloading phase was longer in hemiparetic patients with a lesser vertical stability of the object. The force regulation varied according to grasp configuration in hemiparetic patients.

Discussion: During object manipulation the grasping forces are regulated to control and/or maintain object orientation. The ability of stroke patients to control the grasping forces while lifting vertically an object is affected by the grasping configuration.

Conclusion: These preliminary studies illustrate the complexity of force regulation for object manipulation and the feasibility of using an instrumented object.

Acknowledgments: Labex SMART (ANR-11-LABX-65)
Factors of impaired fine motor control
J. Hermsdörfer, K. Allgöwer

Department of Sport and Health Sciences, Technical University of Munich, Munich, Germany

Introduction / Objective: Our goal was to determine factors which characterize impaired hand function in neurological patients. In particular, technological developments and expertise from clinical studies should be merged into a test-battery with strong predictive power.

Methods: To analyze object manipulation skills, grip forces and load forces were recorded with an instrumented easily-graspable device (GF-Box). The forces as well as temporal measures were examined during lifting actions, repetitive movements of the object and catching tasks. More elementary aspects of force control assessed visuomotor tracking, fast force changes and grip strength. Additional tests included the Jebsen Taylor Hand Function Test (JTHFT), the Nine-Hole Peg Test (9-HPT) and the 2-point discrimination test (2 PD).

Results: Nine parameters from 6 tasks were extracted to distinguish significantly fine motor performance of stroke patients from healthy controls. Using these parameters, we identified 3 principal components (factors): 1) Grip force scaling, 2) motor coordination and 3) speed of movement. Regression analysis found a strong predictability of the performance in the JTHFT based on the three factors ($R^2=0.687$, $p<.001$). Interestingly, in patients with writer’s cramp as well as with complex regional pain syndrome, deficits were largely restricted to the motor coordination factor.

Discussion: Mainly on bases of recordings of finger force, we revealed specific patterns expressed in three key characteristics of fine motor skills. In stroke patients the factors are able to explain the performance in the JTHFT which reflects daily activities.

Conclusion: These findings can serve as a basis for improving diagnostics and enabling more targeted therapy.
Clinical effectiveness of Digital Neuro-Interventions for patients with stroke or dementia and language impairments: behaviour and brain factors explored and exploited
11.30-13.00 | Room 0.4

Using therapy apps and brain stimulation to improve reading in post-stroke aphasia
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Introduction / Objective: Reading impairments are a common consequence of left hemisphere stroke. They can occur as isolated reading impairments (pure alexia), but more occur more commonly in the context of a more general speech and language impairment (central alexia). Here we report the impact of a novel reading therapy app (‘iReadMore’) paired with non-invasive brain stimulation (transcranial direct current stimulation, tCDS) on reading ability and neural networks in patients with central alexia.

Methods: 21 participants with chronic post-stroke central alexia received two 4-week blocks of therapy, each comprising 34 hours of iReadMore training plus 11 tDCS sessions. The primary outcome measure was overt word reading accuracy. Neuroimaging (MRI and MEG) was acquired before and after the first block of therapy.

Results: The trial resulted in significant improvements in word reading ability (d=1.38), but with limited generalisation to untrained words or sentence-level reading. The brain stimulation resulted in a facilitation of word learning (d=0.41), and improved generalisation to untrained items. MRI identified perisylvian areas where lesion location predicted response to therapy, and MEG demonstrated increased strength of bottom-up connections in the left hemisphere after therapy.

Discussion: These results indicate that computer-based therapy apps can improve reading ability in chronic central alexia, and that tDCS can be an effective adjunct to behavioural therapy. The neuroimaging results raise new hypotheses for future investigations of the neural basis of reading recovery after stroke.
Role of brain structure in response to speech comprehension treatment in persons with chronic aphasia

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Introduction / Objective: Imaging methods have demonstrated associations between brain structure and speech comprehension in persons with aphasia (PWA). Less is known about how brain structure influences response to therapy, and how therapies drive structural neuroplasticity. Objectives: [1] Investigate the influence of pre-therapy brain structure on treatment outcomes in PWA, following a digital speech comprehension therapy ("Listen-In"); [2] Investigate therapy-driven structural neuroplasticity.


Results: [1] Increased pre-therapy volume in one GM cluster (right caudate nucleus) and four WM clusters (right fronto-temporo-parietal regions) were associated with greater treatment gains. [2] Greater treatment gains were associated with greater structural changes in two bilateral regions: (i) WM in the left superior temporal gyrus (BA21/22); (ii) GM in the right posterior superior temporal gyrus (BA22).
Discussion: Pre-therapy integrity of predominantly right WM networks predicted how well PWA responded to Listen-In treatment, in line with a key role of the right hemisphere in treatment-related language recovery. Twelve-weeks of Listen-In therapy induced bilateral structural changes in GM and WM structures in key auditory comprehension regions, supporting a role of both hemispheres in treatment-related recovery.

Conclusion: Pre-therapy right hemisphere brain structure can predict treatment outcomes, whilst speech comprehension therapy can induce bilateral structural neuroplasticity, in PWA.

Co-design of a word retrieval app for people with dementia.
C. Doogan
Brain Repair and Rehabilitation, UCL, London, United Kingdom

Introduction / Objective: Between 2010 and 2030 the prevalence of dementia will increase 80% in the over-65s in the UK. The management of long-term conditions associated with dementia is a major challenge. Here we report a co-design project developing a word-retrieval app for people with Alzheimer’s Dementia. The aim of this study was to better understand the ways in which to include people with dementia in the co-design process in a meaningful way from their perspective.

Methods: This co-design project involved carrying out Patient-and-Public engagement events to ask how to develop the focus groups that would facilitate the co-design of the app. The Stroke survivors, their carers, researchers and the software developers attended a series of focus groups. At each focus group the app would be presented, trialled by the person with dementia and discussed as a group. Directly after this focus group semi-structured qualitative interviews were carried out with both the participant with dementia and their carer.

Results: Findings included recommendations such as having a pre-prepared interview schedule, the interview on the same day as the focus group as a face to face and not a telephone call with the carer present. Thematic analysis is being used to identify themes and will be discussed in this talk.

Discussion: This co-design project aimed to facilitate people diagnosed with dementia and their carers to engage meaningfully in helping to create a digital neurological intervention. This co-design study hopefully shows that people living with dementia can continue to make a significant contribution to society after diagnosis in research.
Broca’s area’s contribution to speech function: in healthy and lesioned brains

J. Crinion

Institute of Cognitive Neuroscience, University College London, London, United Kingdom

Introduction / Objective: Lateral inferior frontal cortex (LIFC), including Broca’s area, is argued to be crucial for spoken language recovery after aphasic stroke. As such non-invasive brain stimulation targeting Broca’s area has been proposed as a treatment of anomia (spoken word finding difficulties). However, LIFC is also involved in executive processes and domain-general systems. In this series of experiments we aimed to tease apart the different roles of this region contributing to speech performance in both healthy and aphasic participants.

Methods: 18 healthy older participants and 18 chronic post-stroke aphasics with lesions anatomically sparing Broca’s area took part. They performed two tasks: object naming and object size judgment while undergoing concurrent functional MRI and transcranial direct current stimulation (tDCS). To directly test LIFC’s causal contribution to task performance tDCS (2mA anodal or sham) was delivered in two separate sessions to LIFC concurrently with both tasks. To test for domain generality we manipulated task demands by varying visual and auditory ambiguity of the stimuli. The primary outcome measure was efficiency of overt spoken responses for each task.

Results: Anodal brain stimulation resulted in a facilitation of both groups behaviour irrespective of the task. FMRI identified Broca’s area had higher sensitivity for the auditory manipulation exclusively in the judgment task, and independent of the visual or tDCS conditions. Neural effects of anodal tDCS were observed remotely in limbic and striatal regions sensitive to the task context.

Discussion: The behavioural results indicate tDCS delivered to LIFC can facilitate online task performance both in the older and damaged brain. The neuroimaging results raise new hypotheses for the adaptive executive control role of LIFC in task performance and speech recovery after stroke. Further investigation of individual patients’ responses to brain stimulation and cognitive functioning enable us to make predictions about the therapeutic outcome. We hope this will lead to better patients’ stratification (e.g. identification of good candidates for this approach), optimizing both treatment path and outcome.
The interaction between the expression of the flexion synergy and hyperactive stretch reflexes in chronic hemiparetic stroke

J. Dewald

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2Department of Biomedical Engineering, Northwestern University, Evanston, Illinois, USA
3Department of Physical Medicine and Rehabilitation, Northwestern University, Chicago, Illinois, USA

Objective: Characterize the effect of flexion synergy expression on the manifestation of elbow flexor stretch reflexes unilateral stroke as a result of perturbations and during ballistic reaches.

Methods: Participants with chronic hemiparetic stroke were interfaced with a robotic device that precisely manipulated flexion synergy expression (by regulating shoulder abduction loading) while 1) delivering controlled elbow extension perturbations over a wide range of velocities [1]; 2) during ballistic reaching [2]. The amplitude stretch reflexes was assessed in the biceps brachii by EMG.

Results: Shoulder abduction loading potentiated perturbation induced elbow flexor stretch reflexes via flexion synergy expression in the paretic arm. In the case of ballistic reaching, reaching velocity decreased with abduction loading such that velocity was 30% slower when lifting the arm at 50% of abduction Max compared to when arm weight was supported. Abnormal flexion synergy increased with abduction loading. Biceps spasticity was detected during reaching but only when arm weight was supported.

Discussion/conclusion: Even though the biceps stretch reflex excitability goes up when increasing shoulder abduction loading when delivering elbow extension perturbations, during ballistic reaches shoulder abduction loading reduces reaching velocity which all but eliminates stretch related biceps EMG. In short, these findings demonstrated that the flexion synergy is the predominant contributor to reaching dysfunction while flexor spasticity appears only relevant during passively supported movements.


2. Ellis, M. D., Schut, I. & Dewald, J. P. A. Flexion synergy overshadows flexor spasticity during...
Motor lateralization predicts treatable ipsilesional motor deficits in stroke

R. Sainburg

Neurology and Kinesiology, Penn State University, University park, United States of America

Introduction / Objective: We have developed a model of motor lateralization that attributes different motor control processes to each cerebral hemisphere. This bilateral hemispheric model of motor control has successfully predicted hemisphere-specific motor control and motor learning deficits in the ipsilesional, or non-paretic, arm of patients with unilateral stroke.

Methods: We assess across 110 MCA stroke patients whether these motor performance deficits in the non-paretic arm of stroke patients vary with the side of the lesion, and the severity of contralesional impairment.

We conducted a pilot study focused on improving hemisphere specific deficits using virtual reality as well as real world training to assure transfer to functional activities.

We are now conducting a large 2-site clinical intervention study to assess whether a combination of VR training focused on hemisphere specific deficits and real world dexterity training will transfer to improve functional independence.

Results: Our results indicate that:
1. Ipsilesional deficits depend on both severity of contralesional arm impairment and the hemisphere that is damaged.
2. Our pilot study indicated a 20% improvement in ipsilesional dexterity and that this improvement transfered to activities of daily living and functional independence.
3. Our large clinical intervention is underway.

Discussion: Intervention focused on remediating hemisphere-dependent motor control deficits can improve functional independence, and can also transfer to improve contralesional arm impairment.

Conclusion: Our results indicate that the ipsilesional arm should be tested clinically to assess whether ipsilesional arm intervention is warranted, especially when contralesional impairment is severe.

Acknowledgments: Funding: National Institutes of health: 1R01HD059783, 2R01HD059783 American Heart Association: 16GRNT3101001
Torque Perception in Chronic Hemiparetic Stroke
N. Gurari

Department of Physical Therapy and Human Movement Sciences
Preceptor, Northwestern, University Interdepartmental Neuroscience Program, Feinberg School of Medicine, Northwestern University

Introduction/Objective: In the USA, 5.6 million individuals with stroke face great difficulty performing activities of daily living, possibly in part because they are unable to judge the relative torques they generate with their two arms. The impact of this torque perceptual impairment on activities of daily living is unknown, but prior work suggests that the effect is substantial, particularly during bimanual tasks. Therefore, this impairment is important to investigate since it may hinder the ability of individuals with stroke to safely deal with unfamiliar and potentially dangerous bimanual tasks, such as carrying a tray, pushing a grocery cart, and caring for an infant.

Methods: I will present numerous behavioral experiments in which we used mechatronic systems to quantify the ability of individuals with chronic hemiparetic stroke to identify their self-generated torques at the elbow during unimanual and bimanual perceptual tasks.

Results: Results from these experiments indicate that judgments about whether individuals with stroke have torque perceptual impairments can depend on how an assessment is executed (e.g., single arm/between arms; matching to paretic/non-paretic arm).

Discussion: I will provide a novel hypothesis to explain the reason that a torque perceptual impairment occurs and will discuss the implications of our findings.

Conclusion: The long-term goal of this work is to change the way that clinicians approach rehabilitation by highlighting the importance of intact torque perception, developing appropriate torque perceptual assessments, and providing a targeted rehabilitative treatment.
Fundamental principles in motor control
M. Levin

School of Physical and Occupational Therapy, McGill University, Montreal, Canada

Introduction / Objective: There is increasing interest in understanding the mechanisms of neuroplasticity in the intact brain and how these shape the body’s response to neurological injury and as well as the recovery process (Kleim and Jones 2008). In order to apply this understanding to clinical practice, an in-depth knowledge of motor control and learning principles is needed (Levin et al. 2015).

Methods: The major principles of movement production based on Bernstein’s concept of muscle and kinematic redundancy will be reviewed (Bernstein 1967).

Results: These motor control principles of kinematic redundancy and motor equivalence [i.e., dexterity, adaptability] will be used in the description of the control of simple and complex reaching movement and in the explanation of the disruption of reaching movements after stroke. Examples will be shown of how knowledge of the principle of redundancy helps to understand the underlying motor control deficits of reaching performance in neurological patients, such as those with stroke and Parkinson disease.

Discussion: The implications of these deficits for the appearance of motor compensations and re-learning of functional skilled movement will be discussed.

Conclusion: The notion of redundancy can be incorporated into clinical practice to improve sensorimotor performance and recovery. Awareness and application of the principles of motor control and motor learning will improve outcomes of sensorimotor motor rehabilitation.

Acknowledgments: MFL holds a Tier 1 Canada Research Chair in Motor Recovery and Rehabilitation.
Stability and coordination in neurological patients
D. Piscitelli

School of Physical and Occupational Therapy, McGill University, Montreal, Canada

Introduction / Objective: Stroke is a leading cause of disability worldwide. At six months post-stroke, 50-70% of patients continue to have upper limb sensorimotor impairments. The most common problems of the upper limb are paresis and spasticity leading to residual functional deficits. Higher-order motor control skills are crucial features of functional movement that are affected by stroke (Levin et al. 2015). In particular, stability is a fundamental component of functional movement.

Methods: We will provide evidence that the central nervous system is able to organize different sets of elements within the body (e.g., muscles, joints) into task-specific ensembles (i.e. synergies) stabilizing salient performance variables. We will focus on performance variables of reaching accuracy and vertical posture stability (Latash 2016).

Results: Using a mathematical model capturing dynamic quality of coordination between joints during the performance of the task we quantified stability deficits after stroke for precision point-task made from the sitting position and for balance task. We also quantified anticipatory synergy adjustments related to grasping task in patients with Parkinson disease. We described the relationship between synergies and clinical measures of motor impairments will be described.

Discussion: The knowledge and the implications from this theoretical bench-to-bedside perspective will be discussed.

Conclusion: Stability measures may be used to track motor recovery following treatment interventions that are aimed at improving the voluntary control of movement in neurological patients. The knowledge of higher-order motor control skills may help to develop new rehabilitation treatment strategies, leading to a better recovery.

Acknowledgments: DP is supported by the Fonds de la Recherche du Québec en Santé.
Innovative modalities for motor recovery in neurorehabilitation
A. Turolla

Laboratory of Neurorehabilitation Technologies, Fondazione Ospedale San Camillo IRCCS, Venezia, Italy

Introduction / Objective: Concepts on hierarchical architecture and synergistic functioning of the motor system, are contributing to the development of innovative rehabilitation approaches for motor function recovery, after injuries of the central nervous system (CNS) [Han et al. 2008, Pomeroy et al. 2011].

Methods: The basic computational principles on voluntary human motor behaviour for rehabilitation applications, will be discussed (Frey et al. 2011), together with the rational underpinning the recovery process after lesion of the central nervous system (Nudo, 2011).

Results: Classification and principles of different rehabilitation modalities will be proposed, together with available recent evidence on their effectiveness (Turolla, 2018).

Discussion: How motor control and learning principles can be exploited by innovative technologies for rehabilitation interventions will be addressed.

Conclusion: Recent evidence on the effectiveness of upper limb virtual rehabilitation (Laver et al. 2017) and new perspectives on body-machine interfaces for neurorehabilitation of people with stroke will be presented.
Does multiple sclerosis accelerate age-related deterioration of physical function?
L. Hvid

Section of Sport Sciences, Dep. Public Health, Aarhus University, Aarhus c, Denmark

Introduction / Objective: Deterioration of neuromuscular function (e.g. ability to activate and control skeletal muscles) and physical function (e.g. walking capacity) is a hallmark of both MS and aging, mainly/partly driven by neurodegeneration. The latter comprise marked alterations in CNS morphology and function. In the general population, deterioration of neuromuscular function and physical function tend to accelerate from the sixth decade (i.e. following a non-linear trajectory). Due to the pathology of MS - most often presented early in adult life - an accelerated aging phenotype may likely be present in persons with MS. This talk will summarize the existing knowledge – although scarce – on the effects of aging on neuromuscular function and physical function in persons with MS. Specific focus will be given to the underlying mechanisms associated with deterioration of neuromuscular function and physical function in MS and aging, along with potential counteracting rehabilitation strategies.

Effects of auditory-motor coupling to music compared to metronomes in MS
L. Moumdjian

University of Hasselt, Hasselt, Belgium

Introduction / Objective: Rhythms coupled to walking has become a topic of recent interest in the domain of neurological rehabilitation, yet its potential in applications has not yet been fully explored. This talk will introduce three experimental sessions applying auditory-motor coupling to music compared to metronomes at different tempi in PwMS, and its effects on perceived physical and cognitive fatigue and gait.

Methods: In the first experimental session, 30 PwMS and 30 HC were asked to walk to music without instructions to synchronise at different tempo: tempo equal to their natural cadence, +2, +4, +6, +8 and +10%. In a following session, participants were instructed how to synchronise their steps to beats, and were asked to walk to two blocks, music and
metronome to at different tempo as in the first session. Finally, in a last session, participants were asked to walked at their individualised optimal tempo to 12 minutes to music, metronomes, as well as in silence.

**Results:** The results showed that instruction to synchronise was a requirement in order for PwMS to couple to their steps to the beats. Additionally, synchronisation was possible to both music and metronomes, with a better synchronisation at higher tempi to music, when walking for three minutes. However, the results showed that synchronisation was better with music when PwMS walk for longer periods. Finally, walking to music was perceived to be less cognitively fatiguing than walking to metronomes and in silence in PwMS.

**Conclusion:** Coupling walking to music could offer novel paradigms for motor task-oriented training in PwMS.

**Walking related-fatigability**
F. Van Geel

Hasselt University, Diepenbeek, Belgium

**Introduction / Objective:** Fatigue and fatigability are well known symptoms in neurological diseases, and have a large impact on daily living. Given the high prevalence of these symptoms, better understanding and correct measurement methods of these symptoms in clinical practice is necessary. Therefore, an updated taxonomy of fatigue and fatigability will be discussed, together with the causes and other related factors. The taxonomy will give insights in understanding fatigue and fatigability seen from a holistic point of view. Secondly, different clinical assessment methods (together with some psychometric properties [such as f.e. test-retest]) that are currently used in clinical practice and research will be presented. Afterwards, a shift focus towards walking-related fatigability in persons with Multiple Scelrosis (PwMS) will be made, together with its clinical presence and manifestation. New data in 49 PwMS and 28 healthy controls will be presented to have a deeper discussion about walking-fatigability and how to measure it in a clinical practice and interpret formulas and scores, based on the new taxonomy. Finally, pilot studies on different interventions treating fatigue and fatigability as primary outcome in PwMS will be presented.
Trunk impairments in pwMS, a great impact on upper limb ADL?
an overview of the current evidence.
J. Raats
University of Hasselt, Hasselt, Belgium

Introduction / Objective: Approximately 60% of the persons with Multiple Sclerosis (pwMS) report to have upper limb dysfunction in the first year of the disease, increasing to 81% after 15 years. To reach and grasp, people need hand, arm and shoulder function. The natural path of the hand towards an object is relatively straight and the movements in the different joints of the upper limb (hand, wrist, elbow and shoulder) occur simultaneously. Besides a good upper limb function, the trunk plays an important role as shown in the stroke literature. However, in MS, the trunk is not or insufficiently included in the assessment and rehabilitation of the upper limbs. Current evidence in MS is mainly focused on the assessment and rehabilitation of these components separately. In this presentation, we will provide an overview on the current literature on trunk and upper limb impairments and effects of rehabilitation strategies in PwMS. In a second step, we will discuss how trunk impairments may affect upper limb performance in pwMS. Lastly, we will present preliminary results of test-retest reliability application of the Reaching Performance Scale in pwMS. The Reaching Performance Scale is developed and used in stroke patients to evaluate the trunk, shoulder and upper limb movements during reaching.
Perspectives from a trialist
L. Connell¹, N. Lannin²

¹Health Sciences, University of Central Lancashire, Preston, United Kingdom
²La Trobe University, Melbourne, Australia

Introduction / Objective: Great responsibility rests with trialists, who in the process of testing complex interventions for effectiveness must not only decide on their trial phase and design, but also select the most clinically useful control intervention, and predict potential causal pathways to maximise the likelihood of future implementation of trial results into practice. They must plan how to obtain not only clinician and manager buy-in for the project, but also hospital administrator and policy buy-in. While trialists have traditionally focused on their design and feasibility/recruitment during planning for a trial, we are now more aware than ever of the responsibility we have to ensure our studies shape future clinical care. Complex intervention studies can be placed on a continuum, with phase 1 efficacy trials at one end, and phase 3 effectiveness trials at the other. This presentation will discuss how to move along this continuum, with the ultimate goal of testing the effectiveness of neuro-rehabilitation interventions under ‘real-world’ conditions. We will discuss how trialists can design a trial with dissemination and translation in mind at the outset, and resources we’ve found useful to achieve this. Using neurorehabilitation trials as exemplars, we will share how potential issues related to translation can be anticipated and planned for, and how the implementation components for any complex intervention can be defined during the design phase of a trial which would allow a process evaluation to be embedded alongside the main effectiveness trial.

Perspectives from a clinical academic
L. Connell¹, P. Logan²

¹Health Sciences, University of Central Lancashire, Preston, United Kingdom
²University of Nottingham, United Kingdom

Introduction / Objective: Providing evidence based interventions is the mantra of all healthcare professionals. Historically it has been mostly the medics who have seen themselves as clinical academics, with nurses and
allied health professionals considering themselves as users of research but not instigators or completers of research. This is changing as more masters and PhDs are completed giving people the skills of critical appraisal, reflection and objectivity.

Methods: This presentation will explore the careers of five UK clinical academic stroke healthcare practitioners, reflecting on the barriers and facilitators to implementing evidence into real clinical environments. Data have been collected from clinical records, clinical guidelines, health service policies, interviews, published literature and observation. Quotes from the professionals will be used to illuminate the data.

Results: The results highlighted that many healthcare professionals do not consider themselves as a clinical academic ‘It is not in my job description’. They were afraid of research, do not have time to read papers and have little confidence in themselves to suggest a change to existing health services. They often undermine their own colleague’s research findings and are more likely to respect research from a different location or profession. Interventions have been amended, adapted, modified or reduced to fit the local context, without consideration of impact.

Conclusion: Increasing research capability and capacity with leadership skills among clinical academics will improve implementation. Embedding research facilities in clinical areas, running journal clubs and providing ongoing mentorship could improve clinical outcomes.

Perspectives from a service delivery perspective
L. Connell\(^1\), N. Ward\(^2\)

\(^1\)Health Sciences, University of Central Lancashire, Preston, United Kingdom
\(^2\)UCL Queen Square Institute of Neurology, London, United Kingdom

Introduction / Objective: There is a nihilistic view about what clinically relevant recovery is possible after the early post-stroke phase. This pessimism seems to affect the design of trials designed to examine efficacy of neurorehabilitation interventions. Consequently, poorly thought out, low dose trials are all that we have to go on when considering how to deliver evidence based practice. Another way is to learn from high quality services that are set up and delivered despite the evidence, allowing us to ‘reverse engineer’ the problem. The Queen Square Upper Limb Neurorehabilitation programme is an example of a successful neurorehabilitation service. It delivers high quality, high dose, high intensity upper limb neurorehabilitation during a 3-week programme. The results are better than most clinical trials trying to achieve the same
thing and demonstrate that with intensive upper limb rehabilitation, chronic stroke patients can change by clinically important differences in measures of impairment and activity, and crucially, can continue to improve over the following 6 months. This service provides the perfect opportunity to ask questions about what the key ingredients of effective stroke rehabilitation are so that we can consider how they might be more widely delivered to all stroke patients who might benefit.

Neurophysiological correlates of upper limb sensorimotor function and recovery in stroke measured by electro-encephalography and magnetoencephalography
10.00 - 11.30 | Room 0.2/0.3

20-hz rebound as a neurophysiological correlate of stroke recovery
K. Laaksonen

Department of Neurology, Neurocenter Finland, Helsinki University Hospital, Clinical Neurosciences and Dep. of Neurology, Helsinki University Hospital, Hus, Finland

Introduction / Objective: Recovery from stroke follows the so-called proportional recovery rule. However, about half of the patients with severe stroke fail to follow this rule. The neurophysiological mechanisms driving recovery after stroke are still poorly understood. We have recently succeeded in identifying neurophysiological correlates of spontaneous biological recovery after stroke. However, the important question is, how brain recovery processes differ between patients with initially severe impairment and good vs. bad recovery.

Methods: We used magnetoencephalography to study modulation of rhythmic brain activity in acute stroke patients and during follow-up.

Results: Our results indicate that synchronization of the 20-Hz rhythm (rebound), generated in the sensorimotor cortex, is decreased in the acute phase after stroke and increases concomitantly with recovery of hand function.

Discussion: The different behavior of the 20-Hz rebound in patients with initially severe impairment and good vs. bad recovery will be discussed.

Conclusion: The 20-Hz rebound is a promising biomarker, which gives insights in the neurophysiological mechanisms of stroke recovery, and could potentially distinguish between patients with good vs bad recovery already in the acute phase after stroke.
Exploring the relationship between somatosensory evoked potentials and upper limb impairments in stroke
L. Tedesco Triccas¹, K. Camilleri², D. Mantini³, L. Boccuni³, B. Wittevrongel⁴, A. Peeters⁵, F. Muscat², G. Verheyden¹

¹Department of Rehabilitation Sciences, KU Leuven, Heverlee, Belgium
²Department of Systems and Control Engineering, University of Malta, Msida, Malta
³Department of Movement Sciences, KU Leuven, Heverlee, Belgium
⁴Laboratory for Neuro- and Psychophysiology, KU Leuven, Leuven, Belgium
⁵Department of Neurology, Cliniques Universitaires Saint-Luc, Brussels, Belgium

Introduction / Objective: Nearly half of the people with stroke having upper limb (UL) dysfunction, experience somatosensory impairments. Measures with electroencephalography (EEG) with somatosensory stimulation such as pin-prick evoked potentials (PPEP), have the potential to be neurophysiological indicators for somatosensory deficits. The objective was to compare the amplitude and latency of the PPEP of healthy older adults to those of people with acute and sub-acute stroke with sensorimotor UL impairments.

Methods: People with stroke were recruited from stroke units. EEG and clinical outcome measure data collection was conducted during two separate sessions. A pin-prick stimulator was synchronised to a 32-channel EEG system. Pin-prick stimulation was applied to the dorsum of the left and right hands. EEG epochs were analyzed on EEGLab and Matlab.

Results: Preliminary data was collected from 6 healthy and 5 stroke participants. A consistent PPEP morphology was observed in healthy participants showing a positive peak at a mean latency and amplitude of 168.83±7.68 ms and 3.56±1.88 µV respectively. Stroke participants with clinical somatosensory deficits, showed smaller PPEPs with mean latency and amplitude of 217.08±47.35 ms and 0.53±0.42 µV at the affected side. After two weeks, at this side, the mean latency decreased to 207.05±77.77 ms and mean amplitude increased to 1.44±0.53 µV, while clinical somatosensory measures did not change.

Discussion: Initial data suggests alteration of the PPEP in people with somatosensory UL deficits. Further data is currently being collected in stroke units in Belgium and Malta.

Acknowledgments: Thank you to the clinicians at Saint-Luc Hospital, Brussels and the Physiotherapy Services in Malta.
Power spectral density measures in resting state are related to stroke severity and post stroke motor function of the upper limb.

M. Saes\textsuperscript{1}, C. Meskers\textsuperscript{1}, S. Zandvliet\textsuperscript{1}, A. Daffertshofer\textsuperscript{2}, J. Munch\textsuperscript{3}, G. Kwakkel\textsuperscript{1}, E. van Wegen\textsuperscript{1}

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Introduction / Objective: The Stroke Recovery and Rehabilitation Roundtable task force recommends to measure upper limb recovery post stroke with the Fugl-Meyer motor assessment (FM-UE) and stroke severity with the National Institutes of Health Stroke Scale (NIHSS) at fixed times post stroke. However, these are indirect clinical measures of neural state. EEG may allow for a more direct measure of neural state. Stroke causes an increased power of low frequency oscillations and lateralization of the power distribution over the hemispheres. Power spectral density measures as the Delta-Alpha Ratio (DAR) and Brain Symmetry Index (BSI) show deviations from normal in the early sub-acute phase post stroke. The aim of this study was to investigate the association between EEG biomarkers and behavioral recovery in stroke.

Methods: We quantified differences in resting-state EEG between chronic stroke survivors and controls, as well as the relation between EEG parameters and FM-UE (N=21, C=11). In addition, we performed longitudinal regression analyses to investigate the time course of these EEG and clinical measures in a prospective cohort study (N=41).

Results: Differences between chronic stroke survivors and controls, and associations with FM-UE were most pronounced in the BSI over the low frequency bands. Associations between EEG biomarkers and clinical measures were also found in the prospective cohort study.

Conclusion: Power spectral based measures are associated with upper limb motor function and stroke severity, suggesting a possible role as biomarkers of neural state post stroke.

Acknowledgments: This research was funded by the European Research Council (Grantnr. 291339) and the Netherlands Organization of Scientific Research (NeuroCIMT, n.14905).
Network imaging with electroencephalography suggests treatment targets for stroke patients
G. Guggisberg
Dept. of Clinical Neurosciences, University Hospital Geneva, Geneva, Switzerland

Advances in methods for assessing the human brain network with EEG have enabled new insights into the consequences of stroke and into mechanisms underlying recovery. Thereby, it has become clear that stroke impacts the entire brain network. Neurological deficits do not only arise from focal tissue damage but also from a disruption of neural interactions among structurally preserved areas. Similarly, learning and clinical improvements are associated with plastic increases of neural network interactions. Innovative treatment approaches such as neurofeedback and non-invasive brain stimulation have been successful in targeting such network patterns to enhance recovery. Network assessments with EEG show promise for predicting treatment response and for individualizing rehabilitation.
Clinical Case Examples on Lower and Upper Limb Rehabilitation.

A. Esquenazi

MossRehab Technology in Rehabilitation Initiative

This presentation will make use of clinical case scenarios and case series to demonstrate the utility of the application and benefit of robotics for upper and lower limb rehabilitation. The presentation will attempt to illustrate the functional restoration outcomes to complement and expand on the information presented by my colleagues Frans Steenbrink and Iris Jakob in their earlier presentations.

The cases should promote an opportunity for interactive discussion with the audience and other speakers to exchange information on treatment objectives, device preferences and selection, timing, dosing and progression as well as to discuss the advantages in care delivery efficiency and treatment protocol optimization potential. Brief mention will be made of the ongoing development of home based telerehab use to complement technology-based treatment as patient transition to home and community.

References:


Robotic and Sensor Technology for Upper Limb Rehabilitation
I. Jakob

Tyromotion, Graz, Austria

Robot-mediated therapy and virtual reality for upper limb recovery is providing promising results and gaining increasing attention from clinicians and researchers. On the one side, innovative design can improve current treatments by helping to address the three major challenges of upper limb rehabilitation in terms of upper limb complexity, hand function recovery, and translation to real life. On the other side, technology can serve as a standardization tool to objectify current treatment protocols. Often the focus of inpatient therapy is primarily on walking training, whereas upper limb training accounts for only up to half the time dedicated to the lower extremity. Therapy dose and intensity are major predictors of an effective upper limb rehabilitation program. Technology-assisted group training meets the principles of motor learning and is intended to increase the amount of upper limb therapy within the framework of existing clinic models. This can be achieved by organization models using staggered therapy sessions with 2, 3, or 4 patients treated by 1 therapist, short setup and closure times to maximize the effective training time, and the consideration of a severity mix and clinical characteristics of the patient group. A matched set of devices, with each system acting on a different joint and/or in different planes, allows to globally treat the upper limb in group settings. In addition to the clinical aspects, economic factors are important, not only for health care plans but also because of the pressure to lower overall health care costs to more sustainable levels.

Reference:
This presentation outlines the most important motor learning and locomotor training principles and their implications with regards to the use of lower limb rehabilitation technology. As lower limb rehabilitation devices (gait trainers) are increasingly used in the clinic, it is important to use them to their optimal potential in order to maximize patient outcomes. However, when observing everyday clinical practice or reading corresponding peer reviewed scientific articles on this topic, it becomes clear that motor learning principles are often not sufficiently incorporated in clinical decision making, or even neglected. Examples are, that more support than necessary to provide a save and permissive environment is given, low training intensities are chosen, patients are not challenged appropriately or peripheral input to the central nervous system is not optimized. This sub-optimal use of the devices reduces the effect of therapy and the exploitation of the full potential for neuroplasticity. This presentation is a call for action to remember those guiding motor learning and locomotor training principles, and to appropriately implement them when using rehabilitation technology for gait rehabilitation. We will describe how motor learning and locomotor training principles need to be observed when designing, choosing and using technological support for gait retraining after an event with damage to the nervous system. Both engineers as well as clinicians should be able to apply the learnings directly in their everyday work.

Reference:
Towards personalized rehabilitation for gait impairments in Parkinson’s disease
J.H. Nonnekes
Radboud University Medical Centre, Nijmegen, Netherlands

Introduction / Objective: By using gait impairments as example, I will elaborate on multidisciplinary rehabilitation in Parkinson’s disease. First, I will highlight the interplay between motor and non-motor symptoms. In Parkinson’s disease, anxiety, depression, cognitive decline, fatigue and pain can have a detrimental effect on gait impairments and functional mobility. Second, I will discuss management of gait impairments. Despite optimal medical management, with levodopa as the gold standard, gait impairments are only partially improved. Therefore, complementary non-pharmacological interventions – such as physiotherapy and occupational therapy – are needed to provide optimal care. To apply non-pharmacological interventions in an individualized and evidence-based manner, clinicians and therapists need to know which patient characteristics (e.g., the presence or absence of anxiety or cognitive dysfunction) predict the efficacy of various training modes and what type of training delivery works best. Unfortunately, current evidence is not sufficient to develop such personalized rehabilitation programs. However, I will hypothesize how tailored use of gait rehabilitation can be reached within the near future.

Cognitive function a window of opportunity for training in Parkinson’s disease?
A. Nieuwboer
KU Leuven, Leuven, België

Introduction / Objective: Patients with Parkinson’s disease have a number of cognitive deficits of which executive dysfunction is a very important one. Cognitive decline has a major impact on learning ability and the capacity for dual task integration. Cognitive-motor training aims to tackle both domains simultaneously to create synergistic effects and to achieve better consolidation of motor learning. However, cognitive-motor training may also create brain overload and as such enhance falling and freezing.

Methods: Several controlled trials were conducted tackling this question.
**Results:** I will discuss the evidence on the efficacy of motor-cognitive training in patients with (PD) in the light of the findings and possible adverse effects. I will also review the evidence on targeting cognition alone, such as executive function, with training to improve motor symptoms, i.e. freezing of gait.

**Discussion:** Finally, I will address whether the rehabilitation field is ready for combined interventions and how we could benefit from working together with neuropsychologist to optimise and personalize combined training approaches for PD.

**Conclusion:** Concluding, the cognitive-motor interplay seems a promising area for targeting rehabilitation intervention, at least when delivered by trained professionals.

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**Exercise adherence**

*N. de Vries*

Neurology, Radboud University Medical Center, Nijmegen, Nederland

**Introduction / Objective:** Despite the increasing evidence on the effectiveness of exercise in patients with Parkinson’s disease (PD), exercise adherence remains a great challenge. Patients with PD experience a number of barriers, related to motor- as well as non motor functioning (i.e. balance impairments, but also fatigue), that make it difficult to comply. On the other hand, patients with PD indicate that motivation to exercise increases, for example by knowledge on the effect of exercise, peer support and when they enjoy the activity. Knowledge on these motivators and barriers is essential in order to successfully implement exercise (programs) in clinical practice. In this session, I will discuss the barriers and motivators related to exercise adherence in PD. Moreover, I will focus on possibilities to increase adherence by using technology. One example includes an innovative approach using multiple motivating elements such as gaming, remote monitoring and peer support.
Clinical and demographic variables associated to balance in daily life activities of people with multiple sclerosis
D. Kos1, L. Wouters-d’Oplinter2, S. Schouteden3, L. Kerkhofs3, S. Ferdinand4

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2Rehabilitation Sciences - MSc in Occupational Therapy programme, KU Leuven, Heverlee (leuven), Belgium
3Occupational Therapy, Rehabilitation- and MS Center, Overpelt, België
4Occupational Therapy, National MS Center, Melsbroek, België

Introduction / Objective: Life balance can be described as a satisfying pattern of daily occupations that is healthy and meaningful, and may be compromised by health conditions like multiple sclerosis (MS). This study explored the contribution of clinical and demographic variables to life balance levels in multiple sclerosis (MS).

Methods: Structural Equation Modelling was performed with secondary cross-sectional data to analyse relations between life balance (LB) and clinical (fatigue, quality of life, self-efficacy, depression, mobility, MS type and time since diagnosis) and demographic variables (sex, age, living situation, education, income and work status).

Results: Participants (n= 149, 50±11 years, 61% women) showed a mean Life Balance Inventory score of 2.3±0.4 (range 1-3). LB was positively related to gender (p =.041), living situation (p =.001), MS type (p = .027 & .026), work status (p =.001), age (p =.003), income (p =.001) and quality of life (p =.003). A negative significant relation was found between life balance and education level (p =.001) and fatigue (p =.002).

Conclusion: This study identified several symptoms and consequences of multiple sclerosis and other non-disease-related variables related to the variation in the desired time investment of meaningful activities. The variables are discussed in line with potential therapeutic interventions to optimize life balance in people with MS.

Acknowledgments: The data collection was part of the Life Balance project, supported by Rehabilitation In Multiple Sclerosis (RIMS) grant. Heleen Beckerman is acknowledged for supporting data collection and analysis.
The power of doing: self-management develops through doing of everyday activities
T. Satink

HAN University of Applied Sciences, department of occupational therapy, Nijmegen, Nederland

Introduction / Objective: The way stroke survivors give meaning to their process of self-management post-stroke is unclear. This study explored how stroke survivors gave meaning to their self-management post-stroke and how this evolved over time.

Methods: Data was generated through observations and interviews of 10 stroke survivors at their homes at 3, 6, 9, 15 and 21 months post-discharge. A constant comparative method was chosen to analyze the data.

Results: ‘Situated doing’ was central in stroke survivors’ development of self-management and their sense of being in charge of everyday life. ‘Doing’ provided stroke survivors with an arena to explore, experience and develop self-management and co-management in daily life. The influence of partners on this process was sometimes experienced as empowering and sometimes as constraining. The sense of self-management and being in charge differed from managing only at the level of activities to full role management and experiencing a meaningful life post-stroke.

Discussion: The findings of this study indicate that ‘doing’ is an important arena to develop self-management and being in charge post-stroke. The concepts of co-, and couple management between stroke survivors and their relatives can be further applied to practice. Moreover, self-management interventions should not only focus on medically management but also address meaning full living post-stroke (role & emotional management). Different research methods enhanced the trustworthiness of the findings.

Conclusion: Participants’ self-management and sense of being in charge is interwoven, and developed and attained meaning through ‘doing’.

Acknowledgments: Financial support by HAN UAS Nijmegen is gratefully acknowledged.
Evolution and predictors of life balance after stroke
A. van Gils¹, C. Lafosse², M. Michielsen³, S. Meyer¹, H. Beyens⁴, F. Schillebeeckx⁴, G. Verheyden¹, D. Kos¹

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²Rehabilitation Hospital RevArte, Edegem, Belgium
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Introduction / Objective: Life balance can be defined as having a well-balanced activity pattern that is meaningful and sustainable within the current life situation of an individual. Stroke has a major impact on everyday activities and may compromise life balance. This study examined evolution and predictors of life balance in the first year after stroke.

Methods: First-ever stroke survivors were recruited from three rehabilitation centers in Belgium between February 2016 and November 2017. Within the first week of admission to the rehabilitation center, demographic and clinical characteristics were evaluated. The Flemish Life Balance Inventory (Fl-LBI) (score range 1-3) was administered at six and twelve months post stroke. A paired t-test assessed changes in life balance from six to 12 months. Variables on admission predicting Fl-LBI at six months and one year were determined by multivariate regression analysis.

Results: Participants on admission (n=92) were aged 67±12 years. Mean Fl-LBI total scores improved significantly from six months (2.38±0.34) (n=67) to one year (2.46±0.32) (n=59) (p=0.018). Of all variables measured on admission, mental function, bimanual function and pre-stroke work status explained in total 51% (p<0.001) of the variance in life balance at six months. Mental function and bimanual function were retained as significant and independent variables (R²=40%, p<0.001) at one year.

Conclusion: Small but significant improvement in life balance occurred between six months and one year post stroke in a cohort after inpatient stroke rehabilitation. Mental function and bimanual function are key predictors of life balance within the first year post stroke.
Introduction of Brain Computer Interfaces and their application in Neurorehabilitation

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Introduction / Objective: Brain Computer Interfaces are a general technology where a user’s mental-state is decoded in real time to generate on-line feedback. For patients BCI research has focused on two main areas; communication or rehabilitation. In communication BCIs a patient communicates letters or words by performing particular mental-tasks, such as imagined-navigation, to select between different options. In this way they can select characters to spell sentences. In rehabilitation BCIs the system gives real-time feedback which rewards desired mental-states, such as activation of a damaged part of the motor cortex. In this talk I will give an overview of basic operation of a BCI, the main components, and some examples of BCI applications in communication and rehabilitation.
Cognitive deficits in ALS and BCI: friend or foe?
J. Raaphorst

Introduction/Objective: Brain-computer interfaces (BCI) may provide end-stage ALS patients communication and control without motor responses. Cognitive deficits are present in up to 50% of ALS patients. Clinical questions with regard to BCI, cognitive impairment and ALS are: How many ALS patients have cognitive impairment, what is the cognitive profile, are these symptoms progressive? Is it to be expected that cognitive impairment will hinder the use of BCI in ALS? Is BCI a feasible and valid tool to detect cognitive deficits in end-stage ALS and, is this clinically relevant? How important are motivational and behavioral changes in relation to the use of BCI in ALS?

Methods: A summary of the literature and original data will be presented in an attempt to answer these questions.

Results: Meta-analyses have shown that the cognitive profile of ALS is more extensive than previously thought: the presence and extent of deficits of visuoperception will be presented, based on aggregated data of 1287 ALS patients; and its significance in relation to the use of BCI will be discussed.

Discussion: Data on progression of cognitive impairment in ALS are conflicting, which is in part based on bias due to motor impairment. BCI may provide a valuable tool to gauge cognitive deterioration by means of tests that exclude motor functions completely.

Conclusion: First studies on the adaptation of a standardized ALS cognitive screen for BCI have shown promising results, and will be discussed in relation to behavioral changes, psychological state and motivation.

Acknowledgements: Emma Beeldman, PhD student, Amsterdam UMC
Introduction: Brain computer interface (BCI) can have two important applications in motor rehabilitation for patients with a neurological disorder. The first application has as aim motor recovery. In this BCI application a motor intent will activate an external device which assists in performing the intended movement thereby closing the sensorimotor control loop. The other application is a BCI for motor substitution when the brain is still active. This BCI application is to control external device through brain activity. For both applications, accurately measuring the intention is crucial. The aim of this study is to describe the potential of these two applications in motor rehabilitation for patients with neurological disorders.

Methods: Nine acute stroke patients with moderate and severe walking disabilities participated in a rehabilitation intervention with robotic gait training and their cortical activity was assessed with EEG. The potential of a BCI for motor substitution was tested in 6 Spinal cord injury patients using fNRIS while performing attempted foot movements.

Results: A significant difference (p<0.001) in cortical activity between passive and active walking during robotic gait training was found. The cortical activity increased significantly (p<0.001) after robotic gait training and physiotherapy. Attempted foot movement could be distinguished from rest in 67% and from hand movements in 57%.

Discussion: These results in combination with recently published key publication in the BCI for motor recovery in stroke (e.g. Biassiucci et al.) and spinal cord injury (Donati et al., 2016) indicate that BCI has potential in motor recovery and substitution.
Communication using bci in amyotrophic lateral sclerosis (als)
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Introduction / Objective: The objective is whether patients with Amyotrophic Lateral Sclerosis (ALS) can use a visual Brain Computer Interface (BCI) noise-tagging speller with comparable performance to that of a healthy population during spelling tasks.

Methods: All participants were asked to complete several tasks using the BCI speller: copy-spelling, freespelling and responding to a few questions by selecting a 'yes' or a 'no' button. Performance measures such as accuracy, detection time, Information Transfer Rate (ITR) and Characters Per Minute (CPM) were calculated for each participant. A measure of objective fatigue was analyzed and usability was studied for both groups by means of the System Usability Scale.

Results: Healthy participants performed the tasks with an average accuracy of 92% and patients with 88%. The detection time was approximately 1 second higher for patients. ITR was higher for healthy participants than for patients and the results of CPM are very similar. Participants were not affected by fatigue. Usability scores were within comparable ranges with a score of 80 for patients and 82 for healthy participants.

Discussion: Analyzing the spatial features of the brain activity for each participant show inconclusive differences. Therefore, some of the recommendations are to further investigate the methods used for spatial filtering of the brain responses, to use a group of more advanced ALS patients and to test the system for longer periods of time in a home environment.

Conclusion: The results support the main hypothesis that there are no significant differences that could hinder in any way the use of the BCI speller by ALS patients.
Implicit and explicit motor learning in practice: a framework and examples from research and practice
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Introduction / Objective: Motor learning is particularly challenging in patients within neurological rehabilitation and a great variety of options to facilitate motor skill learning has been described. Therapists are continuously searching for the best approach to support the intensive and complex process of motor learning in their patients.

Methods: To support therapists a framework was developed that integrates results of an international survey, knowledge from literature and experiences from clinical practice. A continuum of implicit and explicit motor learning was used as a conceptual basis. Parts of the framework were evaluated on feasibility and first effects within applied studies in stroke patients.

Results: The framework provides an overview of options for motor learning within clinical practice in a patient-tailored way. Its use will be illustrated by examples from applied research and daily practice.

Discussion: The framework may assist therapists working in neurological rehabilitation in making choices and support communication about motor learning with colleagues and students. More research is needed on the use of motor learning within clinical practice. It would be especially interesting to gain more insight in which motor learning option works best for whom.

Conclusion: The framework may support thinking and communicating about motor learning in clinical practice. Potential users should see it as a starting point and still under development.

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Using an implicit learning approach in early gait rehabilitation

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Introduction / Objective: The process of functional recovery following stroke is underpinned by the concept of motor learning. Instructions and feedback are known to play an important role in this learning process. Evidence in healthy populations has consistently shown the benefit of implicit learning models, facilitated through reduced quantity of instructions, and use of an external focus of attention. However, observational studies in stroke have shown that therapists favour explicit approaches - using frequent and internally focussed instructions. Therapists may find it challenging to adapt their approach to facilitate implicit learning.

Our objective was to develop interventional guidance, providing examples for how common therapy exercises can be adapted to promote implicit learning.

Methods: A three round Delphi survey, with a multi-professional group of motor learning and rehabilitation experts. Within each survey, videos of common exercises were shown. The panel were asked for thier views on each exercise, relating to the type of learning being promoted.

Results: 14 individuals, with a range of expertise in the field of motor learning and/or stroke rehabilitation, took part. Consensus was achieved for a set of clinically grounded principles that promote implicit learning. Specific exercises examples designed to facilitate the recovery of sit to stand, stepping and gait were developed.

Discussion: Commonly used rehabilitation exercises can be adapted to promote implicit learning, by altering the therapist’s use of instructions and/or altering task set up. Specific clinical examples will be shared.

Conclusion: The Implicit Learning Approach will now be tested in a pilot randomised controlled trial.

External focus instructions in stroke rehabilitation: one-size does not fit all

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Introduction / Objective: Healthy adults show enhanced motor learning and movement automaticity when they focus their attention externally – on movement effects – rather than internally – on movement execution itself. It is often thought that external focus instructions could be particularly effective to enhance motor learning of people with stroke. Direct evidence is scarce, however. This presentation aims to highlight recent evidence that challenges this hypothesis, and that sheds a new light on the merits of internal and external focus strategies to stroke rehabilitation.

Methods: First, an observational study is discussed that investigated how external and internal focus strategies are currently used by physical therapists during inpatient stroke rehabilitation. Subsequently, experimental studies are discussed that investigated the immediate and long-term effects of focus instructions on motor performance and automaticity (i.e., dual-task performance) in stroke patients.

Results: Results show that external focus interventions do not always lead to superior movements and automaticity for all stroke patients. Rather, the experimental studies show that a patient’s motor skill, sensory functioning, and attention capacity influence which focus strategy will be most effective. This fits with the observation that physical therapists adapt their use of focus instructions based on these patient characteristics.

Discussion: Converging lines of research suggest that attentional focus instructions could best be tailored to the individual patient, taking into account his or her motor skill, sensory functioning, and attention capacity. Preliminary guidelines for clinical application are presented.

Conclusion: External and internal focus instructions could best be tailored to the individual patient.

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Re-learning motor abilities during arm-hand rehabilitation: the quest to speed up self-efficacy in stroke survivors who, due to a reduced arm-hand capacity, experience difficulties in task accomplishment

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Introduction / Objective: Stroke has an high impact on physical functioning due to serious arm-hand capacity problems which negatively impact on patients’ sense of self-efficacy. A low level of self-efficacy is correlated to diminished beliefs and values of the patient’s self-perceived performance and is associated with sub-optimal use of the affected arm-hand.

Methods: The strongest method to stimulate self-efficacy is ‘mastery experience’ through successful task performance. Recognizing improvements may encourage stroke patients to push their limits and create perspectives to re-use their affected hand more quickly in daily tasks. Ultimately, patients facilitate themselves in creating an optimal retention of learning to use the full potential of the affected hand in post-rehabilitation.

Results: Therapists have to establish the most adequate set-up of exercises for the first week of the arm-hand skill performance training. After setting attainable and meaningful goals, a stepwise clinical management procedure to elicit motor control problems must be developed. Patients’ strategies to meet the task demands and their ability to choose the most efficient strategy for a given task are linked to their underlying cognitive and sensory-motor deficits. If done properly, already in the first week of training patients will use a more efficient problem-solving strategy, leading to a more easy performance of a given task. Patients may recognize and monitor improved performance, leading to successful experience, improved patients self-efficacy, and, ultimately, improved arm-hand performance.

Conclusion: CARAS’ task-oriented arm-hand training incorporates these self-efficacy aspects to empower stroke patients in regaining full potential of their affected arm and hand.
121
Interventions for preventing falls in people after stroke

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Introduction: Falls are among the most common complications after stroke with a reported incidence up to 73% in the first year.

Main objective: This update of the original Cochrane review published in 2013 investigated the effectiveness of interventions aimed at preventing falls in people after stroke.

Methods: We searched the Cochrane Stroke Group and the Cochrane Bone, Joint and Muscle Trauma Group, CENTRAL, EMBASE, CINAHL, PsycINFO, AMED and PEDro for randomized controlled trials of interventions where the primary or secondary aim was to prevent falls in people after stroke. We also searched trial registers and checked reference lists. Review authors independently selected studies for inclusion, assessed trial quality, and extracted data.

Results and discussion: We included 14 studies with a total of 1358 participants. Exercises, provided as either single or multiple interventions and including ambulation, perturbation/vibration-based, balance/strength-oriented or Tai-Chi training, investigated in eight studies (765 participants), were found to significantly reduce the rate of falls (rate ratio = 0.72, 95% CI 0.54 - 0.94), but not the number of fallers post stroke (risk ratio = 1.03, 95% CI 0.90 - 1.19) in comparison to control intervention. Sensitivity analysis for single interventions only (7 studies, 626 participants) still resulted in a significant benefit of exercise (rate ratio = 0.66, 95% CI 0.50 - 0.87).

Conclusion: This updated review found exercises post stroke, either as part of a mixed approach or as a single component, to significantly reduce rate of falls by 28% and 34% respectively.
Position-cortical coherence as a marker for somatosensory integrity early post-stroke, a prospective cohort study.
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Introduction: Neurophysiological assessments in addition to clinical scales can potentially elucidate the role of somatosensory function in post-stroke motor recovery.

Main objective: To investigate the longitudinal construct validity of position-cortical coherence (PCC), the agreement between evoked wrist perturbations and EEG, as a measure of afferent integrity, with respect to longitudinal recovery of sensorimotor function.

Methods: PCC was measured serially in 48 patients after a first-ever ischemic stroke, in addition to Fugl-Meyer motor assessment of the upper extremity (FM-UE) and Erasmus modification of the Nottingham Sensory Assessment (EmNSA), within 3, 5, 12 and 26 weeks post-stroke. Change in PCC over time represented by: percentage presence of PCC (%PCC), mean amplitude of PCC over the affected hemisphere (Amp-A) were addressed as well as their association with FM-UE and EmNSA. Patients were classified into: expected-fitters (FM-UE-baseline=18 points), unexpected-fitters (FM-UE-baseline<18 points) and non-fitters (FM-UE-baseline<18 points), to the proportional recovery model.

Results and discussion: %PCC increased from baseline to 12 weeks post-stroke (β:1.6%, CI:0.32-2.86%, P=0.01), which was no longer significant after adjusting for EmNSA and FM-UE. A significant positive association was found between %PCC, Amp-A and EmNSA. Unexpected fitters (N=8) showed longitudinally significantly higher %PCC than those expected to fit the proportional recovery model (N=23).

Conclusion: We demonstrated the longitudinal construct validity of %PCC and Amp-A as a measure of afferent pathway integrity. A high %PCC in unexpected fitters suggests that this marker contains information above afferent integrity, i.e. cortical excitability. More work is needed to improve clinical prediction models for functional outcome post-stroke.

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Predicting Fugl-Meyer scores from hand motion analysis

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Introduction: After a stroke, a wide range of deficits can occur with varying onset latencies. Assessing impairment and recovery are big challenges in neurorehabilitation. Body function and structure is assessed using clinical scales, such as the Fugl-Meyer Upper Limb Assessment (FMA). Although the FMA shows great specificity and validity to evaluate impairment, it is time-consuming and vulnerable to compensation. Technology-based tools have the potential to collect and process kinematic and kinetic measures to estimate body function and structure with high accuracy. Virtual reality (VR)-based setups for training are equipped with motion capture systems that could serve to automate these assessments while overcoming these limitations.

Main objective: We here study the possibility of estimating UE-FM scores from movement quality parameters that were extracted from kinematic data recorded during rehabilitation sessions performed with the Rehabilitation Gaming System (RGS), a VR rehabilitation tool that uses camera-based motion capture and restraints trunk movements during training.

Methods: The protocol considered here asks patients to intercept spheres on a computer screen using their upper limbs. In this preliminary analysis, we performed a multivariate regression using clinical data from 98 stroke patients who completed 191 rehabilitation sessions with RGS.

Results and discussion: We show that the best multivariate regression model for predicting FMA in a range of 19.2-56.0 points reaches an accuracy of $R^2:0.7$, with an error ($s:11.96$) comparable to the CAHAI accuracy ($s:8.29$). This model includes the predictors finger flexion ($\beta:0.8$) and a descriptor of proximal movements that we name ‘reaction strength’ ($\beta:0.77$). The patient’s ‘reaction strength’ is the extent to which a user can execute controlled movements to training related events and is the strongest predictor of FMA (Pearson $r:0.50$).

Conclusion: These results highlight the predictive power of kinematic data collected during unsupervised motor training and provide insight into new factors underlying recovery.

Acknowledgments: We gratefully acknowledge the participation of the patients and clinicians.
A systematic review on kinematic assessments of upper limb movements after stroke
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Introduction: Assessing upper limb movements poststroke is crucial to monitor and understand sensorimotor recovery. Kinematic assessments are expected to enable a sensitive quantification of movement quality and distinguish between restitution and compensation. However, interpreting the results is challenged by the variable nature and practice of these assessments and the missing information of their clinimetric properties.

Main objective: The purpose of this review was to summarize the state of the art on kinematic upper limb assessments poststroke, with respect to the assessment task, measurement system, performance metrics and their clinimetric properties. Subsequently, recommendations for applications of upper limb kinematics in stroke recovery research were made.

Methods: A systematic search was conducted in PubMed, Embase, CINAHL, and IEEE Xplore. Studies investigating clinimetric properties of applied metrics were assessed for risk of bias using the COSMIN checklist. The quality of evidence for metrics was determined according to the GRADE approach.

Results and discussion: A total of 225 studies (N=6197) using 151 different kinematic metrics were identified and allocated to five task and three measurement system groups. Thirty studies investigated clinimetrics of 62 metrics: reliability (n=8), measurement error (n=5), convergent validity (n=22), and responsiveness (n=2). Eight of these metrics received positive evaluations regarding their quality of evidence.

Conclusion: Studies on kinematic assessments of upper limb sensorimotor function are heterogeneous and rarely investigated clinimetrics. The provided evidence-based recommendations aim to increase standardization in stroke research. Further high-quality studies evaluating clinimetric properties are needed to validate kinematic assessments and their potential to quantify movement quality poststroke.
Is there a dose-response relationship of robotic-assisted therapy in motor rehabilitation of the upper extremity after stroke?

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Introduction: The use of (electro) mechanical devices to support motor rehabilitation can be considered to be effective regarding everyday activities as well as arm and hand function.

Main objective: To investigate whether there is a dose-response relationship in robotics-assisted training of the upper extremity in stroke patients.

Methods: Single blinded case control study in subacute stroke patients with hemiparesis during inpatient neurorehabilitation. For therapy, the Armeo®Spring (Hocoma) is used. The control group receives Armeo®Spring treatment 2 x 30 minutes/week for three weeks. The intervention group receives 5 x 45 minutes/week for three weeks. Motor functions are measured with the Fugl-Meyer Assessment (FMA). In addition, transcranial magnetic stimulation was used to assess motor evoked potentials and cortical silent periods.

Results and discussion: So far, 27 stroke patients have participated in the study. Both groups improved significantly in the FMA (p ≤0.001). However, no significant differences were observed between the groups. Patients with FMA baseline values between 10 and 30 points achieved greater functional improvements than patients with baseline values ≤10 or ≥30 points.

The duration of cSP differed significantly between the affected and healthy sides in both groups (p ≤0.001). The other parameters showed no differences. Changes of electrophysiological parameters did not correlate with the degree of clinical improvement.

Conclusion: No dose-response relationship could be demonstrated in this group of subacute stroke patients when using the Armeo®Spring in addition to other treatments during an inpatient rehabilitation. Patients with FMA baseline values between 10 and 30 points seem to benefit most.
Longitudinal recovery of manual dexterity after stroke: brain lesion location a key predictor of poor precision grip force control

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Introduction: Dexterous manipulation, consistently reported as impaired after stroke, requires generation and control of finger forces.

Main objective: To describe precision grip force control after stroke, and to determine clinical and imaging predictors of 6-month performance and of changes over time.

Methods: Precision grip performance was evaluated in 80 patients using the Strength-dexterity test, at 3 weeks, 3 and 6 months after stroke. Twenty-three healthy individuals participated as control group. Coordination of index finger and thumb forces and Dexterity-score were calculated. Clinical measures included upper extremity Fugl-Meyer Assessment, grip and key-pinch strength and sensory tests. Anatomical MRI was used to calculate weighted corticospinal tract lesion load (wCST-LL) and to perform voxel-based lesion symptom mapping.

Results and discussion: Force coordination and Dexterity-score in the affected hand were dramatically lower at each time point compared to the less-affected hand and the control group, even in patients with good Fugl-Meyer score. The ability to generate a precision grip improved in most patients over time. Multiple regression analysis showed that Fugl-Meyer hand subscale, sensory function and wCST-LL best predicted precision grip status at 6 months. VLSM analysis indicated that lesion to the corticospinal tract was related to poor precision grip. Moreover, wCST-LL greater than 4 cc predicted absence of longitudinal recovery in force coordination, and >6 cc in Dexterity-score.

Conclusion: Findings highlight persistent poor precision grip after stroke. Early sensorimotor hand impairments together with corticospinal tract lesion load can predict 6-month performance and wCST-LL alone predicts post stroke recovery.

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Effectiveness of botulinum toxin treatment for upper limb spasticity after stroke over different ICF domains: a systematic review and meta-analysis

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Introduction: Botulinum toxin (BoNT) treatment for focal upper limb spasticity after stroke is usually evaluated at the ICF level of ‘body functions’. Effect extrapolation to the clinically important levels of ‘activity’ and ‘participation’ is unclear.

Main objective: This review aims to provide a comprehensive overview of reported effects of BoNT treatment and their scientific robustness regarding main post-stroke upper limb spasticity related clinical goals i.e. spasticity-related pain, involuntary movements, passive joint motion, care ability, arm and hand use, and standing and walking performance.

Methods: Randomized controlled trials comparing upper limb BoNT injections with a control intervention in patients with stroke were retrieved through a systematic search. Outcome data were pooled according to assessment timing (i.e. 4-8 and 12 weeks after injection). Summary effect sizes (SESs) and statistical power (1-ß) were calculated for six clinical goals.

Results and discussion: Forty trials were identified, involving 2718 patients. Significant positive effects of BoNT with sufficient power (1-ß=0.80) were found in reducing resistance to passive movement (SES:0.49-0.72, p<0.0001) and improving self-care ability for the affected hand and arm (SES:0.36, p<0.005). Sufficient power was found for the absence of effect on ‘arm-hand capacity’ (SES:-0.51, p=0.40).

Conclusion: No further trials are needed to underpin the favourable effects of BoNT on resistance to passive movement of the spastic wrist and fingers, and on self-care. No trials are needed to further confirm the lack of effects of BoNT on ‘arm-hand capacity’. Additional trials are needed to confirm the suggested positive effects of BoNT on other ‘body functions’.

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Evoked brain responses to robotic wrist manipulations reflect the severity of sensory impairments in patients with stroke.

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Introduction: The electrical response of the brain to robotic wrist perturbations can be recorded with electroencephalography (EEG). We hypothesized that the signal-to-noise ratio (SNR) of this evoked response reflects the integrity of sensory pathways after stroke.

Main objective: To assess whether the SNR of evoked brain responses is smaller in patients with mild as compared to patients with severe sensory impairment after stroke.

Methods: Forty patients with stroke were included. The Erasmus modified Nottingham Sensory Assessment (EmNSA) and EEG measurements took place in a customized measurement van at 3, 5, 12 and 26 weeks after stroke. Patients were considered to have mild or severe sensory impairment if their initial EmNSA score was larger or smaller than 33 points. EEG recordings (64-channel, 2048 Hz) were obtained while the wrist angle was manipulated with a haptic robot. Patients were instructed to relax their wrist and focus on a fixation cross. Cortical evoked response at electrode level was quantified by the SNR, which reflects the magnitude of the response relative to the magnitude of ongoing cortical activity.

Results and discussion: The average SNR of the evoked response was significantly smaller in patients with severe sensory impairment (severe: 0.015±0.013, mild: 0.029±0.011; t(35.7)=5.7, p < 0.001). No significant change in EmNSA and SNR as a function of time was observed.

Conclusion: The SNR of the evoked brain response was associated with severity of sensory function. This result suggests that this metric may be used as a neurophysiological biomarker that reflects the integrity of the sensory pathways after stroke.

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Effect of trunk training on body function and activity post stroke: a systematic review and meta-analysis.
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Introduction: Trunk training has a beneficial effect on trunk function, but it remains unclear what the effect is on other body function and activity measures.

Main objective: To review and summarize the literature on effectiveness of trunk training on upper and lower limb body function and activity.

Methods: MEDLINE, EMBASE, CINAHL, COCHRANE and PEDro were systematically screened for randomized controlled trials comparing focused trunk training versus any control intervention. Meta-analysis was performed with the statistical package R.

Results and discussion: We included 21 trials involving 707 participants. Across all studies, we found five different outcome categories on body function; 1) arm-hand function, 2) gross-motor function, 3) leg performance, 4) balance and 5) postural control, and four on activity outcome; 1) gait, 2) transfers, 3) stroke impairment and 4) functional performance.

Focused trunk training has a significant moderate effect on functional performance (standardized mean difference (SMD)=0.37, 95%CI=0.02-0.73, seven trials/301 participants), stroke impairment (SMD=0.50, 95%CI=0.07-0.93, two trials/86 participants) and postural control (SMD=0.77, 95%CI=0.29-1.24, two trials/99 participants); a significant large effect on arm-hand function (SMD=0.91, 95%CI=0.46-1.37, seven trials/185 participants), gait (SMD=1.05, 95%CI=0.72-1.37, 14 trials/419 participants), balance (SMD=1.08, 95%CI=0.69, 1.47, 14 trials/505 participants), leg performance (SMD=1.13, 95%CI=0.27-1.99, two trials/42 participants) and gross motor function (SMD=1.20, 95%CI=0.65-1.75, two trials/98 participants); and a significant huge effect on performing transfers (SMD=3.79, 95%CI=1.90-5.69, one trials/12 participants).

The small number of participants in the trials and variability in study quality warrants consideration.

Conclusion: Focused trunk training has a beneficial effect on body function and activity outcomes post stroke.

Acknowledgments: A Willemsens, R Lemmens, G Verheyden.
S. Borsato, A. Baroni, S. Straudi, S. Mele, L. Craighero, C. Martinuzzi, L. Brondi, N. Basaglia

Introduction: Upper limb function is frequently impaired following stroke. Constraint-Induced Movement Therapy (CIMT) was developed to improve paretic upper limb activity and reduced the learned nonuse phenomenon. Main objective: To evaluate the feasibility of a Home-based CIMT (hCIMT) compared to a Modified CIMT (mCIMT) delivered in an outpatient setting on upper limb motor recovery in stroke survivors.

Methods: This is a pilot randomized control trial. 20 chronic stroke patients were enrolled and allocated in two groups: hCIMT and mCIMT. Both groups received two hours daily session of CIMT for 10 days, hCIMT completed the treatment at home while mCIMT in inpatient setting. Subjects were evaluated before (T0) and after treatment (T1) and at three-months follow-up (T2) using Wolf Motor Function Test (WMFT), Motor Activity Log (MAL), Upper Extremity Fugl-Meyer Assessment (FMA-UE) and paired-pulse TMS assessment. Repeated-measures ANOVA was used to detect main-effects for treatment and time.

Results and discussion: The results showed significant improvements for time effect T0-T1 (p<0.05) in WMFT (?Total-score = 3.9±5.7; ?Time-score = -5.8±11.1s), ?MAL-amount = 0.3±0.5 and ?FMA-UE = 2.7±4.6. No significant interaction of effect time-treatment was observed at T1. WMFT Total score and FMA-UE improvements were maintained at T2 for both groups. An interhemispheric inhibition was found from the affected-to unaffected hemisphere at T1 (F(1,13) = 11.900, p = 0.004; ?p2 = 0.477).

Conclusion: CIMT proposed in home-based setting seems to be effective as mCIMT on upper limb recovery. Our results need to be confirmed by further studies.

Acknowledgments: The authors thank Emilia Romagna Region (Grant No. 1786/2012) for providing financial support.
Minor stroke, serious balance problems?

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Background: Introduction: Recent findings suggest that even people after minor stroke may have persistent balance impairments. This deserves further examination because poor balance is a key risk factor for falls and a determinant of physical activity in daily life.

Main objective: To test our hypothesis that people in the chronic phase (>6 months) after a minor stroke have an elevated fall risk, show persistent balance impairments, and are less physically active than their healthy counterparts.

Methods: Sixty-four persons with a chronic minor stroke (=24 points on the Fugl-Meyer Assessment lower-extremity) and 50 healthy controls were included. Falls were prospectively registered for 6 months using fall calendars and daily physical activity was assessed for one week using the Activ8 activity monitor. The mini-Balance Evaluation Systems Test (mini-BESTest, range: 0-28) was conducted to assess dynamic balance capacity.

Results and discussion: Fall rates in minor stroke participants were higher compared to controls (1.1 vs. 0.52 falls per person-year, p=0.023). The mini-BESTest demonstrated impaired balance capacity in the vast majority of minor stroke participants (87% vs. 40% in controls; median scores 24.5 vs. 27.0 points, p<0.001). The duration of daily physical activity was not different between groups (p=0.667), but total intensity of physical activity was 28% lower in minor stroke participants (p<0.001).

Conclusion: Individuals in the chronic phase after minor stroke who present with (almost) complete clinical recovery of leg motor impairments still show substantial balance problems and fall relatively frequently. These results may point at an important unmet clinical need in this population.

Acknowledgments: Funding: ZonMW IMDI Grant (104003014).
Running-induced visuospatial memory improvement in MS: a stronger functional embedding of the hippocampus in the default-mode network?


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Introduction: Animal and human studies have demonstrated that endurance exercise can induce structural hippocampal plasticity and can improve memory function. However, how endurance exercise influences the functional connections of the hippocampus in multiple sclerosis is currently unknown.

Main objective: To examine the effects of a community-based running intervention on visuospatial memory and hippocampal functional connectivity in persons with multiple sclerosis (pwMS).

Methods: Twenty-nine pwMS were assigned either to a 12-week running program (n=15) or to a waiting list control group (n=14). Before and after 12 weeks participants’ visuospatial memory was assessed with the spatial recall test (SPART) and participants underwent resting-state functional MRI (fMRI). FC was calculated between the bilateral hippocampus and the default mode network (DMN). SPART-scores and FC values were analyzed with 2x2 ANOVAs with group and time as factors. Change scores (post-pre) for SPART and FC were calculated.

Results and discussion: There was a significant group*time interaction effect on the SPART, in favor of the intervention group (F(1,27)=5.82, p=.023). No significant interaction effects were observed for FC of the bilateral hippocampus with the DMN. However, in the intervention group, the change in SPART scores correlated significantly with the change in FC between bilateral hippocampus and DMN (r=.66, p=.013).

Conclusion: A 12-week running program improved visuospatial memory function in pwMS and this improvement was associated with increased FC of the hippocampus with the DMN. Exercise thus seems to benefit memory function in pwMS, which may be mediated by a stronger functional embedding of the hippocampus in the DMN.

Acknowledgments: The non-profit organization Move to Sport initiated the study.
How does upper extremity fugl-meyer motor score relate to resting-state eeg in chronic stroke? a power spectral density analysis.
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Introduction: The Fugl-Meyer motor assessment of the upper extremity (FM-UE) often serves as the primary outcome measure for quantifying behavioural restitution in clinical trials. The relation between this indirect measure of neural deficits and cortical state reflected by power spectral density measures could provide more insight into the cortical reorganization accompanied with stroke recovery.

Main objective: We investigated whether high-density resting-state EEG potentially has added value by addressing differences compared to healthy individuals and associations with FM-UE scores in chronic stroke.

Methods: Twenty-one chronic stroke survivors with initial upper limb paresis and eleven matched controls were included. Group differences regarding resting-state EEG parameters (power spectral density measures delta/alpha ratio (DAR) and pairwise-derived Brain Symmetry Index (BSI)) and associations with FM-UE were investigated, as well as lateralization of BSI and the added value of considering different frequency bands.

Results and discussion: Chronic stroke survivors showed higher BSI compared to controls (p<.001), most pronounced in delta and theta frequency bands (p<.0001;p<.001). In the delta and theta band, BSI was significantly negatively associated with FM-UE (B: -130, 95%CI:[-222 -37], p=.008; B: -119, 95%CI:[-202 -35], p=.008) corrected for confounding factors. DAR showed no differences between groups nor association with FM-UE. Directional BSI showed increased power in the affected versus the unaffected hemisphere in delta and theta frequency band.

Conclusion: Spectral power asymmetry between hemispheres was higher in chronic stroke compared to controls, most pronounced in low frequencies and related to upper extremity motor function deficit. These EEG parameters potentially have added value, which should be investigated in a prospective cohort study.
Acknowledgments: This research was funded by the European Research Council (ERC Grant Agreement n. 291339, project 4DEEG: A new tool to investigate the spatial and temporal activity patterns in the brain) and the Netherlands Organisation of Scientific Research (research programme NeuroCIMT, project number 14905). Sponsors had no other involvement than financial support.

**Relationship between a 10m & 6min walk test ratio and age in stroke patients**

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**Introduction:** The 10m and 6min walk tests are evaluated tasks to assess gait capacity and endurance in elderly and patients, e.g. strokePohl PS 2002, Kelly JO 2003. The ratio of both (6/10) represents a velocity that can be kept in an aerobic state in relation to the maximum velocity on short distanceDalgas U 2012; therefore it can be considered a gait capacity independent measure of endurance.

**Main objective:** We hypothesized that the 6/10 is age dependent in subacute to chronic stroke patients. We further argue that during in-clinic stay, the 6/10 increases due to rehabilitation with its emphasis on aerobic exercise.

**Methods:** The 6/10 was calculated for a total of 497 subacute to chronic stroke patients at entry and release. Age groups were built with ranges of ≤60a (Age1, n=133), 60-75a (Age2, n=200), and >75a (Age3, n=164). Data were collected at the specialist clinic for neurology Medical Park Loipl in Germany between September, 2015 and September, 2018.

**Results and discussion:** The average stay was 27.35d±14.76d. 6/10s at entry were Age1 .80±.12, Age2 .78±.13, and Age3 .76±.14. 60/10s at release were Age1 .81±.10, Age2 .81±.12, and Age3 .80±.12. T-tests revealed significant changes from entry to release in the age groups Age2 (p=.02, Cohen’s d=.17) and Age3 (p<.01, Cohen’s d=.33). Age groups did not differ in their 6/10s neither at entry nor at release.

**Conclusion:** We conclude that over the course of rehabilitation the 6/10 converged towards values of .80 that could be considered normal in stroke patients. However, reported 6/10s of other work-groups were significantly higher with values of .82Kelly JO 2003, .82Hansbjer UB 2005, .83Tang A 2006, and .88Enright P 2003.
Cortical activation during submaximal contractions of a hand muscle after mild traumatic brain injury

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Introduction: Increased sense of fatigue is often reported following mild traumatic brain injury (mTBI) without changes in motor performance. However, it is not known whether cortical activation is altered to achieve this performance level; a common finding with cognitive paradigms.

Main objective: To study the effect of contractions with increasing force levels (increasing physical effort) on cortical activation in mTBI (>3 months post-injury) using functional MRI.

Methods: Nineteen mTBI and age- and sex-matched controls performed index finger abductions while positioned in an MR-scanner. Isometric contractions (12 per hand) were performed at 10, 30, 50, and 70% of maximal force. Participants had visual feedback of both target and produced force. Region of interest (ROI) analysis was performed on a priori selected anatomical regions. Cortical activation and mean force per contraction was analyzed using multilevel analysis.

Results and discussion: Mean force at each target level was similar across groups (p = 0.32). ROI analysis showed a relationship between mean force and cortical activation in all preselected motor and cognitive regions (p < 0.05) except precuneus. No differences were observed between groups for bilateral caudate and cingulate, or left inferior-, medial- and middle frontal gyrus. In motor areas, activation of the ipsilateral supplementary motor area (SMA) was reduced in mTBI participants (β = -0.04, p = 0.04).

Conclusion: For the present task, anatomical regions known to show changes after mTBI did not differ compared to controls, and only minor differences were observed in the ipsilateral SMA. Increased physical effort does not affect cortical activation differently after mTBI.

Acknowledgments: Grants: Junior Scientific Masterclass, University Medical Center Groningen.
The attitudes of people with progressive ms to the use of mobile applications for symptom monitoring and sharing information with healthcare professionals.

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Introduction: Symptom management for people with progressive Multiple Sclerosis (PwPMS) is essential to quality of life, barriers exist reducing the ability of PwPMS to do this effectively. Mobile apps are increasingly advocated in healthcare to support people to improve health outcomes.

Main objective: To understand the attitudes of PwPMS to using apps for monitoring their symptoms and sharing that information with their healthcare professionals.

Methods: A pragmatic qualitative study. We purposively recruited PwPMS from three MS charities in the UK (n=12). We conducted 1 focus group with 6 participants and semi-structured interviews with 6 different participants. Interviews were face to face or via telephone. Transcripts were transcribed verbatim and analysed using inductive thematic analysis.

Results and discussion: Inclusion of only PwPMS resulted in a population that were older and presented with more complex disability than had been studied before. Similar studies in MS have focused on relapsing remitting MS and excluded these with more complex disability. Participants were motivated to the idea of using apps for symptom management and sharing of this information, despite low self-rated confidence with new technologies. Participant technology skill level resulted in different motivators and barriers to use. Unexpected themes were found such as PwPMS had a poor understanding of symptom management and the potential benefits and there was dissatisfaction with how MS review appointments were conducted.

Conclusion: Apps could be a way to facilitate, engage and motivate PwPMS to monitor and share symptom information more efficiently. Further investigation into PwPMS perceptions of symptom management is required.

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Test-retest reliability of cognitive-motor interference assessments in walking with various task complexity in persons with multiple sclerosis.

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Introduction: Simultaneous execution of motor and cognitive tasks can result in worsened performance on one or both tasks, indicating cognitive motor interference (CMI). A growing amount of research on CMI in persons with Multiple Sclerosis (pwMS) is observed. However, psychometric properties of dual-task outcomes have been scarcely reported.

Main objective: To investigate the between-day test-retest reliability of the motor and cognitive dual-task costs (DTC) during multiple CMI test conditions with various task complexity in pwMS and matched healthy controls (HC).

Methods: 34 pwMS (Expanded Disability Status Scale score 3.0±0.8) and 31 HCs were tested and retested on three single cognitive, four single motor and twelve cognitive-motor dual-tasks. Cognitive tasks included serial subtraction by seven, titrated digit span backwards and auditory vigilance. Motor tasks were walking: at self-selected speed, over obstacles, crisscross and while carrying a water-filled cup. Outcome measures were cognitive and motor DTC, calculated as percentage change of dual-task performance compared to single-task performance. Intraclass correlations (ICCs) and Spearman correlation coefficients were calculated as appropriate.

Results and discussion: For DTCmotor of gait speed, ICCs ranged from 0.45 to 0.81 and Spearman correlations from 0.74 to 0.82. For DTCognitive, ICCs ranged from -0.18 to 0.49 and Spearman correlations from -0.28 to 0.26. Reliability depended on the type of motor and cognitive task.

Conclusion: Reliability of the DTCmotor was, overall, good, while that of the DTCognitive was poor. The ‘walking’ and ‘cup’ dual-task conditions were the most reliable regardless of the integrated cognitive task.

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Perceptions of exercise - what moves people with multiple sclerosis to exercise?
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Introduction: Multiple Sclerosis (MS) is a chronic degenerative neurological condition, symptoms include fatigue, balance problems and muscle weakness. Regular exercise is known to benefit the symptoms of MS, but many people with MS are not active enough to achieve these benefits.

Main objective: Objective: To determine the perceptions of people with MS about exercise, and their needs relating to participation in exercise programmes.

Methods: Methods: Seventeen people with MS took part in focus groups and individual interviews discussing barriers and facilitators to exercise and their support needs for participation in exercise programmes.

Results and discussion: Results: Three main themes emerged. ‘A very accepting atmosphere’, which highlighted the value of community, both of peers with MS and suitably qualified health professionals to encourage exercise participation. The second theme ‘Future-proof, sustain and build’ recognised the importance of exercise as a way of maintaining abilities and slowing functional decline. ‘Getting going and keeping going’, the third theme highlighted motivational tools for regular exercise. The concept of ‘Acceptance’ of the diagnosis and its associated uncertainties was related to all three themes.

Conclusion: Exercise was highly valued among this group of people with MS as a way to remain functional, interact socially with peers and improve both physical and mental health, nevertheless, appropriate behavioural support is deemed necessary to encourage the uptake and maintenance of exercise to achieve these health benefits.

Acknowledgements: The authors thank the people with MS who gave up their time to participate in this study.
Introduction: Self-management for people with Multiple Sclerosis is used to increase patient knowledge, skills, and self-efficacy to maintain their best health and quality of life. The Boost programme was developed in response to a gap in the local services for people starting to experience the impact of impairments.

Main objective: To evaluate the success of the 6 week multi-disciplinary programme of education sessions and included exercise and relaxation sessions, for people living independently.

Methods: Attendees were referred from neuro-rehab outpatient services and MS specialist nurses. Face-to-face screening was carried out and 10 people attended the programme. Outcome measures were carried out at the start and completion of the course included: Hospital Anxiety and Depression Scale (HADS), Warwick Edinburgh Mental Well Being Scale (WEMWBS), Well-being Glass, and a Likert-style measure constructed for the programme.

Results and discussion: Analysis of the results showed improvements in ratings of the WEMWBS and Well-being Glass for most participants, some showing significant change, and none showed significant decline. Group data analysis of the HADS showed significant improvements in ratings of anxiety and non-significant improvements in depression. In the Likert-style measure, all but one participant showed an increase in scores rating confidence in managing and coping with symptoms. The results are in line with other knowledge about the impact of patient education and peer support for people with long-term conditions.

Conclusion: Findings are limited to a small group of patients who were carefully selected for attendance.

Acknowledgments: Supported by the Oxford Centre for Enablement.
Longitudinal changes in upper extremity kinematics during the first year post stroke
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Introduction: Reduction of compensation and improved movement quality indicate recovery after stroke. Clinical measures alone are inadequate to distinguish between neurological recovery and compensation.

Main objective: To quantify longitudinal changes in movement quality during the first year after stroke by using kinematics from time, velocity and joint angle spectra while performing a drinking task.

Methods: In total, 56 individuals with stroke from a non-selected cohort at stroke unit (SALGOT-study) were included when able to perform kinematic analysis of drinking task in at least two occasions out of six during the first year. A cohort of 60 healthy controls was included for reference. Longitudinal changes were analysed using linear mixed models.

Results and discussion: Improvements were predominantly seen in movement time, smoothness, peak angular velocity of elbow and peak velocity in reaching, and for trunk displacement within the first 3 months post stroke. Majority of kinematics reached the peak at 6 months. Movement time and peak velocity reached comparable level with controls at 3 months, but smoothness, peak angular velocity, trunk displacement and arm abduction remained different from controls during the first year post stroke. A common trend, nevertheless non-significant, of decline was observed between 6 and 12 months post stroke.

Conclusion: Kinematic measures improved during the first 3 months, reached the peak at 6 and showed slight decline at 12 months post stroke. The results imply that kinematics like smoothness, peak angular velocity, trunk displacement and arm abduction angle might be the measures that are most suited to distinguish between real neural recovery and compensation strategies.
Extending the proportional recovery rule for the upper paretic limb after stroke

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Introduction: Spontaneous recovery is an important determinant of upper extremity recovery after stroke, and has been described by the 70% proportional recovery rule for the Fugl-Meyer motor upper extremity (FM-UE) scale. However, this rule is criticized for overestimating the predictability of FM-UE recovery.

Main objective: Our objectives were to (1) develop a longitudinal mixture model of proportional recovery, (2) identify FM-UE recovery subgroups, and (3) cross-validate the model predictions.

Methods: We developed an exponential recovery function with the following parameters: subgroup assignment probability, proportional recovery coefficient $r_k$, time constant in weeks $t_k$, and distribution of the initial FM-UE scores. We fitted the model to FM-UE measurements of 385 first-ever ischemic hemispheric stroke patients and cross-validated the endpoint predictions and cluster assignment.

Results and discussion: The model distinguished five subgroups with different recovery parameters ($r_1=0.09, t_1=5.4; r_2=0.48, t_2=11.3; r_3=0.86, t_3=9.7; r_4=0.90, t_4=2.7; r_5=0.93, t_5=1.2$). Endpoint FM-UE was predicted with a median absolute error of 5.8 IQR={1.6 13.5} 1 week after stroke and 4.6 IQR={1.4 10.1} 2 weeks after stroke. Overall accuracy of assignment to the poor (subgroup 1), moderate (subgroups 2 and 3), and excellent (subgroups 4 and 5) recovery clusters was 0.77 95%ETI={0.76 0.79} after 1 week and 0.82 95%ETI={0.81 0.83} after 2 weeks.

Conclusion: Spontaneous recovery on FM-UE reflects different subgroups, each with its own recovery profile. Cross-validation of our mixture model indicates that FM-UE endpoints and cluster assignment can be well predicted. These findings will have major implications for the identification of prognostic biomarkers and the stratification of stroke trials.

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Differentiating the primary motor pathway: premotor contribution as independent predictor of upper limb impairment post stroke

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Introduction: The corticospinal tract is a composite pathway originating from several parietofrontal areas. Previous investigations of corticospinal tract integrity have focused on corticospinal sub-pathway from primary motor area, as predictor of motor impairment after stroke.

Main objective: To investigate the association of lesion load within the corticospinal sub-pathways and motor impairment in the upper limb after stroke, and to identify whether lesion load is a marker of motor recovery.

Methods: Motor impairment was evaluated on 27 subjects at one week and six months post stroke, by means of the Fugl-Meyer Upper Extremity assessment. Diffusion weighted imaging acquisitions were obtained within the first week after stroke; general lesion volume was overlaid to a novel white matter template, in order to calculate lesion load within each sub-pathway of interest. Main analyses included non-parametric correlation and linear regression.

Results and discussion: Results showed moderate correlation coefficients between motor impairment at one week and lesion load within premotor fibers (premotor dorsal cortex, \(\rho = -0.53, p = 0.004\); supplementary motor area, \(\rho = -0.55, p = 0.003\)) and low correlation with lesion load within primary motor fibers (\(\rho = -0.48, p = 0.012\)). For the multivariate regression analysis, three variables (Fugl-Meyer Upper Extremity at one week, lesion load within premotor dorsal fibers, age = 70 years) were retained for the prediction of motor impairment at six months (\(R^2 = 0.81; p \leq 0.001\)).
Conclusion: Early examination of the whole corticospinal tract integrity, with an objective discrimination of the different sensorimotor components, is a promising method to investigate potential biomarkers of motor recovery after ischemic stroke.

Acknowledgments: The authors would like to thank Promobilia Foundation, Sweden, Foundation Van Goethem-Brichant, Belgium, Research Foundation Flanders (FWO) and University of Genova - DiNOGMI, for providing financial support to this project.

Individuals with chronic hemiparetic stroke can accurately identify elbow flexion torques within each arm
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Introduction: Torque perception is important in almost every activity of daily living. A task as simple as pushing a grocery cart requires the accurate perception of torques generated about each elbow. Previous studies have shown that individuals with stroke have between-arms torque perceptual deficits, but it is unclear whether they can accurately perceive torques generated by each arm independently.

Main objective: The goal of this work was to determine whether individuals with stroke have elbow flexion torque perceptual deficits within each arm.

Methods: Fourteen participants with chronic hemiparetic stroke and eight controls performed an elbow flexion torque-matching task with a fixed (5Nm) flexion torque as the reference. Participants generated the reference torque while receiving visual feedback, relaxed, and then matched the reference torque using the same elbow without receiving feedback.

Results and discussion: Participants with stroke could match the fixed elbow flexion torques within each arm with a similar accuracy and precision as controls (p→0.05). The mean±standard deviation of the normalized absolute error for the paretic and non-paretic arms, respectively, of participants with stroke is 50.39±37.65% and 63.19±47.36%, and 60.51±45.42% and 55.49±24.47% for the non-dominant and dominant arms, respectively, of controls.

Conclusion: While previous work shows that individuals with chronic hemiparetic stroke have between-arms torque perceptual deficits, this work indicates that they can accurately identify elbow torques during a single-arm task. This study highlights the need to focus on bimanual,
rather than unimanual, training to rehabilitate torque perceptual ability post-hemiparetic stroke.

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**14:30 - 16:00 | Room 0.8**

19

**Neurofeedback for central neuropathic pain treatment: mental strategies used for successful neuromodulation**

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**Introduction:** Central neuropathic pain (CNP) is a debilitating problem prevalent in 65% of the spinal cord injury (SCI) population. EEG-based neurofeedback (ENF) is a process where individuals self-modulate brain activity (neuromodulation) using mental strategies (MS). Preliminary research suggests ENF has potential to reduce CNP after SCI.

**Main objective:** This exploratory study examined people’s MS used for ENF neuromodulation, with the aim of understanding the learning process.

**Methods:** Twelve patients with CNP after SCI were asked to use ENF on a maximum of eight visits, each consisting of six five-minute ENF sessions; no neuromodulation guidance was given. Resting EEG with eyes open was recorded (baseline) before ENF sessions. Participants were asked at the end of each visit about their MS and perceived-neuromodulation performance. This was compared to actual-performance using frequency-spectrum analysis of their EEG activity and comparing baseline to ENF activity. Interviews were analysed using thematic analysis.

**Results and discussion:** Interviews revealed that mental state (e.g.,
attentiveness), not MS (e.g., imagination), was associated with neuromodulation success. Unsuccessful patients reported they could not differentiate between successful and unsuccessful strategies; this may be due to an inefficient method of displaying EEG activity.

**Conclusion:** MS are a mediator, where MS are used to invoke specific cognitive processes (mental state) needed for ENF neuromodulation. The display of EEG activity may need modifications to facilitate learning ENF neuromodulation. Detailed results linking neuromodulation success rates and mental state will be presented.

**Acknowledgments:** The authors would like to thank DSTL, Spinal Research, SMSR, and NSIC of the Buckinghamshire Healthcare NHS Trust for their support in this study.

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**The role of cerebellar transcranial direct current stimulation on balance and mobility in multiple sclerosis patients: a pilot study**

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**Introduction:** People with multiple sclerosis (PwMS) are affected by motor impairments with negative impact on quality of life. Task oriented circuit training (TOCT) is an intense task-specific intervention for balance and mobility. The cerebellum is involved in balance and motor learning circuits. Transcranial direct current stimulation (tDCS) can modulate cerebellar activity to enhance its specific functions.

**Main objective:** To investigate the role of cerebellar tDCS (ctDCS) combined with TOCT in motor function and perceived quality of life in PwMS.

**Methods:** This pilot study was a double-blind randomized clinical trial. 16 patients (EDSS 4-5.5) were enrolled. Subjects were allocated to experimental (real-ctDCS+TOCT) or control (sham-ctDCS+TOCT) group. Both groups received two hours daily session of combined treatment for 10 days. Subjects were evaluated before (T0) and after treatment (T1) and at two-weeks follow-up (T2) using functional tests and self-reported questionnaires. Two-way repeated-measures ANOVA was used to detect main-effects for treatment and time.

**Results and discussion:** Balance, mobility and perceived walking ability improved for both groups at T1 and T2 assessments. Psychological aspects of quality of life improved in the experimental group with statistical
significance difference at T1. A significant time effect was found for the majority of outcome measures. The results suggest efficacy of TOCT on mobility outcomes. Psychological improvements observed may be influenced by ctDCS activity on postero-inferior areas of cerebellum. **Conclusion:** The combined treatment seems to improve mobility and quality of life in PwMS. The role of ctDCS need to be more investigated. **Acknowledgments:** The authors thank Emilia Romagna Region (Grant No. 1786/2012) for providing financial support.

48  
**Cathodal direct current stimulation over contralesional m1 may be detrimental to leg motor control in more severely impaired chronic stroke patients**  
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**Introduction:** Transcranial direct current stimulation (tDCS) has been reported to speed reaction times (RT) of paretic hand movements in people with stroke. It is hypothesized that cortical excitability may be enhanced directly by ipsilesional anodal tDCS (a-tDCS), or indirectly by contralesional cathodal tDCS (c-tDCS) reducing interhemispheric inhibition.  
**Main objective:** In this study, we aimed to investigate whether tDCS could also speed RT of the paretic leg.  
**Methods:** Thirteen participants with chronic supratentorial stroke performed ankle dorsiflexion movements as fast as possible in response to a visual ‘go’ cue (12 trials each for the paretic and non-paretic leg) directly after 15 minutes of anodal, cathodal or sham stimulation (2mA) over the primary motor cortex. The order of tDCS conditions was balanced across participants. We recorded EMG from bilateral tibialis anterior (TA) to determine RT.  
**Results and discussion:** At the group level, RT did not differ between tDCS conditions (paretic leg, sham: 224±84ms anodal: 233±69ms; cathodal: 228±89ms). RT differences between a-tDCS and sham did not correlate with leg motor impairment. Yet, RT differences between c-tDCS and sham strongly associated with Fugl-Meyer Lower Extremity scores, with more severely impaired patients exhibiting delayed paretic RT following c-tDCS ($\hat{=}=.779$, $p<0.01$).  
**Conclusion:** The observed unfavorable effect of c-tDCS on paretic leg motor control in the more severely impaired stroke patients points at potential vicarious control from the unaffected hemisphere to the paretic leg.
Interhemispheric functional connectivity and mirror movements in chronic hemiparetic stroke patients

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Background: Introduction: Mirror movements are common after stroke but the neural mechanisms remain unclear. Resting-state functional MRI allows measurement of functional connectivity (FC) between brain regions and altered interhemispheric sensorimotor FC has been reported in stroke.

Main objective: The aim of this study was to investigate whether altered interhemispheric sensorimotor FC relates to post-stroke mirror movements.

Methods: Resting-state fMRI was performed in 24 chronic stroke patients with moderate to severe upper limb motor impairment (upper limb Fugl-Meyer Assessment mean=36±12) and nine healthy controls. FC maps were created with a seed-based approach including regions of interest identified within a sensorimotor network known to be important for hand movements. Correlation matrices of FCs were obtained for patients and controls. They were related to a measure of mirror movements obtained during a visuomotor grip force-tracking task.

Results and discussion: In the ANOVA comparing FC across the groups, we found a significant GROUP x FC x ROI interaction. Post hoc testing showed significantly increased interhemispheric FC was increased between supplementary motor cortex (SMA) in both hemispheres in patients compared to controls (FDR, p=0.0007). This increased FC between SMAs correlated with greater mirror movements (r=0.57, p=0.007) but not with maximal grip force.

Conclusion: The findings emphasize the role of SMA in bi-manual movements and suggest that increased interhemispheric SMA connectivity may contribute to the development of mirror movements after stroke.
The influence of psychological factors and mood on the course of participation up to four years after stroke.

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Introduction: Due to major improvements in the acute treatment of stroke the number of stroke patients that have to cope with long-term restrictions in their participation is increasing. However, the long-term course of participation and its determinants remain largely unknown.

Main objective: [1] To explore the course of participation from two months up to four years after stroke, and [2] to examine if adaptive and maladaptive psychological factors and mood measured at two months after stroke are determinants of the course of participation during this period.

Methods: 369 stroke patients were recruited within seven days of symptom onset in six general hospitals and were assessed at two months, six months, one year, two years and three to four years after stroke. The Utrecht Scale for Evaluation of Rehabilitation-Participation (USER-Participation) restrictions subscale was used to measure participation. Psychological factors were clustered into adaptive (proactive coping, self-efficacy, extraversion and optimism) and maladaptive (passive coping, neuroticism and pessimism) psychological factors. The Hospital Anxiety and Depression Scale was used to assess mood.

Results and discussion: Improvements in participation were observed up to one year after stroke. Considerable restrictions in social and physical domains remained up to four years after stroke. More mood problems (p<0.001) and less adaptive psychological factors (p=0.004) were independent determinants of worse participation up to four years after stroke.
Conclusion: Participation improves in the first 12 months after stroke and stabilizes afterwards. Mood problems and less adaptive psychological factors negatively influence the course of participation over time up to four years after stroke.

Prospectively classifying community walkers after stroke: who are they?

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Introduction: Cohort studies that aim to predict independent community ambulation post-stroke are needed to guide clinicians in organizing community services.

Main Objective: To classify stroke patients into homogeneous subgroups based on their characteristics at the moment of discharge from inpatient rehabilitation, in order to predict community ambulation six months later.

Methods: Prospective cohort study with 243 stroke patients, referred for outpatient physical therapy, after completing inpatient rehabilitation in the Netherlands. Potential predictors were assessed at the moment of discharge and included demographics, stroke characteristics, assistive device use, comfortable gait speed, balance, strength, motivation, falls efficacy, anxiety and depression. Final outcome was determined after 6 months using the community ambulation questionnaire. A classification model was developed using Classification And Regression Tree (CART) analysis.

Results and discussion: The CART model accurately predicted independent community ambulation in 181/193 stroke patients, based on a comfortable gait speed at discharge of 0.5 m/s or faster. In contrast, 27/50 stroke patients with gait speeds below 0.5 m/s were correctly predicted to become non-community walkers. To improve the predictive accuracy for patients with lower gait speeds, it might be relevant to consider the strength of the affected leg, but this finding warrants further validation.

Conclusion: We show that comfortable gait speed is a key factor in the prognosis of community ambulation outcome. The CART model may support clinicians in organizing community services at the moment of discharge from inpatient care.
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34
Caregiver mediated exercises with e-health support for early supported discharge after stroke: conclusions of the care4stroke trial.

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Introduction: We designed a caregiver-mediated exercise program with e-health support after stroke (CARE4STROKE) with the aim to improve functional outcome and to facilitate early supported discharge by increasing intensity of training.

Main objective: To evaluate the (cost)-effectiveness of and experiences of the participants with the CARE4STROKE program.

Methods: 66 stroke-patients admitted to a rehabilitation facility were randomly assigned to usual care plus the CARE4STROKE program or usual care alone. Patient and caregiver exercised together 5 times a week for 8 weeks, supported by video-based exercises on a tablet computer. Primary outcome measures in the randomized controlled trial were SIS-mobility assessed at 8 and 12 weeks, and length of stay. In addition, semi-structured interviews were conducted with seven patients and seven caregivers who participated in the CARE4STROKE program. Inductive thematic data analysis was applied.

Results and discussion: No between-group differences were found regarding both primary outcomes. A significant effect in favour of the CARE4STROKE program was found on patient’s anxiety and caregiver’s depression. Four themes were identified from the semi-structured interviews: different role-dynamics, tailor made exercises through active involvement, preparation for the home situation, and opportunity to be involved.

Conclusion: CARE4STROKE was shown to be safe and feasible. Although no significant effects were found on both primary outcomes, we found a
favorable impact on outcome measures related to mood. Future trials should focus on improving our understanding of the effects of caregiver-mediated exercises on psychosocial outcomes and their value for early supported discharge programs

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### Aneurysmal subarachnoid hemorrhage: long-term functional results

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**Introduction:** Within acute cerebral vascular diseases, subarachnoid hemorrhage (SAH) presents a high morbidity and mortality rate and affects younger patients than ischemic stroke or intracerebral hemorrhage.

**Main objective:** To describe the process of rehabilitation and long-term deficits in patients with aneurysmal SAH after 6 months of diagnosis.

**Methods:** This retrospective longitudinal study collects the characteristics of 49 patients with SAH admitted to neurologic rehabilitation ward from January 2010 to July 2017. Through a telephone interview (> 6 months after the SAH diagnoses), the functional, cognitive, and emotional state and quality of life were assessed with the Barthel Index, EQ55, Pfeiffer and Hamilton tests respectively. Details on length and type of rehabilitation therapies received at discharge and workplace reinsertion were described as well.

**Results and discussion:** The average age of the patients was 58 ± 9 years. The rehabilitation program followed at discharge lasted 14.9 ± 21 months (28% in cognitive therapy). In the long term, no patient was institutionalized, 12.5% were dependent and 46% showed cognitive deficits. The main score on the quality of life scale EQ5 was 55/100 and 80% had depressive symptoms. No patient had been reinstated in the workplace.

**Conclusion:** SAH causes persistent long-term deficits that affect quality of life, especially cognitive and emotional domains. Despite this, only a minority of patients have performed specific cognitive therapy. Neuropsychological care should be considered a priority in the rehabilitation of the SAH.
Validity and reliability of a new method for detection of spasticity in the lower limb
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Introduction: There is a generally recognized need for more accurate methods to objectively measure spasticity in the lower limb, distinguishing the muscle resistance arising from hyperactive stretch reflexes from the resistance caused by pathological changes in passive muscle properties.

Main objective: To assess the validity and the reliability of a new diagnostic instrument, the NeuroFlexor foot module.

Methods: Twenty patients in the chronic phase after stroke and with varying degrees of spasticity on clinical assessment, were examined with the NeuroFlexor foot module. Elastic, viscous and neural components of passive movement resistance were quantified (in Newton, N) during passive ankle flexion at controlled velocities. Validity was studied by comparing quantitative surface electromyography signals of medial gastrocnemius and soleus muscles recorded during NeuroFlexor assessment, with the neural component. A test-retest design studied intra-rater reliability. To optimize the NeuroFlexor assessment protocol and to investigate the velocity- and position-dependence of the spasticity response, various knee and ankle joint positions and 4 stretch velocities were also studied.

Results and discussion: Preliminary results in stroke patients indicated a correlation between the neural component and the stretch-induced muscle activation on integrated electromyography, and a neural component velocity-dependent response with increasing stretch velocity. The NeuroFlexor neural component thus reflected the stretch-reflex-mediated resistance during passive muscle stretch, in agreement with Lance’s definition of spasticity. Reliability was good for the neural component (ICC= 0.84).

Conclusion: Findings provide preliminary evidence of validity and reliability of the NeuroFlexor foot module, an easy-to-use biomechanical method to quantify lower limb spasticity.

Acknowledgments: This study was supported by Promobilia Foundation, STROKE-Riksförbundet and NEURO Sweden.
Functional effects of treatment with botulinum toxin and subsequent stretching of the hip adductors in patients with hereditary spastic paraplegia

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Introduction: Hereditary spastic paraplegia (HSP) patients often suffer from hip adductor spasticity. This may lead to frontal-plane balance problems, as hip adductor spasticity causes narrowing of the base of support while standing and walking (‘scissoring’). In addition, it causes difficulties in stepping sideways to recover from lateral balance perturbations. Botulinum toxin type A (BTX-A) injections are often used to reduce this type of spasticity, but functional improvements remain unclear.

Main objective: To investigate the functional effects of bilateral BTX-A treatment and subsequent stretching of spastic hip adductors on gait and reactive lateral stepping responses in patients with pure HSP.

Methods: Twenty-five patients with pure HSP were treated with bilateral BTX-A injections in the hip adductors and performed daily self-administered stretching exercises for 16 weeks. Before the intervention (T0), and 6 (T1) and 16 (T2) weeks thereafter, gait width, gait speed, and leg angles at first stepping-foot contact after lateral balance perturbations were assessed, as well as the corresponding success rates of reactive lateral steps.

Results and discussion: Compared to baseline, gait width and comfortable gait speed increased at both T1 and T2. Leg angles and corresponding success rates also increased at T1 and T2 when the direction of perturbation was known. No effects were found for maximal gait speed or lateral stepping responses in unknown perturbation directions.

Conclusion: BTX-A treatment and subsequent stretching of spastic hip adductors may improve gait and reactive lateral stepping in patients with pure HSP.

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AbobotulinumtoxinA injections in shoulder muscles: results from a real world (ULIS-II) and phase III study

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Introduction: Shoulder spasticity is a common cause of pain and restricted joint range of motion. Few studies have investigated botulinum toxin injections into shoulder muscles for treatment.

Main objective: To explore use of abobotulinumtoxinA shoulder injections in two international, multicentre clinical studies.

Methods: ULIS-II (NCT01020500) was a Phase-4 observational study focused on selection and achievement of patient-centred primary goals. The AUL study (NCT01313299) was a Phase-3 open-label study including a detailed evaluation of the Tardieu scale for passive ROM (XV1), angle of catch (XV3) and spasticity angle (X) for shoulder muscles as well as the Modified Frenchay Scale (MFS) for active function.

Results and discussion: In ULIS-II, patients with shoulder injections (n=82) selected the pain treatment goal twice as often as those without (n=239). Goal achievement for pain was 85.7%. In the AUL study, 96 patients received =1 abobotulinumtoxinA injection in shoulder muscles, 60 of whom received =2 injections. Improvements in shoulder muscle spasticity were identified after first injection: mean change from baseline at Week-4 was +8.1° and +15.4° for XV1 and XV3, respectively, and -7.3° for X. Patients with =2 shoulder injections showed greater improvements in XV3 and X. Improvements were also observed in active function (Week-4, Cycle-4: MFS: +0.62 ± 0.48).

Conclusion: These studies consistently showed positive outcomes for patients receiving abobotulinumtoxinA shoulder muscle injections. Patients in ULIS-II reached a high level of achievement of the most-selected patient-centred goal (pain), and in the AUL study patients had decreased shoulder spasticity on all parameters of Tardieu scale, and improved active function (MFS).

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Goal setting for botulinum toxin injections: impact of the upper limb international spasticity (ulis) programme

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Introduction: The ULIS programme is a series of international cohort studies evaluating treatment of upper limb spasticity with botulinum toxin-A (BoNT-A) in routine practice. Each phase of the programme is supported by investigator training.

Main objective: We explore changes in goal setting and achievement (primary outcome) between the ULIS-II and ULIS-III studies.

Methods: ULIS-II (NCT01020500) followed 456 post-stroke patients over a single BoNT-A cycle. ULIS-III (NCT02454803) examined outcomes from repeated BoNT-A cycles over 2 years in 1004 patients (various aetiologies). We present ULIS-II data for all patients and preliminary ULIS-III data for the first cycle in 807 patients.

Results and discussion: Study comparisons showed progress in the types of goals set. Whereas the frequency of primary goals increased for pain (from 13.4% in ULIS-II to 25.3% in ULIS-III), reduction of involuntary movement (from 9.0% to 13.3%) and passive function (from 28.9 to 30.7%), rates of goal setting decreased for active function (from 22.8% to 15.0%) and range of movement (from 23.0% to 13.9%). Patterns of injection evolved in line with goal setting. For example, the rate of shoulder injections increased from 32.0% to 39.4% - mainly reflecting the increased recognition of pain as a primary goal. Overall rates of goal achievement fell from 79.6% in ULIS-II to 69.4% in ULIS-III, reflecting a tighter definition of goals.

Conclusion: Developed over a decade, the ULIS programme provides a rich dataset to describe the evolution of routine spasticity management as clinicians start to appreciate which goals are more likely to be achieved for which patients.

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Fast but enduring improvement in the covert shift of attention task in visuospatial neglect
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Introduction: Neglect is still a common and disabling syndrome following a stroke. There is nowadays consensus that neglect in essence is caused by a disorder of automatic selective orientation distracting a patient’s attention toward the ipsilesional side. But it is still unknown whether the amelioration of neglect during treatment is based on recovery of the attention disorder per se or due to voluntary compensation strategy.

Methods: To address this question, we analyzed the performance of 20 neglect patients and 10 control patients on a Posner’s covert shift of attention (CSOA) task with central cueing and during three blocks of 100 trials each, and we retested them 2 days later. We looked for improvements of response times related to target position and cue validity and brain behavior correlation using MRICron lesion mapping.

Results and discussion: The results show that neglect patients improved significantly in response time to left sided targets and also to invalid cues, for the latter irrespective of their spatial direction. Moreover, this improvement survived the 2 days break. Response time after left valid cues standardized for response times after right valid cues were associated with right frontal lesions (Brodmann Area 46). A prolonged disengagement effect was associated with lesions in the right posterior putamen or the external capsule.

Conclusion: We conclude that neglect patients profit from repetitive stimulation with left-sided targets. Moreover, they improve in disengaging from invalid trials. Our results therefore argue that rehabilitation of neglect target left-side automatic orienting (as part of skill learning) and visuospatial re-orienting (as cognitive control function).
Adaptive cueing treatment of neglect in stroke patients leads to improvements in activities of daily living: a randomized controlled, crossover trial

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Introduction: Neglect is a disabling syndrome commonly occurring after unilateral stroke with serious consequences for activities of daily living (ADL) and is related to prolongation of the rehabilitation process.

Main objective: The aim of the conducted study was to develop a possible treatment for neglect, investigating the effect of adaptive cueing during a reading task. Following points were taken into account: (a) use of a task relevant for the patient’s daily life, (b) a fading out procedure to stimulate independent orientation to the left, and (c) a definition of neglect severity for the adaptive treatment protocol.

Methods: Using a randomized controlled design, 26 patients from an early rehabilitation unit with left-sided visuospatial neglect after stroke or hemorrhage were included. Patients were examined twice at baseline (T1, T2), after 15 daily sessions in 1 condition (T3), and again after 15 daily sessions in the other condition (T4). The intervention condition was provided by a therapist and included a daily reading task combined with endogenous and exogenous cues. The cues were continuously reduced after a patient had reached a defined level of performance. The control condition consisted of a neuropsychological treatment of the same length, not targeting visuospatial attention.

Results and discussion: Neglect patients improved after intervention on scores for word/text reading, Catherine Bergego Scale for daily life activities, Line Bisection and Clock Drawing Task.

Conclusion: The study shows that neglect and patients ADL impairments can be reduced using adaptive, therapeutic-induced cueing combined with an ADL relevant task in an intensive fashion.
Neuronavigated theta burst stimulation (tbs) in chronic post-stroke aphasia
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Introduction: Aphasia, a significant aftermath of stroke, impacts more than a third of all survivors. Transcranial magnetic stimulation (TMS) is a novel approach aiming to influence language abilities by altering cortical excitability.

Main objective: The objective of this study was to investigate the effectiveness of Theta Burst Stimulation (TBS) as a standalone treatment for chronic aphasia post-stroke.

Methods: This was a single subject experimental design (SSED) trial, in which three adults who had suffered a single left hemispheric stroke at least six months before participating in the study, were treated with continuous Theta Burst Stimulation (cTBS) over the right pars Triangularis (pTr) for 10 consecutive days. Each participant underwent linguistic examination, with standardized and functional measures, and cognitive assessment two times before-, one day after- and two months post-treatment. Quality of life was also assessed once before treatment and two months post-treatment. Weighted statistics (WEST) were applied for the analysis of standardised language data, whereas functional communication followed thorough linguistic analysis.

Results and discussion: Behavioural changes included trends in improvement in verbal comprehension, expressive language, naming and reading abilities. There was one case that showed significant improvement in spoken comprehension and reading performance two months post-TBS. Regarding functional communication, the total number of narrative words i) increased post-treatment and reversed to baseline in one participant and ii) increased two months post-treatment in another participant. Quality of life (QoL) did not significantly change as a result of the treatment.

Conclusion: Findings revealed that cTBS over the right pars triangularis (pTr), of the right Broca homologue shows promise to promote language gains

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Transcranial direct current stimulation (tDCS) for improving aphasia after stroke: a network meta-analysis of randomised controlled trials

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Introduction: Transcranial Direct Current Stimulation (tDCS) is an emerging approach for improving aphasia after stroke. However, it remains unclear what type of tDCS stimulation at which location is most effective.

Main objective: To give an overview of the evidence network regarding the efficacy and safety of different tDCS stimulation paradigms for improving aphasia after stroke.

Methods: We performed a systematic review of randomised trials with network meta-analysis (NMA). We searched the following databases until 06/2018: CENTRAL, MEDLINE, EMBASE, CINAHL, and six other databases. We included studies with adults with stroke. We compared any kind of active tDCS (anodal, cathodal, or dual, that is applying anodal and cathodal tDCS concurrently) for improving functional communication, performance in naming nouns or verbs and safety, versus control. We performed an a priori subgroup analysis regarding current applied, treatment duration and electrode size.

Results and discussion: We included 15 studies with 340 participants. Our NMA showed no evidence of an effect of tDCS for improving functional communication and verb naming, but there was evidence of an effect in improving performance in naming nouns for anodal tDCS over the left inferior frontal gyrus (standardized mean difference, SMD = 0.51; 95% CI 0.11 to 0.90). There were insufficient data for subgroup analyses. Safety, measured by the number of dropouts and adverse events, did not differ between groups.

Conclusion: Comparing different forms of tDCS shows that anodal tDCS over the left IFG is the most promising treatment option to improve noun naming in people with aphasia after stroke.
Introduction: The prevalence of balance impairments associated with cortical lesions indicates important cortical components of human balance control. Perturbations to upright stance modulate ongoing cortical activity, but the functional significance of this modulation is unknown. Our recent work suggests cortical theta (3-7Hz) activity represents an internal state of upright stability.

Main objective: Because post-stroke upright stability is asymmetric, we investigated whether balance perturbations towards paretic and non-paretic sides can be distinguished from cortical theta activity.

Methods: We analyzed high-density EEG recorded from three individuals with chronic stroke and six healthy young individuals, while they attempted to maintain standing balance in response to low-intensity translations of the support surface (200 trials, four diagonal directions). We used common spatial patterns and Fisher’s linear discriminant analysis to classify perturbations with mediolateral components in direction of paretic/non-paretic leg and dominant/non-dominant leg in healthy individuals. For each participant, classification accuracy was estimated via cross-validation and evaluated for statistical significance (α=0.05) via permutation statistics.

Results and discussion: Classification accuracy was 81.9±8.4% (mean±S.D.; range: 74.7-91.1%) in stroke participants and 72.4±4.0% in healthy participants (range: 68.1-78.1%). All accuracies were significantly better than chance. Our results demonstrate that cortical theta activity carries salient information that differentiates mediolateral perturbation directions. Furthermore, cortical representations of perturbation direction are more distinctive after stroke, possibly due to asymmetric resistive capacity to balance perturbations.

Conclusion: This preliminary study indicates that cortical theta activity reflects the direction of balance perturbations and that it may represent direction-specific balance capacity.

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Motor impairment in post-stroke individuals may be related to a reduced ability of the corticospinal system to shift stretch-reflex thresholds

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Introduction: Stretch reflex thresholds (SRTs) pre-determine the positions of body segments at which muscles begin to be activated. The ability to shift SRTs underlies voluntary motor actions. Stroke leads to an impairment of this ability, resulting in sensorimotor deficits such as spasticity, weakness and abnormal muscle activation.

Main objective: To investigate the relationship between SRT regulation in spastic elbow flexors in chronic post-stroke individuals with different levels of impairment and cortical excitability compared to age-matched healthy controls.

Methods: Transcranial magnetic stimulation (TMS) was used to elicit motor-evoked potentials (MEPs) in elbow flexor muscles in different angular positions (i.e. elbow in flexion and extension). MEP amplitude was considered as a measure of corticospinal excitability. The range of regulation of tonic stretch reflex thresholds (TRSTs) was evaluated based on muscle responses to passive stretches.

Results and discussion: Position-related patterns of MEP modulation were similar in healthy subjects and in individuals with mild stroke. Less consistent modulation was found in patients with more severe stroke. MEP modulation was correlated with arm motor impairment (Fugl-Meyer Upper Limb Assessment) and with the range of regulation of TSRTs in post-stroke individuals. Results confirm the link between TSRT modulation and corticospinal excitability. Deficits in the regulation of TSRTs may underlie motor impairment in moderate-to-severe stroke, which can be targeted in rehabilitation efforts to promote motor recovery.

Conclusion: Neurorehabilitation programs aiming to recover the ability of the nervous system to modulate TSRTs may lead to better motor outcomes in post-stroke individuals.

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Does transcranial magnetic stimulation have an added value to clinical assessment in predicting upper limb function very early after severe stroke?

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Introduction: The added prognostic value of Transcranial Magnetic Stimulation (TMS) induced Motor Evoked Potentials (MEPs) above clinical modelling for the upper limb is still unknown early post-stroke.

Main objective: To determine the added prognostic value of TMS of the Adductor Digiti Minimi (TMS-ADM) to the clinical model based on voluntary Shoulder Abduction (SA) and Finger Extension (FE) during the first 48 hours and at 11 days after stroke.

Methods: Prospective cohort study with three logistic regression models, developed to predict upper limb function at 6 months post-stroke. The first model showed the predictive value of SA and FE measured within 48 hours and at 11 days post-stroke. The second model included TMS-ADM, while the third model combined clinical and TMS-ADM information. Differences between derived models were tested with ROC-analyses.

Results and discussion: Within 48 hours, no significant added value of TMS-ADM to clinical modelling was found (p=0.369) in 51 patients. Both models suffered from a relatively low negative predicted value within 48 hours post-stroke. TMS-ADM combined with SAFE showed significantly more accuracy than TMS-ADM alone at 11 days post-stroke (p=0.039).

Conclusion: TMS-ADM showed no added value above clinical modelling when measured within first 48 hours post stroke, whereas optimal prediction is achieved by SAFE combined with TMS-ADM at 11 days post-stroke. Our findings suggest that accuracy of predicting upper limb motor function by TMS-ADM is mainly determined by the moment of assessment early after stroke onset.

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Acute diffusivity biomarker for prediction of language outcome in mild-to-severe stroke patients

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Introduction: Early severity of stroke symptoms - especially in mild-to-severe stroke patients - is imperfect predictors of aphasia outcome. Language processing heavily relies on the preservation of important white matter fasciculi in the brain. Axial diffusivity (AD) from the diffusion tensor imaging (DTI) model has repeatedly shown to accurately reflect acute axonal damage and is thus optimal to probe the integrity of white matter bundles.

Main objective: To investigate the independent prognostic value of the AD of white matter tracts in the language network evaluated at 24 hours post-stroke for aphasia outcome at 3 months post-stroke.

Methods: Twenty-eight patients with initial mild-to-severe post-stroke aphasia (assessed by the Aphasia Rapid Test-ART) underwent a DTI sequence at 24 hours post-stroke. Language outcome was evaluated with the Aphasia Handicap Scale. We used stepwise regression to determine which clinical (age, ART, and lesion volume) and then clinical+imaging (ratio of affected/unaffected AD of language fasciculi) factors were related to outcome.

Results and discussion: The clinical model retained only day 1 ART (p<0.001) for explaining aphasia outcome (R²=53.7%, p<0.001). On the other hand, after introducing radiological variables, the AD of the arcuate fasciculus (p=0.013), age (p=0.037), and day 1 ART (p=0.002), explained together an additional 12.9% of the variance in aphasia severity at 3 months.

Conclusion: AD of the arcuate fasciculus assessed at day one post stroke is an effective biomarker of long-term aphasia outcome in mild-to-moderate stroke.

Acknowledgements: The research leading to these results has received funding from ‘Investissements d’avenir’ ANR-10-IAIHU-06 and ANR-11-INBS-0006.
Determinants of activity participation and life satisfaction one year after ischemic stroke: contributions of early executive function and psychosocial characteristics

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Introduction: Decreased participation in valued activities has been reported in people with stroke. Participation in work, leisure and social activities may be limited due to cognitive deficits particularly executive dysfunction, if not identified and treated. It is important to understand how post-stroke cognitive deficits contribute to persistent changes in activity participation and life satisfaction.

Main objective: To identify significant factors for predicting activity participation and life satisfaction one year after a mild to moderate ischemic stroke, with primary focuses on baseline cognitive functions (executive functions and verbal memory) and psychosocial characteristics (baseline depression and social resources).

Methods: Patients aged 18 or above with acute ischemic stroke were classified as having mild or moderate stroke, an NIHSS score = 16. Hierarchical multiple regression analysis was used to evaluate the predictors of activity participation [Activity Card Sort (ACS)] and life satisfaction [Reintegration to Normal Living (RNL)] one year after stroke.

Results and discussion: Data were collected from 105 participants completing the ACS and RNL assessment one year after stroke. Participants in the study sample were predominantly African American (88%). Executive functions within 30 days post-stroke independently predicted one-year activity participation and life satisfaction scores, after controlling for demographic characteristics, socio-economic status, social resources, and stroke severity.

Conclusion: Individuals with acute executive dysfunction experience restricted participation one year after a mild or moderate stroke. Rehabilitation interventions aimed at improving post-stroke participation must carefully consider the evaluation and treatment of executive deficits during the acute phase.

Acknowledgments: This study was funded in part by the US National Institutes of Health: Stroke Disparities Project, National Institute of Neurologic Disease and Stroke: 1U54NS057405-01A1, PI: C.S Kidwell MD
The mini-bestest as clinical test for balance problems after minor stroke; an item-wise comparison.

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Introduction: There is limited knowledge about balance problems in persons who have sustained a minor stroke. Recent work of our group has shown that individuals after minor stroke scored worse on the mini-Balance Evaluation Systems Test (mini-BESTest) compared to healthy controls.

Main objective: To investigate which aspects of dynamic balance capacity are most impaired in individuals with minor stroke by conducting an item-wise analysis of the mini-BESTest.

Methods: Sixty-four persons with a chronic (>6 months) minor stroke and fifty healthy controls were included. All minor stroke individuals had ≥ 24 points on the Fugl-Meyer Assessment (FMA) lower-extremity (range: 0-28). Participants underwent the mini-BESTest, a 14-item dynamic balance scale (range: 0-28). A chi-square test was used to compare the percentage of individuals who reached the maximum score on each item between groups.

Results and discussion: The percentage of individuals with minor stroke who scored maximally on a specific item was significantly lower compared to controls for the following items: standing on one leg (50% vs. 82%, p≤0.001), standing with eyes closed on foam surface (64.1% vs. 94%, p≤0.001), walk with pivot turns (65.6% vs. 86%, p=0.013), compensatory backward stepping (39.1% vs. 62%, p=0.015), compensatory lateral stepping (51.6% vs. 72%, p=0.027) and timed up&go with dual task (43.8% vs. 66%, p=0.018).

Conclusion: Individuals with minor stroke showed abnormalities on all four subdomains (i.e., anticipation, reactive balance, sensory, gait) of the mini-BESTest, which points at clinically relevant balance problems.

Acknowledgments: This research was financially supported by an IMDI Move On Research Grant [104003014] of The Netherlands Organisation for Health Research and Development.
Effectiveness of an innovative upper limb programme for stroke survivors: a mixed-methods investigation of quality-of-life outcomes

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Introduction: A major contributor to stroke-related disability is upper limb dysfunction,¹ with significant impact on quality-of-life.²-⁴ The Queen Square Upper Limb (QSUL) programme aims to provide high-intensity, evidence-based upper limb rehabilitation focusing on long-term recovery.

Main objective: Evaluate changes in quality-of-life and explore psychosocial influences on social participation and recovery of stroke survivors following upper limb rehabilitation.

Methods: Mixed-methods with quantitative (pre-post design with follow-up) and qualitative phases. Subjects included 65 stroke survivors who participated in the QSUL programme from July 2015 to March 2016 with measures including the Stroke Impact Scale (3.0); routinely collected at four time points over six months. Ten stroke survivors were purposively sampled for semi-structured interviews, based on change in Stroke Impact Scale-participation domain.

Results and discussion: Significant improvements occurred between time points in seven of eight Stroke Impact Scale domains, overall self-rated recovery (p<0.001) and arm activity (p<0.001). Emotion domain significantly improved from admission to discharge (p<0.001) and declined from discharge to six-month follow-up (p<0.001). Hospital Anxiety and Depression Scale at baseline significantly predicted participation at six months (p=0.045). Interview findings showed four key psychosocial themes with contrasting positive and negative perspectives between high- and low-change groups; themes ‘hidden negative effects’ and ‘loneliness’ were evident in the low-change group and ‘getting on with my life’ in the high-change group.

Conclusion: The Queen Square upper limb rehabilitation programme had measurable therapeutic benefits on physical and non-physical quality-of-life outcomes. However, lack of sustained improvement in self-reported emotion contrasts with the clear benefits in other domains indicating a need for ongoing psychosocial support for some stroke survivors, supported by qualitative findings.
Shaping therapy: what influences the content and time for therapy of the upper limb after stroke? a survey of UK therapists.

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**Introduction:** Restoration of upper limb function after stroke is often notoriously difficult and the factors that influence a therapist’s practice are unclear.

**Main objective:** To describe the influences reported by occupational and physiotherapists (OTs and PTs) upon treatment of the upper limb after stroke.

**Methods:** An online survey - SUPPLES UK - was developed and distributed to UK OTs and PTs currently working clinically with people after stroke via ACPIN, other professional networks and social media. Respondents indicated how frequently they used 10 specific evidence-based treatments and, if they did not use a treatment, explained why. Participants also indicated the factors which influenced the time available to treat the upper limb.

**Results and discussion:** Complete data were obtained from 85 PTs and 69 OTs (n=154) who were 16.9 mean years qualified (SD 8.8; range 1-36; n=154). The least used treatments were: robotics (rarely or never used by 93%, n=143), virtual reality/video gaming (69%, n=106) and constraint induced movement therapy (66%, n=102). Reasons for rarely or never using a treatment were often related to equipment availability or lack of training. The reported influences on treatment time for the upper limb varied; those cited most frequently were patient availability and condition, competing treatment priorities and evidence informing the dose of treatment.

**Conclusion:** This survey identifies barriers that UK therapists encounter when trying to implement treatments for the upper limb after stroke and provides greater understanding of the factors that influence practice.

**Acknowledgments:** We wish to thank all respondents and our funders - the Lancashire Institute for Global Health and Wellbeing (LIFE).
Neurorehabilitation and physical management in the context of spasticity
Chair: Prof. Dr. Alexander Geurts MD PhD
Presenters: Dr Stephen Ashford PhD, FCSP\textsuperscript{1} and Prof. Dr. Alexander Geurts MD PhD\textsuperscript{2}

\textsuperscript{1}London North West University Healthcare NHS Trust & King’s College London, UK
\textsuperscript{2}Radboud University Medical Centre / Sint Maartenskliniek, Nijmegen, The Netherlands

Learning objectives
To learn evidence-based and expert-opinion-based recommendations on physical management in the context of spasticity treatment.

13.00 - 13.15 – Alexander Geurts
The recently issued Dutch guideline on “Cerebral and spinal adult spasticity” (KIMS, 2017)\textsuperscript{1} addresses several conservative treatment options such as exercise therapy, orthotic interventions, and neuromuscular electrical stimulation. The Dutch guideline indicates that evidence is lacking for the specific muscle tone reducing effects of these interventions but, at the same time, emphasises that these interventions are important to optimise and prolong the effects of invasive interventions such as intramuscular injections with botulinum neurotoxin type A (BoNT-A), chemical neurolysis, or surgical interventions such as selective neurotomy and orthopedic surgery (e.g. tendon transfers and arthodesis). For instance, in addition to BoNT-A, repetitive muscle stretching is advocated to prolong muscle tone reduction and task-oriented exercises are advised to optimise passive and active range of joint motion and functional benefits.

13.15 - 13.45 – Stephen Ashford
The UK national guidelines from the Royal College of Physicians on “Spasticity in adults: management using botulinum toxin” (RCP, 2018)\textsuperscript{2} emphasise the role of botulinum toxin A intervention in supporting physical rehabilitation and postural management as part of an overall patient management programme. In these guidelines physical interventions, used with concomitant pharmacological interventions, such as botulinum toxin A, are discussed with an examination of the evidence base. Recommendations are made based on the strength of the current evidence. Expert consensus is used to make
recommendations where the evidence is lacking. These guidelines are used in this seminar to discuss the rehabilitation of individuals with neurological impairment, who also have spasticity requiring management to optimise physical outcome.

To discuss the presented guidelines and recommendation with the audience and to give the opportunity to ask questions.

Intended audience
Rehabilitation physicians, physiotherapists, neurologists, and physician assistants.

Relevance to neurorehabilitation and neuroscience
This symposium will provide the audience with practical recommendations for supporting physical management as part of an overall programme for managing spasticity in adult patients with neurological disability.

References:
Volker Hömberg, Chief, Professor | Bad wurzach, Baden-Wurttemberg, Germany

For this lunch symposium it is our great pleasure to introduce prof. Volker Hömberg, Secretary General of the World Federation for NeuroRehabilitation.

Prof. Hömberg did his medical education at the Universities of Düsseldorf, Freiburg and Boston Massachusetts. After spending an elective in Neurology at Boston City Hospital and the National Hospital of Nerves Diseases Queens Square London he was a research fellow at the C. and O. Vogt Institute for Brain Research in Düsseldorf. In 1981 he started a residency in neurology with Prof. Hans Freund at Heinrich Heine University Düsseldorf. In 1987 he was appointed Director of the Neurological Therapy Centre at Heinrich Heine University in Düsseldorf. He was also founding Director of the NTC in Cologne and many other outpatient rehabilitation centers in Germany. In 2001 he started the St. Mauritius Therapy Clinic in Meerbusch near Düsseldorf and since 2011 he is Director of the Dept. of Neurology at the Gesundheitszentrum Bad Wimpfen and works for the SRH-Group.

He was founder president and vice president of the German Society for Neurorehabilitation and serves as Secretary General for the World Federation and Vice President of the European Federation of Neurorehabilitation Societies.

He has published more than 250 articles in international peer reviewed journals and many book chapters. His primary interest in neurology is in the field of motor rehabilitation cognition and pharmacology.

Prof. Hömberg will discuss the use of advanced rehabilitation robotic for clinical rehabilitation. After his presentation there will be a Q&A to discuss several topics such as the state of the art scientific evidence, but also some more practical consideration and challenges for successfully implementing advanced robotics in your routine clinical practice.
Evidence for maladaptive cerebral neuroplasticity in persistent motor dysfunction despite recovery from peripheral nerve damage: a motor imagery study

R. Lustenhouwer①, I. Cameron②, N. van Alfen③, T. Oorsprong①, I. Toni②, B. van Engelen③, R. Helmich②, J. Groothuis①

Introduction: Neuralgic amyotrophy (NA) is a common peripheral nerve disorder with acute autoimmune inflammation of the brachial plexus. Subsequent weakness of the stabilising shoulder muscles leads to compensatory strategies and abnormal motor control of the shoulder; scapular dyskinesia. Despite peripheral nerve and muscle strength recovery over time, scapular dyskinesia often persists. We therefore hypothesize that peripheral nerve damage may lead to (mal)adaptive neuroplasticity in the brain, which is compensatory at first, but leads to persistence of motor dysfunction (i.e. persistent scapular dyskinesia).

Main objective: To determine if NA patients show behavioural evidence for altered cerebral processes of the affected upper extremity.

Methods: 21 NA patients with lateralized symptoms in the right upper extremity (mean age 45 yrs, 5 women) and 20 age- and sex-matched healthy controls, all right-handed, performed a task, where they had to judge whether a hand shown on a screen was a left or a right hand. This involves motor imagery (i.e. mental simulation of movements of your own upper limb without movement execution), which enables the study of cerebral, rather than peripheral, processes.

Results and discussion: NA patients were significantly less accurate than healthy controls on their affected, right, side. This indicates that altered cerebral processes play a role in persistent scapular dyskinesia in NA.

Conclusion: Lateralized NA patients show decreased motor imagery performance of the affected upper extremity, supporting our hypothesis that maladaptive cerebral neuroplasticity is involved in persistent motor dysfunction despite recovery from peripheral nerve damage.

Acknowledgements: The authors thank Prinses Beatrix Spierfonds (grant no. W.OR.16-05) for providing financial support to this project.
Walk to the beat: describing the effects of haptic cueing on lower limb kinematics in chronic stroke survivors
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Introduction: Temporal gait asymmetry is a residual impairment experienced by chronic stroke survivors. It is associated with paretic limb knee joint pain⁴ and falls². Wearable technologies such as haptic cueing, using vibro-tactiles, could offer a way of continuing effective rehabilitation outside the clinical setting with minimal therapeutic guidance³

Main objective: To evaluate the lower limb kinematic adaptations made by chronic stroke survivors to haptic cueing during walking.

Methods: Nine chronic stroke survivors completed tests of mobility, balance testing and rhythm detection. 3D motion analysis lower limb temporal parameters and kinematics were measured during four ten metre walks under three experimental conditions:
- Haptic off (familiarisation period)
- Haptic on (the cueing frequency and duration were determined using the IMU data from the haptic off condition)
- Post off (haptic device switched off).

The data was processed in Visual 3D. Mixed method ANOVAs examined differences between hemi paretic and non-paretic limbs joint rotations and velocities for the three conditions.

Results and discussion: Mixed method ANOVA for joint rotations and velocity at the hip knee and ankle revealed no significant condition effect for all the kinematic variables. However, significant between-limb differences, in the joint kinematic variables during, stance gait at the hip and the knee in the sagittal and transverse plane (P<0.05) were found between the three conditions.

Conclusion: These findings demonstrate promise in using haptic cueing to improve gait symmetry in stroke. Further research is now needed to verify these results in a larger sample.

Acknowledgements: This work was funded by the Greater Manchester Academic Health Science Network
Can the application of kinesiotape improve functional performance in those with an upper limb neurological impairment?

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Introduction: In a tertiary neurosciences setting upper limb (UL) rehabilitation is challenging. Therapeutic taping is routinely used as part of individualised UL rehabilitation.

Main objective: To investigate the effect of kinesiotape on UL functional performance in patients with acute UL neurological impairment.

Methods: Observational cohort study of acute neurosurgical patients undergoing UL rehabilitation. Therapeutic taping intervention consisted of application of kinesiotape on partial stretch to the dorsal aspect of the affected UL.

To assess the efficacy of the therapeutic taping, time taken to complete the Box and Block test (BBT) without and with therapeutic taping was measured. Data was analysed using non parametric descriptive statistics and Wilcoxon signed –rank test using SPSS.

Results and discussion: 10 patients were studied [male = 5, median (range) age = 58(31–74) years, diagnosis included: spinal cord infarct and acquired traumatic/non-traumatic brain injury.] There was a significant reduction in individual patient time taken [seconds (s)] to complete the BBT test with kinesiotape [32.3 (41.8-16.3) compared to without kinesiotape [48.8 (78.9- 23.7)]: median difference = 10.2 (6.9 -38.1), p=0.05. Statistically significant improvements were observed in performance using therapeutic taping. Whether these improvements can be maintained or increased by using therapeutic taping as an adjunct to rehabilitation needs to be explored. Furthermore, therapeutic taping may improve performance of activities of daily living considering the excellent correlations between the BBT and the Action Research Arm Test \( r = 0.95 \) and the Motor Function sub-score \( r = 0.92 \) of the Fugl-Meyer Assessment. (Platz 2005).

Conclusion: UL therapeutic taping improves individual patients timed ability to complete BBT.
Feasibility and likability of a telerehabilitation module designed to increase self-directed training

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Introduction: Self-directed training is essential to optimising training frequencies in neurorehabilitation; yet patients’ actually conducted training falls strictly short of the recommended duration and frequency. This proof-of-concept study tested the feasibility and likability of a new telerehabilitation module designed to increase self-directed training.

Methods: Twenty patients with severe arm paresis were instructed to conduct 30 minutes of self-directed tele-training, consisting of observation of finger, hand and arm movements, each day for two weeks. Training times were presented at the end of each session in an incentivizing manner, and reflected by the patient and occupational therapist once a week. Likability (ease of usage, motivation effects, and perceived effectiveness) and feasibility were assessed by standardized questionnaires.

Results and discussion: Patients conducted the self-directed tele-training on 79.5% of the 14 days, on average (range: 43%-100%), with a mean duration of 16.4 minutes per day (range: 6.2 – 39.7 minutes). Patients rated the telerehabilitation module as very easy to use, motivating and effective. 16 patients (80%) continued with the tele-training after the observation period, without control of or feedback about the training amounts by the therapists. Thereby, training frequency dropped to 26% of days and average training duration to 11.7 minutes per day.

Conclusion: Self-directed tele-training with incorporated control of and feedback about training amounts seems a promising avenue to increase training frequency in neurorehabilitation.

Acknowledgements: We thank the participating patients, the occupational therapists at our clinic and Deborah Röthgens and Hannah Strenger for their help in recruiting and data collection.
Speech and occupational therapy - the interdisciplinary comprehensive concept of graphomotor training in patients with acquired brain injury

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Introduction: The aim of this paper is to describe the possibility of uniting the occupational therapy and the speech therapy in the area of graphomotor skills. In practice, we encounter graphomotor training in the occupational therapy mainly as a grip training and the functional training of the paretic upper limb. On the other hand, speech therapists focus on the content of a written text to alleviate the symptoms of agraphia.

Main objective: The case study demonstrates a woman at the age of 50 after an ischemic stroke, up to 1 year after the outset, with mild right side hemiparesis, admitted to the Kladruby Rehabilitation Centre.

Methods: The patient was objectively observed and tested along 3 months. The evaluation of fine motor skills, graphomotor skills and writing was initiated at time T0 upon admitting, then at time T1 when the patient started to attend the graphomotor training group and T2 was at the discharging date.

Results and discussion: Based on objective observation and assessment, the patient improved in the area of pencil grip, font transparency, readability of messages and fluency of writing. According to the speech therapy evaluations, the patient was able to write a simple sentences without any word deformation or incorrect content of messages.

Conclusion: Uniting the perspective of the occupational therapy to the motor-based graphics training and the speech therapy focused on content of writing appears to be an appropriate solution for saving the therapeutic time of both professions, increasing the efficiency of complex writing, and improving the quality of life of patients through written communication.
Upper limb boost programs during early inpatient rehabilitation after stroke
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Introduction: Upper-limb impairment is experienced in approximately 75% of patients post stroke. Studies showed that the greatest potential for improvement is in the first month, and that intensity of therapy is of utmost importance.

Main objective: The aim is to investigate changes in upper limb function following an intensive group therapy program for the arm and hand, starting early post stroke.

Methods: A multidisciplinary intensive upper limb boost program is provided to patients post stroke, early after admission to inpatient rehabilitation. Patients with sufficient trunk control are included if scores on Fugl-Meyer Assessment (FMA) stage 2 (synergies): 8-17 points, or if FMA stage 2 <8 points, but FMA stage 5 (hand) ≥6 points. The program is provided for 4 weeks, 5 days/week, 60'/day, adjunct to conventional therapy. Therapy content is focused around 5 topics: core stability for reaching, scapula setting, activities with shoulders in 30-60°, manipulation and integrated ADL. Additionally patients train 60'/week using the Armeo Power and self-directed exercise programs are provided. Patients are assessed before and after 4 weeks of training, using the Action Research Arm Test (ARAT) and FMA.

Results and discussion: Preliminary results in 5 participants showed an increase in ARAT scores for all participants from baseline to post-intervention (+7,+13,+13,+13,+35 points) and an increase in FMA scores (+1,+2,+4,+11,+23 points). Patients with lower motor function at baseline showed the largest gains during the training period.

Conclusion: Providing high-intensity boost programs for the upper limb, starting early post stroke, might accelerate reaching dexterity in a larger amount of patients.

Acknowledgements: No financial support was provided to this project.
Topic 4: Functional diagnostics/prognostics

2
A novel setup and protocol to measure the range of motion of the wrist and the hand
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Introduction: The human hand is important for the performance of activities of daily living which are directly related to quality of life. Various conditions, such as Duchenne muscular dystrophy (DMD) can affect the function of the human hand and wrist. The ability to assess the impairment in the hand and the wrist by measuring the range of motion (ROM), is essential for the development of effective rehabilitation protocols.

Main objective: In this study we explore the feasibility and reliability of the Leap motion sensor in measuring active hand/wrist ROM.

Methods: We measured the hand/wrist ROM of 20 healthy adults with the goniometer and the Leap motion sensor, in order to assess the agreement between them and additionally, we performed a test-retest of the Leap motion sensor with 12 of them, to assess its reliability.

Results and discussion: The results suggest a low agreement between the goniometer and the leap motion sensor, yet showing a large decrease in measurement time and high reliability when using the later. Future research should focus on improving data acquisition and quality and evaluate the Leap motion sensor for submaximal angles.

Conclusion: Despite the low agreement between the two Methods, we believe that the Leap motion sensor shows potential to contribute to the development of hand rehabilitation protocols and be used in a clinical setting.

Acknowledgements: This work was initiated by the Flextension Foundation and it was financially supported by the Netherlands Organisation for Scientific Research (NWO), the Duchenne Parent Project, Hankamp Rehab, Spieren voor Spieren, TMSi, Festo and Pontes Medical. Project Number: 13525.
Reliability of a robotic assessment of finger proprioception in stroke and multiple sclerosis patients

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Introduction: Impaired proprioception is a frequently reported symptom in patients with a stroke or Multiple Sclerosis (PwMS). However, scales to objectively evaluate these deficits are missing.

Main objective: The present study aimed to investigate the within- and between-session reliability of a robotic assessment of finger proprioception at the metacarpophalangeal joint (MCP) of the index finger using a passive gauge position matching task in stroke patients and PwMS.

Methods: Thirteen stroke patients and fourteen PwMS performed the robotic assessment in three bouts of 21 trials, on two days. Each trial consisted of the presentation of one randomly selected passive MCP-flexion angle by the device. The subject was asked to indicate the perceived angular position by adjusting the position of a needle displayed on a touchscreen placed above the tested hand. The reliability of the constant error (CE; Error = difference between actual and the reported angle), absolute error (AE), variable error (VE) and total variability (E) were evaluated using intraclass correlation analyses (ICC).

Results and discussion: A good to excellent within-session reliability was found for CE (ICC range 0.89-0.98), a moderate to excellent reliability for AE (ICC range 0.81-0.99), VE (ICC range 0.68-0.92) and E (ICC range 0.78-0.92) for both PwMS and stroke patients. In both groups the between-session reliability was higher in bout 3, ranging from 0.41 to 0.82 (PwMS) and from 0.60 to 0.93 (stroke) for the different errors.

Conclusion: The proposed robotic assessment provided reliable information on the proprioceptive function of the finger, demonstrating the potential for its application.
Association between respiratory muscle strength and measures of stroke severity and function

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Introduction: Respiratory muscle weakness following stroke might be associated with measures of stroke severity and function.

Main objective: To examine associations between respiratory muscle strength and measures of stroke severity/function.

Methods: Maximal Inspiratory (MIP), Expiratory (MEP) and Sniff Nasal Inspiratory Pressures (SNIP) were assessed in subacute stroke patients. Spearman’s correlation was used to identify associations with time since stroke, NIHSS, Barthel, Rivermead, and Trunk Impairment Scale (TIS) scores. Linear regression was used to describe statistically significant associations using SPSS 24.

Results and discussion: Eighteen patients (11 male) with mean (SD) age 59.1 (14.5) years were assessed at median (range) 50 (21-128) days post stroke. Mean (SD) NIHSS score was 7.4 (2.1); median (range) Modified Rankin score 4 (3-5); mean (SD) Barthel score 9 (5); mean (SD) Rivermead score 13.5 (7) and mean (SD) TIS score 14 (4). Mean (SD) for MIP was 81 (36) cmH2O, with mean (range) % predicted 106 (46-184); for MEP 112 (33) cmH2O, with mean (range) % predicted 100 (51-137); and for SNIP 86 (39) cmH2O. There were (near) significant moderate correlations only between Barthel score and MIP (r=0.58, p=0.02), MEP (r=0.42, p=0.08) and SNIP (r=0.58, p=0.02). Linear regression coefficients between Barthel score and MIP, MEP and SNIP were 3.7 (p=0.03), 3.0 (p=0.05) and 3.8 (p=0.04), respectively.

Conclusion: Respiratory muscle strength values in subacute stroke patients vary widely; in this sample respiratory muscle strength was significantly associated with Barthel score, but not with other stroke severity measures.

Acknowledgements: The authors thank Santander (Mobility Grant) for financial contribution.
Are tms induced motor evoked potentials of the less affected upper limb normal very early after severe stroke?

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Introduction: Ipsilesional impairments at the so-called less-affected arm are still unexplored after severe stroke

Main objective: The first aim was to investigate the corticospinal tract of the non-lesioned hemisphere with Motor Evoked Potentials and central motor conduction time of the non-lesioned hemisphere within 48 hours and 11 days post-stroke. Second, to determine if prolonged CMCT at the less non-lesioned hemisphere is associated with poor motor recovery

Methods: TMS-MEPs measured at the non-lesioned hemisphere within 48 hours and 11 days after a severe, first-ever ischemic stroke. Recoverers of spontaneous neurological recovery were defined by the proportional recovery rule for Fugl-Meyer motor assessment scores of the upper paretic extremity (FM-UE) measured during the first 6 months post-stroke.

Results and discussion: All 50 patients, mean CMCT was significantly prolonged (10.3 ms, SD= 4.35) in 30 (60%) patients at the less affected side within the first 48 hours (P = .044). Prolongation of CMCT did occur significantly more often in non-recoverers (10.8 ms) than those who showed no spontaneous recovery (8.57 ms; P=.035). At 11 days, the ratio of subjects showing normal and prolonged CMCT was significantly different between those that showed spontaneous neurological recovery (19 normal and 11 prolonged) when compared to those that failed (6 normal, 13 prolonged and 1 lost to follow-up; P=.032).

Conclusion: Normalization of CMCT at the less-affected side is related recovery at the affected side. This finding supports the hypothesis of the existence of an interhemispheric suppression of the CST at the less affected side. This suppression was significantly more resolved in recoverers.
Inter-rater reliability and feasibility of the motricity index and the trunk control test in hospitalized patients with a primary brain tumor

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Introduction: The guidelines for stroke rehabilitation, recommend to use a coreset of bed side tests for assessing muscle strength, trunk stability and balance. The tests in the coreset are important predictors for sitting, standing and ADL activities. Reliability and feasibility of these tests are excellent for the stroke patient population in the acute phase. Many physiotherapists already use the same tests to assess functioning of patients with a primary brain tumor while hospitalized. Clinimetric properties of these instruments are not investigated for this population yet.

Main objective: The aim of this study is to assess the inter-rater reliability and feasibility of the Motricity Index and Trunk Control Test, the most frequently used tests of the stroke coreset, in patients with a primary brain tumor.

Methods: Thirty patients with a primary brain tumor, hospitalized in the University Hospital of Utrecht were assessed independently by two physiotherapists. Informed consent was obtained before assessment. Both assessments were executed within four hours to minimize the influence of fatigue. Intra class correlations coefficients were calculated. Feasibility was investigated by the notes that were taken during assessment and recording adverse events.

Results and discussion: High correlation class coefficients were found for the inter-rater reliability, all above .90. Some patients reported fatigue after the assessments. All assessments were safely executed.

Conclusion: Applying the Motricity Index and Trunk Control Test in hospitalized patients with a primary brain tumor is feasible. Inter-rater reliability of these bed side tests is high and comparable to the stroke patient population in the acute phase.

Acknowledgements: Conflicts of interest: non declared
Introduction: The diagnostic criteria for bilateral vestibulopathy (BVP) leave room for some variable amount of remaining vestibular function. Consequently, symptoms can be diverse leading to heterogeneity in functional consequences.

Main objective: To investigate whether clinical balance assessments, visual acuity and quality of life assessments differ between BVP-patients with and without some residual vestibular function characterized by vestibulo-ocular reflex (VOR) gain during rotatory chair testing.

Methods: This was an exploratory study in 22 BVP-patients. The results of static (standing on foam with eyes closed) and dynamic (Timed-Up-and-Go test (TUG) with(out) cognitive/motor dual-task, Tinetti test, Functional Gait Assessment) balance tests, visual acuity testing during treadmill walking (2, 4, and 6 km/h) and quality of life assessments were compared among patients with reduced caloric responses and residual (VORgain \(\geq\) 0.1; n=8) or reduced (VORgain \(<\) 0.1; n=14) VOR-function during rotatory chair testing (Mann-Whitney U test).

Results and discussion: As expected, patients with residual VOR performed significantly better during standing on foam with eyes closed (p=0.015) and experienced less visual acuity loss at 6 km/h (p=0.029). Surprisingly, these patients tended to performed worse on TUG-conditions with dual tasks (p=[0.076;0.104]). The reduced performance during dual task TUG-conditions and limited visual acuity loss might be related to the presence of central compensation mechanisms, as competition for central processing resources during dual-tasking might compromise functional performance in this subset of BVP-patients.

Conclusion: Results of this preliminary study suggest individual variation in central compensation mechanisms in BVP-patients, affecting functional performance.

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Smartphone based assessment of postural control in stroke: a feasibility trial
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Introduction: Postural control (PC) is impaired in many neurological diseases like Parkinson's [Vaugoyeau M 2007], stroke [Mizrahi J 1989], or multiple sclerosis [Huisinga JM 2012]. The gold standard is to assess PC via force platforms [Raymakers JA 2005]. However, in order to assess PC in clinical daily life, it is necessary to do so on a mobile basis with minimum expenses and durations [Yeung LF 2014].

Main objective: Recommendations are measurements of ≥25s at ≥50Hz [Scoppa F 2012]. We evaluated the performance of a smartphone based application (APP) to assess PC for 10s at approx. 20Hz using accelerometry. We hypothesized that stroke patients reveal increased mean rectified accelerations (MRA) in comparison to healthy controls and that APP can recognize differences between PC with and without vision.

Methods: Using accelerometers of Lumia550s (Microsoft, no gyroscopes) for 10s, we assessed PC by MRA in two conditions (pseudo-randomized order): Shoulder-width stance (pressing the smartphone against the frontal waist line) with eyes opened (OPEN) and eyes closed (CLOSED). We compared the performance of 10 healthy controls (58.7a±2.7a) and 10 stroke patients (63.9a±8.8a).

Results and discussion: An rmAnova revealed a strong effect of group (p<.01, controls 73.0mm/s²±18.5mm/s², patients 119.5mm/s²±39.0mm/s²), but no effect of condition (p=.282) or an interaction (p=.626). Correlations revealed no association with age. Sensitivity was 1.00 (OPEN) and 0.60 (CLOSED), and specificity 0.70 (OPEN) and 1.00 (CLOSED) for thresholds of 66mm/s² (OPEN) and 105mm/s² (CLOSED). The recording frequency was 18.9Hz±0.3Hz.

Conclusion: APP (10s, 18.9Hz) appears sensitive enough to differentiate between stroke patients and healthy controls, but not between OPEN and CLOSED. Future measurements will include reliability and different age groups and neurological diseases.
Development and content validation of a comprehensive tool to measure motor coordination

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**Introduction:** Motor coordination, the ability to produce context-dependent organized movements in both spatial and temporal domains, is impaired after neurological injuries. Clinical assessments of coordination impairments commonly quantify only performance level variables (i.e., temporal qualities of endpoint movement). The quality of movement level (including compensations) is rarely considered or quantified.

**Objective:** To develop a comprehensive tool to measure unilateral and bilateral coordination of upper and lower limb segments that can be quantified by observational kinematics at both performance and quality levels.

**Methods:** The tool was constructed from five commonly-used tests of unilateral (Finger-to-Nose, Arm-Trunk Gain, Lower Extremity Motor Coordination) and bilateral (two and four-limb) coordination. Performance and quality variables were assessed on 4-item scales totaling 63-points, with higher scores indicating better performance. The content validity of the tool was tested by clinical experts who completed questionnaires and attended a focus group. A TRIAGE method was used to summarize focus group results.

**Results and discussion:** Six experts (physical/occupational therapists, clinical researchers) responded to questions about 1) relative importance of the tool; 2) level of comprehension of items and instructions, and 3) potential feasibility for use in clinical practice. Based on expert comments, changes were made to the wording of specific items on some tests and the instructions were simplified in the final version. All experts felt that the tool filled a gap in neurological assessment, for which coordination skills are essential to the recovery of functional movement, and that it was feasible to include the tool in clinical practice.

**Conflicts of interest:** The authors disclose no conflicts of interest.
What do stroke survivors actually learn when regaining walking ability after stroke? a protocol for a repeated-measurements prospective cohort study

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Introduction: During the first 3 months post-stroke, typically large improvements in leg paresis and walking are observed. However, previous studies suggest that these improvements are mainly driven by learning compensation strategies rather than by restoring inter-limb coordination.

Main objective: Stroke survivors from the first days onwards are assessed repetitively to identify the neurological and behavioral changes responsible for improvements in walking.

Methods: In total, 24 participants with leg paresis (i.e., NIHSS item 6 ≥0) and limited walking ability (i.e., FAC ≤3) will be included within the first 14 days after a first-ever ischemic stroke. Longitudinal changes in selected outcomes will be investigated at 3, 5, 8, 12 and >24 weeks post-stroke. Leg paresis (i.e., Fugl-Meyer Assessment and Motricity Index), standing (i.e., BBS-standing and posturography) and walking ability (i.e., 10-mWT) will be assessed. In addition, kinetics during upright activity will be investigated using a dual-force plate set-up as soon as participants are able to stand unsupported. For this purpose, the COP displacements and margins of stability will be calculated to estimate the contribution of paretic and non-paretic side to the control of balance.

Results and discussion: In the present study, we will investigate behavioral restitution and compensation strategies for improvements in standing and walking during the first 6 months post-stroke.

Conclusion: A better understanding of what patients actually learn when regaining walking ability is required to give evidence-based guidelines for clinicians in order to choose for impairment-focused or adaptive treatment strategies early post-stroke.

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92  
**Case study evaluating the use of assistive technology and virtual reality (vr) treadmill training for gait re-education in a chronic stage stroke patient**  
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**Introduction:** Gait re-education for improved functional mobility is often a patient’s highest priority post Stroke. Intensive rehabilitation past 1 year of Stroke is not routinely provided by statutory services due to a belief in a plateau of functional improvements.  

**Main objective:** To evaluate whether significant gait changes and functional improvements can be made in chronic Stroke using Motek C-Mill Virtual Reality (VR) treadmill training with Augmented Feedback (AF) and other assistive technology.  

**Methods:** Retrospective single case study of a right hemiplegic patient, 37 years old, who suffered brain haemorrhage 3 years ago. On initial presentation mobilising short distances indoors with elbow crutch, AFO, knee hyperextension, leg circumduction, severe right sided sensory impairment.  

**Treatment included:** Bioness L300 FES system, initial gait re-education with a TAP splint progressed to custom lycra shorts, intensive Motek C-Mill VR treadmill training using gait adaptability programmes with AF for sensory impairment. Evaluation of treatment records with Motek C-Mill force-plate recordings of step length, stance time, speed, distance, SiliconCoach software gait video analysis.  

**Results and discussion:** Evaluation of treadmill force-plate data shows increased speed, step length, stance time, distance and steps taken. SiliconCoach analysis demonstrates overall improvements in posture and gait pattern using the FES system. The patient’s functional goal of mobilising 5km unaided was also achieved. Possibly the AF technology allowed this patient with sensory deficits to improve further.  

**Conclusion:** Results from this single case review highlight that intensive practise with VR / AF treadmill training using assistive technology enhances motor learning, leading to significant functional gait improvements.
Test-retest reliability of stability outcome measures during walking
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Introduction: Various stability outcome measures based on the (extrapolated) centre of mass ([X]CoM), base of support (BoS), and centre of pressure (CoP) have been proposed to quantify balance control during walking in patients with balance and gait problems. Differences between healthy controls and patient groups have been described, but for the clinical evaluation and monitoring of balance control these stability outcome measures should be reliable.

Main objective: Investigate the test-retest reliability of six different stability outcome measures during treadmill walking in patients with balance and gait problems and healthy controls.

Methods: Patients with balance and gait problems (n=45) and healthy controls (n=20) performed two times a two-minute walk test on an instrumented treadmill in the self-paced mode. Six different stability outcome measures were calculated: dynamic stability margin (DSM), margin of stability (MoS), distance between XCoM and CoP in anterior-posterior (XCoM-CoPAP) and mediolateral (XCoM-CoPML) direction and CoM-CoP inclination angles in anterior-posterior (CoM-CoPAP-angle) and mediolateral (CoM-CoPML-angle) direction. ICCs and Bland-Altman tests (Coefficient of Repeatability, CR) were used to evaluate the test-retest reliability.

Results and discussion: Based on the ICCs ranging from 0.51 to 0.94, moderate to excellent reliability was found for all stability outcome measures for both patients and controls. The XCoM-CoPML and CoM-CoPML-angle showed no difference between the measurements and smaller CRs than the differences between patients and controls.

Conclusion: The evaluation of the test-retest reliability indicates that the XCoM-CoPML and CoM-CoPML-angle are the most promising stability outcome measures to evaluate and monitor balance control during walking on a group and individual level.

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Foot placement control during walking in stroke patients and healthy controls
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Introduction: Quantification of balance control during gait is important for diagnosis and evaluation in neurological disorder patients with gait problems., Hof et al. (2007) introduced parameters for the gross and fine balance control during walking based on correctness of the foot placement and adjustment for ‘incorrect’ foot placement during the single stance phase, respectively. It was hypothesized that these control parameters are affected in the paretic side of stroke patients and minimally influenced by walking speed.

Main objective: Test the validity of foot placement control (FPC) and single stance control (SSC) during walking.

Methods: Nine stroke patients and 18 healthy controls performed a 2 minute walk test in the self-paced mode and fixed speed on the GRAIL. Healthy controls were also tested at half their preferred speed. FPC was defined as the correlation between the lateral position, and the lateral foot placement for multiple steps. SSC was the correlation between the correction in Two-way repeated measures ANOVA were used to indicate the effect of walking mode and side on FPC and SSC.

Results and discussion: FPC and SSC were not significantly different between the walking modes in healthy controls (p=0.55, p=0.24) and stroke patients (p=0.29, p=0.10). FPC and SSC were significantly smaller (p<0.001) for the paretic side of stroke patients (r=0.84±.09) compared to the non-paretic side (r=0.95±.02) and both legs of the healthy controls (r=0.96±.02). The SSC was significantly different between healthy controls (r=-0.57±.13), paretic (r=0.15±.34) and non-paretic (r=-0.36±.21) side of stroke patients (p<0.001).

Conclusion: FPC and SSC are valid measures to indicate the balance control during walking irrespective of walking speed or walking mode. FPC and SSC is reduced in stroke patients and mostly affected in the paretic side.

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Quality improvement project: improving the amount of active physiotherapy in patients with neurological and neurosurgical admission diagnosis on the intensive care unit

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Introduction: Early mobilization became an important part of physiotherapy treatment in the Intensive Care Unit (ICU). An Evidence Statement (ES) for physiotherapy in the ICU provides recommendations on treatments along with safety criteria. In neurological and neurosurgical (NEU/NEC) patients on the ICU, adherence to the ES appeared to be low, with underuse of activation strategies like mobilization in the chair or using the bed-cycle-ergometer.

Main objective: The objective of this study was to improve the amount of active physiotherapy in NEU/NEC ICU patients. We undertook a quality improvement project for more mobilization and use of the bed-cycle-ergometer according to recommendations of the ES.

Methods: A before-after evaluation comparing retrospective collected data of applied physiotherapy treatment strategies before and after the intervention. The intervention consisted of interviewing ICU-physiotherapists to explore barriers towards mobilization and using the bed-cycle-ergometer. Subsequently we addressed the identified barriers: (1) enhancing knowledge of the ES, including safety criteria, (2) enhancing knowledge to use the bed-cycle-ergometer, (3) removing organizational barriers, (4) developing a treatment protocol targeting NEU/NEC ICU patients. Main outcome measures were active physiotherapy interventions, in terms of mobilization and using the bed-cycle-ergometer.

Results and discussion: Mobilization in the chair increased significantly, use of the bed-cycle-ergometer increased (non-significantly). Barriers and interventions in our study are comparable to previous research, yet differ (study design, time to conduct, targeted group). Our study represents a pragmatic approach and addresses daily practice. Through our intervention we initiated a culture on our ICU/MCU.
Conclusion: Implementing targeted interventions increased the frequency of early mobilization of NEU/NEC ICU patients.
Acknowledgements: Participating therapists, patients.

74
Device design in neurological rehabilitation: managing multiple perspectives
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Introduction: Healthcare teams working with people after stroke are looking to technology to facilitate self-directed practice, increase adherence and motivation and improve the efficiency of healthcare delivery. People with stroke present with a number of impairments which may mean that ‘off the shelf’ technology is not accessible to them. There is a growing body of work aimed at co-producing and co-designing new devices and technologies that are accessible to and appropriate for people following stroke.

Main objective: The aim of this qualitative study was to explore the experiences and perspectives of all stakeholders involved in the co-design of a novel ankle rehabilitation device.

Methods: Semi-structured interviews were conducted with all stakeholders involved in the co-design and development of an ankle rehabilitation device: academics (n=3); stroke survivors (n=3); industry partners (n=2); clinicians (n=2). Interviews were transcribed and analysed using inductive thematic analysis.

Results and discussion: Four key themes were common to all stakeholders: motivation; roles and responsibilities; process of development; and project management. One additional theme (perspective shift) was discussed only by industry partners and service users. Our study identified both similar and differing stakeholder perspectives within these themes, and thoughts and opinions expressed gave insight into the mechanisms and process of co-design, from the perspective of all stakeholders.

Conclusion: Successful co-design requires clear articulation of roles and responsibilities and proactive facilitation to ensure participation and inclusion of all stakeholders in the process. This study offers insights into how co-design could be enacted in future studies.

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Evaluating the awareness, implementation and usefulness of national splinting guidelines: a UK based cross-sectional online survey of neurological physiotherapists

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Introduction: The Splinting Guidelines were developed to support decision-making and reduce variation in splinting practices for adults at risk of contracture due to neurological dysfunction.

Main objective: This study aimed to evaluate UK neurological physiotherapists’ awareness of the guidelines and their utility as a practice resource.

Methods: A web-based survey was developed according to the CHERRIES statement, using a literature review and expert consultation, and was piloted. As it was not possible to identify members of the Association of Chartered Physiotherapists in Neurology who undertake splinting, all members on their research database were invited to participate.

Results and discussion: 100 surveys were returned. 85% of physiotherapists reported being aware of the guidelines and 67% reported an influence on their practice; often supporting clinical decision-making and evidence-based practice. Nearly half integrated them into departmental standards and teaching programmes. Environmental barriers to implementation were associated with limitations in training and resources. Personal barriers often related to difficulties with application of the guideline recommendations given the provision of only suggestions for practice. Whilst respondents commented on the paucity of evidence upon which the guidance document was developed, most respondents still considered them useful.

Conclusion: Survey findings indicate some uptake of the guidelines as a resource to support best-practice delivery amongst physiotherapists. However the lack of robust evidence available to formulate the guidelines’ recommendations was noted as a key limitation. Further high-quality research exploring the effectiveness of splinting is required to build the strength of the evidence-base and inform clinical practice recommendations.

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Shear-wave elastography in spinal muscle atrophy: a feasibility study
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Introduction: Early detection of changes in mechanical properties of muscles in spinal muscular atrophy (SMA) may improve clinical management and prevention of contractures. Ultrasound shear wave elastography (SWE) can measure muscle shear wave velocity (mSWV) as an index of muscle stiffness.

Main objective: To investigate feasibility and validity of SWE in young children with SMA and healthy controls.

Methods: Five children with SMA (type 1-3, aged 5-9 years) with decreased passive range of motion (PROM) in elbow, knee and/or ankle joint and five controls (aged 7-10) underwent ultrasound (US) measurements of 3 muscles (lateral vastus, medial gastrocnemius, biceps brachii) at resting muscle length in SWE mode and B-mode to evaluate feasibility (number of subjects able to complete the US-assessment within 30 minutes) and validity of SWE. Validity was evaluated from differences in mSWV between children with SMA and contractures versus controls and from associations between mSWV, PROM restriction and muscle thickness.

Results and discussion: All US assessments (SWE and B-mode) could be performed within 30 min. No differences were found in mSWV-values between children with and without contractures nor between children with SMA and controls which may be due to the large variability in mSWV in controls.

Conclusion: Measurement of muscle stiffness with SWE is feasible in children aged 5-10 years. Validity of SWE in quantifying muscle stiffness could not be confirmed and needs further study in children with SMA, together with reliability and sensitivity to detect changes over time.

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The reliability and feasibility of a hand held dynamometer to measure muscle strength in patients with htlv-1 infection
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Introduction: Detecting early, evolving change and responses to treatment are important clinically in HTLV-1 infection. Loss of muscle strength is an early sign of onset or worsening HTLV-1-Associated Myelopathy (HAM). The reliability, feasibility and minimal detectable change (MDC) of a Hand Held Dynamometer (HHD) in people with HTLV-1 is unknown.

Main objective: To test a HHD for reliability and acceptability in patients with HTLV infection.

Methods: 30 patients with HAM (pwHAM) and 22 asymptomatic carriers (ACs) were recruited during routine clinic visits. Testing were conducted twice, 4 weeks apart, of the hip flexors/extensors; knee flexors/extensors, ankle plantar/dorsiflexors. Participants were randomised to being tested before or after their walking assessments. Standardised testing procedures included 3 tests per muscle group with 10 seconds rest in-between each test. Reliability is reported using the intra-class correlation coefficients (ICC) and its 95% confidence interval and the MDC is calculated as SEM x 1.96 x √2 where SEM = SDx√1-ICC

Results and discussion: Of the 30 participants with HAM (20â™€ 4; mean age 59.5 years) and 22 ACs (8â™€ 4â™€; mean age 51.5 years) the median testing times were 18 minutes for HAM and 15 minutes for ACs. Reliability, measured using the ICC, was excellent (ICC→0.80) in pwHAM & ACs, similar to people with stroke and spinal cord injury. However the minimal detectable change was high (24 – 62% in pwHAM) whereas in ACs ranged from 13-23%.

Conclusion: Despite the excellent ICCs in both groups, the amount of change needed in pwHAM to indicate true change is too high to be clinically useful.

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Neuromuscular electrical stimulation in addition to exercise therapy in acute ischemic stroke - a randomized clinical trial

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Introduction: Annually 16.9 million people worldwide suffer a first stroke. About 33 million stroke survivors and 5.9 million stroke-related deaths are reported. Stroke is the second-most common cause of death and one of the main causes of acquired adult disability. Intensive exercise therapy initiated early after stroke may benefit recovery of activities such as gait and upper limb function. The aim of this trial is to determine whether Neuromuscular Electrical Stimulation (NMES) in addition to exercise therapy is more effective in improving walking endurance than exercise therapy alone in patients suffering acute first-ever ischemic stroke.

Main objective: NMES combined with exercise therapy improves the walking endurance more than exercise therapy alone early after stroke.

Methods: Acute ischemic stroke patients (N=50) are randomized into either control or intervention group with an assessor-blinded follow-up 3 months post stroke. Both groups will receive exercise therapy including sit-to-stand and walking 10 minutes daily. The intervention group will also receive NMES in addition to exercise therapy. The exercise therapy will be provided on weekdays for 2 weeks, starting within the first day after stroke onset. Primary outcome will be the six-minute walk test measured at 3 months post stroke. Secondary outcomes include self-reported quality of life (EQ-5D-5L), and cortical activation threshold of the motoric cortex measured by Transcranial Magnetic Stimulation.

Results and discussion: Medical ethical approval has been achieved (ClinicalTrials.gov Identifier: NCT03653312). A pilot study (N=5) showed that the test battery and treatment protocol are safe and feasible to apply.

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Inpatient rehabilitation for functional neurological disorder - a case series with the development of a management pathway
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Introduction: Functional neurological disorder (FND) is a clinical syndrome with the occurrence of altered neurological function with clinical findings that are inconsistent with a known neurological cause. Inpatient rehabilitation can be beneficial. However, it can be difficult to determine the best approach to management, and to select which patients may best benefit from inpatient rehabilitation.

Main objective: The aim of this paper is to present outcomes for a group of patients with FND undergoing a multidisciplinary inpatient rehabilitation program, and to present the development of a rehabilitation management pathway.

Methods: Case series of consecutive patients with FND admitted to a general rehabilitation unit for inpatient multidisciplinary rehabilitation.

Results and discussion: 21 patients (16 females) were admitted for inpatient rehabilitation. Mean age was 44 years and mean length of stay was 20 days. Mean admission functional independence measure (FIM) was 100, with a mean FIM change of 15. A rehabilitation management pathway has been developed. This includes pre-admission assessment and triage, a patient information booklet, and a patient agreement. Management principles include use of an activity diary, self-monitoring, graded exercises, and fatigue management. Patient acceptance of diagnosis was associated with functional improvement. Higher functional gain was noted in patients with more recent onset of symptoms.

Conclusion: Inpatient rehabilitation may be an effective treatment approach for select patients with FND. Patients should be given a clear explanation regarding diagnosis, and should be actively involved in the rehabilitation plan. Rehabilitation management should be offered as early as possible.
Robotic exoskeleton therapy in subacute stroke patients with severe motor impairment of the upper limb: a pilot randomized controlled trial study

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Introduction: We developed an upper limb exoskeleton robot (ExoMotion). In a case series study, Fugl–Meyer Assessment of Upper Extremity (FMA–UE) was improved in subacute stroke patients with severe impairment of the upper limb after occupational therapy (OT) plus robot therapy (RT).

Main objective: To compare the effects of OT (control group) and OT plus RT (experimental group) in subacute stroke patients with severe impairment of the upper limb.

Methods: A pilot assessor–blinded randomized controlled trial was conducted. Twelve subacute stroke patients (control, n=7, experiment, n=5) with FMA–UE score ≤ 28/66 underwent 60 minutes upper limb training/day, 5 days/week for 4 weeks. A control group participated in 60 minutes OT. An experimental group participated in 30 minutes OT and 30 minutes RT. FMA–UE and Barthel ADL Index (BAI) was assessed at baseline (wk0), after 4 weeks–training (wk4) and 4 weeks after training (wk8). An ANCOVA was used to compare training effects.

Results and discussion: Mean age was 62 years old. FMA–UE of an experimental and a control group are as follows: wk0 (14.2±4.52 vs. 10.3±2.56), wk4 (15.6±5.05 vs. 14.1±4.13) and wk8 (15.6±5.05 vs. 14.3±4.11). BAI of an experimental and a control group are as follows: wk0 (13.4±1.57 vs. 11.0±1.31), wk4 (16.0±1.52 vs. 15.1±0.74) and wk8 (16.2±1.39 vs. 15.3±0.78). FMA–UE and BAI was not different between groups when compare at wk4 and 8 (p>0.05).

Conclusion: Improvement of motor control in subacute stroke patients with severe upper limb impairment is not different between OT and OT plus ExoMotion RT.

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Improvement of walking ability following stroke: a systematic review and network meta-analysis of randomized controlled trials

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Introduction: Gait velocity and walking distance are central parameters for measuring the success of gait rehabilitation after stroke.

Main objective: To give an overview of the evidence network regarding the efficacy and safety of gait rehabilitation approaches after stroke.

Methods: We did a systematic review of RCTs using network meta-analysis. Our primary endpoint was gait velocity; our secondary endpoints were the ability to walk, walking distance, and gait stability. We analysed the following interventions: no gait training, conventional gait training (ref.), training on a treadmill with or without BWS, training on a treadmill with or without a speed paradigm, and electromechanically assisted gait training with end-effector or exoskeleton.

Results and discussion: From 40 567 hits we included 95 RCTs with a total of 4458 patients. With respect to gait velocity, gait training assisted by end-effector led to significant improvement [MD = 0.16 m/s; 95%CI [0.04; 0.28]]. None of the other interventions improved gait velocity. With respect to walking distance, both gait training assisted by end-effector and treadmill training led to significant improvement [MD = 47 m, [4; 90], and MD = 38 m, [4; 72], respectively].

Conclusion: In comparison to conventional gait rehabilitation, gait training assisted by end-effector apparatus leads to a statistically significant and clinically relevant improvement in gait velocity and maximum walking distance after stroke, while treadmill training with body weight support leads to a statistically significant and clinically relevant improvement in maximum walking distance.
Factors affecting the use of a rehabilitation robot in a clinical research context: a first qualitative study applying utaut model

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Introduction: Robotic-assisted therapy has been shown to be effective for post-stroke rehabilitation. However, clinicians seem to be reluctant to use it in clinical practice.

Main objective: This qualitative study aims to examine the reasons underlying the lack of rehabilitation robot (RR) use in the clinical practice among therapists.

Methods: Eight French speaking therapists underwent a semi-structured interview. Questions where defied from the Unified theory of Acceptance and Use of Technology. Interviews were transcribed, summarized and a transversal analysis was finally performed.

Results and discussion: Seven themes were highlighted: effort expectancy, performance expectancy, social influence, self-efficacy, relationship, experience and cost. Some therapists found that RR did not provide a functional training and had a perception of ineffectiveness. However, almost all therapists mentioned that RR was complementary to conventional therapy, provided a high number of movement repetitions and was effective for some responders. Most of the therapists found that the installation time was an additional energy cost. All therapists were positively influenced by their head of department to use the RR, but a small number of them were negatively influence by their team. Finally, all therapists received a training session before using the RR and found it essential.

Conclusion: This study showed that it is really difficult to change routine in clinic. The communication between clinicians and researchers is crucial and could help to further develop and improve certain aspect of the RR.

Acknowledgements: Authors would like to thank all therapists for their participation in the study.
Network meta-analysis on randomized trials focusing on the effects of electromechanical-assisted hand-arm-training for improving upper limb capacity and function after stroke

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Introduction: There are many different approaches of electromechanical-assisted hand-arm-training after stroke. Until now, however, no head to head comparison exists.

Main objective: To give an overview of the evidence network regarding the efficacy and safety of different approaches of electromechanical-assisted hand-arm-training after stroke.

Methods: This is a systematic review of randomized controlled trials with network meta-analysis. Primary endpoints were everyday competence and hand-arm functions, secondary endpoints were hand-arm strength and safety. We used conventional arm training as our reference category and compared it with different intervention categories of electromechanical-assisted arm training depending on the therapy approach.

Results and discussion: We included 46 randomized controlled trials with a total of 1,629 patients after stroke. For the primary endpoint everyday competence, the primary endpoint hand-arm function and the secondary endpoint hand-arm strength, none of the interventions achieved significant improvements, taking into account the heterogeneity of the studies. Safety did not differ with regard to the individual interventions of arm rehabilitation after stroke.

Conclusion: In comparison with conventional hand-arm therapy none of the electromechanically assisted arm rehabilitation approaches appears to improve everyday competence, hand-arm functions and hand-arm strength neither statistically significant nor clinically relevant.
Assessment protocol to quantify upper limb impairment in stroke and cerebral palsy

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Introduction: Several robotic devices have been developed to obtain reliable, valid and operator-independent measurements of upper limb function to overcome the limitations of clinical assessment tools. With these devices, however, generally only one or two impairments are quantified simultaneously, such as only spasticity and changes of viscoelasticity or only abnormal synergy.

Main objective: To develop an assessment protocol to quantify the impaired upper extremity function in terms of muscle weakness, spasticity, abnormal synergy and changes of viscoelastic properties around the elbow with a single device in stroke and adult cerebral palsy (CP).

Methods: Measurement protocols in literature were reviewed, combined and adapted for an assessment protocol to quantify impaired upper extremity function using a shoulder-elbow-perturbator (SEP) in combination with electromyography (EMG).

Results and discussion: Varying the arm support levels and different tasks (passive and active tasks) enable us to distinguish all four impairments for the elbow in stroke patients and adults with CP. The output of the SEP in combination with EMG is measured in terms of torques, angular rotation, and muscle activation. Both signal analysis and system identification techniques were applied to translate the measured data into meaningful variables describing upper limb impairments.

Conclusion: Based on literature, we propose an assessment protocol for the SEP that is operator-independent and can quantify muscle weakness, spasticity, abnormal synergy and changes of viscoelastic properties around the elbow in stroke and CP.

Acknowledgements: The authors would like to thank Hankamp Rehab and Health Holland for building the SEP and providing financial support to this project.
Robot-assisted gait training with the lokomat in patients after stroke: multicenter study on motivation, expectation, credibility and experiences

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Introduction: Information about the psychological impact of stroke patients who have experiences with robot-assisted gait training can help the further development and refinement of rehabilitation robotics.

Main objective: This study aimed to examine stroke patients’ motivation and experiences, and their credibility and expectation of robot-assisted gait training with the Lokomat-system.

Methods: A cross-sectional, multi-center trial was conducted in all centers in Belgium who provide Lokomat training (n=3). In stroke patients with experience with Lokomat-training, the Intrinsic Motivation Inventory (IMI) and the Credibility and Expectancy Questionnaire (CEQ) were used for data-collection. For more in-depth information, open-ended questions were added to the IMI. Descriptive statistics, Kruskal Wallis tests and Spearman’s correlations were interpreted.

Results and discussion: Twenty post-stroke patients (age: 58±13 years; post stroke time: 17±19 months) participated. The scores on the CEQ varied from 70% to 80% and on the IMI subscales from 76% to 89%, except for the ‘Pressure/Tension’ subscale (34%) in which the interpretation is reversed (low percentages indicate little pressure). Patients experienced the Lokomat training as exhausting, but felt safe due to the harness and supervision of the physiotherapist. They indicated the training as an added value to their stepping pattern, strength and balance.

Conclusion: In general, the patients were motivated to train with the Lokomat and they believed in the value, usefulness and credibility of the therapy, as well as the beneficial effects on their gait function.

Acknowledgements: Thanks to Lisa De Donder and Lore Henuset for data-collection, the physiotherapists of the participating centers and all participants of this study.
Introduction: Recovery is very dynamical during the acute phase of stroke [1-7 days post-stroke]. However, it is unknown whether acute stroke patients can acquire new motor skills with their paretic upper limb (UL). This question is critical because neurorehabilitation largely relies on motor learning.

Main objective: Our first aim is to quantify motor skill learning that acute stroke patients can achieve with the paretic UL compared to healthy individuals (HI). The second aim is to explore the impact of the lesion on motor skill learning in patients through Voxel-based Lesion Symptom Mapping (VLSM).

Methods: Over 3 consecutive days, 20 acute stroke patients and 34 HI achieved a motor skill learning task involving a speed/accuracy trade-off (SAT) with their paretic UL on a neurorehabilitation robot (REAplan®, AXINESIS, Belgium). Motor control was quantified by a Reaching task, grip force and the Box & Blocks test. Furthermore, a high-resolution 3D brain MRI was acquired to perform VLSM.

Results and discussion: Most of the acute stroke patients were able to improve and retain a new SAT motor skill with their paretic UL in a way similar to that observed in HI. Generalization of SAT gains was observed in both groups. The VLSM and reaching task results will be presented during the conference.

Conclusion: Most patients are able to improve and retain a new motor skill with their paretic UL in a similar way to that observed in HI, suggesting that patients achieved motor skill learning on top of improved motor control.

Acknowledgements: We are grateful to all subjects who participated in this study.
Robot-based arm movement analysis in subacute stroke rehabilitation: preliminary outcomes of feasibility of quantifying independent joint control in clinical practice

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Introduction: Treatment options for arm-hand function after stroke are manifold, especially through innovative technologies (robotics, gaming). Collecting standardized objective diagnostic information in clinical settings is therefore an important step. Robotic devices provide a solution for quick quantitative impairment evaluation.

Main objective: To demonstrate feasibility of evaluating shoulder abduction strength (AS) and independent joint control (IJC) using robot-based metrics in clinical practice.

Methods: Stroke patients performed 4 evaluation sessions during the first 12 weeks after admission to rehabilitation. AS and IJC were quantified using HapticMaster robot during isometric contractions and standardized reaching tasks (requiring selective control of shoulder-elbow), respectively, along with Fugl-Meyer assessment (FM). Robot-based metrics were reduced versions of previously reported laboratory-based measures.

Results and discussion: Of 24 patients included, robot metrics were collected in 18 (≥2 sessions in 10 patients). Missing data were related to technical problems (mainly during first 6 months), shoulder pain or early discharge.

At baseline, FM ranged from 15 to 66. FM and AS increased across sessions in all patients but one. IJC remained unchanged (n=6) or decreased at session 2 (n=4). IJC correlated with AS (ρ=-0.22) nor FM (ρ=0.05), whereas AS did (ρ=0.74).

Conclusion: After technical start-up issues, clinical administration of robot-based metrics was feasible. However, assessment using reduced IJC version may suffer from insufficient AS or display ceiling effects. Outcomes illustrate a relation of AS with FM, but IJC appears a different construct. AS and IJC deserve distinctive attention during evaluation, possibly using adapted robot-based metrics.

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Therapeutic effect of repetitive transcranial magnetic stimulation on non-lesional focal refractory epilepsy

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Introduction: Repetitive transcranial magnetic stimulation (rTMS) is a non-invasive technique that enables changes in the excitability of different cortical areas. Several studies using rTMS for the treatment of epilepsy have shown diverse degrees of seizure control. One aspect that influences rTMS results is the precise localization of the epileptic focus.

Main objective: This study was performed to investigate the effects of low-frequency rTMS on non-lesional focal epilepsy to investigate the effects of low frequency rTMS on non-lesional refractory focal epilepsy.

Methods: This was a prospective open-label longitudinal study with four patients with multi-drug-resistant non-lesional focal epilepsy and no control group. The patients received daily doses of 900 pulses of 0.5-Hz stimulation for 10 days over the epileptic foci in neocortical areas determined by electrical source analysis. The outcomes were measured in terms of seizure reduction. The incidences of seizures were measured at baseline (4 weeks), intervention (2 weeks), and follow up (8 weeks).

Results and discussion: Seizure reduction was observed in three of four subjects. The effects of rTMS persisted over a follow-up period of 8 weeks. One of the four patients did not respond to rTMS and showed no seizure reduction.

Conclusion: The low frequency rTMS would be an effective treatment for non-lesional focal refractory epilepsy, may be an adjunctive treatment with conventional medical treatment for refractory epilepsy. These results are therefore useful for planning treatment strategies for patients with refractory epilepsy, as well as for treatment of epilepsy.
The effects of rtms on eating disorder in a patient with stroke:
a case report
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Introduction: The rTMS can modify excitability at the cerebral cortex site stimulated as well as in remote structures along functional anatomical connections. Recent RCT showed one evidence which the rTMS would modify eating behaviors and weight.

Main objective: We present a case who has had chronic stroke, morbid obesity, and binge eating disorder history, was treated by rTMS.

Results and discussion: A 63 year-old male visited our rehabilitation clinic due to binge eating disorder, progressive weight gain and mild dysphagia. He had stroke histories; first attack was intracranial hemorrhage at left striatum 12 years ago, second attack was intracranial hemorrhage at right striatum 10 years ago. Since then, he has suffered by gait disturbance, cognitive decline, regularly visited in rehabilitation outpatient clinic. Several months ago, his caregiver has complaint of obsession for eating, mild dysphagia, and frequent binge eating. He experienced asphyxia due to binge eating in mealtime, recently. The patient received 10 Hz stimulation over the left dorsolateral prefrontal cortex(DLPFC) for 10 days with a daily dose of 1000 pulses. After then, total energy and macronutrient intakes were reduced, the weight of patient also reduced.

Conclusion: These patients usually got the lower physical activities than premorbid state, and have gotten obese. These multi-dimensional reasons with eating behaviors would be a barrier for conventional treatment with medication or exercise. In our case, high frequency rTMS for left DLPFC modified eating behavior, and induced reduction of weight and food intake. The rTMS would be a useful addition of patients with stroke, for modification of eating behaviors or weight.
Towards the estimation of lesion conductivity in chronic stroke patients through combined eeg/tdcs: a simulation study

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Introduction: The efficacy of transcranial direct current stimulation (tDCS) after stroke is reported to be mixed. This may be partially explained by lack of individualisation of the target stimulation location. Numerical simulations can guide the choice of the anode-cathode configuration that optimally stimulates the target. Such simulations require a correct value for the lesion conductivity, which is not accurately known.

Main objective: The goal of this study is to develop a method that allows for accurate estimation of a chronic stroke lesion conductivity, using combined tDCS and EEG simulations.

Methods: A realistically shaped 3 compartment head model (3H) was generated from a T1w-MRI image, including scalp, skull and brain. From 3H, a second model was created (4S) including as a fourth compartment a stroke lesion. The conductivities were fixed in both models.

Step 1: Identification of anode-cathode configuration that maximises the scalp potential difference between 3H and 4S.

Step 2: Estimation of the lesion conductivity for the anode-cathode configuration identified in Step 1.

Results and discussion: Step1 converged and an optimal configuration was identified. Step 2 was able to estimate the true lesion conductivity.

Conclusion: This study gives promising results towards the estimation of the lesion conductivity in chronic stroke patients. The Methods presented were able to, first, identify the anode-cathode configuration that is maximally affected by the presence of the lesion and, second, give an accurate estimation of the true lesion conductivity.

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Electrical stimulation in lower limb during exercise to improve gait speed and functional motor ability early after stroke. A scoping review with meta-analysis

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Introduction: Stroke is the third most common cause of disability in adults over 65 years of age and there are 30.7 million survivors after stroke worldwide. Stroke survivors have the highest odds of reporting severe disability and the greatest variety of individual domains of disability compared to a range of other conditions. Electrical stimulation of peripheral sensory-motor systems increases voluntary movement and muscle strength and thereby raises the activities of daily living (ADL).

Main objective: Little is known about electrical stimulation during physical activity in early rehabilitation; the objective of this review is therefore to investigate early rehabilitation and whether external electrical stimulation combined with activity improves functional motor ability and gait speed in patients who have experienced a stroke within the last 6 months.

Methods: A scoping review and random effects meta-analysis of randomised controlled clinical trials on gait speed and functional motor ability measured with Barthel Index (BI) and Bergs Balance Scale (BBS).

Results and discussion: 8 trials were included (n= 191). Explorative meta-analysis was performed on gait speed (5 trials, n=120), BI (3 trials, n=74) and BBS (3 trial n=79). A small, significant difference on gait speed 0.15 ([95 % CI: 0.08-0.21]) m/s, but no difference in BI 2.88 ([95 % CI: -3.3-9.07]) and BBS 1.73 ([95 % CI: -2.8-6.27]).

Conclusion: Sparse, moderate quality evidence indicates that in order to improve ADL, electrical stimulation combined with activity is a relevant intervention for stroke patients having a stroke within the last six months.
The affect of lycra compression on upper limb muscle activity during a reaching task

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Introduction: Impairment of the upper limb is common in neurological injury. Lycra garments have been used in neurological rehabilitation as an adjunct however the evidence base remains limited. Lycra has been reported to improve function in children with cerebral palsy and adult stroke survivors. The physiological effect of garments is not clearly understood. Increases in muscle activity around the shoulder have been found in static positions but have not been replicated during functional tasks.

Main objective: To investigate the affect of a Lycra garment on upper limb muscle activity during a reaching task.

Methods: A same subject crossover design was used. 21 healthy participants were randomised to a Lycra or ‘no lycra’ condition. The garment comprised an arm sleeve and hand/finger gauntlet. Surface electromyography (EMG) was applied to the anterior/middle deltoid, wrist extensor and long finger flexor muscle groups. Subjects undertook three repetitions of a standardised reaching task. Following an interval subjects repeated the task in the alternate condition.

Results and discussion: When wearing Lycra garments there was a significant 7.5% reduction in middle deltoid activity (p<0.001) and a 32% increase in wrist extensor activity (p<0.001). Changes in activity may only be seen in muscles which are more active during tasks. Decrease in deltoid activity may have been a result of increased activity more proximally around the shoulder girdle which was not investigated. Future study of girdle muscles and alternate functional tasks is warranted.

Conclusion: Lycra garments are increasingly used as an adjunct in neurological rehabilitation. This study adds to the evidence base in this developing area.
Changes in premotor beta and parietal alpha oscillations indicate gait adaptation to walking with a transfemoral dummy prosthesis

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Introduction: After transfemoral amputation, gait adjustments are necessary to safely walk with a prosthesis. Cortical oscillations are modulated by various walking conditions and may reflect gait adjustments. Identifying cortical correlates of gait adaptation is important for development of neuroprosthetics and novel EEG-based parameters for rehabilitation progression.

Main objective: Our objective was identifying specific cortical oscillations distinguishing when healthy individuals walk without or with a dummy mechanical-knee prosthesis.

Methods: Fourteen participants walked on a treadmill without (one block: four minutes) and with a dummy-prosthesis (three blocks), while 32-channel EEG was recorded. After artifact correction and visual inspection, independent component analysis isolated brain-related activity from distinct anatomical sources. Source-level data was divided into step cycles and the average power spectral density (PSD) was computed within each walking block. According to estimated source locations, the PSD was compared at group-level between walking without prosthesis, first, and last blocks with dummy-prosthesis (pair-wise two-tailed repeated measures t-tests). Statistical significance was determined by surrogate statistics (n=1000,α=0.05).

Results and discussion: The power of premotor beta (21-27Hz) and parietal alpha (10-15Hz) oscillations was reduced during first and last block with dummy-prosthesis (cf. walking without, p<0.05), indicating increased cortical activation, possibly due to changes in motor planning (premotor) and sensory integration (parietal). Comparing first vs. last dummy-prosthesis blocks showed a trend towards decreased cortical activation (premotor) in the last block (p=0.06).

Conclusion: Changes in premotor beta and parietal alpha oscillations indicate motor adaptation during initial use of a (dummy) transfemoral prosthesis.
109
A cohort study of functional electrical stimulation in people with multiple sclerosis demonstrating improvements in quality of life and cost effectiveness.
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Introduction: Functional Electrical Stimulation is used to improve walking speed in people with multiple sclerosis and foot drop, this study explores it’s impact on health related quality of life (HrQOL) and cost-effectiveness.

Main objective: Does Functional Electrical Stimulation improve HrQOL and walking speed in people with Multiple Sclerosis and is it cost-effective?

Methods: Data on health related quality of life (EQ-5D-5L and the Psychosocial Impact of Assistive Device Scale; PIADS) and walking speed were collected on 82 patients with multiple sclerosis attending for set up with Functional Electrical Stimulation and at six months. EQ-5D-3L utilities were derived and cost-effectiveness analysis completed utilising a 5 year time horizon and methodology and inflated costs published by National Institute for Health and Care Excellence (NICE, UK).

Results and discussion: Significant differences were seen in walking speed with FES use at baseline and maintained over 6 months (p<0.001). HrQOL significantly improved with a meaningful mean score in all aspects of the PIADS and a statistically significant change in EQ-5D (p<0.001) over 6 months. No correlations between changes in walking speed and HrQOL. In the cost-utility analysis, compared to standard care, FES was more expensive and more effective with an incremental cost effectiveness ratio of £6,137.

Conclusion: FES is a cost-effective treatment to improve walking speed and health related quality of life in people with multiple sclerosis. Longer term studies on the continued cost-effectiveness and quality of life changes in people with multiple sclerosis and other neurological conditions are recommended.


Acknowledgements: Work supported by ERC-H2020 MyLeg (n.780871). Data collection conducted at Center of Human Movement Sciences, UMCG.
Introduction: Many patients with Parkinson’s disease (PD) suffer from impaired dexterity, which impacts activities of daily living and quality of life (QoL). The Leap Motion™ Controller (LMC) combines video game-based training with augmented virtual reality.

Main objective: The aim of the present pilot study was to comprehensively evaluate the feasibility of a dexterity training program using the LMC, in patients with PD.

Methods: Ten patients with PD (aged between 55-75 years, Hoehn and Yahr stage II-IV) trained over a period of four weeks, twice a week for 30 minutes. Baseline (T0) and post-intervention (T1) assessments were done. Primary outcomes with respect to feasibility were the compliance rate, open-end questions, the level of participation (Pittsburgh Rehabilitation Participation Scale) and the usability (System Usability Scale). Dexterous function was measured with the Nine Hole Peg Test and the Dexterity Questionnaire 24. Upper limb motor impairment was assessed by a modified version of the Movement Disorders Society Unified Parkinson’s Disease Rating Scale III. Finally, QoL was assessed by the Parkinson's disease questionnaire 39.

Results and discussion: Compliance rate was 99%, motivation increased significantly from 3.9 to 4.8 (PRPS, p=0.03) and system usability of the LMC system was acceptable to very good. Regarding potential efficacy, patients with impaired dexterity at T0, significantly improved in dexterity (Nine Hole Peg Test) and QoL (PDQ-39, both p<0.05)).

Conclusion: The present pilot study suggests that video game-based LMC dexterity training in PD is feasible and has potential to improve dexterity. Its efficacy should now be investigated in a properly powered randomized controlled trial.
The effectiveness of peroneal nerve functional electrical stimulation (fes) for the reduction of bradykinesia in parkinson’s: a pragmatic feasibility study for a single blinded randomised control trial. the steps project.

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Introduction: FES is a means of producing movement in paralysed muscles and is commonly used to correct dropped foot in MS or Stroke. Two small studies have indicated that the same technique may reduce bradykinesia, akinesia and hypokinesia in Parkinson’s.

Main objective: STEPS aimed to gather information to inform the design of a multicentre trial to demonstrate the clinical effectiveness of common peroneal stimulation to improve mobility for people with Parkinson’s. Feasibility aims included the determination of recruitment and retention rates, acceptability of the protocol and intervention and size of a future study.

Methods: 64 people with Parkinson’s were recruited over 18 months at 2 centres. The control group received normal care. The treatment group received FES and normal care for 18 weeks and were reassessed 4 weeks after FES was withdrawn. Assessments were, 10m walking speed and stride length, UPDRS, MiniBESTest, NFOG, FESI, PDQ39, EQ5D5L and a falls-diary. All measures were taken without FES in the on-phase by a blinded assessor.

Results and discussion: Recruitment rate was 1.8 participants per month per centre. 51 participants completed the protocol indicating (retention rate 80%). The protocol was acceptable to participants and walking speed identified as a surrogate marker for overall gait ability. 21 of 32 achieved a substantially clinically meaningful improvement in walking speed of 0.1ms-1
Conclusion: The feasibility of the study was demonstrated. FES use was associated with reduced bradykinesia, hyperkinesia and akinesia. A fully powered study (n=274-470) is required to confirm these observations.

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**Developing the swipe-slide pattern task to capture smartphone skill learning in parkinson’s disease**

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**Introduction:** Fine motor skill impairments have a severe impact on the use of touchscreen technology in Parkinson’s disease (PD). Although recent work showed that intensive training results in improvements of upper limb functions in PD, little is known regarding practice effects of manipulating touchscreen technology.

**Main objective:** We investigated whether the newly-developed Swipe-Slide Pattern (SSP)-task, similar to a smartphone unlock-trace, can capture learning of touchscreen skills in PD.

**Methods:** Ten patients and 10 healthy controls learned the SSP-task. On day 1, two consecutive runs were performed (early and late learning, each nine blocks of 36s). After 24h, a retention test (six blocks of 36s) followed. Movement time (MT, s), Euclidean distance (ED) and a performance index (PI=MT/ED) were compared using Friedman ANOVAs for both groups. Learning and offline consolidation indices were compared between both groups with Mann-Whitney U-tests. SSP outcomes were correlated (Spearman) to clinical characteristics.

**Results and discussion:** Both groups significantly improved MT and PI across the learning stages (all p<0.01). However, controls demonstrated further benefits from late learning to retention, while patients did not. This difference was confirmed by a significantly worse offline consolidation index in PD for MT and PI (both p<0.05). In patients, these consolidation difficulties were correlated to a longer disease duration (D=0.897). Overall, results suggest that the SSP-task is capable of detecting the difficulties that PD patients experience with retention, corroborating earlier studies.

**Conclusion:** The SSP-task is a valid test to assess motor learning of smartphone skills in PD.
The association between freezing of gait, fear of falling and anxiety in Parkinson’s disease: a longitudinal analysis.

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Introduction: Freezing of Gait (FoG), Fear of Falling (FoF) and anxiety are common in Parkinson’s disease (PD).

Main objective: However, their mutual, time-varying interactions have not been well investigated and therefore we studied the longitudinal associations between FoG, FoF and anxiety and how these associations are influenced by confounding factors such as demographics, disease characteristics, medication and adverse effects of medication.

Methods: We analysed longitudinal data from the observer-blinded, randomized, clinical RESCUE trial (Rehabilitation in Parkinson’s disease: Strategies for Cueing) of 153 PD patients. Motor impairment scores, questionnaires and physical activities were measured every three weeks, over a 12 week period. All crude and adjusted analyses were performed with random coefficient analyses using MLwiN (version 3.00) with a two-tailed significance level of 0.05.

Results and discussion: All crude associations between all the main factors FoG, FoF and anxiety were significant and remained so after adjusting for especially disease characteristics, medication and adverse effects. When analysing FoF and anxiety together as independent variables, the relationship between FoG and FoF remained equally strong, while the relationship between FoG and anxiety became less strong.

Conclusion: Our findings, based on a longitudinal design, show positive interactions between FoG, FoF, and anxiety, suggesting that these symptoms interact and may aggravate each other. These reported interactions between motor and non-motor problems in PD underline the importance of an integrated interdisciplinary approach in diagnostics and treatment in these patients.

Acknowledgements: We are grateful to all patients who volunteered to participate in this study. We are indebted to the researchers Lim I, Jones D, Rochester L, Nieuwboer A, Willems AM, Baker K and Hetherington V.
Evaluation of an occupational educational training for caregivers of patients with Parkinson’s disease: a prospective pilot study

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Introduction: Caregivers often experience a burden when giving support to their spouses, who suffer from Parkinson’s disease (PD), and this during many activities of daily living (ADL). It is assumed that if caregivers are integrated, and are well educated within an occupational treatment setting, this may lead to a lesser burden and improved quality of life (QoL). However, this has not yet been systematically evaluated.

Main objective: The aim of the study is to evaluate, whether an occupational educational training for caregivers of patients with PD leads to a positive perceived change in the patient’s ADL performance. We assume that the specific training of caregivers will lead to lesser burden and better QoL.

Methods: In this study twenty caregivers and their spouses are recruited and receive a 3-4 week training, which incorporates specific ADL management and educational strategies. Baseline and two follow-up standardized measurements are done by an occupational therapist. These measurements include various questionnaires which evaluate the performance and satisfaction of ADL, as well as burden and QoL. The Canadian Occupational Performance Measure (COPM) is used to enable a client-centered definition of therapy priorities and goals.

Results and discussion: It’s an ongoing study and so far two pairs were included. Based on initial feedback, caregivers were very positive towards this new approach. Especially the educational support with regards to aids was highly appreciated. We anticipate to observe an improvement in the aforementioned outcomes and expect to present first preliminary results at the Congress.
A sustainable model of integrating self-management support across stroke and neurological services: the ‘people1st’ project
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Introduction: Self-management support has an evolving evidence base for people with neurological conditions and is a priority for commissioners of health and social care. ‘Bridges’ is an established approach to self-management, used in stroke and other complex conditions, that has been commissioned for implementation and evaluation across the East of England, UK.

Main objective: To evaluate the implementation, mechanisms of impact and sustainability of the Bridges self-management approach in neurorehabilitation services in the East of England.

Methods:
Participants:
Neurorehabilitation team members, from a range of clinical services, attending training delivered according to the Bridges programme.

Design:
Mixed-Methods evaluation consisting of: Participant questionnaires completed pre and post-training and at three-month follow-up workshops; embedded evaluator observations of Bridges training; semi-structured interviews with sub-groups of multi-professional participants. The evaluation framework, questionnaires and interview topic guides were developed incorporating key concepts from Normalisation Process Theory (NPT).

Analysis: Quantitative questionnaire data will be analysed using descriptive statistics. Qualitative observations and interviews will be transcribed, coded then interrogated using thematic analysis.

Results and discussion: To date (January 2019), a total of 80 hours of Bridges training has been delivered to 204 participants, across six host locations, with pre- and post-training questionnaires completed. Sub-group interviews begin February 2019. Key findings, focussed on barriers and facilitators to sustainable implementation of this complex intervention, will be available for reporting May 2019.

Conclusion: This is the first large-scale independent evaluation of the Bridges self-management approach, across multiple clinical settings; it is anticipated that findings will support development of an implementation model for sustainable self-management support in neurological services.

Acknowledgements: The authors would like to thank Health Education East of England for providing financial support to this project.
Stroke survivors’ perceptions and experiences of ‘next steps group exercise and education programme’: a qualitative study

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Introduction: Stroke is the leading cause of disability in the western world. The number of people living in the community with the long term problems with stroke is continuing to grow. Group exercise classes have shown beneficial effects. ‘Next Steps’ a group exercise class initiative in the South West of England has shown beneficial effects. However, little is known stroke survivors’ experiences of this ‘Next Steps,’ class.

Main objective: The aim of this study was to therefore, to explore the stroke survivors’ perception and experiences of ‘Next Steps’ with a focus on education, exercise, social interaction and biopsychosocial outcomes.

Methods: A qualitative study consisting of semi-structured face-to-face interviews were conducted with stroke survivors (n=4). Convenience sampling was used. Interviews were audio-recorded and transcribed verbatim. Data were analysed using principles of thematic analysis.

Results and discussion: Results: Four themes emerged: 1) ‘The importance of tailored exercise’: Patients identified improved strength and function 2) ‘More relevant education’: Participants identified education could have been more interactive and specific 3) ‘All in it together’: participants reported increased motivation due to social interaction which lead to increase confidence. 4) ‘Direction and purpose’: The class provided direction and purpose to participants’ ongoing needs.

Conclusion: This study supports the evidence on perceived benefits of group exercise classes. While this study suggests stroke survivors could benefit from education personalisation and exercise delivery adaptations to improve functional outcomes, small convenient sample limits the findings. Further research is required to explore carers and family members perspectives on group exercise class for people with stroke.

Acknowledgements: This work was undertaken as part of UG physiotherapy programme at the University of West of England. We would like to thanks Bristol After Stroke for help with recruitment and participants for thier time.
When does spasticity in the upper limb develop after a first stroke? a nationwide observational study on 861 stroke patients
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Introduction: Despite efforts to identify early predictors of spasticity following the stroke, it is not yet clear when and in whom spasticity occurs after stroke.

Main objective: This study investigated the time taken for upper extremity spasticity to develop and its topical distribution after first-ever stroke onset in a nationwide multicenter study in South Korea.

Methods: The study recruited 861 individuals with post-stroke spasticity in the upper limbs and followed them for 12 months. Spasticity in the upper extremity joints was defined as a modified Ashworth Scale score ≥ 1.

Results and discussion: The mean time to develop upper limb spasticity after stroke onset was 62.03 ± 118.21 days. Approximately half of the patients with post-stroke spasticity developed spasticity during the first month, whereas approximately 16% of post-stroke spasticity cases developed after 180 days from onset. At the time of diagnosis of spasticity, most patients showed only a slight increase in muscle tone, which was observed most frequently in the elbow, followed by the wrist, fingers, and shoulder. Younger stroke survivors were more spastic, and the severity of spasticity increased with time.

Conclusion: The time until development of upper-extremity spasticity following a stroke averaged 2 months, but ranged widely. Post-stroke spasticity can develop more than 6 months after stroke onset. Therefore, it is important to assess spasticity, even in the chronic state.
What lesions in the brain produce spasticity?

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Introduction: Spasticity is an important barrier that can hinder the restoration of function in stroke patients. Although several studies have attempted to elucidate the relationship between brain lesions and spasticity, the effects of specific brain lesions on spasticity according to the involvement of the upper or lower limbs remain unclear.

Main objective: The present study aimed to investigate the roles that specific brain lesions play in the development of spasticity according to the upper and lower limbs using lesion symptom mapping Methods.

Methods: The retrospective longitudinal observational study assessed 45 stroke patients using the modified Ashworth Scale to measure muscle spasticity. Each patient was assessed four times: initially (within 2 weeks of stroke) and at 1, 3, and 6 months after the onset of stroke. Brain lesions were analyzed using voxel-based lesion symptom mapping (VLSM) with MRI images.

Results and discussion: The VLSM revealed that lesions in the superior corona radiata, posterior limb of the internal capsule, posterior corona radiata, thalamus, putamen, premotor cortex, and insula were associated with the development of upper-limb spasticity. Lesions of the superior corona radiata, posterior limb of the internal capsule, caudate nucleus, posterior corona radiata, thalamus, putamen, and external capsule were associated with the development of lower-limb spasticity. The striatum and thalamus likely play important roles in the development of spasticity in the upper and lower limbs.

Conclusion: The involvement of white matter tracts and the striatum influenced the development of spasticity of stroke patients. These results may be useful for planning rehabilitation strategies and for understanding the pathophysiology of spasticity.
First results from the early-bird study, a prospective, non-interventional study to assess effectiveness of abobotulinumtoxinA in post-stroke upper limb spasticity in relation to timing of treatment

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Introduction: Recent studies of botulinum toxin for post-stroke spasticity indicate potential benefits of early treatment.

Main objective: This non-interventional study aimed to assess the impact of disease duration on the effectiveness of abobotulinumtoxinA (AboBoNT-A) treatment for upper limb spasticity.

Methods: The early-BIRD study [NCT01840475] followed adult patients with post-stroke upper limb spasticity undergoing routine AboBoNT-A treatment for ≤4 treatment cycles. Patients were categorized by time from stroke event to first BoNT-A treatment in the study (as defined by the 1st and 3rd quartiles time distribution) into early-, medium- and late- start groups. We hypothesised that the early-start group would show a larger benefit as assessed by the modified Ashworth scale (MAS, primary endpoint) on elbow plus wrist flexors versus the late-start group.

Results and discussion: Of the 303 patients enrolled, 292 received treatment and 186 completed the study (main reason for early discontinuation was lost to follow-up, n=51). Patients in all groups showed a reduction in MAS scores from baseline over the consecutive injection visits (i.e. at end of each cycle). However, the primary analysis did not show a significant difference between early versus late start treatment (ANCOVA: difference in adjusted means of 0.15, p=0.546) at last study visit.

Conclusion: Patients in all groups displayed a benefit from AboBoNT-A treatment, supporting the utility of treatment for patients at various disease stages. While no significant benefit of early versus late start of
treatment was observed in terms of MAS, further analyses will evaluate goal attainment and quality of life.

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Topic 15: Spinal cord injury

95

A single subject case study into functional gait improvements seen 18 months post incomplete spinal cord injury (sci) using functional electrical stimulation (fes) and augmented feedback (af)/virtual reality (vr) treadmill training.

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Introduction: This case report evaluates the use of FES and AF/VR treadmill training in late SCI rehabilitation.

Main objective: To present the rehabilitation and functional gait improvements of a patient from 9th to 18th month after sustaining a C5/6 SCI.

Methods: Retrospective case study of a patient 9 months post SCI receiving treatment twice a week for 9 months with a goal to improve walking speed, balance and reduce spasms which were having a detrimental effect on gait. Measurements were taken throughout using Motek treadmill embedded force plate and video gait analysis.

Results and discussion: Intensive treadmill training using the Motek forcelink C-Mill treadmill and Bioness L300 PLUS lower limb FES system with a 23-year-old male, who initially presented with AIS D C2 Tetraplegia associated with spastic left hemiplegia including problematic spasms/ clonus inhibiting function. Grade 1 dorsiflexion and reduced passive range of movement (unable to achieve plantargrade). Mobile indoors and out unaided with a Boxia AFO. Berg balance was 47/56 with Boxia AFO in situ. Comparison of baseline and follow-up gait data shows gradual improvement in speed, distance and stride length. Associated with improved active/ passive left LL dorsiflexion range and decreased spasticity. Including FES therapeutic effect, being able to mobilise unaided/without FES or AFO.

Conclusion: The data recorded demonstrated significant functional improvements in gait, reducing the secondary complications of spasticity and loss of ROM, showing carry over of therapeutic gains, to walking without FES, identifying benefits of FES and AF treadmill training, 18 months post SCI.
Crossed cerebellar diaschisis has an adverse impact on functional outcome in the subacute rehabilitation phase of stroke: a case-control study

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Introduction: Crossed cerebellar diaschisis (CCD) has played an important role in explaining the impact of supratentorial stroke on the cerebellum. However, it remains unclear whether CCD influences functional outcome.

Main objective: To investigate whether CCD is associated with functional outcome in the subacute rehabilitation phase of stroke.

Methods: Forty-eight participants who underwent brain single-photon emission computed tomography were retrospectively enrolled. Patients with CCD were identified (n=24). Twenty-four controls were selected for each case-patient by matching age, stroke type, lesion laterality and location. The Functional Ambulation Category (FAC), the modified Barthel Index (MBI), and the Mini-mental State Examination (MMSE) were administered at the initial assessment (initiation of rehabilitation therapy) and at the follow-up assessment (4 weeks after rehabilitation therapy).

Results and discussion: The CCD group showed lower FAC, MBI, and MMSE scores at the initial assessment (p=0.016, 0.001, 0.032, respectively) and lower FAC and MBI scores at the follow-up assessment, compared with the non-CCD group (p=0.001, 0.036, respectively). Although CCD was not associated with cognitive impairment, non-ambulatory status and dependent activities of daily living (ADL) at the initial assessment (p=0.538, p=0.083 and 1.000, respectively), the CCD group has a higher risk of cognitive impairment (odds ratio [OR]=4.044, 95% confidence interval [CI]=1.071–15.270, p=0.039), non-ambulatory status (OR=7.000, 95% CI=1.641–29.854, p=0.009) and dependent ADLs (OR=13.500, 95% CI=1.535–118.692, p=0.019) at the follow-up assessment.

Conclusion: CCD may be associated with severe functional impairment, and may have an adverse impact on functional outcomes related to cognition, ambulatory function and ADLs during the subacute rehabilitation phase of stroke.
‘Does this feel like stroke to you?’ - a qualitative study of a community neuro and stroke teams’ perspectives on stroke with functional overlay and functional neurological disease

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Introduction: Approximately 8.4% of patients admitted to an acute stroke unit are functional strokes and 13% of stroke patients have symptoms that cannot be fully explained by the disease. However in practice, there appears to be a lack of understanding amongst clinicians’ with regards to functional symptoms in relationship to stroke patients.

Main objective: The aim of this study was to investigate clinicians’ perspectives of functional neurological disorder and functional overlay with stroke.

Methods: Qualitative study design using interpretative phenomenological analysis (IPA) to review data generated from 10 semi-structured interviews with experienced clinicians (a stroke consultant, a clinical psychologist, speech and language therapists, occupational therapists, physiotherapists and a nurse) in a Community Stroke Team in England. All interviews were transcribed verbatim and themes were identified from the text, in accordance with the principles of IPA.

Results and discussion: Three main themes were identified from the data collected:
1) Making sense of functional overlay; clinicians identified functional overlay as a ‘grey murky area’.
2) Functional overlay challenging the medical model; clinicians described the incompatibility of functional overlay with the medical model as potentially problematic, not just for themselves, but also for patients and families.
3) Treating functional overlay; clinicians felt frustrated by lack of clear diagnosis, evidence and education.

Conclusion: This research provided an in-depth insight into clinicians’ experience of stroke and functional symptoms and identified the need for an overt diagnosis as well as further education and research into this field.

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The effect of additional core stability exercises on improving dynamic sitting balance, trunk control, functional rehabilitation and quality of life for subacute stroke patients: a randomized controlled trial protocol

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Introduction: Trunk impairment and restricted balance in post-stroke subjects are correlated with increasing risk of falls and impaired mobility. Implementing core stability exercises may be a strategy for improving trunk performance and dynamic sitting balance, standing balance, and gait in post-stroke patients.

Main objective: To compare the efficacy of conventional physiotherapy versus an approach based on a core stability exercises (CSEs) program, in terms of dynamic balance, gait and functional rehabilitation at the end of the intervention (5 weeks) and in the long term (sustained effect over time at 3 and 6 months), in sub-acute post-stroke patients. A secondary objective will be to develop and evaluate the feasibility and efficacy of a specific mobile application (app) to reinforce the adherence to unsupervised home-based CSEs by the own patient in the long term.

Methods: Multicentre (4 hospitals) blinded-assessor randomized controlled (parallel group) trial. Study duration per patient will be 29 weeks (intervention period: 5 weeks, followed by 24 weeks follow-up). The study will consist in two parts: 1) A main study (CORE Trial) where physiotherapy modalities will be compared (main comparisons), and 2) an ancillary substudy (CORE-App Study) where the effect of a mobile application (app) will be evaluated (secondary comparison). Both studies will consist in a randomized controlled trial.

Results and discussion: Expected results: The study will provide useful information on the short and long term effects of a physiotherapy rehabilitation program based on core stability exercises, as well as the potential use of a mobile app to reinforce long term adherence to unsupervised home-based physiotherapy.
Muscle activity in the affected leg of stroke patients can be manipulated by altering guidance offered to the unaffected leg during lokomat guided gait

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Introduction: The Lokomat, a robotic exoskeleton, offers the possibility to train asymmetrically. By providing asymmetrical movement guidance during Lokomat therapy in stroke patients, the capacity of the unaffected leg may be utilized to evoke a higher muscular activity in the affected leg.

Main objective: To assess whether the level of muscle activity in the affected leg of hemiplegic stroke patients can be manipulated by varying the level of guidance offered to the unaffected leg.

Methods: Ten patients with chronic hemiplegic stroke walked in the Lokomat at two treadmill speeds (0.28 and 0.56 m/s), while guidance to the legs was offered symmetrically (both legs received 30% or 100%) or asymmetrically (one leg receiving 30% and the other leg 100%). Muscle activity was recorded from Biceps Femoris, Rectus Femoris, Vastus Medialis, Medial Gastrocnemius and Tibialis Anterior. Repeated Measures ANOVAs were conducted to assess the effects.

Results and discussion: At 0.28 m/s, muscle activity (Vastus Medialis and Medial Gastrocnemius) in the affected leg increased when guidance to the unaffected leg was lowered. Conversely, muscle activity of these muscles decreased when more guidance was offered to the unaffected leg. At 0.56 m/s, no such effects were observed.

Conclusion: This study suggests that, for specific speed settings during Lokomat guided gait, the capacity of the unaffected leg may be exploited to evoke a higher muscular activity in the affected leg of stroke patients by asymmetric guidance.

Acknowledgements: The authors wish to thank Emyl Smid, Steven Floor, Matthijs Dijkema and Geke van der Heide for their help conducting the study.
Validation of questionnaires measuring flow for patients with subacute stroke

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Introduction: Being in “Flow” during rehabilitation training may have a considerable impact on functional outcome. Flow can be described as a subjective state that people report when they are completely involved in an activity, feeling satisfaction and enjoyment. Flow questionnaires have been developed to measure Flow. To date the reliability and validity of Flow questionnaires for stroke remains unexplored.

Main objective: The purpose of this prospective study was to evaluate the reliability, responsiveness and construct validity of two Flow questionnaires in stroke patients.

Methods: Stroke in-patients with impaired upper limb function were consecutively recruited at one neurorehabilitation center. They received intensive upper limb therapy (on weekdays, from admission to discharge). The participants completed two Flow questionnaires: the Flow State Scale for Occupational Tasks (FSSOT) and the Flow Kurzskala (FKS), once a week immediately after upper limb training. Validation of both questionnaires was based on internal consistency, exploration of floor-ceiling effects, responsiveness and construct validity by correlating both questionnaires with a measure of mood state, the Hospital Anxiety and Depression Scale (HADS).

Results and discussion: Twenty-eight in-patients with stroke were included (mean age 67.50; 13 females, time after stroke onset (mean 7.4 days [SD=3.1]). Good internal consistency was found for FSSOT and FKS (Cronbach’s α 0.758; 0.812 respectively). No floor or ceiling effects were found. Good responsiveness was presented within one week (Pearson r=0.681,p=0.000; r=0.84,p=0.000). Significant negative correlations between the HADS and both questionnaires (Pearson r=-0.521,p=0.011; r=-0.555,p=0.006) were found indicating good construct validity.

Conclusion: The FSSOT and FKS are reliable and valid measures for evaluating Flow in stroke rehabilitation settings.
Sensory attenuation in post-stroke fatigue
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Introduction: Sensory attenuation is a phenomenon whereby the perception (intensity) of afferent input caused by a self-generated movement is reduced. Sensory attenuation provides an account for how two physically identical sensory stimuli can be perceived differently. Post-Stroke Fatigue may be a result of reduced sensory attenuation. A commonly used method to assess and quantify sensory attenuation behaviourally, is by using the force matching task.

Main objective: Assess whether sensory attenuation is reduced in high fatigue patients using a modified version of the force matching task.

Methods: The study is being carried out in both healthy volunteers and stroke patients with varying severity of fatigue. Subjects performed a simple force matching task in order to quantify sensory attenuation. The force transducer produced pre-determined force levels (1, 2, 3 and 20 Newtons) directly onto the index finger of their non-dominant hand for 3 seconds (target force). After the 3 second time window, subjects were instructed to simply remember the force they just experience on their finger and do nothing else for a further 3 seconds. Subjects were then given a cue to match the intensity of the force on the same finger by moving the force transducer using a lever with their dominant hand. Subjects had 5 seconds to produce the appropriate force and were instructed to hold it (match force) until they saw a stop signal on the monitor.

Results and discussion: Data collection is still ongoing at the time of Abstract Submission.
39

Stroke in young adults: quality of life and rehabilitation goals of young adults following stroke

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Introduction: The affect a stroke has on the quality of life of young adults is relatively unexplored, and there are no rehabilitation guidelines that are specifically tailored for them that takes into account their aims post-stroke.

Main objective: The aim of this research study was to establish key themes of the difficulties faced by and rehabilitation goals of young adults who have had a stroke.

Methods: Participants who had experienced a stroke (18-40years: n=6, 41-54years: n=20, 55-65years: n=15) were recruited from six health boards in Wales, UK. Data were investigated using interpretative thematic analysis of feedback from participants who were asked to complete a questionnaire asking them to name three things they find difficult and three aims they have since they had a stroke.

Results and discussion: Two key themes of difficulties emerged: Independence and communication. Sub-themes of difficulties within independence included walking (walking fast, loss of endurance, walking outside and up/down stairs), and inability to complete activities of daily living (washing, dressing and preparing food). Sub-themes within communication included talking, writing and reduced concentration during a conversation. Regain independence and participate in social activities were key aims with sub-themes of these including return to work and to be able to “walk normally.”

Conclusion: Understanding the effect of stroke on young adults’ quality of life is critical to successful targeted rehabilitation and in enabling a greater proportion of individuals to return to work and participate in social activities.
**Acknowledgements:** The authors would like to acknowledge Mr Samuel Wishdish for his assistance during data collection and data analysis.

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**Pre-movement excitability in post-stroke fatigue**

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**Introduction:** Movement preparation includes predicting the sensory consequences of one’s own actions, a key component of sensory attenuation. Movement preparation has been studied using reaction time tasks in which a delay separates an instruction stimulus from a subsequent “go” cue. Neuronal activity in a number of brain areas is dynamically regulated during the delay period in such tasks. In humans, motor cortex excitability, assessed using transcranial magnetic stimulation (TMS), is transiently suppressed during the delay period and then increases progressively after the “go” cue before the onset of voluntary movement. The underlying mechanisms and functional role of these excitability changes occurring to movement are still unclear.

**Main objective:** By measuring motor cortex excitability during a simple warned reaction time task, I set out to answer the following question: does pre-movement motor cortex excitability change as a function of fatigue in stroke patients?

**Methods:** The study is being carried out in both healthy volunteers and stroke patients with varying severity of fatigue. Subjects performed a simple reaction time task in which an auditory warning stimulus (WS) preceded an auditory imperative stimulus (IS) by a fixed interval of 500ms, and the latter signal cued a response. Participants were instructed to respond quickly and accurately to the IS by making a finger abduction with their index finger. TMS was delivered at time points during the task to assess motor cortex excitability.

**Results and discussion:** Data collection is still on going at the time of Abstract Submission.
Mobilization techniques for the hemiplegic shoulder in subacute stroke patients with severe arm impairment
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Introduction: Preserving the passive range of motion (PROM) of the shoulder is essential to prevent hemiplegic shoulder pain. For a substantial amount of patients, due to severe arm impairments, therapists have to rely on more passive interventions. However, no studies are available that investigate which mobilization technique is the most effective and safest for the hemiplegic shoulder of stroke patients.

Main objective: To compare the effect of different mobilization techniques for the hemiplegic shoulder on shoulder PROM.

Methods: Three mobilization techniques were applied in randomized order in 11 subacute stroke patients: (1) combined soft-tissue mobilization in the scapular plane, (2) scapular mobilization without glenohumeral movement and (3) angular mobilization in the frontal plane. Primary (PROM shoulder) and secondary [pain, FM upper extremity, TIS, spasticity] outcome measures were assessed before and after each intervention [3*4 weeks]. A Friedman test was used to compare the different techniques. Followed by a Wilcoxon Signed Rank test for pairwise comparison.

Results and discussion: After technique 1 patients showed an increased PROM for external shoulder rotation (p=0.006) compared to the other techniques. No other significant differences could be detected, although the difference in shoulder abduction nearly reached significance (p=0.057) in favor of technique 1. The use of transversal stretch of hypertonic shoulder muscles and the relative external rotation of the humerus during technique 1 might explain the positive effect on PROM for external rotation.

Conclusion: Since external rotation is an essential biomechanical component in the prevention of shoulder pain using the combined soft-tissue mobilization in this study population can be recommended for that matter.
Feasibility and acceptability of objective arm-hand activity feedback applied via a wrist-worn device in stroke patients
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Introduction: Studies show that a high amount and intensity of arm usage contributes to better arm-hand functioning. However, feasible interventions to stimulate arm-hand use are lacking.

Main objective: To develop a wrist-worn activity tracker that stimulates arm-hand use after stroke by objective feedback, we evaluated the feasibility of different forms of feedback applied via a wrist-worn activity tracker in stroke patients.

Methods: Six stroke patients (5 males, 1 female; age: 58.2±18.2 yrs; 1 month - 5 years post stroke) participated in a semi-structured interview. To evaluate the feasibility of vibrotactile feedback, participants experienced for approximately ten seconds a series of vibrotactile triggers. Visual feedback was evaluated by showing ficticious activity feedback on the display of the wrist-worn activity tracker.

Results and discussion: Five out of six patients were able to feel the vibrotactile trigger applied to the more affected arm. These five patients also accepted the vibrotactile trigger. All six patients were able to read and understand the visual activity feedback. Furthermore, all patients preferred the combination of vibrotactile and visual feedback over a single form of feedback. These results provide support for including both forms of feedback in the wrist-worn activity tracker.

Conclusion: The results of this pilot study indicate that vibrotactile feedback and visual feedback applied via a wrist-worn activity tracker are feasible in stroke patients and should be combined to stimulate arm-hand use after stroke.

Acknowledgements: The authors would like to thank Rijndam Rehabilitation and Health Holland (Grant no: LSHM17065) for providing financial support to this project.
Do occupational performance correlate with reintegration to normal living? a prospective cohort study from patients’ view 1-4 years after aneurysmal subarachnoid hemorrhage

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Introduction: Many studies demonstrate that patients with aneurysmal subarachnoid hemorrhage (aSAH) experience limited participation even after several years. Unfortunately, the use of client-centered assessment tools that involves the patient are low.

Main objective: The main objective is to describe participant’s individual occupational performance and satisfaction with that performance in self-care, work and leisure 1-4 years after aSAH and the correlation to reintegration to normal living. The secondary objective is to investigate if there is any correlation between demographic factors or aSAH characteristics in the acute phase and occupational performance problems 1-4 years after the bleeding.

Methods: This study includes all patients over 18 years, treated for aSAH from 2014 to 2018 at the Haukeland University Hospital, Bergen, Norway, who were ADL independent at discharged. After approval, the patients will be interviewed by telephone with the Canadian Occupational Performance Measure and the Reintegration to Normal Living Index.

Results and discussion: Here the protocol and the first experiences with that study will be presented. Our full statistical results will be expected in December 2019.

Conclusion: This work will close a gap in the literature by identifying, from the patients’ perspective, occupational problems 1-4 years after aSAH and whether these problems relates to limited participation.

Acknowledgements: The project leader is grateful for the good cooperation with the study supervisors. Many thanks to the Department of Occupational Therapy and Neurosurgery of the University Hospital Haukeland in Bergen/Norway for their support and cooperation.
Increasing viscosity improves safety of swallow and airway protection mechanisms in post-stroke oropharyngeal dysphagia

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Introduction: Stroke may affect the neuronal circuits involved in swallowing. This can result in post-stroke oropharyngeal dysphagia (PSOD), which is characterized by unsafe swallowing and delayed swallowing kinematics.

Main objective: This study investigated the effect of increasing fluid viscosity with a gum-based thickener (Nutilis Clear®) on safety and physiology of swallowing by evaluating six viscosities (150-2000 mPa.s) compared to thin liquid in PSOD patients.

Methods: In this reference controlled, multiple dose, fixed order, single-blind and single-centre study 120 patients (≥28 days after stroke) were included. Boluses (10 mL) thin liquid, 150, 250, 450, 800, 1400 and 2000 mPa.s were given in a fixed order in duplicate and with a stop rule for safety. Each swallow was evaluated with Videofluoroscopy; statistical analysis was performed with McNemar’s, Wilcoxon signed rank test or MMRM.

Results and discussion: Prevalence of patients with safe swallowing significantly increased at each thicker viscosity compared to thin liquid (p<0.001 for each viscosity). Laryngeal vestibule closure (LVC) was delayed at thin liquid 382.5(139.1) ms (mean(SD)) and ranged 300.4(107.8) - 330.1(143.4) ms at the thickened viscosities (p<0.01). Bolus velocity was 0.3138(0.1265) m/s (mean(SD)) at thin liquid and decreased to 0.2835(0.0948), 0.2613(0.0784), 0.2564(0.0803) and 0.2729(0.1010) m/s at 450, 800, 1400 and 2000 mPa.s, respectively (p<0.05). Total swallowing duration decreased at each thicker viscosity compared to thin liquid (p<0.01). The gum-based thickener increased the prevalence of safe swallowing in PSOD in a viscosity-dependent manner and significantly improved airway protection mechanisms.

Conclusion: These results support the recommendation to use the thickener in PSOD management.

Acknowledgements:
Introduction: As cognitive deficits are associated with long-term restrictions in participation after stroke, measuring cognitive functioning is important during follow-up assessments after stroke. Various approaches exist to measure cognitive functioning, including assessing subjective cognitive complaints (SCC), cognitive screening and extensive neuropsychological testing (NPT). However, the relation between these cognitive test approaches and restrictions in participation after stroke is largely unknown.

Main objective: To examine the relationship between different ways to measure cognitive functioning (SCC, cognitive screening and NPT) and restrictions in participation in the chronic phase after stroke.

Methods: The Checklist for Cognitive and Emotional Consequences Cognition subscale (CLCE-24-C), Montreal Cognitive Assessment (MoCA) and NPT (testing multiple cognitive domains, including attention, executive functioning, memory, mental speed, verbal expression and visuospatial perception) were administered in 118 patients three to four years after stroke. The Utrecht Scale for Evaluation of Rehabilitation-Participation (USER-Participation) restrictions subscale was used to measure participation. Spearman’s rank correlations and multivariate linear regression analysis were performed.

Results and discussion: Among the different cognitive instruments the CLCE-24-C showed the strongest correlation ($r = 0.50$) with participation and the highest explained variance in bivariate analyses ($R^2 = 0.19$). The MoCA ($r = 0.23$) and NPT ($r = 0.03 - 0.29$) weakly correlated with participation. CLCE-24-C and visuospatial perception were independently associated with
restrictions in participation in the multivariate model using backward selection.

**Conclusion:** SCC are strongly associated with restrictions in participation in chronic stroke patients. Therefore, SCC should be part of the cognitive assessment during follow-up after stroke, for example using the CLCE-24-C.

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**61**

**Ctbs improves and accelerates recovery of neglect and of associated upper limb use**

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**Introduction:** Spatial neglect is a strong and negative predictor of upper limb use in activities of daily living (ADL) after stroke. Inhibitory continuous Theta Burst Stimulation (cTBS) over the contralesional hemisphere has been shown to ameliorate neglect. However, its effects on upper limb outcome are not known.

**Main objective:** In a randomized controlled trial, we assessed the effects of cTBS on neglect and upper limb use.

**Methods:** Thirty subacute right-hemispheric stroke patients with spatial neglect received cTBS (sham, 8 or 16 cTBS trains) over the left posterior parietal cortex. Neglect was measured using a neuropsychological test battery and the Catherine Bergego Scale. Upper limb use was assessed with the Upper Limb subscale of the Lucerne ICF-based Multidisciplinary Observation Scale (LIMOS). The improvement between admission and discharge from inpatient neurorehabilitation was compared between groups using univariate ANOVA. Hierarchical regression and voxel-based-lesion-symptom-mapping (VLSM) was used to analyse outcome predictors.

**Results and discussion:** Both cTBS protocols (i.e., 8 and 16 trains) significantly reduced neglect severity at discharge on a group level. On an individual level, hierarchical cluster and VLSM analyses revealed that the cTBS effects were dependent on intact inter-hemispheric connectivity. Furthermore, associated with neglect recovery, upper limb use in the ADL also significantly improved after cTBS.

**Conclusion:** In subacute stroke patients, contralesional inhibitory cTBS improves neglect recovery and, in association, upper limb use in the ADL.
Machine learning-driven personalisation of therapy in a reading rehabilitation app

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Introduction: Alexia is an acquired reading impairment which is often caused by stroke and experienced as part of a generalised communication disorder, aphasia. iReadMore is a digital therapy shown to significantly improve single word reading accuracy and speed for people with central alexia (Woodhead et al., 2018).

Main objective: In this feasibility study, we aim to demonstrate the methodology that will eventually be applied to optimising and personalising treatment in the iReadMore app.

Methods: Data previously obtained from the phase II trial of iReadMore (Woodhead et al., 2018) was used to investigate various machine learning models for algorithm optimisation and perform data analyses exploring factors affecting rehabilitation. ML models were compared for their effectiveness in representing patient’s rehabilitation progress using reading accuracy and speed as outcomes.

Results and discussion: Completed model analyses using data from 21 patients with alexia will be presented in the poster. Following on from this feasibility study, we intend to use a considerably larger sample obtained from the online roll-out of the iReadMore app to develop the algorithm to allow for personalised treatment.

Conclusion: This feasibility-stage study demonstrated how ML can be applied to complex datasets for data analysis and treatment algorithm-development. These concepts will be the focus of future research.

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The influence of dose, severity of paresis and time on efficacy of lower limb mirror therapy after stroke: an individual participant data meta-analysis
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Introduction: There is evidence to suggest that mirror therapy might improve lower limb function after stroke.

Main objective: To identify whether the efficacy of lower limb mirror therapy may be modified by: dose (the amount of mirror therapy); severity of paresis and/or time after stroke.

Methods: A systematic review conducted according to Cochrane guidelines. Two reviewers independently: identified studies; assessed risk-of-potential-bias; and extracted data. Key criteria for inclusion of controlled studies of lower limb mirror therapy for stroke survivors were: the mirror was physically present; the contribution of experimental mirror therapy was discernible; and, motor impairment, functional capacity and/or neurophysiological characteristics were measured. Electronic databases were searched (MEDLINE, PubMed, AMED, EMBASE, CENTRAL, CINHAL complete, PsycINFO, Pedro, Open Grey) using keywords including: stroke, lower limb, and mirror therapy. The reference lists of included studies were searched. Potential risk of bias was assessed using the Cochrane tool. An individual participant data meta-analysis is planned.

Results and discussion: Of 280 studies identified, 118 were removed as duplicates or as irrelevant during review of titles. Abstracts of 162 studies were screened and 35 full papers assessed for eligibility. This process yielded 14 studies for inclusion. Assessment of the risk-of-potential-bias is underway. Initial contacts with authors of included studies are planned for February 2019. Completion of Individual participant data meta-analysis is anticipated by mid-May 2019.

Conclusion: It is anticipated that findings from this review will inform future research and clinical protocols for mirror therapy for the lower limb after stroke.

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Reduced striatal recruitment to rewarding motor performance feedback after stroke

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Introduction: One factor that keeps patients motivated is what they receive in return for the training effort – the training reward, e.g. a gain in function. Often, these gains are small, occur incrementally over long periods of time and are compared against expectancies. In stroke survivors, activity of the reward system may not only be reduced because rewards are small with respect to expectancies, but also because patients after stroke may have deficits in reward processing.

Main objective: Performance dependent reward activates the striatum, a key region of the reward system. Here, we aimed at comparing the neural response to a monetary reward linked to motor skill performance in subdivisions of the striatum between stroke patients and controls.

Methods: Striatal activity in response to performance dependent monetary reward was measured in 28 subacute stroke patients and 18 age-matched peers during the training of a repetitive arc-tracking task in an fMRI scanner.

Results and discussion: Although monetary gains were comparable, stroke patients showed reduced reward-related activations in the ventral part (p<0.01), but less clearly in the dorsal part of the striatum (p=0.11). While these large divisions were affected by lesions in 10 and 14 of the 28 patients, respectively, the nucleus accumbens was preserved in all patients. Interestingly, in this subpart of the ventral striatum the activation difference was even more pronounced (p<0.001).

Conclusion: This is of particular interest as boosting ventral striatal activation was found to be the key factor for improved overnight consolidation in an earlier study using a similar task.
Lower limb muscle synergies during walking after stroke: a systematic review
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Introduction: A better understanding of the coordinated activation patterns of the lower limbs, also known as muscle synergies, might help us improve assessment, goal setting and treatment plans. Therefore, it is necessary to gain insight in the number of muscle synergies and the distribution of muscle weightings that are present during gait after stroke.

Main objective: To determine the number of muscle synergies and the distribution of muscle weightings in stroke patients during gait.

Methods: A systematic search was conducted using following databases: PubMed, Web of Science, Naric, Cochrane and PEDro. Methodological quality was assessed by the Newcastle-Ottawa Scale and data extraction included subject characteristics, outcome measures and walking protocols. The two main outcome measures were the amount and structure of the muscle synergies.

Results and discussion: Ten studies were included in this review. While four synergies are common in healthy controls, stroke patients had either the same or a reduced number of synergies in the paretic limb. A similar composition as healthy adults was found when the same amount of synergies was present. When less synergies were described, merging occurred as muscles of different synergies were included into one synergy. Merging was often seen in hip/knee extensors with plantar flexors and hip/knee extensors with knee flexors.

Conclusion: Further research is necessary to investigate the relationship between muscle synergies and motor function in stroke patients.

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Which clinical measures are associated with objective accelerometer-based activity of the affected arm, leg and trunk in persons with subacute stroke?

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Introduction: Accelerometers are used in clinical stroke research to quantify real-life physical activity, but not yet generally in ordinary clinical practice. A better knowledge of how to understand different variables of accelerometry against commonly used clinical scales is needed in advance of introducing accelerometers in regular stroke rehabilitation.

Main objective: Investigate to what extent arm, leg and trunk activity, measured by accelerometers, are associated with sensorimotor impairment, walking capacity and other potential factors in the subacute stage after stroke.

Methods: Arm, leg and trunk activity was measured over two 48 hours periods within one week in 26 individuals. Activity was derived from acceleration raw data and expressed as signal magnitude area (m/s²). Sensorimotor impairment, spasticity and walking capacity were assessed with standardized clinical scales. A forward stepwise linear regression was used to determine variables that showed associations with each of the activity measures.

Results and discussion: Sensorimotor impairment uniquely explained 67% of the variance in activity of the affected arm. Walking speed explained the highest amount, 60% of the variance in activity of the affected leg. Walking speed, Functional Ambulatory Categories and modified Ranking Scale explained 34%, 33% and 28%, respectively, of the trunk activity.

Conclusion: Clinical measures commonly used in stroke rehabilitation showed highest association with accelerometer-based activity of arm and leg with sensorimotor impairment and walking capacity, respectively and for trunk activity with walking capacity, ambulation ability or disability post-stroke but to a lower degree.
Redefining conventional neurological physiotherapy. revisiting 10 years of data from multisite trials

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Introduction: Treatment schedules designed to capture content of conventional neurological physiotherapy have been used in clinical research trials for the last 10 years. This data provides a unique snapshot into NHS provisioned therapy and gives insight into changes related to the delivery of physical therapy interventions delivered to stroke survivors.

Main objective: To investigate change over time in lower limb conventional neurological physiotherapy provided to participants of research trials with respect to:
1) Patient characteristics
2) Therapy techniques used
3) Dose provided

Methods: Standardised treatment schedules developed through previous consultation with specialist physiotherapists were completed by NHS therapists detailing the non-trial (usual) physiotherapy intervention after each therapy session throughout multisite trials. A retrospective analysis of anonymised trial data from three stroke services across the UK was carried out.

Results and discussion: N=215 stroke survivors from 2 trials of lower limb therapy recruiting between 2004-2012. Analysis shows dose of physiotherapy (total time) has decreased but the number of therapy sessions remains unchanged, indicating that patients are seen as frequently but for less time. Facilitation of movements has decreased, whereas techniques aimed at functional tasks have increased in line with a move towards task specific practice. Baseline Modified Rivermead Scores show increased severity over time although this may reflect an improvement in recruitment of these patients to trials rather than a change in the overall stroke survivor population.

Conclusion: Trial data from multisite trials between 2004 and 2012 shows a shift in lower limb neurological therapy provision in terms of both content and dose.
Introduction: After stroke secondary prevention strategies and health management are important. Movement behavior, i.e., both the amount of physical activity and sedentary behavior, are independently associated with health risks. However, little is known about differences in movement behavior in people with stroke.

Main objective: The aim of this study was to identify movement behavior phenotypes in people with stroke and factors associated with these phenotypes.

Methods: Patients after stroke discharged from hospital to their home-setting were eligible to participate. Personal and stroke characteristics, functional status, participation restrictions, and movement behavior were obtained within three weeks after discharge. Participants wore an accelerometer for 14 days. Cluster analysis was performed to identify phenotypes based on movement behavior, using a k-means clustering algorithm. Multivariate logistic regression analyses were performed to study factors associated with a movement behavior phenotype.

Results and discussion: A total of 190 participants were 68% of their waking hours sedentary, 28% of the total time was spent in light physical activity and 4.6% in moderate to vigorous physical activity. Three phenotypes were identified: 1. Active and interrupted sedentary (n=43); 2. Inactive and interrupted sedentary (n=87); and 3. Inactive and prolonged sedentary (n=60). Low self-efficacy and lack of physical activity pre-stroke were associated with phenotype three.

Conclusion: Three movement behavior phenotypes were identified in people with a first-ever stroke. Reducing sedentary behavior is an important behavioral change target for people with phenotype ‘inactive and prolonged sedentary’.

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The role of multiple demand system in object naming in aphasia
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Introduction: Language processing is generally assumed to be supported by a specialised left lateralised language network, including left inferior frontal cortex (LIFC) as one of the main nodes. Damage to the language network typically leads to anomia – a debilitating deficit in verbal object naming. This network has also been implicated in non-language task and LIFC is proposed to be a part of a bilateral multiple demand system (MDS) – a bilateral network of regions that support domain general processing.

Main objective: To examine whether domain general MDS underlies language processing in individuals with damaged left hemisphere, but spared LIFC.

Methods: To meet the study aim, we used functional fMRI and transcranial direct current stimulation (tDCS - 2mA anodal vs. sham) to concurrently scan the brain and stimulate LIFC of 18 aphasic stroke participants with left hemisphere lesions, but intact LIFC. Participants gave overt verbal responses during object naming (language) and object size judgement (non-language control) tasks while they viewed high or low visually ambiguous objects paired with high or low auditory ambiguous cues.

Results and discussion: Neurally, a right dominant (SMA, ACC, fronto-parietal, striatal) network showed enhanced activity for high compared to low ambiguity auditory conditions, solely in the naming task. Furthermore, anodal tDCS of LIFC improved online Naming accuracy.

Conclusion: Involvement of the right hemisphere network during naming supports the view that after acquired left hemisphere damage the multiple demand system supports spontaneous speech performance. Behavioural improvement by anodal tDCS opens promising new avenues for application of online brain stimulation in anomia treatment.

Acknowledgements:
Measurement properties of the neuroflexor device for quantifying neural and non-neural components of wrist hyper-resistance in chronic stroke

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Introduction: Differentiation between the contributing factors to wrist hyper-resistance post stroke, i.e. pathological neuromuscular activation (“spasticity”) and biomechanical changes will impact individual treatment decisions.

Main objective: This study aims to assess the reliability and construct validity of an innovative measurement device (NeuroFlexor) that quantifies aforementioned neural and non-neural components of wrist hyper-resistance by biomechanical modelling.

Methods: Forty-six patients with chronic stroke and 30 controls were assessed with the NeuroFlexor. Test-retest reliability was evaluated using intraclass correlation coefficients (ICC) and smallest detectable changes (SDC). Construct validity was assessed by testing the difference between patients and controls, and the association of the Neuroflexor with clinical scales.

Results and discussion: Test-retest reliability was excellent for the neural (NC) and non-neural elastic (EC) component (respectively, ICC=0.93 and 0.95), and good for the viscosity component (VC) (ICC=0.84). SDC was 10.3N for NC, 3.1N for EC, and 0.5N for VC. NC and EC were significantly higher in patients compared to controls (p<0.001). A significant positive association was found between the NC and EC, and the modified Ashworth scale (respectively, rs=0.60 and rs=0.52, p<0.01), and between the NC and the Tardieu scale (rs=0.36, p<0.05). NC and EC showed a negative association with the Fugl-Meyer Assessment of the upper extremity and action research arm test (rsκ=-0.38, p<0.05).

Conclusion: The NeuroFlexor reliably quantifies neural and non-neural components of wrist hyper-resistance in chronic stroke, however, is less suitable for clinical evaluation at individual level. The NeuroFlexor is able to discriminate between chronic stroke and controls, and shows validity compared to clinical scales.

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Changes in movement behavior outcomes within the first two months after discharge to the home-setting from hospital care in people with stroke

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Introduction: Movement behavior outcomes in people with stroke are associated with health risks. The first period after stroke seems to be crucial to set future movement behavior.

Main objective: To investigate changes in movement behavior outcomes within the first two months after discharge to the home-setting from hospital care in people with stroke.

Methods: Within three weeks after discharge, participants wore an accelerometer for five weeks. Movement behavior outcomes were: mean time spent in sedentary behavior (SB), light physical activity (LPA) and moderate to vigorous physical activity (MVPA), mean time MVPA spent in bouts ≥ 10 minutes, mean time SB spent in bouts ≥ 30 minutes, weighted median sedentary bout and fragmentation index. GEE analyses were performed per movement behavior outcome to investigate changes over time.

Results and discussion: On average participants (n=140, mean age 67, 79% minor stroke symptoms NIHSS) spent 9.22 hours in SB, 3.87 hours in LPA and 42 minutes in MVPA. However, mean MVPA time accumulated in bouts ≥ 10 minutes was 17 minutes per day and mean SB time accumulated in bouts ≥ 30 minutes was 3.99 hours. Fifty percent of the time sedentary bouts were spend in bouts over 21.81 minutes. A mean of two fragmentations per hour were found. Over time, a small significant decrease in SB and an increase in LPA was found.

Conclusion: In the period immediately after discharge from hospital care, movement behavior remains relatively stable. The majority of the population is inactive and highly sedentary.

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Italkbetter: the development and testing of a digital neuro-intervention for patients with word-retrieval difficulties caused by stroke

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Introduction: Language impairment (aphasia) is the second most common major impairment after stroke, with a prevalence of 250,000 in the UK. Despite this, provision of speech and language therapy is far below what is needed for optimal rehabilitation [Code & Heron, 2003]. A common symptom of post-stroke aphasia: impaired word retrieval problems. This is particularly important for patients receiving rehabilitation for associated disabilities as poor speech production can impair participation with treatment programmes.

Main objective: The main aim of our study is to develop and test the clinical efficacy of a novel, digital neuro-intervention. iTALKbetter will provide an effective training tool that post-stroke aphasic patients can use to practice independently.

Methods:
Our study has three phases:
1) Co-design: development of the app with patients, researchers, and software developers.
2) Small-scale randomised clinical trial to test the efficacy of the app in post-stroke aphasic patients.
3) Web-release: online roll-out of the app. We will continue to ask scientific questions during this phase.

Results and discussion: Phase 2 will be a small scale clinical trial with 36 post-stroke aphasic participants. Each will be randomised to one of two versions of the therapy and complete a 6-week programme. Data from all 5 time-points will be analysed using a repeated-measures ANOVA to determine whether there is an interaction between time (therapy block vs baseline) and item (trained vs untrained). Structural MRI data will be analysed using voxel-based morphometry to identify whether our therapy app induces any structural brain changes over time.

Conclusion: All comments and feedback welcome.

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Critical periods after stroke study (cpass): a phase ii trial

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Introduction: Better treatment of stroke, whether to reduce impairment or target the goals and preferences of individuals, can enable independence and increase participation. There is evidence for timing effects in rehabilitation; motor training delivered at certain times may be more effective. It is hypothesized that the periods of greatest responsiveness after a stroke are analogous to the sensitive periods in normal human development. We expect that individuals receiving early intensive motor training will show greater upper extremity motor improvement measured at one year post stroke compared to individuals receiving therapy at later time points.

Main objective: We are investigating the optimal time after stroke for intensive upper extremity motor training.

Methods: Eighty participants will be adaptively randomized to receive an additional bolus of 20 hours of upper extremity therapy within 30 days post-stroke, 2 to 3 months post-stroke, 6 to 9 months post-stroke, or to a control group. The primary outcome is the Action Research Arm Test administered at one year. Blood will be drawn at up to 3 time points for biomarker studies.

Results and discussion: We have enrolled two run-in subjects and randomized seventy-two participants to date; the study will be completed in 2019. Results from this study will help to plan a Phase III clinical trial.

Conclusion: If sensitive periods exist in rehabilitation and can be identified after stroke, then current resources can be better targeted to promote recovery.
Posters

Inclusion of biomarker determination opens up the possibility of understanding the biological mechanisms of recovery and supports future drug development.

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124

Automatic versus manual tuning of robot-assisted gait training in people with neurological disorders
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Introduction: In clinical practice, therapists choose the amount of assistance that patients receive while walking in a robotic gait trainer. A disadvantage is that therapists cannot directly feel what the device does. Therefore, algorithms were developed that automatically adjust the assistance, however, they have not been compared to the settings that therapists would choose.

Main objective: The goal of this study was to compare the assistance set by an automatically-tuned (AT) algorithm to manually-tuned (MT) assistance in a robotic gait trainer.

Methods: Ten participants (6x stroke, 4x spinal cord injury) walked with both approaches in the LOPES II gait trainer. In both cases, the assistance was adjusted for various subtasks of walking (e.g. step height). Either the therapist changed the assistance for each subtask (MT) or the AT algorithm adjusted the assistance based on errors compared to reference trajectories.

Results and discussion: The different approaches did not always focus on the same subtasks. On average, participants received less assistance with the AT algorithm for all subtasks. In spite of this, the largest errors compared to the reference trajectory were found for the MT approach. A possible reason for this is that therapists might focus on other factors while setting the assistance.

Conclusion: An automatically-tuned algorithm can decrease deviations from a reference trajectory, however, large differences were found compared to the settings chosen by a therapist and further research should focus on how this information can be used to optimize robotic gait therapy.

Acknowledgements: We would like to thank the participants and Martijn Postma for his assistance during the experiments.
Introduction: Research investigating the generalisability of aphasia therapy indicates limited generalisation of therapy gains to functional communication following single word impairment-based intervention (Webster, Whitworth & Morris, 2015¹). This is often the case despite the implementation of protocols to promote across-level generalisation (Marshall et al, 2018²). There appears to be some intermediary steps that are required before the learning of single words can generalise across communicative environments.

Main objective: This study aimed to provide a contribution to this topic by investigating generalisation across linguistic presentations (single words, phrases and sentences) within a novel, word-to-picture matching, digital speech comprehension therapy application ‘Listen-In’.

Methods: 35 participants with aphasia completed the 12-week Listen-In intervention programme in which single word comprehension was targeted by presenting items in a variety of spoken word contexts (single words, carrier phrases and sentences). Hierarchical multi-level logistic regression was then used to evaluate whether improvements on a novel outcome assessment were due to the exposure of the exact linguistic presentation tested post-therapy, or whether exposure to the word in other linguistic presentations also mediated improvements.

Results and discussion: Statistical analysis revealed that all presentation types contributed to improvements following intervention, suggesting generalisation of single word learning across linguistic presentations. Although a secondary finding indicated that exposure to the exact presentation assessed post-therapy was predominantly driving improvements, these presentations were found to be pre-advantaged by the therapy algorithm leading to a greater overall exposure.

Conclusion: This study provides a novel methodology for examining generalisation following intervention and future directions on improving the generalisability evidenced will be discussed.

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A specific nutritional intervention improves functional recovery in preclinical models of ischemic stroke, traumatic brain injury, and spinal cord injury

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Introduction: Brain phospholipid synthesis depends on the availability of nutritional elements that act either as precursor or cofactor in the synthesis pathways. Since intake and bioavailability of these nutrients is compromised in age-related disorders like Alzheimer’s disease (AD), a specific nutritional concept was designed to support the dietary management of early AD. Recently, a 24-month intervention with this concept in prodromal AD was shown to reduce both hippocampal atrophy and loss of function/cognition, providing evidence for nutrition in maintaining brain functional connectivity.

Main objective: Our aim was to obtain preclinical proof of concept in other conditions that could benefit from a nutritional intervention supporting brain connectivity and, possibly, functional recovery.

Methods: Experiments were conducted employing rodent models of various conditions characterized by loss of functional connectivity in the central nervous system (CNS). These included the mouse middle cerebral artery occlusion model of ischemic stroke, the mouse cortical impact model of traumatic brain injury, and the rat compression model of spinal cord injury. Experiments were properly powered. Nutritional interventions started after model-induction.

Results and discussion: In all three models of CNS injury, the nutritional intervention significantly improved functional recovery that coincided with histological/imaging results indicating reduced injury size and decreased inflammatory response. Together, these data demonstrate an impressive therapeutic potential of nutrition during recovery and/or rehabilitation after CNS damage. The relative safety of nutrition may help to swiftly incorporate optimal nutritional support into rehabilitation strategies.

Conclusion: Current preclinical evidence of significant benefits of specific nutritional intervention for functional recovery after loss of brain and spinal connectivity warrants further, clinical investigation in neurorehabilitation.
Development of neural and non-neural components of wrist hyper-resistance in the first 26 weeks post stroke
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Introduction: Understanding how post-stroke joint hyper-resistance develops over time and interacts with motor recovery may elucidate recovery related neurophysiological changes and may impact treatment decisions.

Main objective: To investigate the time course of development of neural and non-neural components of wrist hyper-resistance and its interaction with motor recovery during the first 26 weeks post stroke.

Methods: Components of wrist hyper-resistance (measured with the NeuroFlexor) and synergistic-dependent motor recovery (Fugl-Meyer assessment of the upper extremity [FM-UE]) were assessed prospectively in 17 patients within 3 weeks, and at 5, 12, and 26 weeks post stroke. Seventeen age-matched controls served as a reference group. Friedman tests with post-hoc Wilcoxon Signed Ranks Tests were used to compare outcomes at different moments post stroke. Mann-Whitney U tests were used to assess the difference between patients and controls.

Results and discussion: Only the neural component (NC) showed a significant increase between weeks 3 and 5 post stroke (p<0.008). NC gradually increased within the first 26 weeks in patients with poor motor recovery (FM-UE≤42) (p<0.01), whereas no significant change was found in patients with good motor recovery (FM-UE>42). Patients had significantly higher NC and non-neural elastic component (EC) compared to controls (p<0.001), and a significantly lower viscosity component (p=0.02).

Conclusion: The NC develops mainly in the first 5 weeks post stroke, during the period of spontaneous neurobiological recovery, and continues to increase gradually in patients with moderate to severe upper limb motor impairment, whereas the development of EC is not restricted to the first 5 week time window.

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Effectiveness of different types and duration of trunk training on trunk function: a systematic review and meta-analysis.

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Introduction: It remains unclear which type of trunk training has the best effect on trunk recovery post-stroke.

Main objective: The aim of this study is to review the literature concerning the effectiveness of different types of trunk training on trunk function.

Methods: Databases MEDLINE, EMBASE, CINAHL, COCHRANE and PEDro were screened for randomized controlled trials, written in English, Dutch, French or German. PRISMA guidelines were followed. Trial quality was assessed using the PEDro scale. Meta-analyses were performed.

Results and discussion: A total of 29 trials were included involving 1028 participants, describing seven different training therapies, with a median PEDro score of 6 points (range 4-8). All therapies had a significant effect in favor of the experimental group. Largest effect sizes were observed for selective trunk training (SMD=1.64, 95%CI=0.55-2.73) in the early rehabilitation phase; for selective trunk training (SMD=3.73, 95%CI=2.45-5.02) in the late rehabilitation phase; and for sitting reaching training (SMD=2.06, 95%CI=0.90-3.23) in the chronic phase. Difference in duration and amount of trunk training had no significant impact on results. In the rehabilitation and chronic phase after stroke, strongest effects were found for trunk training that specifically stimulates trunk muscle activation. Variation in duration and amount of training does not appear to modify the effect. The small number of participants in the trials, lack of detailed description of therapy content, and variability in study quality warrants consideration.

Conclusion: From the early to the chronic phase after stroke, active trunk training significantly improves trunk function.
Influence of sarcopenia and change in body composition on functional outcomes in stroke patients.

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Main objective: To assess changes in body composition of stroke rehabilitation patients in a 6-month follow-up; and secondary, to study the influence of sarcopenia defined by the new diagnostic criteria proposed by the European Working Group of Sarcopenia in Older People (EWGSOP-2) on functional outcomes.

Methods: Prospective study of 65 consecutive stroke patients (aged 67.4±9.3 years; 69.4% men) admitted in a neurologic rehabilitation ward in the period from Setembrer 2016 to February 2018. Main outcome variables: the EWGSOP-2 components (fat-free mass and handgrip strength assessed in the non-paretic hand), Barthel index, gait speed, and functional ambulation classification (FAC) at 3 and 6 months.

Results and discussion: The prevalence of sarcopenia in our sample when applying the newer EWGSOP-2 criteria was low (baseline 9.7%, 3 months 9%, 6 months 5.1%). Nevertheless, 10 (13.9%) and 7 (9.7%) patients had lost >5% of fat-free mass at 3 and 6 months, respectively. An initial low fat-free mass was significantly associated with lower Barthel at admission (mean difference 18.6 [CI95% 1.9-35.2]) and lower muscle strength in the paretic hand in the follow-up period. Low non-paretic handgrip in the baseline assessment was significantly associated with older age, lower Barthel during the study period, and worse FAC at 6 months.

Conclusion: The prevalence of sarcopenia in this sample of stroke rehabilitation patients is similar to those observed in other samples of chronic patients. Both low fat-free mass and handgrip strength are associated with poor functional outcomes at 3- and 6-month follow-up, but only non-paretic handgrip strength associates with worse FAC.
Efficacy of manual dexterity training using the dextrain method after stroke: effect on hand function and cerebral plasticity
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Introduction: Stroke is a main cause of physical disability in adults. About 50% of stroke patients have impaired hand function in the chronic phase. There is a lack of therapeutic approaches to specifically train manual dexterity after stroke. Recently, we developed a device to measure manual dexterity consisting of sensitive force sensors coupled with visuomotor tasks. This device allows quantitative assessment of multiple key components of dexterity, such as finger force control, timing, motor sequencing and independence of finger movements.

Main objective: This “proof-of-concept” study, aims to estimate the benefit of a targeted-training using an improved version of this device, the DexTrain method.

Methods: In this randomized control trial single blind study, 46 chronic stroke patients will be recruited and randomized between two rehabilitation groups: (a) a conventional occupational therapy group and (b) an experimental group using DEXTRAIN focusing on the affected dexterity components. In each group, patients will have 12 sessions of 1h of training (3 sessions per week during 4 weeks). To evaluate the effect of the therapy, clinical evaluations and multidimensional dexterity measures will be performed before (T0), at the end (T1) and 3 months after the rehabilitation (T2). The principle outcome measure is the change in Box and Block score post-training. To study the neural correlates and the brain plasticity involved in the recovery of dexterity components fMRI and electrophysiological (TMS) measures will be performed during force control and individuation tasks, before (T0) and after the rehabilitation (T1).

Results and discussion: This study is currently recruiting.
Brain computer interface (BCI) in the rehabilitation after stroke: a systematic review
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Introduction: Since the 1970s, the research field of BCI has continuously developed. This therapy approach could also be used in rehabilitation after stroke in the future. So far, however, there have been few studies on the potential effects of BCI and there is also a lack of systematic reviews.

Main objective: Systematic review of the current state of research on functional restoration of the upper extremity after stroke.

Methods: A literature search was carried out. Primary outcome measure was the improvement of motor function of the upper extremity and secondary outcome measures included everyday activity, participation and ‘brain connectivity’.

Results and discussion: So far, 8 studies have been included in the meta-analysis. However, data synthesis was not possible for all outcome measures. For the improvement of the motor function of the upper extremity, a significant effect (p<0.05) was found but with low effect size. The present paper gives first indications of a possible efficacy on motor function recovery of the upper extremity after stroke. Especially the combination with other therapy approaches seems promising.

Conclusion: BCI could be an additional treatment approach for stroke rehabilitation in the future.

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Minimal clinically important difference between comfortable and fast gait speed in stroke patients following one month of rehabilitation

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Gait speed is one of the most important parameters to characterise function and is considered the 5th vital sign. It is not known whether the minimal clinically important difference (MCID) is the same for comfortable and fast gait speeds.

Main objective: To assess the MCID of comfortable and fast gait speeds obtained from a 10-metre walk test (10MWT).

Methods: Stroke patients who could ambulate with or without physical assistance undergoing a regular stroke rehabilitation programme were recruited. Gait speed was measured twice over 10 metres at both comfortable and fast speeds and the mean obtained. The measurement was done at baseline and one month after rehabilitation. Receiver operating characteristic curve analysis was used to identify the change in gait speed that best differentiated between patients who perceived that they did or did not improve based on a subjective global rating of change scale of at least 5 from 7 points.

Results and discussion: Twenty-six patients (11 female) aged 58.6 ± 13.5 years (mean ± SD) completed the study. Fourteen patients (53.9 %) described improvement. The best cutoff changes in comfortable and fast gait speed MCIDs were 0.09 m/s (sensitivity 100 %, specificity 60 % and area under curve [AUC] 0.80) and 0.13 m/s (sensitivity 81.8 %, specificity 66.7 % and AUC 0.74), respectively.

Conclusion: MCIDs for comfortable and fast 10MWT were different. Changes in comfortable gait speed of 0.09 m/s and fast gait speed of 0.13 m/s were related to perceived improvement in gait speed.

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Upper limb proprioceptive deficits and recovery during rehabilitation in subacute stroke survivors
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Introduction: Since commonly-used proprioceptive assessments have poor psychometric properties, only a few studies have examined proprioceptive recovery after stroke. To address these limitations, a protocol that quantifies elbow position sense in stroke survivors with multiple impairments was developed.

Main objective: [1] to quantify elbow position sense in stroke survivors and compare their results with a control group, and [2] to measure proprioceptive recovery during rehabilitation.

Methods: Elbow position sense of the most affected arm was evaluated using an exoskeleton and a virtual reality display. The exoskeleton moved the participant’s arm from an initial to a target position (no visual cues). A virtual arm representation was projected on a screen placed over the participant’s arm. The participant had to indicate his arm position (more flexed or extended) compared to the virtual representation. A 75% discrimination threshold was extracted from a sigmoid curve representing the relationship between the angular difference and the % of successful trials and was compared between groups. In a subset of stroke participants (n=10), threshold was evaluated at admission and discharge and compared.

Results and discussion: Seventeen subacute stroke patients (68±10 yo; 8 males)and 19 age-matched controls were recruited. A significant difference in threshold was observed between stroke (12.8±5.3°) and control (7.3±3.5°; p=0.001) groups. A significant improvement in thresholds between admission (15.0±7.5°)and discharge (12.8±6.2°)was shown in stroke participants (p<0.001).

Conclusion: These results confirm the presence of proprioceptive deficits in stroke survivors. A small but significant improvement in proprioceptive function was measured during rehabilitation.

Acknowledgements: We would like to thank JLeblond, NRobitaille, IRDPQ stroke unit clinicians and participants for their contribution to this project.
Experiences of diagnostic ultrasound-guided shoulder rehabilitation programme for people with stroke: a qualitative study

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Introduction: Stroke is a leading cause of disability in western world. Loss of motor control leads to a range of musculoskeletal complications in the shoulder region in people with stroke. These include shoulder pain, shoulder subluxation, muscle weakness and tightness. Our previous work showed that diagnostic ultrasound guided shoulder rehabilitation improved outcomes in stroke survivors.

Main objective: The aim of this study was to explore physiotherapists and patients experiences of the shoulder rehabilitation programme that was informed following ultrasound scanning.

Methods: A qualitative study consisting of semi-structured face-to-face interviews were conducted with stroke survivors (n=3) and physiotherapists (n=3) in South Wales. Data were analysed using principles of thematic analysis.

Results and discussion: Four themes emerged: 1) ‘Ultrasound informed treatment’: both physiotherapists and patients reported that ultrasound imaging enhanced their understanding of deficits in the shoulder and facilitated problem specific treatment. 2) ‘Psychological benefits to patients’: patients understanding of the problems resulted in compliance and high participation satisfaction towards the rehabilitation programme. 3) ‘Physical and functional benefits’: all three patients achieved improved range of movement in shoulder and therapists described improvements in other aspects such as gait and functional independence. 4) ‘Resource intensive’: The cost, training involved with ultrasound may impose practical challenges for its wider use.

Conclusion: This study provides valuable insight into the personal experiences of novel approaches to shoulder rehabilitation in people with stroke. Physiotherapists were able to target the problem and provide specific exercises which improved patients’ outcomes. These findings can be used to guide both the development and evaluation of problem specific shoulder rehabilitation programme to improve functional outcomes in people with stroke.

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Development of a standardised multidisciplinary upper limb assessment proforma to improve functional upper limb outcome measures in the acute stroke unit setting.

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**Introduction:** 75% of stroke survivors have upper limb symptoms (Lawrence 2001). Over of 40% of patients never recover significant function for activities of daily living. Current upper limb rehabilitation is poor with stroke patients only engaged in “activity” for 13% of the day (Bernhardt 2004) and task specific functional upper limb movements only accounting for 51% of upper limb therapy sessions (Lang 2016). Current NICE Guidelines for Stroke Rehabilitation (2016) advocate high intensity, repetitive task specific practice for patients with purposeful upper limb function and education for those with limited movement. However, in a busy acute stroke unit setting upper limb rehabilitation is challenging due to service pressures and environmental constraints.

**Main objective:** The purpose of this study is to review whether a multidisciplinary upper limb pathway, with a standardised assessment proforma and stratified functional levels, alongside an individualised rehabilitation plan can improve upper limb outcomes.

**Methods:** Upper limb service provision was benchmarked against other London Stroke Units. From this a multidisciplinary proforma and a standardised upper limb pathway were developed. 15 patients on the local acute stroke unit were included in the study.

**Results and discussion:** 100% of patient received education booklets and a multidisciplinary assessment. 80% of patients were identified with shoulder pain and were subsequently reviewed by the Consultant within an average of two working days. 100% of patients had upper limb goals set within their admission in comparison to 60% in the four months prior to this study.

**Conclusion:** Substantial improvements in functional outcome, timely pain management, education and patient satisfaction throughout patient pathway.
Added-value of early spasticity reduction to improve arm-hand skill performance in sub-acute stroke patients with a moderately to severely affected arm-hand

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Introduction: Spasticity is a hindrance when trying to elicit the full training potential of the affected arm-hand during rehabilitation in stroke patients with a moderately to severely affected hand.

Main objective: To assess to what extent arm-hand-function (AHF) and arm-hand-skill-performance (AHSP) may improve by reducing early signs of spasticity in sub-acute stroke patients.

Methods: Ten sub-acute stroke patients (UAT:1-2, MAS:1+ to 3). Multiple baseline single-case-experimental-design and meta-analysis, involving 10 single cases. Training: 2x6 weeks of a well-described arm-hand regime, i.e. CARAS, including gross-motor-grip arm-hand rehabilitation. BoNT-A: administered once within the first 5 weeks. Measurement dates: weekly within the first 12 weeks; every 2-weeks during the ensuing 12 weeks. Measures: ARAT, Abilhand, Fugl-Meyer-test, grip-strength, Motricity-Index.

Results and discussion: At individual level, after baseline trend correction, adjusting for spontaneous recovery and therapy-as-usual effects, 7/10 patients improved on AHF: FM (N=4) (p<0.019), grip-strength (N=3) (p<0.014) and MI (N=4) (p<0.002), whereas 6/10 patients improved on AHSP: ARAT (N=3) (p<0.042), Abilhand (N=5) (p<0.034). At group level, after linear detrending, added-value of BoNT-A on AHF and AHSP could not be confirmed. Non-detrended data revealed that patients improved significantly over time on AHF and AHSP on all measurements (p<0.037) after a combination of BoNT-A and CARAS.

Conclusion: In a number, though not all, individual patients, application of BoNT-A may have an added-value in reducing early signs of spasticity. To combine a well-defined therapy-as-usual with early post-stroke spasticity reduction may improve arm-hand performance in sub-acute stroke patients suffering from spasticity, and who display no dexterity at the point of therapy admission.

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Shoulder function after constraint-induced movement therapy assessed with 3d kinematics and clinical and patient reported outcomes: a prospective cohort study

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Introduction: Although there is evidence for the effect of constraint-induced movement therapy (CIMT) on the overall UE function, less is known about specific improvements in shoulder function. It is a challenge to differentiate between restitution and compensation by means of clinical function tests. Therefore, three dimensional (3D) kinematic measures are recommended.

Main objective: We hypothesised that shoulder function improves from pre to post CIMT when measured with 3D kinematics and that the improvements are still present after three months. Additionally, we hypothesised that improvement in scapula upward rotation measured with 3D kinematics is associated with improvements in clinical and patient reported outcomes.

Methods: We conducted a prospective cohort study with three test sessions: pre CIMT, post CIMT and at three month follow up. Kinematic outcome measures were ranges of scapula, shoulder, trunk and elbow movements – with scapula upward rotation as the primary outcome - and temporospatial measures during tasks 5 (ReachLow) and 6 (ReachHigh) from the Wolf Motor Function Test. Clinical and patient reported outcomes were also included. Changes in kinematic and patient reported outcomes were identified with linear mixed models and Stuart-Maxwell test. Logistic regression analysis was used to identify clinical changes.

Results and discussion: The primary outcome was reduced from 16.2° pre CIMT through 15.9° post CIMT to 15.6° at three month follow up during ReachHigh. Statistically significant reductions of <2° were also found for shoulder flexion during ReachLow and trunk lateral flexion during ReachHigh. Movement time was reduced by 0.1–0.2 seconds. Reach length did not change. The clinical and patient reported outcomes showed improvements post CIMT, and at follow up, the outcomes resembled post CIMT values.

Conclusion: We found at most marginal improvements in selected kinematic and temporospatial measures of upper extremity movements. Therefore, the clinical and patient reported improvements post CIMT did not seem to reflect restitution of shoulder function.
Clinical feasibility of a wearable sensor device to support upper limb rehabilitation post-stroke: mechanical muscle activity with real time kinematics (m-mark)

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Introduction: M-Mark, a wearable sensor system used during performance of upper limb (UL) exercises, has been developed. The novel approach, which combines inertial measurement units with mechanomyography sensors, aims to improve intensity, motivation and adherence to rehabilitation. Therapist and patient computer interfaces support design and implementation of personalised exercise programmes, and provide avatar feedback and metrics representing quality and quantity of movement and muscle activity.

Main objective: Usability and acceptability of the prototype in an outpatient clinic setting are reported.

Methods: Six chronic stroke patients attended two testing sessions. UL impairment was assessed (Fugl-Meyer) and an M-MARK exercise programme was designed. Comparator recordings on the unaffected UL were taken. In the first session therapists gave support; in the second participants completed their exercise programme and responded to feedback independently. Observational data were recorded during the intervention, and therapists’ and participants’ views recorded afterwards using semi-structured interviews.

Results and discussion: Participants could don and doff the garment and found it comfortable; low functioning patients needed some assistance. Therapists were able to design exercise programmes from a library of activities. All participants were able to follow the on-screen and audio instructions and carry out the exercises effectively. They found the system motivating; were able to understand the avatar and written/auditory feedback, with evidence of improved movement when activities were repeated. Issues around garment design, set up and feedback options were identified.

Conclusion: Having demonstrated usability and acceptability with six participants and two therapists in a clinic, we will evaluate extended home-use, measuring changes in exercise intensity and functional outcomes.

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Assessing motor imagery ability in patients with traumatic brain injury

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Introduction: Mental training through motor imagery (MI) is a neurorehabilitation technique that offers the possibility to mentally rehearse task-specific actions, independent of motor recovery. One important prerequisite is that MI ability is preserved. However, little is known about MI ability in patients after a traumatic brain injury (TBI).

Main objective: To assess MI ability in patients with TBI, using a combination of tests that have been validated in a healthy and/or neurologic population.

Methods: Twenty-eight patients with TBI (174.54 ± 80.7 days post trauma) and 21 healthy controls (matched for age, gender and educational level) completed the following MI test battery: 1) timed-dependent motor imagery screening test (TDMI), 2) movement imagery questionnaire – second revised version (MIQ-RS), 3) temporal congruence test (TCT) and 4) mental rotation (MR) test. Differences between groups were assessed using a Mann-Whitney U test.

Results and discussion: When comparing the TBI group to the healthy controls no significant differences could be detected, except for the reaction time of the MR test (p<0.001). This implies that MI ability is preserved in patients with TBI in our study cohort. The slower reaction time in the TBI group might be explained by the known correlation between response times and biomechanical constraints.

Conclusion: MI ability seems to be preserved in TBI patients, which implies these patients are eligible for MI training. However, during therapy sessions the slower reaction time should be taken into consideration.

Acknowledgements: The authors would like to thank Revalidatieziekenhuis Inkendaal for allowing us to include eligible patients from their department.
Introduction: Cost-effective treatments for persistent cognitive problems following Mild Traumatic Brain Injury (MTBI) are needed. In a recent RCT, we found very large treatment effects of hypnosis in a sample predominantly comprised of stroke and moderate TBI, but the effect on MTBI patients is unknown.

Main objective: To study whether hypnotic suggestion reduces fatigue, anxiety, and depression symptoms for MTBI patients.

Methods: Twenty-two MTBI patients with reduced vocational status participated. All were at least six months post-injury. Patients completed the Mental Fatigue Scale and Hospital Anxiety and Depression Scale before and after treatment. Treatment consisted of eight 1-hour sessions of individualized hypnosis focusing on fatigue, concentration, and memory. During therapy, the patients imagined regressing to their pre-injury state and mentally visualized neuroplasticity.

Results and discussion: Paired t-tests between pre-test and post-test measures showed large fatigue reductions ($d = 0.4$ to $1.3$, $p = .001$, $BF_{10} = 41.1$) and medium-sized reductions of anxiety ($d = 0.2$ to $0.7$, $p = .001$, $BF_{10} = 49.5$) and depression ($d = 0.2$ to $0.9$, $p = .003$, $BF_{10} = 14.0$). These effect sizes compare favorably to the main effects of Cognitive Behavioral Therapy and Mindfulness Based Stress Reduction reported in the literature. However, a formal control group or a multiple-baseline design is needed to isolate the treatment effect.

Conclusion: Extending findings from stroke and moderate TBI, we found preliminary evidence that hypnotic suggestion may be a cost-effective treatment method for fatigue and other persistent cognitive problems following MTBI.

Acknowledgements: Mimi Nettelbladt conducted the treatment.
**Topic 18: Virtual reality training**

75

**Validity of reaching movements made in a 2d virtual environment compared to the real world**
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**Introduction:** Virtual reality (VR) is increasingly used in stroke rehabilitation to remediate upper limb motor impairments. However, before the effectiveness of a VR-based intervention can be determined, it is crucial to know whether motor performance (endpoint trajectories) and quality variables of movements made in a 2D virtual environment are kinematically similar to those performed in the physical world.

**Main objective:** To compare kinematics of functional reaching movements performed in a low-cost 2D VR environment versus a comparable physical environment in post-stroke and healthy subjects.

**Methods:** Post-stroke hemiparetic (60.6±11.5yr) and healthy participants (56.8±17.3yr) performed unilateral and bilateral reaching tasks in each environment. In the virtual environment, arm movements were tracked using the Kinect 2 camera (Microsoft, USA) and an avatar of the arm and hand was displayed on the screen, providing a first-person perspective. In both environments, arm and trunk kinematics were recorded (Optotrak motion analysis system; 23 markers; 120Hz) and 3D kinematics were reconstructed. Temporal and spatial characteristics of the endpoint trajectory and arm and trunk movement patterns were compared between environments and groups using repeated-measures analyses of variance.

**Results and discussion:** Arm and hand orientation relative to object contact differed between environments and groups. Differences may be related to the lack of accuracy of the Kinect 2 motion tracking camera and disparities in object affordances based on reduced visual cues in the 2D virtual environment.

**Conclusion:** When using 2D virtual environments for upper limb rehabilitation post-stroke, differences in motor performance and quality should be taken into account.
Immersive virtual reality during robot-assisted walking in healthy adults: preliminary results of the effect of optic flow manipulation

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Introduction: A disadvantage of robot-assisted gait training (RAGT) is that people do not always actively participate while walking in a gait exoskeleton. Virtual reality (VR) has now been proposed as a tool to increase the participation during RAGT by manipulating the training environment.

Main objective: The aim of this study was twofold: 1) to investigate the effect of optic flow manipulation during VR-enhanced RAGT on active participation in healthy adults, and 2) to evaluate the level of enjoyment and motion sickness.

Methods: Healthy adults walked in the Lokomat with immersive VR for 21 minutes under 3 conditions (each lasting 7 minutes): walking with an optic flow that is equal to, two times faster and two times slower than their walking speed. Active participation was measured by continuously assessing the muscle activity of the vastus medialis and biceps femoris (bilaterally). To evaluate the level of enjoyment and motion sickness, respectively the Physical Activity Enjoyment Scale (/126) and Simulator Sickness Questionnaire (/48) were used.

Results and discussion: Preliminary results of 13 participants (59.9±4.3 years old) showed that walking with a manipulated optic flow significantly increased muscle activity of the vastus medialis bilaterally. The use of immersive VR during RAGT was enjoyable (mean PACES: 89.9±20.7) and well tolerated (mean SSQ: 1.9±2.1).

Conclusion: Preliminary results suggest that adding immersive VR to RAGT could increase people’s participation and enjoyment. Optic flow manipulation seems to affect the muscle activity when walking in a gait exoskeleton.

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## Authors index

### A

<table>
<thead>
<tr>
<th>Author</th>
<th>Page(s)</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adonis, A.A.</td>
<td>159</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Alt Murphy, M.</td>
<td>106</td>
<td>Sweden</td>
</tr>
<tr>
<td>Alouche, S.</td>
<td>150</td>
<td>Canada</td>
</tr>
<tr>
<td>Andersson, S.</td>
<td>206</td>
<td>Sweden</td>
</tr>
<tr>
<td>Andringa, A.S.</td>
<td>93, 210, 217</td>
<td>the Netherlands</td>
</tr>
<tr>
<td>Anil, K.</td>
<td>110</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Ashford, S.</td>
<td>121, 134</td>
<td>United Kingdom</td>
</tr>
</tbody>
</table>

### B

<table>
<thead>
<tr>
<th>Author</th>
<th>Page(s)</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bajuaifer, S.</td>
<td>203</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Baroni, A.</td>
<td>111</td>
<td>Italy</td>
</tr>
<tr>
<td>Baets, de L.</td>
<td>31</td>
<td>Belgium</td>
</tr>
<tr>
<td>Beek, van, J.J.W.</td>
<td>177</td>
<td>Switzerland</td>
</tr>
<tr>
<td>Bladel, van, A.</td>
<td>31, 196, 229</td>
<td>Belgium</td>
</tr>
<tr>
<td>Blanchette, A.K.</td>
<td>222</td>
<td>Canada</td>
</tr>
<tr>
<td>Boccuni, L.</td>
<td>108</td>
<td>Belgium</td>
</tr>
<tr>
<td>Bolivar-Prados, M.</td>
<td>199</td>
<td>Spain</td>
</tr>
<tr>
<td>Borsato, S.</td>
<td>96</td>
<td>Italy</td>
</tr>
<tr>
<td>Bowman, M.</td>
<td>161</td>
<td>Australia</td>
</tr>
<tr>
<td>Boza, R.</td>
<td>219</td>
<td>Spain</td>
</tr>
<tr>
<td>Broersen, L.M.</td>
<td>216</td>
<td>the Netherlands</td>
</tr>
<tr>
<td>Busk, H.</td>
<td>160, 173</td>
<td>Denmark</td>
</tr>
<tr>
<td>Buurke, J.</td>
<td>31</td>
<td>the Netherlands</td>
</tr>
<tr>
<td>Burridge, J.</td>
<td>33</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Cabanas Valdés, R.C.V.</td>
<td>190</td>
<td>Spain</td>
</tr>
<tr>
<td>Cai, N.</td>
<td>109</td>
<td>United States of America</td>
</tr>
<tr>
<td>Chandler, E.</td>
<td>207</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Choi, H.H.</td>
<td>170</td>
<td>Republic of Korea</td>
</tr>
<tr>
<td>Coley-Fisher, H.</td>
<td>212</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Connell, L.A.</td>
<td>65</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Corcos, M.</td>
<td>38</td>
<td>United States of America</td>
</tr>
<tr>
<td>Criekinge, van, T.</td>
<td>205</td>
<td>Belgium</td>
</tr>
<tr>
<td>Cruijsen, van der, J.</td>
<td>172</td>
<td>the Netherlands</td>
</tr>
<tr>
<td>Crinion, J.</td>
<td>55</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Dahancke, O.</td>
<td>140</td>
<td>Germany</td>
</tr>
<tr>
<td>Dalgas, U.D.</td>
<td>40</td>
<td>Denmark</td>
</tr>
<tr>
<td>Dávalos Yerovi, V.</td>
<td>117</td>
<td>Spain</td>
</tr>
<tr>
<td>Dehem, S.</td>
<td>164</td>
<td>Belgium</td>
</tr>
<tr>
<td>Denissen, S.A.M.</td>
<td>87</td>
<td>Belgium</td>
</tr>
<tr>
<td>Dewald, J.</td>
<td>44, 56</td>
<td>United States of America</td>
</tr>
<tr>
<td>Dohle, C.</td>
<td>35, 41</td>
<td>Germany</td>
</tr>
<tr>
<td>Doncker, de, W.</td>
<td>193, 195</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Donaldson, G.J.</td>
<td>138</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Doogan, C.E.</td>
<td>54</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Dromerick, A</td>
<td>213</td>
<td>United States of America</td>
</tr>
<tr>
<td>Dupin, L.</td>
<td>49</td>
<td>France</td>
</tr>
<tr>
<td>Edwards, D.</td>
<td>130</td>
<td>United States of America</td>
</tr>
<tr>
<td>Eisenthal, A.J.</td>
<td>157</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Esquenazi, E.</td>
<td>71</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Elsner, B.E.</td>
<td>32, 125</td>
<td>Germany</td>
</tr>
<tr>
<td>Farquhar, J.D.R.</td>
<td>79</td>
<td>the Netherlands</td>
</tr>
<tr>
<td>Fleming, V.A.A.</td>
<td>53</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Fleuren, J.</td>
<td>31</td>
<td>the Netherlands</td>
</tr>
<tr>
<td>Franck, J.A.</td>
<td>86</td>
<td>the Netherlands</td>
</tr>
<tr>
<td>Fricke, S.S.</td>
<td>214</td>
<td>the Netherlands</td>
</tr>
<tr>
<td>Gaskell, H.M.</td>
<td>105</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Georgiou, A.M.</td>
<td>124</td>
<td>Cyprus</td>
</tr>
<tr>
<td>Geel, van, F.V.G.</td>
<td>63</td>
<td>Belgium</td>
</tr>
<tr>
<td>Geurts, A.</td>
<td>31, 134</td>
<td>the Netherlands</td>
</tr>
<tr>
<td>Name</td>
<td>Page(s)</td>
<td>Country</td>
</tr>
<tr>
<td>-----------------------</td>
<td>------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>Gils, van, A.</td>
<td>78</td>
<td>Belgium</td>
</tr>
<tr>
<td>Graaf, de, J.A.</td>
<td>114, 200</td>
<td>the Netherlands</td>
</tr>
<tr>
<td>Groothuis, J.T.</td>
<td>82</td>
<td>the Netherlands</td>
</tr>
<tr>
<td>Guggisberg, G.</td>
<td>70</td>
<td>Switzerland</td>
</tr>
<tr>
<td>Gulde, P.</td>
<td>100, 149</td>
<td>Germany</td>
</tr>
<tr>
<td>Gurari, N.</td>
<td>58</td>
<td>United States of America</td>
</tr>
<tr>
<td>Hancock, N.J.</td>
<td>182</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Hansen, G.</td>
<td>227</td>
<td>Denmark</td>
</tr>
<tr>
<td>Harling, S.J.</td>
<td>152</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Henderson, M.</td>
<td>221</td>
<td>Germany</td>
</tr>
<tr>
<td>Hensman, M.Y.</td>
<td>104</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Hermsdörfer, J.</td>
<td>51</td>
<td>Germany</td>
</tr>
<tr>
<td>Herssens, N.</td>
<td>148</td>
<td>Belgium</td>
</tr>
<tr>
<td>Hildebrandt, H.</td>
<td>122</td>
<td>Germany</td>
</tr>
<tr>
<td>Hoideková, K.H.</td>
<td>141</td>
<td>Czech Republic</td>
</tr>
<tr>
<td>Holland, C.E.</td>
<td>102</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Hömberg, V.</td>
<td>136</td>
<td>Germany</td>
</tr>
<tr>
<td>Hoonhorst, M.H.J.</td>
<td>128, 146, 186</td>
<td>the Netherlands</td>
</tr>
<tr>
<td>Huiskamp, M.</td>
<td>98</td>
<td>the Netherlands</td>
</tr>
<tr>
<td>Hvid, L.G.</td>
<td>62</td>
<td>Denmark</td>
</tr>
<tr>
<td>Immerseel, van, L.</td>
<td>226</td>
<td>the Netherlands</td>
</tr>
<tr>
<td>Jaenicke, D.S.</td>
<td>155</td>
<td>the Netherlands</td>
</tr>
<tr>
<td>Jakob, I.</td>
<td>72</td>
<td>Austria</td>
</tr>
<tr>
<td>Jarvis, H.L.</td>
<td>194</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Johnson, L.</td>
<td>84</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Jong, de, L.A.F.</td>
<td>153</td>
<td>the Netherlands</td>
</tr>
<tr>
<td>Jones, T</td>
<td>37</td>
<td>United States of America</td>
</tr>
<tr>
<td>Juckes, F.M.</td>
<td>176</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Kal, E.C.</td>
<td>85</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Kaufmann, C.</td>
<td>201</td>
<td>Switzerland</td>
</tr>
<tr>
<td>Keersmaecker, de, E.</td>
<td>232</td>
<td>Belgium</td>
</tr>
<tr>
<td>Keijzers, N.L.W.</td>
<td>81, 154</td>
<td>the Netherlands</td>
</tr>
<tr>
<td>Kessner, M.</td>
<td>198</td>
<td>Norway</td>
</tr>
<tr>
<td>Kitisomprayoonkul, W.</td>
<td>162</td>
<td></td>
</tr>
<tr>
<td>Kleyven, M.</td>
<td>83</td>
<td>Thailand</td>
</tr>
<tr>
<td>Koene, P.J.A.</td>
<td>180</td>
<td>the Netherlands</td>
</tr>
<tr>
<td>Kooiman, G.M.</td>
<td>175</td>
<td>the Netherlands</td>
</tr>
<tr>
<td>Kordelaar, van, J.</td>
<td>94</td>
<td>the Netherlands</td>
</tr>
<tr>
<td>Kos, D.</td>
<td>76</td>
<td>Belgium</td>
</tr>
<tr>
<td>Krawczyk, M.K.</td>
<td>145</td>
<td>Poland</td>
</tr>
<tr>
<td>Kumar, P.</td>
<td>183, 224</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Kulnik, S.</td>
<td>32</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Kuppuswamy, A.</td>
<td>35, 43</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Laaksonen, K.</td>
<td>67</td>
<td>Finland</td>
</tr>
<tr>
<td>Lamers, I.</td>
<td>144</td>
<td>Belgium</td>
</tr>
<tr>
<td>Langford, T.</td>
<td>202</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Lee, K.B.</td>
<td>185</td>
<td>Republic of Korea</td>
</tr>
<tr>
<td>Lejeune, T.</td>
<td>120</td>
<td>Belgium</td>
</tr>
<tr>
<td>Levin, M.F.L.</td>
<td>59, 231</td>
<td>Canada</td>
</tr>
<tr>
<td>Liepert, J.</td>
<td>46</td>
<td>Germany</td>
</tr>
<tr>
<td>Lim, S.H.</td>
<td>171, 184</td>
<td>Republic of Korea</td>
</tr>
<tr>
<td>Lindberg, P.</td>
<td>48, 113</td>
<td>France</td>
</tr>
<tr>
<td>Lindeløv, J.K.</td>
<td>230</td>
<td>Denmark</td>
</tr>
<tr>
<td>Lith, van, B.J.H.</td>
<td>119</td>
<td>the Netherlands</td>
</tr>
<tr>
<td>Lustenhouwer, R.</td>
<td>137</td>
<td>the Netherlands</td>
</tr>
<tr>
<td>Mares, K.A.</td>
<td>156</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>Mead, G.</td>
<td>39</td>
<td>United Kingdom</td>
</tr>
</tbody>
</table>
Mehrholz, J. 32, 163, 165
Germany
Meyer, S. 142
Belgium
Miggins, S.J. 187
United Kingdom
Moloney, S. 139, 225
United Kingdom
Morris, G. 174
United Kingdom
Moumdjian, L.M. 62
Belgium
Mulder, M. 115
the Netherlands

N
Nackaerts, E. 179
Belgium
Nieuwboer, A. 74
België
Nigg, J. 181
Switzerland
Nizamis, K. 143
Netherlands
Nonnekes, J.H. 31, 74
the Netherlands
Nyffeler, T.H. 45
Switzerland

O
Ondobaka, S. 209
United Kingdom
Ottiger, B. 192
Switzerland

P
Pascucci, Z.M. 189
United Kingdom
Pennati, G.V. 92, 118
Sweden
Piscitelli, D.P. 60, 127
Canada
Prak, R.F. 101
the Netherlands
Prange-Lasonder, G.B. 169
the Netherlands

R
Raaphorst, J 80
the Netherlands
Raats, J.R. 64
België
Regterschot, G.R.H. 197
the Netherlands
Riga, A. 168
Belgium
Roby-Brami, A. 50
France
Roelofs, J.M.B. 97
the Netherlands
Rosso, C. 129
France
Rubio Ballester, B. 89
Spain

S
Saengsuwan, J. 222
Thailand
Saes, M. 69, 99
the Netherlands
Sainburg, R.L. 57
United States of America
Satink, T. 77
the Netherlands
Schröder, J. 151
Belgium
Schwarz, A. 90
Switzerland
Solis-escalante, T. 126
the Netherlands
Staring, W.H.A. 112
Netherlands
Steenbrink, F. 73
the Netherlands
Steenhuisen, M. 147
the Netherlands

Stockley, R.C. 133
United Kingdom
Strawson, A.J. 132
United Kingdom
Stuerner, J. 91
Germany
Swinnen, E. 167
Belgium

Taylor, P.N. 33, 178
United Kingdom
Tedesco Triccas, L.T.T. 32, 68
Belgium
Térémétz, M. 220
France
Thijs, L. 95, 218
Belgium
Turgut, N. 123
Ecuador
Turk, R. 228
United Kingdom
Turolla, A. 61
Italy

U
Upton, E. 215
United Kingdom

V
Velden, van der, L.L. 166
the Netherlands
Veldkamp, R. 103
Belgium
Verheyden, G. 32
Belgium
Vliet, van der, R. 107
the Netherlands
Vloothuis, J.D.M. 116
the Netherlands
Vries, de, N.M. 75
the Netherlands
### Authors index

**W**  
Ward, N. 36  
United Kingdom  
Weiland, S. 191  
the Netherlands  
Widmer, M. 204  
Switzerland  
Wijck, van, F. 33, 47  
United Kingdom  
Wondergem, R. 208, 211  
the Netherlands  
Woodhead, Z.V.J. 52  
United Kingdom  

**Y**  
Yoon, M.J. 188  
Republic of Korea  

**Z**  
Zandvliet, S.B. 88  
the Netherlands
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