

Abstracts: 23rd Annual RIMS Conference 2018

Submission ID: 6; Submission Group: Outcome Measures; Submitter: Massimiliano Pau

Use of inertial sensor to analyze gait patterns during simultaneous texting and walking in people with Multiple Sclerosis

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Background: Approximately 90% of people with Multiple Sclerosis (pwMS) own a mobile phone to communicate, retrieve health-related information and interact with MS health care services. The use of a smartphone involves a cognitive load on the working memory and requires physical resources to manipulate the device. This represents a source of distraction and hazard when pwMS are simultaneously engaged in other tasks like walking.

Aims: To assess the effect of texting on a smartphone on spatial-temporal parameters of gait objectively assessed by means of inertial sensors.

Methods: Forty-five pwMS (low disability EDSS 1-2.5, n=23, moderate disability EDSS 3-6, n=22) and 17 healthy controls were tested under two conditions: 1) walking along a 20m straight path 2) same as 1) while texting on a smartphone with a dedicated application previously employed in similar studies. Stride length, gait speed, cadence, stance, swing and double support phase were calculated. A two-way RM-ANOVA was performed to investigate differences associated with the presence of the disease and the performed task.

Results: Significant effects of task and group were found for speed, stride length and cadence ($p < 0.001$) while significant task x group interactions were detected only for speed and stride length. Healthy individuals and low-disability pwMS seems to give higher priority to texting, while individuals with moderate disability privilege walking. This results in larger speed and stride length reduction in controls and pwMS with low disability in "texting+walking" condition (-30% speed, -15% stride length) with respect to pwMS with moderate disability (-20% speed, -5% stride length).

Conclusions: The smaller changes in speed and stride length found in pwMS with higher disability during the dual-task, seem to indicate that MS might induce a prioritization towards the motor task, probably due to a protective mechanisms which take into account the motor and sensory impairments associated with the disease.

Submission ID: 7; Submission Group: Outcome Measures; Submitter: Massimiliano Pau

Men and women with Multiple Sclerosis exhibit different kinematics of gait: implications for rehabilitation

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Background: it is known that Multiple Sclerosis (MS) affects men and women differently in terms of prevalence, cognitive impairments, disability accumulation, and overall risk of a poorer prognosis. However sex-related issues still remain partly unexplored. For instance, although walking impairments represent a common feature in MS and thus have been extensively investigated, it is unknown whether men and women with MS exhibit different gait patterns.

Aims: to assess the existence of possible sex-related differences in terms of spatio-temporal and kinematic parameters of gait in people with MS (pwMS) using computerized three-dimensional gait analysis

Methods: Sixty pwMS (32F, 28M) stratified in two groups (low disability, EDSS 1-3, n = 28, mild-moderate disability EDSS 3.5-5.5, n = 32) underwent a computerized 3D gait analysis performed using a motion-capture system composed of 8 infrared cameras. Trend of flexion-extension and dorsi-plantar-flexion at hip, knee and ankle joints were calculated together with main spatial-temporal parameters. One-way ANOVA was performed to investigate differences associated with sex on all variables of interest.

Results: When normalized considering individuals' anthropometry, no significant differences were found between men and women with MS in speed, stride length, cadence and stance/swing phase's duration. In contrast, men exhibited significantly reduced ankle plantar-flexion at the terminal stance/initial swing, increased knee flexion at initial contact and increased hip flexion at initial-mid stance and terminal swing with respect to women. However, when analyzed according to their disability level, some changes become either more evident (hip joint) or tend to disappear (ankle joint) as the disease progresses.

Conclusions: The obtained results suggest that it is crucial to investigate gait dysfunctions in pwMS without neglecting their sex. Such an approach may be useful not only in better understanding the pathophysiology of gait disturbances originated by MS, but also in supporting a better orientation of rehabilitative treatments.

Submission ID: 10; Submission Group: Describing and understanding functioning; Submitter: Elizabeth Peterson
Understanding Falls among Full-time Wheelchair Users with Multiple Sclerosis: A Mixed Methods Study

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Background: To develop and implement effective fall prevention interventions for people with multiple sclerosis (PwMS) who are full-time wheelchair users, a deeper understanding of the circumstances surrounding falls among these individuals is needed. This study explored circumstances of falls among full-time wheelchair users with MS.

Methods: A mixed method approach was used to explore circumstances of falls of 18 full-time wheelchair users with MS. In addition to collecting participants' demographic information (age, gender, type of wheelchair used, duration of wheelchair use, and duration of disability), self-reported fall frequency in the past 6 months, fear of falling and activity restriction due to fear of falling was collected. Qualitative data in the form of participants' responses to an open-ended question yielding information regarding the circumstances of the most recent fall were also collected. Qualitative data were analyzed via thematic analysis.

Results: Among study participants 72% were female. Participants' mean age was 56 years; their mean length of MS duration and duration of wheelchair use was 20 years and 6 years, respectively. The median number of falls in the past six months was 3, and 83% reported fear of falling. Among the participants reporting fear of falling, 78% reported restriction in activity. Analysis of the participants' descriptions of the circumstances of their most recent falls resulted in three main categories: action-related fall contributors (e.g., transfer, wheelchair propulsion, reaching), (2) location of falls (e.g., bathroom, bedroom, living room, garage, garden), and (3) fall attributions, which were further categorized as intrinsic (e.g., distraction, muscle weakness, losing balance) and extrinsic (e.g. surface condition, equipment failure).

Conclusion: Results reveal the diverse nature of fall circumstances among PwMS who are full-time wheelchair users. Findings will inform the development of an intervention to support full-time wheelchair users with MS in their fall prevention efforts.

Submission ID: 11; Submission Group: Rehabilitation interventions; Submitter: Noemi Martinez Lerin

Caminem: A pilot program of outdoor physical activity for spanish people with multiple sclerosis

Noemi Martinez Lerin

Background: Scientific evidence suggests that regular physical activity in people with multiple sclerosis (PwMS) has beneficial effects. The objective of this prospective randomized clinical trial was to investigate the effects of outdoor physical activity program supplemented with a health education on walking endurance, health-related quality of life, sleep quality, impact of fatigue and adherence to treatment in Spanish PwMS.

Patients and Methods: Twenty-three PwMS were selected and randomly assigned to the Treatment (TG) or Control (CG) group.

The TG completed a treatment program supervised by a physiotherapist and a nurse both specialized in PwMS of 24 sessions of physical activity based on walking (twice a week, outdoors) and 4 group sessions of health education (empowerment and healthy lifestyle). The CG did not change his physical activity habits or receive any additional information. All participants were evaluated on an initial and final examination 12 weeks apart. The

variables studied were walking endurance: Six Minutes Walking Test (6MWT), health-related quality of life (HRQL): Short-Form 36 scale (SF-36), sleep quality: Pittsburgh Sleep Quality Index (PSQI), fatigue impact: Fatigue Severity Scale (FSS) and attendance. In the case of the TG, a satisfaction questionnaire was administered.

Results: The TG showed statistically significant results in walking endurance (6MWT: $p = 0.000$), HRQL (SF-36 vitality subscale: $p = 0.011$) and fatigue impact (FSS: $p = 0.023$). There were no significant changes in sleep quality (PSQI: $p = 1,000$). Adherence to the treatment was 14% higher than others offered by the Center and the satisfaction of the program was 9 points out of 10.

Conclusions: The results suggest that a program of regular physical activity based on walking outdoors supplemented with professional advice to empower PwMS, increases walking endurance and vitality, contributes to the management of fatigue, increases adherence to treatment and it is perceived as very satisfactory.

Submission ID: 12; Submission Group: Rehabilitation interventions; Submitter: Tom Meurrens

Accreditation in a rehabilitation hospital

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Introduction: External accreditation in smaller hospitals bears a higher relative cost. Contributing factors are the fixed cost for the survey process and a higher administrative burden. The achievability and desirability of external accreditation for smaller hospitals is open for discussion.

Objectives: To achieve JCI accreditation as a rehabilitation hospital.

Method: The National MS Center Melsbroek began its accreditation trajectory at the end of 2013. The administrative burden was decreased by involving people who are actually doing clinical work and by working bottom up. The NMSC used its position within its network to gain access to knowledge and cooperation with specialized personnel concerning JCI accreditation and quality improvement. This helped to formulate a clear path to 'constant survey readiness'.

Results: In October 2017 the NMSC attained, as the first rehabilitation hospital within the BeNeLux, the JCI accreditation for hospitals.

Discussion: We showed that it was possible for a smaller hospital to gain external accreditation, but the challenges of a higher relative cost and a higher administrative burden should be acknowledged. Strategies to handle these challenges should be explored before starting an accreditation trajectory. Preferably using the advantages of a small hospital as a key strategy. Quality projects and other engagement were formulated mostly bottom up due to the small scale of the hospital. This facilitates the implementation of quality of care standards for clinical practice. The multidisciplinary, patient-centered approach also reflected well. The surveying team stated to have seen an organization working together around a patient as one. The external accreditation was a learning moment for the organization. It considerably increased involvement of stakeholders and positive imaging of the center. Analyzing the impact of the accreditation on rehabilitation outcome will be an objective for the future.

Submission ID: 14; Submission Group: Rehabilitation interventions; Submitter: Freya Davies

Providing self-management support: A survey of UK health professionals who work with people with multiple sclerosis
[Freya Davies](#)

Introduction: Supporting self-management is increasingly seen as an important part of the role of healthcare professionals. We set out to describe what self-management support (SMS) techniques nurses and therapists who work with people with multiple sclerosis (MS) currently use and what they think benefits their patients. We also aimed to identify barriers to SMS provision and priority areas for training.

Methods: We invited 643 members of the MS Trust (a UK charity) mailing lists to participate in an online survey. The survey was designed following scoping searches of the literature and was piloted and refined with input from a local MS team. The survey used multiple-choice questions alongside free-text comment boxes. Data collection took place from April to May 2016. Data were imported to IBM SPSS Statistics (Version 23, 2015) and descriptive statistics generated.

Results: We received 146 responses (22.7% response rate). Sixty-three percent of respondents worked in nursing roles, and 37% were therapists. Reported usage of SMS techniques varied from 46.2% of staff frequently using motivational interviewing to 93.8% of staff frequently using shared decision-making. The majority of staff believed that most of their patients would benefit from all ten SMS techniques described in the survey. Staff reported being very interested in future training in providing psychological support (78.9%), motivational interviewing (76.2%) and assessing a patient's capacity to self-manage (60.1%). Barriers to SMS provision relating to organisational factors affected most staff at least to some extent (e.g. need to prioritise other tasks during appointments (85.2%) and working pattern inhibiting follow-up (78.3%)). Perceived lack of training in SMS techniques had affected 78.2% of respondents.

Conclusions: Staff working with people with MS recognise the benefits of providing SMS but are inhibited by organisational constraints. Staff also feel that they lack training in SMS skills and have identified priority training needs.

Submission ID: 15; Submission Group: Rehabilitation interventions; Submitter: Claudia Marck

Understanding Barriers and Enablers to long-term adherence 3-5 years after a MS lifestyle intervention

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Modifiable lifestyle factors play a key role in MS symptoms, progression and comorbidities. Few multimodal management strategies are available and little is known about long-term adherence. This qualitative study aimed to assess barriers and enablers to long-term adherence in people with MS who self-selected for a 5-day lifestyle intervention promoting healthy diet, regular exercise, vitamin D supplementation and sun exposure, non-smoking, and stress-management. 13 women and 5 men participated in semi-structured phone interviews, which were transcribed and

thematically analysed. Despite purposive sampling, no smokers participated.

Participants reported improvements in health behaviours 3-5 years after participating in the intervention, although no one was adhering fully at the time of this study, and adherence seemed to decline slightly over time. Episodic patterns for exercise and meditation were common. The time commitment involved to meet these recommendations was cited as a major barrier, others included injuries and MS symptoms, weather, financial or geographical barriers, and motivation. Those who had a regular exercise regimen often had established this before diagnosis. Less time-consuming behaviours such as supplementing with vitamin D were better adhered to, although many were unsure if they were reaching adequate vitamin D levels. Most participants followed the dietary recommendations most of the time. Support at home, ability to, and enjoyment in, food preparation, and ability to resist unhealthy foods were cited as both barriers and enablers. Increased fitness and mobility, weight loss, and a sense of accomplishment, and control over health were motivators.

Several practical and attitudinal strategies were employed, including some unique strategies involving goal setting and methods tailored to one's ability and preference, planning, and self-monitoring. A few reported significant help from local MS societies, but many reported a lack of support or advice from specialists. These qualitative data will potentially inform future quantitative studies and lifestyle interventions.

Submission ID: 16; Submission Group: Rehabilitation interventions; Submitter: Claudia Marck

The effectiveness of exercise interventions for pain reduction in people with multiple sclerosis: a systematic review and meta-analysis of randomized controlled trials.

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Introduction: There is increasing evidence that modifiable lifestyle factors are associated with multiple sclerosis (MS) health outcomes, and may be important in disease management. In particular, exercise has been shown to improve mobility, mood, and quality of life. Pain is a common disabling symptom for people with MS and treatment options are currently limited, costly and with side-effects. Exercise may reduce the causes of pain, through promoting neuroplasticity, neuro-regenerative and anti-inflammatory processes; and the perception of pain. Therefore, exercise therapy may offer a low-cost, accessible management strategy for pain, with likely additional health benefits.

Methods: We systematically reviewed the evidence to determine the effect of exercise on pain in people with MS. Five electronic databases were searched for randomized controlled trials conducted in people with MS where exercise was the exposure and pain a primary or secondary outcome. A random effects meta-analysis was conducted to calculate standardized mean differences between treatment and control to estimate the overall effect of exercise on pain. We fitted meta-regression models to investigate heterogeneity of the effect, and used funnel plots and Egger's regression asymmetry test to ascertain bias due to small study effects.

Results: Ten studies met the inclusion criteria (n=389). The meta-analysis showed that people allocated to exercise interventions

experienced less pain compared to those allocated to control groups (standardized mean difference=-0.44, 95% CI=-0.02, -0.86). Heterogeneity of the estimated effects between studies was high ($I^2=71.1\%$).

Conclusion: This is the first systematic review investigating the effect of exercise interventions on pain in MS. While there was weak evidence that exercise alleviates pain, this review highlights a lack of high quality evidence in this area. There were substantial limitations in reporting and high levels of bias. Future randomised trials should have larger samples, adequate randomization, stringent methods and more detailed reporting.

Submission ID: 17; Submission Group: Outcome Measures; Submitter: Kim-Charline Broscheid
Revision of the Fatigue Index Kliniken Schmieder
 Kim-Charline Broscheid

Fatigability is a common and frequently disabling symptom in people with Multiple sclerosis (pwMS) and is one of the main reasons for an early retirement. Nonetheless, it is not well understood and in most cases, qualitative questionnaires are used to get a subjective evaluation of fatigue. Only a few methods focus on an objective and easy to apply approach to quantify fatigability. Hence, the university of Konstanz developed in cooperation with the Kliniken Schmieder Konstanz a kinematic gait analysis to quantify motor fatigability in pwMS: The Fatigue index Kliniken Schmieder (FKS) (Sehle, Vieten, Sailer, Mündermann, & Dettmers, 2014). The FKS is based on the “attractor method”, focusing on the dynamics of human locomotion (Vieten, Sehle, & Jensen, 2013). It classifies the fundamental walking pattern by calculating the Limit-Cycle-Attractor and its variability from acceleration data. The acceleration data were assessed at the beginning and the end of a walking trial on a treadmill until exhaustion of the participants (Borg-Scale 17) or for a maximum of 60-minutes. The 3D inertial sensors (RehaWatch, Hasomed) were fixed laterally on the feet. The method has the potential to clearly differentiate between healthy subjects/pwMS without and with fatigability. The FKS is quite promising, however, it is too time consuming to apply. This is why we conducted a new pilot-study in 2017 with a shorter protocol of only 20 min. The evaluation of the acceleration data indicates that even with a shorter protocol it can be distinguished between pwMS with and without fatigability. In further projects, it has to be considered to define a more precise classification of the FKS to graduate mild, moderate and severe fatigability and a how to establish this assessment in a clinical environment.

Submission ID: 18; Submission Group: Rehabilitation interventions; Submitter: Andrea Weise
Inpatient fatigue-management education
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Background: Studies have shown the efficacy of outpatient fatigue management with energy conservation strategies in people with MS (pwMS). However, these treatment protocols are not compatible with multidisciplinary inpatient rehabilitation.

Aim: Development of an evidence-based inpatient energy management group education (IEME) protocol and materials, and user-evaluation of a test-run

Methods: Based on a literature review of fatigue management education protocols and their scientific evaluation, the IEME framework, a manual for occupational therapists (OTs) and a workbook for pwMS were developed. Three OTs have been trained, followed by a 9-week test-run in 12 pwMS. Users' experiences were evaluated by focus groups: OTs n=3, pwMS n=9.

Results: IEME starts with an individual introductory session. Subsequently, participants enter into the first available group session. Group sessions are self-contained units with self-training assignments in between. IEME concludes with an individual goal-setting session. Patient empowerment and behavioural change strategies are incorporated in the 3-weeks protocol. During the test-run, OTs executed 24 individual and 15 group sessions with high treatment fidelity.

Focus groups: Working in groups was seen as the decisive factor for success by pwMS and OTs. Exchanging experiences and strategies was reported by pwMS as motivating and enriching. They evaluate the individual and group tasks as realistic and meaningful. IEME-materials are experienced by both groups as multi-sided, oriented towards participants' resources and understandable. OTs rate their training in IEME as useful and necessary, but more time for group moderation training is needed.

Conclusions: IEME was implemented in an inpatient rehabilitation setting without problems. OTs and pwMS were satisfied with the protocol and materials. No substantive changes are needed, but valuable improvements were implemented within the materials. A clinical trial is planned to establish the effect of IEME on self-efficacy and fatigue impact after discharge.

Submission ID: 19; Submission Group: Describing and understanding functioning; Submitter: Elisabetta Groppo
Clinical predictors of the short-term effects of inpatient multidisciplinary rehabilitation in multiple sclerosis: a single-center retrospective study.

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Background: Multidisciplinary rehabilitation (MDR) can be effective in improving functional recovery and quality of life (QoL) in persons with multiple sclerosis (pwMS). The identification of short-term predictors of inpatient MDR is important to better define its cost/benefit profile and to optimize the access priority.

Materials and methods: Clinical charts of pwMS admitted to our Unit for intensive MDR between July 2011 and June, 2016 were retrieved. Subjects' demographics, disease profiles, modified Barthel Index (mBI), Expanded Disability Status Scale (EDSS), pain Numerical Rating Score (NRS), types of intervention administered (motor, occupational, speech/swallowing, respiratory, cognitive, psychological) were collected in a database. Improvement was defined for mBI as an increase of ≥ 5 points, for EDSS as a decrease of 1.0 for baseline score ≤ 5.5 and 0.5 for baseline scores >5.5 ; any decrease in NRS was considered as an improvement.

Results: Data from 653 pwMS were collected; at admission, median values were 15 years for disease duration; 6.5 for EDSS, 63 for mBI, 3 for number of interventions. At discharge, 65% and 22% of patients showed mBI and EDSS improvement, respectively, while NRS decreased in 89% of them. mBI improvement was associated with a disease duration ≤ 15 years (OR 0.64, $p=0.02$) and with access to psychological counseling (OR 1.63, $p=0.02$). EDSS improvement was associated with baseline EDSS >6.5 (OR 8.5, $p<0.001$), disease duration ≤ 15 years (OR 1.00, $p=0.01$), relapsing-remitting MS (OR 1.00, $p=0.01$), female gender (OR 1.00, $p=0.03$) and longer duration of the admission period (OR 1.02, $p=0.05$). Pain NRS improvement was associated with higher scores at admission and psychological counseling.

Conclusions: Inpatient MDR improves the autonomy in activities of daily living in the majority of pwMS and its effect can be more pronounced in females with shorter disease duration. More comprehensive measures reflecting QoL changes are needed to capture the actual effectiveness of inpatient MDR.

Submission ID: 20; Submission Group: Outcome Measures; Submitter: Niels Steenstrup Zeeberg

A walk-through of the basic structure, strengths and weaknesses of the most commonly used methods to model costs and the effect of different intervention strategies applying demographic, epidemiological and clinical data.

Niels Steenstrup Zeeberg

Background: Mathematical models can simulate the effect and estimate the impact of strategic decisions such as providing disease modifying treatment (DMT) or specialized rehabilitation to MS-patients and the impact on health care cost and human lives of alternative approaches. They represent a valuable tool that at low cost provides policy makers with key insights about consequences of hypothetical situations that would otherwise be unknown.

Purpose: It is the purpose of this presentation to provide a general understanding of relevant models applicable to MS, to demonstrate a static cohort (Markov) model and to run an agent-based dynamic transition model (ABM) during presentation. Both models use registry data on the Danish MS population and a matched background population in order to calculate consumption of health care, care and production loss attributable to MS.

Method: This presentation provides a walk-through of the basic structure, strengths and weaknesses of the most commonly used methods to model costs and the effect of different intervention strategies applying demographic, epidemiological and clinical data.

Model types differ on three main characteristics, i.e. being compartmental vs. individual-based, discrete vs. continuous and deterministic vs. stochastic. While Markov-models are individual-based, discrete and deterministic ABM's are compartmental, continuous and stochastic. The ABM's stochastic nature enables it to simulate switch in DMT caused by both disease progression and side effects of the treatment, while allowing the modeller to keep track of how individuals move between compartments across time.

Results: The average cost-utility-ratio (ACUR) for a thirty-year period has been calculated using each of the two models applying same transition probabilities for natural disease progression, treatment effects, consumption data on health care and care, production loss and costs.

ACUR is DKK 283,529/ QALY using the Markov-model and DKK 289,553/QALY using the ABM.

Conclusion: The main results are in line with findings in recent qualitative studies in Denmark and Europe.

Submission ID: 21; Submission Group: Rehabilitation interventions; Submitter: An van Nunen

TMST, transmigration of MS expertise

An van Nunen

In 2015, the National MS Center (NMSC) Melsbroek started with the Transmural MS Team (TMST) as innovative care model for PwMS, especially targeting those who are novice in a multidisciplinary approach.

This 'pilot' convention allows us to organize new care programs (targeting issues like 'Work', 'Cognition', 'Fatigue', 'Sexuality', 'Nutrition', ...) in an outpatient construct. More innovative TMST-aspect is the creation of a network, where MS-teams are sent to peripheral hospitals to work together with local neurologists. In this collaboration a 6-discipline consultation is organized, creating a window of 3 hours for the PwMS to interact not only with their own neurologist, but also with an MS-nurse, physiotherapist, dietician, social worker and rehabilitation doctor. This NMSC expert-team addresses a wider gamma of questions and needs, and broadens the view of the PwMS on possibilities for trouble shooting and living healthy with MS. If there is a need for more elaborated care input the team refers the PwMS as much as possible to local care professionals and facilities. Another option can be the engagement in one of the NMSC care programs. Key target is working together with PwMS in an experience based way, transcending the first levels of information/advice transfer. Persons with recent MS diagnoses literally 'meet' the potential of interdisciplinary collaboration in their known location, which lowers the threshold for rehabilitation interventions. Being time and attention offered for complex and changing needs is also seen as an advantage besides the low-barrier, interactive approach of all team members. Accessibility for patients to own reports (including interdisciplinary goalsetting) promotes growing insight and self-management behavior.

We will present experiences, barriers and lessons learned in two first years of TMST-activity, based on the Evaluation Report for the Health Insurance Service (R.I.Z.I.V.) in April 2017. Future opportunities and plans will also be discussed shortly.

Submission ID: 23; Submission Group: Rehabilitation interventions; Submitter: Alessandra Solari

Participant perspectives of a home-based palliative approach for people with severe multiple sclerosis: a qualitative study nested in a randomized controlled trial

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Background: We undertook a multicenter randomized controlled trial to assess the effectiveness of a home-based palliative approach (HPA) for adults with severe multiple sclerosis (MS) and their caregivers. Concurrently, we performed a qualitative study to investigate the experiences of the patients, their caregivers, patient referring physicians, and the teams who delivered the HPA intervention. Our aim was to explore the strengths and challenges of the intervention, and circumstances that may have influenced its efficacy.

Methods: We performed semi-structured one-on-one interviews with 12 patients and 15 informal caregivers chosen using a maximum variation strategy, two focus group meetings with patient referring physicians (4 participants each), and one with the HPA teams (9 participants).

Results: From data analysis (framework method) 38 sub-categories emerged, which were grouped into 12 categories and 3 themes: 'expectations,' 'met and unmet needs', and 'barriers'. Intervention benefits were improved control of symptoms and reduced sense of isolation of the dyads. Limitations were: factors related to experimental design (difficulty of dyads in identifying examiner and team roles, additional burden for caregivers); team issues (insufficient team building /supervision, competing priorities); limitations of the intervention itself (insufficient length, lack of rehabilitation input); and external factors (resource limitations, under-responsive services/professionals). The referring physician focus groups provided little experiential data.

Conclusions: The HPA reduced patient symptoms and sense of isolation in patients and caregivers. The indirect role of the HPA teams, and insufficient length of the intervention were key limitations. The experimental design imposed additional burdens on the dyads. Key barriers were the paucity of available services, the demanding administrative procedures, and lack of networking facilities. These findings suggest that two major requirements are necessary for home palliative care to be effective in this patient population: HPA teams well-connected with MS rehabilitation services, and care delivered over the long-term, with variable intensity.

Submission ID: 24; Submission Group: Describing and understanding functioning; Submitter: Marta Bassi
Illness perceptions and mental health among persons with multiple sclerosis: The mediating role of coping strategies

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Background: According to Leventhal's Common Sense Model, illness perceptions influence patients' well-being both directly and indirectly through the coping responses adopted to face health threats. Studies on multiple sclerosis highlighted the direct relation between illness perceptions and well-being, while the mediational role of coping strategies still lacks investigation.

Aim: This study tested the mediation of coping strategies and social support between illness perceptions and mental health of persons with multiple sclerosis (PwMS).

Method: Participants were 680 PwMS ($M_{age}=40.1$; 64.4% women; $M_{EDSS}=3.3$) from eight Italian MS centers. They completed the Illness Perception Questionnaire-R, evaluating illness beliefs (identity, chronic and cyclical timelines, consequences, personal and treatment control, coherence, emotional representations, psychological causes, risk causes, chance); the Brief COPE, measuring problem-focused, emotion-focused and avoidance coping; the Multidimensional Scale of Perceived Social Support; and MS Quality of Life-54, investigating mental health. SPSS PROCESS macro was used in mediational analyses.

Results: Direct negative effects on mental health emerged for identity ($B=-17.61$, $p<.001$), consequences ($B=-2.66$, $p<.04$), cyclical timeline ($B=-1.93$, $p<.009$), emotional representations ($B=-3.72$, $p<.001$), psychological causes ($B=-1.93$, $p<.02$); positive effects were observed for treatment control ($B=2.74$, $p<.006$) and MS attribution to chance ($B=1.15$, $p<.009$). Moreover, mediational analysis based on bootstrapping technique revealed that identity, personal control, treatment control, coherence and psychological causes were related to better mental health through higher use of emotion-focused coping and/or lower avoidance. Conversely, emotional representations, consequences and chance were related to worse mental health through lower use of emotion-focused coping, lower social support, and higher avoidance. Problem-focused coping did not emerge as a significant mediator.

Conclusions: The relationship between illness beliefs and PwMS' mental health varies according to the adoption of adaptive versus maladaptive coping strategies. Health professionals should consider these complex relations in order to effectively promote PwMS' well-being.

Submission ID: 25; Submission Group: Outcome Measures; Submitter: Alessandra Solari
Patient and caregiver involvement in formulation of guideline questions: Findings from the EAN Guideline on Palliative Care of People with Severe Multiple Sclerosis

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Background: The involvement of consumers in clinical practice guideline development is recommended to increase guideline trustworthiness and relevance.

Objective: To engage multiple sclerosis (MS) patients and caregivers in definition of the key questions to be answered in the EAN Guideline on Palliative Care of People with Severe MS.

Methods: A mixed methods approach was used: 1) International online survey launched by the national MS societies, after pilot testing/debriefing on 20 MS patients and 18 caregivers. 2) Focus group meetings (FGMs) of Italian and German MS patients and caregivers.

Results: 1) Of 1199 participants, 951 (79%) completed the whole survey, and 934 from seven countries were analyzed: 751 (80%) were MS patients (74% women, mean age 46.1) and 183 (20%) caregivers (36% spouses/partners, 72% women, mean age 47.4). Participants agreed/strongly agreed on inclusion of the nine pre-specified topics (from 89% for 'advance care planning' to 98% or 'multidisciplinary rehabilitation'), and fewer than 5% answered 'I prefer not to answer' to any topic. Free comments were 569: 182 (32%) on pre-specified topics, 227 (40%) on additional topics (16 guideline-pertinent), and 160 (28%) on outcomes. 2) Five FGMs (three of MS patients, two of caregivers, overall 35 participants) corroborated the survey findings, and helped to identify patient-important outcomes.

Conclusions: Consumer involvement was resource and time intensive, but rewarding. It was key for the formulation of the guideline questions, and for the identification of patient-important

outcomes. In particular free comments from several participants concerned sensitive issues which were purposely excluded from the pre-specified topics.

Submission ID: 26; Submission Group: Describing and understanding functioning; Submitter: Federica Corona
Relationship between upper and lower limb impairments objectively assessed in people with Multiple Sclerosis

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Background: In people with Multiple Sclerosis (pwMS), clinical assessments of motor disability is usually focused on lower limbs (LL), particularly as regards gait dysfunctions, while upper limb (UL) functional limitations are less considered. However, UL movements are of great importance in many activities of daily living. Despite most of pwMS exhibit UL and LL impairments, a clear relationship has not yet quantitatively investigated.

Aims: To investigate relationships between UL and LL impairments in pwMS while performing motor tasks relevant for their quality of life, such as walking and "hand-to-mouth" (HTM) movement.

Methods: Twenty-four pwMS (EDSS: 3.8±2.3, range 1-6) underwent a 3D kinematic analysis during gait and HTM movements. The following parameters were computed: for HTM, overall movement duration, velocity, smoothness and adjusting sway (AS, trajectory length during mouth localization); for gait, speed, stride time and length and cadence. Correlations between UL and LL parameters and between EDSS and UL/LL parameters were assessed using Spearman's rank coefficient.

Results: Moderate correlations were found between total HTM duration and stride time ($\rho=0.56$, $p<0.01$), and between HTM velocity and gait speed ($\rho=0.35$, $p<0.05$). The precision of the HTM movement, expressed by AS, was also found moderately correlated with gait speed ($\rho=-0.36$, $p<0.05$) and stride length ($\rho=-0.34$, $p<0.05$). The index associated with movement smoothness was found negatively correlated with gait speed ($\rho=-0.31$, $p<0.05$). Lastly, EDSS was found weakly correlated with total HTM duration ($\rho=0.35$, $p<0.05$) and strongly correlated with gait speed ($\rho=-0.85$, $p<0.01$).

Conclusions: UL and LL motor abilities in pwMS appear weakly-moderately correlated, although both worsen as disability increases. This suggests UL and LL impairments should be separately assessed using specific tests to have a whole view of the motor functions in MS. However further studies on a larger set of UL movements are needed to verify if such lack of relationship is confirmed.

Submission ID: 27; Submission Group: Outcome Measures; Submitter: Hans Bogaardt

The development and validation of a new Speech pathology-specific questionnaire for persons with Multiple Sclerosis (SMS).

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Faculty of Health Sciences, The University of Sydney, Sydney, Australia

Purpose: The aim of this study was to develop and validate a Speech pathology-specific questionnaire for persons with Multiple Sclerosis (SMS).

Method: 41 items were generated through a literature review. Items were submitted to a preliminary psychometric validation process consisting of principal component analysis, internal consistency, test-retest reliability, and floor and ceiling effects using data from 164 participants. Criterion validity was assessed by comparing the SMS with the 12-item Short Form Health Survey (SF-12). Participants were recruited internationally through online channels and questionnaires were completed online.

Results: The SMS contains 17 items describing three components: speech and voice, language, and swallowing. Internal consistency (Cronbach's alpha) of the three components was satisfactory ($\alpha=0.89$ – $\alpha=0.91$). Criterion validity was evaluated using Spearman's rank correlation coefficient (ρ). A weak to moderate correlation between the SMS and the SF-12 was identified ($\rho=-0.29$ – $\rho=-0.46$). No ceiling effects were present. Floor effects were detected across two components. This is not problematic as these results align with estimated prevalence data of speech-language pathology symptoms in persons with MS (PwMS). The SMS demonstrated strong test-retest reliability. All items had an intra-class correlation coefficient ≥ 0.70 .

Conclusion: The SMS is a psychometrically robust PROM to assess speech-language pathology symptoms in PwMS.

Submission ID: 28; Submission Group: Rehabilitation interventions; Submitter: Mariette Eijkenaar
The Relapse Prevention Plan for sustained behavioural change in MS

Mariette Eijkenaar (health care psychologist) and Saskia Koning (occupational therapist)

Institution: *Merem, location Almere, The Netherlands*

Topic area: Supporting Self-management. Sustaining the behavioural changes required to deal optimally with MS and signal a potential behavioural relapse in time.

Background: Achieving sustained behaviour change is complex, with a multitude of different factors driving a person's behaviour and working to maintain it.

Behavioural relapse is common, especially in periods of stress or other situations disrupting daily structure.

Objective: To share 'The Relapse Prevention Plan' we developed in Merem, a manual for patients with MS to sustain behavioural changes.

Evidence is on relapse prevention in mental disorders (for example depression).

Method: In the last weeks of the multidisciplinary rehabilitation programme the patient fills in the behavioural relapse prevention plan in consultation with their spouse and therapists.

Triggers and early warning signs of a relapse are identified and actions are formulated that can prevent behavioural relapse. The patients can use the plan to check if he or she is in the danger zone for a behavioural relapse and can perform the pre-defined actions according to the plan.

The plan is described in such a way that it is concrete and directly applicable for the patient when it is needed. When a patient experiences a behavioural relapse, the attention narrows often and he or she can have trouble thinking creatively and solution-oriented.

Discussion: In the follow-up meetings (after 3 months) with the rehabilitation specialist the prevention plan is evaluated. They discuss possible behavioural relapses and evaluate how successful the patient can apply the plan.

The prevention plan enables patients to enhance their self-management skills to cope with MS, and helps to evaluate sustained effects of the rehabilitation programme.

Submission ID: 29; Submission Group: Rehabilitation interventions; Submitter: Sara Navarro Gómez
Psychotherapeutic Intervention program in newly diagnosed young patients of multiple sclerosis

Sara Navarro¹, Laia Miralles¹, Gisela Carres¹

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Background: Different cross-sectional studies about the premature diagnosis of Multiple Sclerosis (MS) suggest, that the diagnosis promotes appearance of different psychological symptoms (e.g., feeling of generalized anxiety, fear of uncertainty, depressive mood, insomnia, low self-esteem). These symptoms modulate the quality of life of newly diagnosed patients, especially young patients who are diagnosed between 20-30 years. In the same line, different cross-sectional studies report that the diagnosis of MS generates a greater sense of social stigma, isolation and low self-esteem compared to other clinical samples.

Objectives: The main objective of this study was to create a program of psychotherapeutic intervention (PPI) for newly diagnosed MS young patients (PndSM) and offer them a therapeutic space to reduce social stigma, isolation and low self-esteem generated by the diagnosis.

Method: The treatment group (TG) consisted of 10 biweekly sessions and was formed by 10 PndSM between 18 to 35 years, of which 90% of them had relapsing-remitting MS and had an average age of 30.6 years. They were evaluated at the beginning and at the end of the follow-up by the different scales; Short Form-36 Health Survey (SF 36) and Self-esteem Inventory of Buss and Perry.

Results: Statistically significant differences were found between the beginning and the end of the follow-up. There was obtained, 1) an increase in the sensation of perceived health, especially in the scales of physical function (64.46 vs 84.50), general health (53.35 vs 63.45) and emotional role (54.61 vs 66.54), 2) increase in self-esteem levels (20.80 vs 31.40)

Conclusions: The results indicate that the program of intervention in newly diagnosed young patients helped them promote their quality of life and self-esteem, as well as the feeling of belonging to a social group.

Submission ID: 30; Submission Group: Outcome Measures; Submitter: Niels Steenstrup Zeeberg
Epidemiology, socio-economy and costs of MS

Niels Steenstrup Zeeberg, Associate Professor, MA Econ, MPH, Anders Green, MD, PhD, DrMedSci, Professor., Camilla Sortsø, PhD Scient. San. Publ., Cecilie Sørup Yssing, MA Econ, Anastasija Komkova, MA, Hans Keiding, PhD and Professor in Economics, Lasse de Fries Jensen, MA Econ.

Background: This study characterizes updated epidemiological and socioeconomic aspects of MS in Denmark and provides estimates of costs attributable to MS.

Methods: A registry-study based on data from a cohort of all Danish MS-patients and an age and gender matched control cohort applying a societal perspective. Costs in 2014 Danish Kroner (DKK) are converted to Euro using the 2014 average annual exchange rate (Euro 100 = 745.4741). The analyses are stratified according to gender, age group, cost sector, occupational status, receiving or having received disease modifying treatment (DMT) or not, and health-state groups based on EDSS-scores.

Results: Epidemiological findings

Using symptom debut year as operational start, the Danish MS-population has grown by 2-3% p.a. from 1997-2015.

This is due to an improvement in the disease progression prognosis. The study indicates that the excess mortality in MS-patients is decreasing and may be eliminated within the next decades.

Socio-economic findings

On average from 1997-2015, 37% of the MS-population compared to 66% of the controls are employed while 38% compared to only 7% are on early retirement. MS-patients in DMT are generally younger, with a higher education level and a higher employment rate.

Costs attributable to MS

In 2014, the total annual costs of health care, caregiving and productivity loss attributable to MS in Denmark amounted to €447,597,911 (30,177/patient), hereof healthcare €168,166,772 (11,373/patient), care €117,707,012 (7,961/patient), productivity loss (sick leave, early retirement) €144,974,376 (9,720/patient) and productivity loss (premature death) €16,749,752 (1,123/patient). Health care costs varies considerably between patients receiving first-line, second-line and no DMT. Care costs vary with age, time from disease debut and between DMT and no DMT. Productivity loss is higher with males and primarily driven by sick leave and early retirement.

Conclusion: MS has huge impact on labor market association and disease progression causes massive societal production loss and care costs.

Submission ID: 32; Submission Group: Rehabilitation interventions; Submitter: Ambra Mara Giovannetti

Unmet needs of patients transitioning to secondary progressive MS: Qualitative findings for a resource development

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Introduction: About 50% of patients with relapsing multiple sclerosis (MS) convert to secondary progressive MS (SPMS) 15 years after clinical onset. Despite the complexity and potential impact of this transition, little research has been done on this topic and no targeted interventions to promote patients wellbeing are available. Managing the Transition to SPMS (ManTra) aims to develop and assess the efficacy of a user-led resource for newly diagnosed SPMS patients. Here, we describe a key project phase: assessment of the experiences and needs of SPMS transition, as reported by the patients, patient significant others (SOs), neurologists and other MS health professionals (HPs).

Methods: We performed: personal semi-structured interviews with 15 recently diagnosed SPMS patients (8 women, mean age 48.7 (SD 7.5), median EDSS 6 (min-max=4-7)); three focus group meetings (one with patient SOs, one with neurologists and one with other MS HPs across Italy). Interviews and focus group meetings were audio-recorded, transcribed verbatim, and analysed (framework method).

Results: Data analysis revealed 62 sub-categories, grouped into 10 categories and four themes: 'Awareness of the transition'; 'Transition'; 'Reaction to disease progression'; 'Resources'. All the stakeholders agreed on the following unmet needs: Management of SPMS at the MS Centre; Psychological support; MS HP training; Communication and information; Job and welfare.

Conclusions: We observed a general lack of communication of the transition by neurologists and low awareness by SPMS patients who massively used defensive mechanisms. All stakeholders unanimously asked for improved management at the MS center, provision of psychological support, specific HP training, access to more information, dedicated worker protection policies and job outplacement in this disease phase. Our finding will be combined with those of the ongoing German qualitative study. An online survey (>400 recently diagnosed Italian and German SPMS patients) will follow to substantiate needs on a large, independent sample.

Submission ID: 33; Submission Group: Outcome Measures; Submitter: Daphne Kos

Life balance of European people with MS: RIMS multicenter psychometric study

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Introduction: A balanced person is able to spread time (and energy) optimally across the different life domains. Especially in people with multiple sclerosis (MS) the ability to self-steer an optimal balance in daily activity may be compromised.

Objective: To evaluate cross-cultural, construct validity and test-retest reliability, of the translated versions of the Life Balance Inventory (LBI) in people with MS within different European cultures (Danish, French, Spanish, Slovenian, Dutch and Flemish).

Method: The LBI was translated according to the principles of translation and cultural adaptation process of patient-reported outcomes and evaluated in people with MS in each country/language area. To evaluate construct validity, correlations of the LBI with quality of life, fatigue, depression and self-efficacy are explored. LBI (score range 1-3; higher scores refer to better balance) is registered twice to evaluate test-retest reliability.

Results: Complete data collection will be finalized in April 2018. Preliminary results are available of the Dutch (n=81, 74% women, 55±9.6 years), Flemish (n=155, 60% women, 50±11.3 years) and Slovenian (n=48, 78% women, 44±11.2 years) samples. Total LBI scores of Flemish version (2.31 ± 0.4) differed significantly from Dutch version (2.47 ± 0.3) (p=0.02) and Slovenian version (2.47 ± 0.3) (p=0.001). ICC [95% CI] of total LBI was 0.90 [0.86 – 0.93] (Flemish), 0.71 [0.54-0.82] (Dutch) and 0.50 [0.08-0.73] (Slovenian). Correlations ranged from 0.178 to 0.487 in the total sample, not fully confirming a priori hypotheses.

Conclusion: The Dutch, Slovenian and Flemish LBI show interesting results which will be further explored in the other languages to make conclusions about the usefulness of the LBI for clinical practice and international research.

Submission ID: 34; Submission Group: Rehabilitation interventions; Submitter: Linda Renfrew

A comparison of the orthotic and therapeutic effects of FES and AFO for foot drop in MS on the speed and oxygen cost of walking, fatigue, falls and quality of life: results form a 12 month randomised trial

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Introduction: Ankle-foot Orthoses (AFO) and Functional Electrical Stimulation (FES) are assistive devices used in the management of foot drop in Multiple Sclerosis (MS). FES has been found to have positive effects on the speed and energy cost of walking, falls frequency and quality of life. There have been no studies investigating the comparative effects of these devices in people with MS (pwMS).

Method and Materials: PwMS presenting with foot drop, who had not previously used either device, were recruited across 7 NHS health boards in Scotland to a Randomised Trial. Participants received a custom made standardised AFO or FES (ODFS PACE (OML, Salisbury, UK)). The following outcomes were collected at baseline, 3, 6 and 12 months; gait speed (25ft walk test, 5min self selected walking speed) and oxygen cost of walking (COSMED K4b2 (Cosmed, Rome, Italy) with and

without the device, falls frequency, fatigue (MFIS) and quality of life (MSIS-29, EQ5D). Repeated measures ANOVA models will analyse variables and their interactions to compare the orthotic and therapeutic effects of both devices on these outcomes.

Results: Seventy-eight pwMS were recruited and received either AFO or FES. Initial analysis of walking speed found that the AFO group walked significantly slower than the FES group (5minSSWT, p=0.037) at baseline. The AFO group walked significantly slower with AFO than without (25ftWT, p=0.037), particularly in the fast-walking (≥0.8 m/s) group (p=0.011). The slow-walking (<0.8m/s) FES group walked significantly faster with FES than without (25ftWT;p=0.029, 5minSSWT;p=0.037). Final assessments will be complete by mid February and analysis of the full data set will be presented at conference.

Discussion and conclusion: Results from this study, the first randomised trial comparing AFO and FES in MS, will inform clinical practice and policy at a national and international level in the management of foot drop in MS.

Submission ID: 35; Submission Group: Rehabilitation interventions; Submitter: Linda Renfrew

An interpretative phenomenological analysis of the experiences and utility of functional electrical stimulation used for foot drop in people with multiple sclerosis.

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Introduction: Functional electrical stimulation (FES) is effective in improving many aspects of walking in people with Multiple Sclerosis (pwMS) presenting with foot drop. There is however limited research exploring pwMS experiences using FES. This study aims to explore their experiences with regards to its utility, efficacy, acceptability and impact on daily life.

Method and Materials: An interpretative phenomenological approach, using telephone interviews with ten pwMS who had used FES for twelve months was undertaken, as an integral part of a randomised trial comparing FES with ankle foot orthoses (AFO). Each interview was analysed involving exploratory commentary examining the descriptive, linguistic and conceptual content of the data. Emergent themes were identified and subsequent analysis of the recurrence of emergent themes across the interviews identified three super-ordinate themes.

Results: Six female and four male participants were recruited. Four participants had relapsing remitting (RR), three had secondary progressive (SP) and three had primary progressive (PP) MS. The extended disability status score (EDSS) of participants ranged from 3 to 6.5. Analysis identified three relevant super-ordinate themes; *Impact of FES*, *Sticking with FES* and *Autonomy and control*. Despite some challenges using FES, positive physical and psychological benefits of FES and increased engagement in valued activities were reported. Intrinsic and external factors in addition to participant's experiences using the device contributed to a weighing up of the pros

and cons and influenced the final decision to continue to use FES. Nine of the ten participants were continuing to use FES at 12 months.

Discussion and conclusion: This study has contributed to our understanding of pwMS experiences of using FES and will help inform prescribing decisions and support the continued, appropriate use of FES over the longer term. These results are particularly salient in a progressive and variable disease such as MS.

Submission ID: 36; Submission Group: Rehabilitation interventions; Submitter: Moira Tzitzika
Sexual Dysfunction among Greek patients with Multiple Sclerosis

Moira Tzitzika

Objectives: Multiple sclerosis can cause changes that affect one's usual ways of expressing sexuality in a variety of ways.

Sexual changes in MS can best be characterized as primary, secondary, or tertiary in nature. Primary sexual dysfunction stems from changes to the nervous system that directly impair the sexual response and/or sexual feelings. Secondary sexual dysfunction refers to MS-related physical changes that indirectly affect the sexual response. Tertiary sexual dysfunction results from psychosocial and cultural issues that can interfere with sexual feelings and sexual response.

The present study is the first registration among Greek MS patients regarding sexual dysfunction in both sexes.

Materials and Methods: 607 MS patients (186 men, 421 women) all members of the MS Societies all over Greece participated in the study. They filled out the Greek version of the Multiple Sclerosis Intimacy and Sexuality Questionnaire (MSISQ19) along with demographic data.

Results: Sexual dysfunction is present in both sexes with high rates in all levels of SD but with statistically significant differences between Primary SD and the two other categories. There were no statistically significant differences between the prevalence of SD among sexes.

Conclusion: Sexual dysfunction among Greek MS patients is frequent in both sexes. This emphasizes the necessity for evaluation and treatment of SD from doctors and other healthcare professionals dealing with MS patients and the need for future studies about these issues.

Submission ID: 37; Submission Group: Outcome Measures; Submitter: Ambra Mara Giovannetti
Individualized quality of life in people with MS: advantages of using the SEIQOL-DW

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Introduction: In contrast to traditional inventories, individualized quality of life (QoL) measures require that each person define his/her own QoL domains and their weightings.

We assessed the feasibility of the Schedule for Evaluation of Individual QoL-Direct Weighting (SEIQoL-DW) interview in people with multiple sclerosis (PwMS), correlations between the SEIQoL-DW index score and standard patient-report outcome measures (PROMs) and the key QoL domains.

Methods: Participants were people with MS who undertook the baseline evaluation of the READY for MS randomized controlled trial. A trained psychologist (RQ) administered the SEIQoL-DW in a dedicated room of the MS Centre. PwMS then received the following PROMs: the 54-item MS QoL (MSQOL-54), the Hospital Anxiety and Depression Scale, the Perceived Stress Scale, the Connor-Davidson Resilience scale, and the Comprehensive assessment of Acceptance and Commitment Therapy processes.

Results: Thirty-nine PwMS were enrolled, participants' mean (SD) age was 44.9 (9.6), 62% were women, median (range) EDSS score 2.0 (0–6.5). SEIQoL-DW was completed and deemed valid in all cases; mean (SD) administration time was 37.4 (8.3) minutes, SEIQoL-DW index score was 66.8 (15.4). SEIQoL-DW index was significantly correlated with the MSQOL-54 Mental Health Composite scale score (Pearson's $r = 0.46$, $p = 0.003$), but was unrelated to other MSQOL-54 scales and PROMs. The most commonly nominated SEIQoL-DW areas were family (100% of the patients), leisure activities (59%), physical and mental health (56%), self-fulfilment (51%), and relationships (49%). The MSQOL-54 contained eight of the 13 (62%) SEIQoL-DW-nominated areas. Self-fulfilment, spirituality, information, financial resources, and values were additional areas that emerged in the SEIQoL-DW only.

Conclusions: Individualized QoL can be a useful and feasible outcome measure for PwMS. It provides information not tracked by the standard inventories and may lead to the elaboration of patient-tailored therapies.

Submission ID: 38; Submission Group: Outcome Measures; Submitter: Leonie Ruhaak

Validation of DYMUS-NL for swallowing function in MS
Leonie Ruhaak, Joke Geytenbeek, PhD, Caroline Bruggeman, BSc, Hans Bogaardt, PhD, Vincent de Groot, MD, PhD

Background: Over 30% of individuals with multiple sclerosis have difficulty eating and drinking, especially in the advanced stages of the disease. Dysphagia is associated with an increased risk of aspiration pneumonia, increase in health-care cost and increase in mortality. Therefore, an easy and valid tool for an early and accurate diagnosis of dysphagia in MS is needed.

Objectives: The DYMUS is a 10-item questionnaire to assess DYsphagia in MULTiple Sclerosis. This study was designed to assess the accuracy of the Dutch DYMUS compared with fiberoptic endoscopy (FEES) in diagnosing dysphagia in individuals with MS and to determine the reproducibility of the DYMUS.

Methods: Sixty-seven individuals with advanced MS enrolled in a prospective study of diagnostic accuracy that complies with the STAndards for Reporting of Diagnostic Accuracy (STARD

criteria). Dysphagia was evaluated by the question whether they had difficulty swallowing, DYMUS (test and re-test) and FEES being the reference standard. Sixty-five participants completed the DYMUS (test and re-test) and sixty-three participants underwent FEES-examination.

Results: According to FEES, prevalence of dysphagia was 93.7%, 41.8% showed penetration or aspiration and 92.1% showed residue. The DYMUS showed a ROC AUC of 0.744 for dysphagia with an optimal cut-off at a score of 1 (74.6% sensitivity and 50% specificity). McNemar's Test shows a significant difference between the DYMUS and FEES ($p = 0.02$), i.e. the tests do not match adequately. The reproducibility of the DYMUS is acceptable.

Conclusions: Unlike earlier validation studies of the DYMUS, the results of this study show that the DYMUS is not accurate in screening for dysphagia in progressive MS in the advanced stages of the disease. Hence, instrumental evaluation should always be used in clinical practice as well as future studies in assessing swallowing function and safety in advanced MS.

Submission ID: 39; Submission Group: Describing and understanding functioning; Submitter: Susan Coote
Does cognition affect falls self-efficacy, falls control, worry about falling and activity curtailment in people with MS who have had a fall?

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Background: Over 50% of people with MS (PwMS) will fall in a three month period. Falls are associated with reduced falls self-efficacy, reduced falls control, worry about falling (WAF) and activity curtailment (AC). Cognitive deficits are prevalent among PwMS, and some elements may affect these psychosocial variables.

Objective: To investigate the association between self-reported and performance-based measures of cognitive function and the above psychosocial variables.

Method: 140 PwMS completed a telephone survey containing the Blessed Orientation-Memory-Concentration (BOMC) Test and a question about problems with concentration and forgetfulness (Not a problem, Interferes a little bit, Interferes a great deal). They also completed the 16-item Falls Efficacy Scale-International (FES-I), the Falls Control Scale (FCS), and answered questions about WAF and AC.

Results: Mean age was 51.8(11.3) and years since diagnosis was 14.3(9.0). 69.3% were female, with the majority having "deteriorating" MS symptoms in the past year (39%). There were no association (Spearman's Rho) between BOMC and FES-I scores, the association between BOMC and WAF approached significance ($r=0.14$, $p=0.09$). Using ANOVA, there was no difference in BOMC score across WAF or AC categories. There was a correlation between poor concentration and forgetfulness and FCS ($r=0.18$, $p=0.036$) only. Chi Squared tests revealed no association between poor concentration and forgetfulness and WAF or AC categories.

Conclusion: Since the BOMC is a test of attention and concentration, and since our findings contrast with these earlier studies that measured executive functioning and global cognitive functioning, our study suggests directions for future research intended to refine/better understand the relationship between fall-related psychosocial variables and cognitive status.

Submission ID: 41; Submission Group: Rehabilitation interventions; Submitter: Elaine Coulter
The effectiveness of interventions targeting physical activity and/or sedentary behaviour in people with Multiple Sclerosis: a systematic review

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Background: Remaining physically active is important to maintain functional ability and reduce the incidence of comorbidities in People with Multiple Sclerosis (PwMS). Interventions that encourage PwMS to be more physically active are highly warranted. The aim of this systematic review was to evaluate the effectiveness of interventions which target Physical Activity (PA) or Sedentary Behaviour (SB) in PwMS.

Methods: A systematic search was conducted in September 2017 of the following databases: Web of Science Core Collections, Embase and Medline using appropriate keywords. Included studies were randomised controlled trials (RCTs) involving PwMS who completed an intervention, which was compared to a passive or active comparator. Outcomes included subjective or objective measures of PA or SB. Quality assessment was performed using the PEDro scale.

Results: Twenty-one RCTs were included (25 articles) including 1337 participants, the majority of which had mild-moderate disability. The average PEDro score was 5.9 ± 1.6 . Interventions included exercise prescription ($n=5$), behaviour change interventions ($n=9$), combined exercise and behaviour change techniques ($n=5$) and health promotion education ($n=2$). Intervention duration ranged from one week to six months, the majority lasted 8-12 weeks ($n=13$). Generally, subjective, but not objective, PA improved in PwMS with mild-moderate disability. Only two trials, including those with mild-moderate disability, reported SB as an outcome with conflicting results found between trials.

Conclusions: Interventions were heterogeneous in type, dosage, frequency and duration. Objective and subjective methods of evaluating PA appear to give conflicting results with the latter indicating effects. Effects on SB remain to be elucidated.

Submission ID: 42; Submission Group: Rehabilitation interventions; Submitter: Blathin Casey
Activity Matters: A Web-based resource to enable people with Multiple Sclerosis to become more active.

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Background: Increasing physical activity (PA) through exercise is associated with improvements in many of the symptoms associated with Multiple Sclerosis (MS). Despite this, people with MS (pwMS) remain largely inactive. Interventions that are grounded in theory and aim to change PA behaviour need to be developed, implemented and evaluated further.

Objectives: To describe the development of a web-based resource to enable pwMS to become more active, namely, 'Activity Matters'.

Methods: Development of 'Activity Matters' was guided by the UK's Medical Research Council (MRC) Complex Interventions framework and a behavioural model entitled the Behaviour Change Wheel (BCW). Seven sources of data were used to inform the process and were mapped on to both the MRC and BCW. Five of these sources were research papers conducted by the authors. These included three systematic reviews and two original research studies. The other data sources were conducted by MS PA research groups from North America and Europe.

Results: The intervention is theoretically based and constructs including, knowledge, memory, attention and decision processes, skills, social influences, environmental context and resources, beliefs about capabilities, beliefs about consequences, goals and emotions were recognised as important. Intervention functions and techniques that will be used on the website include, education, enablement, environmental restructuring, persuasion, incentivisation, action planning, goal-setting, social-support and problem-solving.

Conclusions: 'Activity Matters' is the first MS PA intervention to use the theoretical approach outlined by the MRC and BCW. The next phase of this work is to test the usability, acceptability and preliminary effectiveness of 'Activity Matters'.

Submission ID: 43; Submission Group: Outcome Measures; Submitter: Alon Kalron

The relationship between somatosensory evoked potentials and functional measures of the upper limb in people with multiple sclerosis

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Background and purpose: Individuals with multiple sclerosis (MS) frequently suffer from impaired sensory function, reduced strength and tremor in the upper limbs, which lead to impairments in upper limb function. Somatosensory evoked potentials (SEPs) reflect the sequential activation of neural structures along the somatosensory pathways. In the current study we evaluated the prevalence of upper limb impairments in relation to SEPs in people with MS (PwMS).

Methods: The analysis was based on data obtained from 140 PwMS (95 women), mean age 47.4 (S.D.=12.8) years, disease duration 9.3 (S.D.=8.9) years and EDSS score 3.5 (S.D.=1.8). SEPs measurements included the latency (msec) and amplitude

(microv) of waves N9 (Erb's point), N13 (Fifth cervical), and N19 (cortical). Upper limb clinical measures included the 9-Hole Peg test (s) (9-HPT), Functional Dexterity test (s) (FDT) and the 2-Point Discrimination test (mm) (2PD).

Results: Mean scores for latency of N9, N13, N19 were 9.6 (S.D.=0.8), 13.6 (S.D.=1.3), and 20.2 (S.D.=1.9), respectively. Mean scores of the 9-HPT, FDT, 2PD were 31.1 (S.D.=14.5), 39.0 (S.D.=16.2) and 1.4 (S.D.=0.6), respectively. N19 latency correlated significantly with 9-HPT (Rho=0.249, $P=0.003$), FDT (Rho=0.395, $P=0.001$) and 2PD (Rho=0.266, $P=0.008$) in the right upper extremity and with 9-HPT (Rho=0.231, $P=0.001$) and 2PD (Rho=0.174, $P=0.042$) in the left upper extremity. Non-significant scores were noted between the latency of N9, N13 and amplitude parameters with all clinical upper limb measures. According to the regression analysis, by utilizing the 9-HPT and gender we were able to explain 44.3% of the variance related to the N19 latency of the right upper extremity.

Conclusions: Functional measurements of the upper limb provides insight into the impaired myelin conduction of the upper extremities, related with MS.

Submission ID: 44; Submission Group: Describing and understanding functioning; Submitter: Karin Riemann-Lorenz

ADAMS-PA: Facilitators and Barriers of long-term adherence to physical activity in MS – Results from a German RIMS funded survey study

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Background: Systematic reviews support the beneficial effects of physical activity (PA) and exercise on various outcomes in Multiple Sclerosis (MS), yet such outcomes require long-term engagement. We examined the facilitators and barriers of long-term adherence with PA and exercise in MS.

Methods: We focused on the findings of three behavior change models associated with PA behavior change and a review of the MS-specific literature. We conducted 12 interviews with MS exercise experts from various disciplines and five European countries. We used the Theoretical Domains Framework (TDF) to structure the variety of identified constructs, identified valid scales and developed a comprehensive online survey questionnaire. We collected data from 1529 people with MS (pwMS) in Germany from 19th of April until 4th of October 2017.

Results: We classified adherence to regular PA with a modified Physical Activity Staging Questionnaire. Descriptive analysis indicated that 52.8 % of our sample were classified as long-term active (≥ 1 y), 12.5% as currently active (≥ 6 months but < 1 y) and 34.7 % as not active on a regular basis. Long-term active pwMS had more positive experiences with PA, scored higher on intrinsic motivation, and perceived less environmental barriers compared with the group that was not active ($p < 0.001$). Those classified as

not active scored lower on behavioural regulation and worse on measures of depression compared with the long-term active group ($p < 0.001$). Two thirds reported receiving no or not much information about PA and MS, 72% were not aware of PA guidelines and 48% had no knowledge about appropriate athletic exercises or physical activities for pwMS.

Perspective: Our comprehensive questionnaire was well accepted and provided important information on determinants of long-term involvement in PA and exercise among pwMS. We are currently analysing the impact of TDF constructs on PA adherence and are preparing surveys in other countries.

Submission ID: 45; Submission Group: Outcome Measures; Submitter: Insa Schiffmann

Development and validation of a questionnaire assessing the emotions and attitude of people with multiple sclerosis towards the MRI

Short: A questionnaire on the attitudes of PwMS towards the MRI.

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Background: Magnetic resonance imaging (MRI) plays a major role in the life of people with multiple sclerosis (PwMS) from the beginning of the disease. Not only is it the gold standard for the diagnosis of multiple sclerosis (MS) itself, it is then used to determine prognosis and efficacy of immunotherapy. Studies investigating MRI use for a variety of diseases showed, that the scan itself may be the cause of anxiety, and receiving the results even more so. However, little to no data exists on how PwMS feel about MRI, what effect MRI results have on patients' well-being and how they are communicated to them. Additionally, no adequate tool exists to assess these topics.

Objective: We aimed to develop and validate a questionnaire on the "EMotions and Attitudes of people with MS towards MRI" (MRI-EMA) in a mixed methods approach.

Methods: Based on previous research findings, a prototype questionnaire was developed and revised according to the input of $n=6$ MS-patients collected in semi-structured interviews and the results of 2 rounds of testing with a total of $n=207$ patients. Afterwards, the questionnaire was validated using exploratory and confirmatory factor analysis on a sample of $n=457$ PwMS recruited via the website of the German MS society.

Results: The final questionnaire consists of 10 items. Exploratory factor analysis revealed 4 latent factors underlying the questionnaire:

1. Fear of MRI scan
2. Fear of MRI results
3. Feeling of control over the disease
4. Feeling of competence in the patient-physician encounter.

Confirmatory factor analysis demonstrated a good fit and thereby validated the 4-factor solution.

Conclusion: The questionnaire MRI-EMA is the first tool to assess emotions and attitude towards the MRI in PwMS. Its validity has been confirmed using exploratory and confirmatory factor analysis.

Submission ID: 46; Submission Group: Rehabilitation interventions; Submitter: Andrea Weise

Feasibility of an inpatient fatigue education study
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Background: Outpatient fatigue management education by occupational therapists in persons with MS (pwMS) is efficient, but no program is available for the inpatient setting. To close this gap an inpatient energy management education (IEME) was developed.

Aim: To evaluate the feasibility of a RCT study-protocol and to explore the effect of IEME on self-efficacy and fatigue

Methods: Design: RCT. Sampling: Persons with MS-related fatigue during a three-week inpatient rehabilitation at Rehabilitation Centre Valens. Interventions: Six IEME or progressive muscle relaxation (PMR) group sessions as part of a personalized rehabilitation program. Data-collection: Evaluation of recruitment and assessment procedures, drop-out and follow-up rate, treatment fidelity, compliance with therapy and six telephone-interviews with IEME-participants after returning home. Outcomes were fatigue impact, self-efficacy, quality of life and occupational performance at baseline, discharge and 16 weeks follow-up.

Results: Between July and November 2017, 47/83 pwMS were included and randomized (IEME:24/PMR:23). Reasons for discontinued participation were preliminary discharge and insufficient energy for the strenuous rehabilitation program (IEME:2/PMR:4). Treatment fidelity was high and 89% of all tasks were completed. SF 36 at discharge (T1) was not suitable as questions relate to everyday situations in the usual environment not fitting with changed routines during inpatient-stay. At T1 there were no differences in fatigue between groups, but a significant difference in self-efficacy applying energy conservation strategies, and a reduced demand for individual OT-sessions in the IEME group. At the follow-up, participants at home reported the exchange in the IEME groups as being positive, they were more aware of energy management and had introduced changes in daily routine. Data analysis from the 4-month follow-up until March 2018 will depict the effect of IEME on self-efficacy in everyday life.

Conclusion: The feasibility of the study protocol was confirmed and preliminary effects of IEME are promising.

Submission ID: 48; Submission Group: Rehabilitation interventions; Submitter: Kamer Unal Eren

Is 6-week individualized task-specific exercise training sufficient to change health-related behaviors in patients with Multiple Sclerosis: a pilot study

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Background: Motor, sensory and cognitive symptoms of Multiple Sclerosis (MS) may negatively affect individuals' life-style and quality of life. Exercise training which is one of symptomatic

approaches has an important role to reducing symptoms and increasing quality of life. The purpose of this study was to determine whether task-specific exercise training has changed the individual's lifestyle and quality of life.

Methods: A total of 15 relapsing-remitting MS patients (13 female, 2 male) were participated to this study and their median age was 40 years [18, 58] and median duration of disease was 4 years [1, 19]. The mean Expanded Disability Status Scale (EDSS) score was 1.70 ± 1.04 and no physiotherapy was applied to all patients before this study. Individualized task-specific exercise training was performed 3 times a week for 6-weeks with supervised by physiotherapist. Task-specific exercise training was included aerobic exercise, muscle strengthening, core stabilization and balance training. Life-style behaviours and quality of life were assessed with Health Promoting Lifestyle Profile-II and MS Quality of Life-54; respectively, before and after training.

Results: After 6-weeks exercise training, there was no change in the behaviour of individuals in interpersonal relationships, health responsibility, nutrition, physical activity, stress management and spiritual development ($p > 0.05$). However, it is noteworthy that spiritually is the highest and physical activity is the lowest area in patients before the training. After the training; while physical composite of quality of life has been increased ($p < 0.05$); mental composite has not been increased significantly ($p > 0.05$).

Conclusion: The 6-weeks exercise training period alone was not sufficient to change whole lifestyle behaviors, however exercise training was effective in improving quality of life. To consider that disease management should be included cognitive and fatigue management too. In future studies are needed longer follow-up period, control groups and different severity of disease and also an exercise training program is needed over 6-weeks.

Submission ID: 49; Submission Group: Rehabilitation interventions; Submitter: Freya Davies

Training staff who work with people with progressive neurological conditions in health coaching: A realist evaluation

Freya Davies

Introduction: Supporting self-management in multiple sclerosis (MS) can be challenging for health professionals. It requires specific skills which may not be part of traditional professional training. In response to this unmet need, training courses have been developed to try to change attitudes and enhance competencies around self-management support provision. Health coaching is one approach that is gaining momentum in the UK. Using this approach, health professionals support their patients to identify their own goals and develop their own solutions.

Methods: We undertook a realist evaluation of a two-day health professional training course delivered to 21 nurses and therapists working with a range of (mostly progressive) neurological conditions. Participants completed questionnaires prior to training and after the second training day. A further questionnaire is planned at 3 months. Questionnaires examined attitudes to self-management support, together with levels of knowledge, confidence and current usage in relation to seven key health coaching competencies. Qualitative data were collected via participant observation during the training. Follow-up telephone interviews are ongoing (due for completion July 2018). The data from the evaluation stage will be used to develop and refine our existing theories about how and when the training works which are based on an earlier review of the literature.

Results: We will present our initial theories about important ways in which the training operates. We will discuss how these theories might be refined based on the emerging data from the training evaluation (initial questionnaires, observation data, early interview findings)

Conclusions: Understanding the way in which staff who work with people with progressive neurological conditions experience and respond to training in health coaching will allow us to make recommendations about the relevance of this approach for working with people with MS, and to suggest any adaptations that may be required for this setting.

Submission ID: 50; Submission Group: Outcome Measures; Submitter: Gillian Quinn

Development of a Falls Risk Tool for use in MS

Gillian Quinn, Laura Comber, Prof. Chris McGuigan, Dr. Rose Galvin, Prof. Susan Coote.

Background: Balance and mobility are commonly impaired in people with Multiple Sclerosis (PwMS) and fall prevalence in this population is high with a falls incidence of greater than 60%. Therefore, it is essential to identify potential fallers early and initiate appropriate falls prevention interventions.

Objectives: To develop a falls risk screening tool for PwMS using objective measures of mobility and various clinical variables including demographic information and data from a falls screening questionnaire.

Methods: Consecutive PwMS attending the Neurology service in a tertiary hospital were recruited. Data collected included the EDSS score (disability), disease duration, MS type and walking aid(s) used. Consenting participants completed a questionnaire of falls risk factors and the Timed Up and Go test (TUG) under single and dual task conditions. Falls were prospectively recorded for 3 months using falls diaries.

Results: Mean age ($N=100$) was 52.6 (10.7) and 66% were female. Majority of the group had progressive MS (72%) and 73% used a walking aid. 56 participants recorded a total of 791 falls. Initial bivariate analysis resulted in 11 potential variables suitable for inclusion in multivariate logistic regression. Variables from the questionnaire that were significantly different between groups include a fall in the past 3 months ($p = 0.008$) and problems with bladder/bowel ($p = 0.03$). Following stepwise regression, the resulting model with a sensitivity of 88% (Nagelkerke $R^2 = 0.197$, $p = 0.003$) included the variables of problems with bladder control, no visual problems, fall in the past three months and TUG score.

Conclusion: This model has a high sensitivity but does not explain a substantial proportion of variance. In this notably older and progressive MS cohort this unexplained variance may be due to co-morbidities and other psycho-social factors that were not examined for this study.

Submission ID: 51; Submission Group: Rehabilitation interventions; Submitter: Hans Bogaardt

Incidence and effects of speech, language and swallowing problems in persons with MS in Australia and New-Zealand.

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Introduction: The Speech pathology-specific questionnaire for persons with Multiple Sclerosis (SMS) is a 17-item questionnaire

for persons with MS (PwMS), identifying possible problems with speech, language and swallowing in PwMS. The questionnaire contains 8 statements on possible problems with speech, 4 statements on productive and receptive language and 5 on swallowing difficulties. Each statement has to be rated on a 5-point scale (“never”, “almost never”, “sometimes”, “almost always”, “always”). A recent validation study of the SMS has determined that the questionnaire is a robust tool for the evaluation of the speech pathology specific functional health status in this population. Scores on the SMS were compared with questions on the SF12, a general quality of life survey.

Methods: For this study the SMS was completed by 143 PwMS from Australia (N=52) and New-Zeeland (N=91). The majority of respondents were diagnosed with relapsing remitting MS (62%), 18% with secondary progressive MS and 12% with primary progressive MS. Between the two countries there was no difference in distribution of disease type.

Outcomes: For this study the answers were converted to a 0 (never) to 4 (almost always) scale to allow statistical analysis. The maximum score for ‘Speech’ is therefore 32, for ‘Language’ 16 and for ‘Swallowing’ 20. Mean subscale scores on the SMS were 6.0 for Speech (SD 6.2; range 0-29), 5.6 for Language (SD 3.5; range 0-16) and 5.1 for Swallowing (SD 4.1; range 1-20).

In this study we considered only the answers “sometimes”, “almost always” and “always” as clinical relevant and used these as a cut-off score to determine whether a clinical problem was present. 43% of respondents reported problem with controlling their voice and 31% reported that their speech was slow. 48% to 68% on two questions reported word finding problems and 36% of respondents reports “difficulty of making sense out of what people say to me”. Around 30% reports frequent coughing and choking while eating and drinking.

Problems with speech, language and swallowing did not correlate with the time since diagnosis of MS (Spearman’s Rho, $p=0.237$, $p=.967$ and $p=.404$ resp.). Speech, language and swallowing problems did correlate however with a negative effect on social activities ($\rho=0.441$; $p<.0001$, $\rho=0.399$; $p<.0001$ and $\rho=0.441$; $p<.0001$ resp.) and were associated with depressed feelings ($\rho=0.266$; $p=.001$, $\rho=0.258$; $p=.002$ and $\rho=0.337$; $p<.0001$ resp.). Only one participant had sought advice of a speech pathologist for these problems, other participants had never received speech therapy.

Conclusions: Our study shows that speech, language and swallowing problems are frequent findings in PwMS in Australia and New-Zeeland. However, almost to none PwMS seek help of a speech pathologist for these problems, although these problems are correlated with a detrimental effect on quality of life. Our data warrants a larger survey of PwMS in these countries to validate these findings. Data suggest however that there is a need to evaluate policies regarding speech pathology service provision in order to provide better care to PwMS.

Submission ID: 52; Submission Group: Rehabilitation interventions; Submitter: Ambra Mara Giovannetti
READY for MS, a group intervention to promote resilience in people with multiple sclerosis: a single blind RCT with a nested qualitative study.

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Introduction: A recent Australian case series study demonstrated that the READY (REsilience and Activity for every DaY) for multiple sclerosis (MS), a group intervention based on Acceptance and Commitment Therapy improved the quality of life (QoL) of people with MS.

We present the design and baseline data of a pilot randomized controlled trial (RCT) assessing the efficacy of READY for MS.

Methods: Single-blind RCT and nested qualitative study comparing READY for MS with relaxation. Each intervention consisted of 7 weekly group sessions, plus a booster session after 5 weeks. Measures of QoL (54 items MS QoL, MSQOL-54), mood (Hospital Anxiety and Depression Scale, HADS; Perceived Stress Scale, PSS), resilience (Connor-Davidson Resilience scale, CDRISC-25), psychological flexibility (Comprehensive assessment of Acceptance and Commitment Therapy processes, CompACT) and its protective factors were collected at baseline, after seven, 12 and 24 weeks.

Results: Mean (SD) age of participants was 44.9 (9.6), 61.5% were women, 82.1% had relapsing MS, median (range) years from diagnosis 7.0 (0.5–36.0), and median EDSS 2.0 (0–6.5). Mean MSQOL-54 composite scores were: Mental Health 58.1 (17.3), Physical Health 59.6 (15.0). Participants with moderate or severe HADS scores were 22/39 (56%) for Anxiety and 19/39 (49%) for Depression. Mean PSS score was 20.8 (3.9); mean CDRISC-25 score was 51.8 (14.7); and mean CompACT score was 83.5 (22.4). Four intervention groups were conducted with 39 participants: 20 assigned to READY for MS, 19 to relaxation. Two patients (READY for MS) withdrew before beginning the intervention due to unexpected work commitments. Median retention was 7/8 in both arms.

Conclusions: This is the first RCT of the READY for MS program. Participants had mild disability, but elevated psychological difficulties, and low levels of resilience. Participant engagement in the RCT was high with only 5% attrition. Findings will be available by May 2018.

Submission ID: 53; Submission Group: Describing and understanding functioning; Submitter: Laura Comber
Postural control deficits in people with MS

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Background: The pathological nature of multiple sclerosis can affect the postural stability of an individual causing imbalance and predisposing falls for this population.

Objective: To identify and quantify deficits in postural control in people with multiple sclerosis (pwMS) in comparison to

healthy controls with the goal of informing falls prevention interventions.

Methods: A systematic literature search identified case-control studies investigating differences in postural control across a diversity of task conditions between people with MS and healthy controls. Meta-analysis was conducted where a variable was presented by four or more studies.

Results: Forty-three studies of people with a mean Expanded Disability Status Scale (EDSS) of 1.0 to 6.0 were included. Seven assessment conditions were identified; Quiet stance eyes open, quiet stance eyes closed, compliant surface eyes open, compliant surface eyes closed, leaning towards limits of stability, perturbed stance and clinical measures. 105 individual measurement variables of postural control were identified within the studies. Six of these case-controlled studies explored the relationship of identified deficits to falls, with centre of pressure path length being significant and the only variable investigated using a prospective methodology. Quiet stance was the only condition (n=11) possessing sufficient data to contribute to meta-analysis of centre of pressure path length (SMD=1.04, 95% CI {0.86-1.22}, $p<0.001$), medio-lateral velocity (SMD=1.35, 95% CI {0.77-1.92}, $p<0.001$) and 95% confidence ellipse (SMD=0.83 95% CI {0.59-1.08}, $p<0.001$). Results indicate that regardless of task complexity or sensory condition, people with MS display considerable deficits in postural control.

Conclusions: A considerable lack of standardisation of reporting exists regarding postural control measurements for pwMS. However, pwMS possess significant deficits in postural control compared to healthy controls regardless of task complexity or sensory condition. The association between such deficits and falls using prospective falls recording requires further examination when considering falls prevention for this population

Submission ID: 54; Submission Group: Describing and understanding functioning; Submitter: Moira Tzitzika
Female Sexual Dysfunction among Greek women with Multiple Sclerosis: correlations with organic and psychological factors
 Moira Tzitzika

Objectives: Multiple Sclerosis (MS) is a degenerative, neurological disease which influences the patients' QoL. Women with MS very often experience Female Sexual Dysfunction (FSD). The aim of our study is to determine and evaluate the prevalence of FSD in Greek women with MS and correlate it with organic and psychological factors.

Materials and Methods: 267 consecutive women with MS, aged over 18, who were admitted in our outpatient clinics from 02/2016 to 03/2017 were included in the study. Demographic data included age, marital status, menopause status, the number of children. Additionally, disease related data such as duration of the disease, Expanded Disability Status Scale (EDSS) and medication of MS was obtained. All participants completed the Greek validated version of the Depression, Anxiety, Stress Scale 21 (DASS-21) [15-17] questionnaire along with the Greek validated version of Female Sexual Function Inventory (FSFI). Statistical analysis was used to calculate the prevalence of FSD and its correlation with organic (age, EDSS, duration of the disease, menopause status) and psychological factors (Depression, Anxiety, Stress).

Results: FSD was diagnosed in 64.5% of our sample. The correlation analysis between clinical variables and FSFI subscales scores showed that age had a significant negative correlation with all subscales of the FSFI. Additionally, there was no significant correlation in any FSFI subscale with duration of the disease. Correlation of EDSS and FSFI scores found to be statistically significant with a negative correlation in all Subscales apart from the Satisfaction subscale. Regarding the correlation analysis between DASS domains and FSFI subscales, there were significant correlations in Desire and Arousal dysfunction with Depression, Anxiety and Stress and in Lubrication domain with Anxiety and Stress.

Conclusion: FSD is common among Greek female patients, it is influenced by the age, the severity of the disease and the co-existence of depression anxiety and stress.

Submission ID: 57; Submission Group: Outcome Measures; Submitter: Laurits Madsen

A cross-sectional study on the relationship between cardiorespiratory fitness, disease severity and walking speed in persons with Multiple Sclerosis.

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Background: In persons with Multiple Sclerosis (PwMS) lower cardiorespiratory fitness has been associated with disease severity, walking capacity and comorbidities. However, current evidence is of moderate quality and a large-scale single-center study is needed to further elucidate these relationships.

Objective: The purpose of the study was 1) to examine the relationship between cardiorespiratory fitness and disease severity in PwMS; 2) to investigate the relationship between cardiorespiratory fitness and walking speed; and 3) to examine the potential impact of Multiple Sclerosis (MS) disease type on these relationships. **Methods:** Data was collected from a database consisting of data from 700 inpatients at Valens Rehabilitation Center, Switzerland. VO₂peak (cardiorespiratory fitness), information on disease course and MS type, walking performance, comorbidities and anthropometric was eligible from 242 PwMS.

Results: Cardiorespiratory fitness and Expanded Disability Status Scale (EDSS) was inversely related ($r = -.465$, $p < .01$). A multiple linear regression analysis showed that an increase of 1 point on the EDSS score was associated with a decrease of 1.88 mL·Kg⁻¹·min⁻¹ and explained 36 % of the variance, when adjusted for time since diagnosis, gender, age, and phenotype of MS.

Walking speed and cardiorespiratory fitness was significantly correlated ($r = .584$, $p < .01$) and the relapse remitting MS (RRMS) group (1.12 ± 0.42 m/s) walked significantly faster than the secondary progressive MS (SPMS) group (0.91 ± 0.37 m/s) $p < .05$, but the difference was non-significant when adjusted for age, $p = .429$.

Conclusions: In PwMS a significant relationship between cardiorespiratory fitness and disease severity was confirmed, and an increase of 1 EDSS point decreases cardiorespiratory fitness by 1.88 mL·Kg⁻¹·min⁻¹. Furthermore, cardiorespiratory fitness was related to walking speed, and for both EDSS and walking speed MS phenotype was of influence.

Submission ID: 58; Submission Group: Rehabilitation interventions; Submitter: Elaine Ross

To investigate to feasibility of an eight week breath-stacking (BS) programme in secondary progressive Multiple Sclerosis (SPMS).

Elaine Ross

Objectives: Respiratory problems can occur in MS (1) leading to morbidity and mortality. BS is a low-cost lung volume recruitment technique, associated with a slower decline in lung function and peak cough flow (PCF) in MS. (2) The aim of this study is to investigate the feasibility of an eight week BS programme in progressive MS.

Methods: This pre and post observational pilot study received ethical approval from SJH/AMNCH ethics committee. Convenience sampling recruited participants, between April-May 2016. All had been referred for routine physiotherapy, a clinical diagnosis of SPMS, cognitively intact, medically stable and without significant respiratory symptoms. Demographic data was collected by the lead investigator. Baseline PCF and PF measurements were recorded by second investigator. Participants completed the following pre and post intervention: Leicester cough questionnaire(LCI), The Epworth Sleepiness Scale(ESS), SWAL QOL (Clinical rated), SWAL Care (Patient rated), Voice Handicap Index (VHI), MS Swallowing Performance scale(MSSP), Modified fatigue Impact Scale (MFIS) and the MS Impact Scale-29(MSIS-29). All participants and carers were educated in BS technique and were instructed to continue for eight weeks. Carer and participant satisfaction questionnaires were also completed. Data was analysed using descriptive statistics.

Results: Ten people with SPMS (7 female; mean age= 56.7 years) completed the study. High satisfaction levels with the intervention were reported by all carers and participants. Reductions in participants' disease impact (16.4 %, 13.5) and fatigue levels scores (26.3%, 10.9) were demonstrated post intervention. No significant improvements were demonstrated in participants' PCF, PF measurements, voice, cough, general level of daytime sleepiness and swallow measurements.

Conclusion: This study demonstrated the acceptability and feasibility of a BS intervention in people with 2PMS. More research is indicated into the potential benefits this intervention may have in this population

Submission ID: 59; Submission Group: Rehabilitation interventions; Submitter: Anna Barabasch

Patient Experiences of MS Therapies (PEXMS)

Development of a Website with Patient Experiences of Multiple Sclerosis Therapies

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Background: For relapsing-remitting multiple sclerosis (RRMS) several therapies (e.g. immunotherapies, lifestyle interventions and rehabilitation) are available. However, immunotherapies have different risks and benefits, which make the decision for or against a relevant therapy complex with a remaining feeling of uncertainty. In addition to the compulsory information, the expressed experience of other patients in comparable situations may help to support other patients in their decision-making. However, using

patient experiences (PEX) is controversial because of their potential enhancement of subjectivity rather than plain examination. As there are no evaluated PEX in multiple sclerosis in Germany so far, the PEXMS-study aims to assess PEX and to create a multimedia website presenting these. In a controlled study, we aim to clarify whether PEX help patients in the decision-making process for or against a disease modifying therapy.

Methods: Semi-structured interviews will be conducted with 40-50 persons with RRMS throughout Germany. Participants will be recruited using the maximum variation sampling method. Data will be analysed thematically using deductive and inductive categories. A website with PEX will be created, structured in topics, which are illustrated with video, audio and text files. Possible effects of the PEX-website on decision making will be assessed in a randomised controlled trial. PEXMS is mentored by an advisory panel of six members (representatives of MS patient groups, researchers and neurologists).

Results: A problem-centred interview guide according to Witzel (2000) was developed and discussed several times with the advisory panel and a working group for qualitative research. The final version contains open-ended and closed questions on decision-making processes, experiences with the MS diagnosis, talking about MS with others, MS in everyday life and different therapies. At the conference, first interview results shall be presented.

Conclusion: PEXMS will lead to a website containing PEX and might be of value in the decision-making process.

Submission ID: 61; Submission Group: Rehabilitation interventions; Submitter: Kamila Řasová

Content of physical therapy in multiple sclerosis across Europe: questionnaire survey

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Background: Understanding the differences in the content of physical therapy (PT) in multiple sclerosis across Europe, and understanding what is causing the differences, can help to deliver the best care to people with MS according to the Code of Good Practice.

Methods: A descriptive, cross-sectional online survey, using convenience sampling.

Results: 212 respondents from 115 European workplaces in 26 countries participated in the study.

PT interventions with an existing evidence base to support their effectiveness, such as balance training and postural awareness, training for transfers and ambulatory abilities, muscle stretching, strengthening or aerobic training are interventions known by almost all therapists and mostly offered to their patients. Less known and used are interventions confined to specific regions, such as Vojta reflex locomotion, Brünstrom approach or Perfetti approach. The four European regions significantly differed in use of some PT interventions. Cluster analysis provided deeper insight about which PT interventions are often offered together and about characteristics of centers similar in composition of the PT interventions they offer to their MS patients.

Subjective opinions of respondents show on relatively low accessibility of PT. Regions also differed in accessibility to physiotherapy, both in hospital or MS centers ($p=0,002$) and in a community setting ($p=0,042$). Generally, physiotherapy is more accessible in West region, where average grade was 8 out of 10 both for hospital/MS centers and for community setting. Contrary, in East region, the median grades were 7 for hospital and 5 for community setting, in North they were 7 and 6 and in South only 6 and 5.

Conclusions: A wide range of PT interventions are used in people with MS across Europe. Content of physical therapy is partly evidence-based, but also influenced by the region and other setting of the workplace.

Acknowledgements

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Submission ID: 62; Submission Group: Describing and understanding functioning; Submitter: Sjoerd Timmermans
Decline of arm and leg function in patients with Multiple Sclerosis – a 10 year follow up study.

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Background: The course of the neurodegenerative process differs between relapsing onset MS (RO) and non-relapsing onset MS (NRO), which may lead to different developments of arm and leg function over time.

Objective: To compare the development of arm and leg function in RO and NRO in the first 10 years after diagnosis and to see which function declines earlier.

Methods: In an inception cohort of 156 patients with MS arm and leg function were measured at the start, after 6 months, 1, 2, 3, 6, and 10 years. Leg function was determined with the fast 10-meter walk test (10mTWT), arm function with the Action Research Arm test (ARAT) and nine-hole peg test (NHPT).

Results: 128 MS patients had RO and 28 NRO. Patients with RO started with a median EDSS, 10mTWT, ARAT and NHPT score of respectively 2; 5.5 sec; 57 points; and 20.2 sec. In 10 years, their scores worsened on average on EDSS 1.4 (95%CI_Δ: 1.0 to 1.7), 10mTWT 13.7 sec (95%CI_Δ: 4.4 to 23.0), ARAT -0.8 (95%CI_Δ: -1.8 to 0.2), NHPT 6.8 (95%CI_Δ: -2.1 to 15.7). Patients with NRO started with a median EDSS, 10mTWT, ARAT and NHPT score of respectively 3.0; 6.6 sec; 57 points; and 20.3 sec. Their scores worsened on average on EDSS 2.8 (95%CI_Δ: 2.0 to 3.6), 10mTWT 74.3 sec (95%CI_Δ: 33.7 to 114.9), ARAT -6.4 (95%CI_Δ: -14.0 to 1.3), NHPT 49.6 (95%CI_Δ: 3.3 to 95.8).

Conclusion: In all patients with MS, the EDSS and leg function worsened significantly in the first 10 years. With regard to the arm, the RO group showed small, non-significant changes. In NRO, however, the fine motor skills (NHPT) worsened significantly as compared to the gross motor function of the arm (ARAT). Overall, the results suggest that leg function declines earlier than the arm and hand function.

Submission ID: 63; Submission Group: Describing and understanding functioning; Submitter: Martin Langeskov-Christensen

Association between aerobic capacity and cognitive performance in people with multiple sclerosis – A cross-sectional study.

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Hypothesis: In persons with multiple sclerosis (PwMS) it was hypothesized that aerobic capacity would be associated with (1)

cognitive performance in the domain of information processing, and (2) a global Z-score of the Brief Repeatable Battery of Neuropsychological tests (BRB-N).

Methods: The current study presents baseline data from an ongoing randomized controlled trial. After completing the BRB-N all subjects performed a maximal oxygen consumption (VO_2 peak) test. Uni- and multivariate (adjusting for age, sex and education level) regression analyses were performed to evaluate the relationship between aerobic capacity and cognitive performance. Based on published norms for healthy controls Z-scores were computed for each individual BRB-N test. Subjects were categorized as cognitively impaired if the Z-score of one or more of the BRB-N tests were below 1.5 SD of healthy controls. Finally, composite Z-scores for the BRB-N and its subdomains were calculated.

Results: Baseline data from 84 subjects were included (44.9±9 years, 28.4±7 ml O_2 /min/kg, 16.3±2 education years, EDSS: 2.6±1.4, MS type (RR, PP, SP): 73/6/5, disease duration: 9.9±7 years). Regression analyses revealed no significant association between aerobic capacity and cognitive performance in the BRB-N tests. An average global Z-score of -0.2±0.66 indicated a cognitively well-functioning sample. A significant, but weak, relationship was found between the composite processing speed Z-score and aerobic capacity ($R^2=0.06$, $P = 0.02$). When comparing the cognitively impaired (34.5%) to the non-impaired group (65.5%) lower aerobic capacity ($P = 0.02$) and higher age ($P < 0.01$) were found.

Discussion: Exercise has been suggested as a potential intervention to improve cognitive performance in PwMS. The current study only provide limited support to the association between cognitive performance and aerobic capacity. However, the present findings must be considered in relation to methodological limitations including the cross-sectional design, inclusion of cognitive performance as a secondary outcome and only mildly cognitively impaired subjects.

Submission ID: 64; Submission Group: Rehabilitation interventions; Submitter: Jacqueline R Mhizha-Murira
Implementing cognitive rehabilitation for people with multiple sclerosis: bridging the gap between research and clinical practice

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Background and aims: Cognitive problems such as memory, attention and executive dysfunction are frequently reported by people with multiple sclerosis (MS). Although research has shown some cognitive rehabilitation programmes to be effective, few individuals are offered it clinically. One possible reason is the inadequate reporting of interventions in research studies, which may prevent implementation. The aim of this research is to increase the clinical impact of trials of cognitive rehabilitation through the development of a clinicianinformed, evidencebased checklist to guide researchers to better report cognitive rehabilitation studies.

Method: This mixedmethods research consists of three phases: (1) A systematic review of descriptions of the content of cognitive

interventions to document salient details and omissions in reporting; (2) A content analysis and time-sampling analysis of video recordings of an intervention delivered as part of the Cognitive Rehabilitation of Attention and Memory in MS (CRAMMS) trial, focusing on the content of treatment sessions. Findings from these two stages will inform stage three; (3) A modified Delphi consensus study with healthcare professionals and researchers who work with people with MS to ascertain the key aspects for cognitive rehabilitation that research studies should report to enable implementation in clinical practice. The outcome of this stage will be a consensus checklist.

Results: (1) 54 studies involving various types of MS and techniques to improve difficulties with memory, attention and executive function were included in the review. The results showed that important features of cognitive rehabilitation, such as intervention procedures, were not reported well. This has been published. (2) Data analysis of the content of the CRAMMS intervention and (3) The Delphi consensus study are ongoing.

Conclusions: The development of a clinician-informed, evidence-based checklist may enable researchers to report important aspects of complex cognitive rehabilitation interventions and may enhance the implementation of such research in clinical practice.

Submission ID: 65; Submission Group: Describing and understanding functioning; Submitter: Martin Heine
Physical activity and risk factors for chronic non-communicable disease in relation to disease severity in patients with MS – a cross sectional survey

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Background: Due to the improved medical management of patients with MS (pwMS) there has been an increased interest in secondary prevention of chronic comorbidity. It can be hypothesized that with increasing disease severity, pwMS are less likely to engage in physically activity thereby are predisposed for factors for comorbidity and specifically chronic non-communicable diseases of lifestyle.

Methods: The first ever national survey including outcomes on health status, physical activity, and societal participation of patients with MS in South Africa was conducted through the national MS Society. Self-reported risk factors including Body Mass Index (BMI; underweight, normal, overweight, obesity I - III), presence of high blood pressure and high cholesterol, were compared using descriptive statistics across levels of disability (Patient Determined Disease Steps [PDDS]; mild, moderate, severe) and physical activity (International Physical Activity Questionnaire [IPAQ]; Inactive, Minimally-Active, and Health-Enhancing Active).

Results: 122 of 1000 (12.2%) completed the survey (Age=47.4±9.7yr, Male(%)=14, disease duration=10.7±9.1yr). Patients with moderate MS reported a significant (Chi-Square<.05) higher presence of high blood pressure (37%), and high cholesterol (37%) relative to patients with mild MS (12 and 14%). Independent of disease severity, >68% of pwMS were either

overweight or obese. Patients with severe MS reported the highest BMIs (Obese class I 27%, class II 14% and class III 9%). Five percent of pwMS are health-enhancing active, 31% minimally active and 64% inactive. There was a trend ($p=.06$) towards lower levels of physical activity in patients with moderate MS (Inactive=77%, Minimally-Active=23%).

Conclusion: Patients with MS are generally inactive independent of disease severity. The presence of self-reported risk factors significantly increased with disease severity, and are indicative of a higher risk for chronic non-communicable disease across the lifespan.

Submission ID: 66; Submission Group: Rehabilitation interventions; Submitter: Anne Christin Rahn
Evidence-based patient information handbooks on immunotherapies – a nationwide German project

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Background: Being confronted with 18 different options, people with multiple sclerosis (PwMS) face complex decisions on immunotherapies. PwMS explicitly want to have an active role in the decision-making process and their right on evidence-based patient information as a decisional base is legally and ethically justified. The aim of this joint project of the German competence network MS (KKNMS) and the MS society (DMSG) is to develop handbooks on all immune-therapeutic treatment options for PwMS.

Methods: The development follows the criteria of evidence-based health information and the first handbook on Tecfidera® will serve as a blueprint respective structure, layout, content and graphics. It consists of an introduction to the drug, information on risk reduction of relapses and progression, side-effects and monitoring. It was developed in close collaboration with consumer representatives, authors of the corresponding physician handbook, the management boards of the KKNMS and DMSG, the national board of PwMS and the respective pharmaceutical company. Previously developed figures on absolute risk reduction (ARR) were modified and tested on $n=20$ PwMS, newly developed figures on relative risk reduction (RRR) and side effects on $n=9$ respectively. Two focus groups with $n=5$ neurologists and $n=3$ PwMS were conducted to explore the handbooks' feasibility.

Results: Patient feedback led to a change in colour of the ARR-figure and figures on RRR and side-effects were revised multiple times. Feedback of the boards was generally positive. Members of the neurologist focus group were rather critical, as they expressed, that it was too much and too complex information. On the other hand, participants of the PwMS-focus group found it comprehensive and considered it a viable decision making-aid.

Conclusions: The handbook might support PwMS in making informed decisions in accordance with personal preferences. Further evaluation of the handbook is planned and an evaluation trial concept will be presented at the conference.

Submission ID: 68; Submission Group: Describing and understanding functioning; Submitter: Morten Riemenschneider

Dynamically induced muscle fatigability relates stronger to fatigue than statically induced muscle fatigability in persons with multiple sclerosis

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Background: In multiple sclerosis (MS), fatigue is divided into two domains; perceptions of fatigue and performance fatigability. Although the relation between these two domains has been reported to be non-existing or weak, a recent study applying a static fatigability protocol in a hand model reported a strong relation when adjusting for muscle strength and depressive symptoms. However, no studies have so far investigated the relation by both static and dynamic protocols and in the functionally important muscle groups of the lower extremities.

Objective: The purpose of this study was to investigate and compare the relationship between perceptions of fatigue and static or dynamic fatigability of the knee extensors using multivariate analyses.

Methods: 46 persons with MS had maximal strength determined, along with muscle fatigability during matched maximal static and dynamic contraction protocols of the knee extensors. Perceptions of fatigue was assessed by the Modified Fatigue Impact Scale (MFIS), and muscle fatigability is expressed as the relative decline in muscle strength. The level of depressive symptoms was determined by the Hospital Anxiety and Depression Scale (HADS).

Results: No relation existed between perceptions of fatigue and muscle fatigability, when fatigability was induced by a static protocol ($R^2=0.01$, $p=0.93$), but when induced by a dynamic protocol a significant relationship was found ($R^2=0.18$, $p<0.01$). Using a multivariate regression model including muscle fatigability, maximal strength and the HADS score, 29% ($p<0.01$) and 43% ($p<0.001$) of the variation in perceptions of fatigue were explained by the static and dynamic protocol, respectively.

Conclusion: Muscle fatigability assessed by a dynamic protocol is superior in explaining the variation in perceptions of fatigue in persons with MS when compared to a static protocol, and a larger part of the variation can be explained when adjusting for muscle strength and level of depressive symptoms.

Submission ID: 69; Submission Group: Rehabilitation interventions; Submitter: Megan Roberts

Do MS services need to refocus on the needs of people with advanced MS? An exploration of the needs of people with advanced MS in the UK as part of MS Forward View and commencement of a pilot programme to evaluate the Advanced MS Champion role.

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Objective: MS Forward View¹ was a project undertaken by the MS Trust to identify the priority actions required across the MS sector to ensure delivery of efficient, equitable and effective care for everyone with MS.

Method: A variety of methods were used to identify challenges faced by MS services in delivering specialist care across the disease trajectory. We report on the methodologies from the project relevant to care of people with advanced MS². These include surveys and a graphic facilitation workshop involving health and social care professionals, people with advanced MS and carers.

Results: The results of each approach will be summarised within the poster. The findings show that people with advanced MS are not getting access to the specialist care they need³. We report on the reasons identified for this and our recommendations for next steps required to improve care and outcomes for this patient group.

Conclusion: The MS Trust have obtained funding to set up a pilot programme to establish and evaluate six Advanced MS leads over the next three years. The pilot will be evaluated using both qualitative and quantitative data collection methods to demonstrate the value of this role across the UK. The aims and objectives for the pilot will be presented.

Submission ID: 70; Submission Group: Outcome Measures; Submitter: Laura Bonzano

Effects of aging on hand function in MS

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People with multiple sclerosis (PwMS) report restrictions related to fine hand use which may impair daily living activities.

Fine hand motor function measures can be obtained with an engineered glove quantitatively assessing motor performance during sequences of finger opposition movements.

We demonstrated finger motor performance alterations even in PwMS with normal neurological examination. Normative values of finger motor performance parameters obtained in 255 healthy controls (HC) showed that increasing age resulted in decreased movement speed and bimanual coordination. Our aim was to investigate the effects of aging on finger motor performance in PwMS, taking into account disease duration and the commonly used EDSS score.

Ninety-six PwMS performed self-paced (dominant hand) and metronome-paced (dominant hand and both hands simultaneously) repetitive finger opposition movements (thumb to index-medium-ring-little fingers).

Age significantly correlated with RATE ($r=-0.27$), touch duration (TD; $r=0.26$), inter-tapping interval (ITI; $r=-0.22$), and inter-hand interval (IHI; $r=0.22$), indicating finger motor performance worsening with age. An interaction between age and EDSS was observed for both RATE and TD. Particularly, older (age > 40y (median)) PwMS among those with lower disability (EDSS < 2.5 (median)) showed worse performance than younger, whilst younger and older PwMS with higher disability performed similarly.

With reference to the normative values, the 82% ($n=79$) of PwMS resulted to be out of the normal range of finger motor performance parameters. Focusing on the single parameters, 74 (77%) PwMS were out for IHI, indicating bimanual coordination impairment in the most of PwMS, 32 (33%) for RATE and 19 (20%) for TD-ITI.

Patients with higher disease duration (>8y (median)) showed higher probability to be out of range (OR=4.9; $p=0.048$), whilst disability levels did not impact significantly ($p=0.16$).

PwMS mostly show bimanual coordination impairment, followed by movement slowing and then a change in the adopted strategy, which becomes more based on the phase of finger contact.

Submission ID: 71; Submission Group: Outcome Measures; Submitter: Jacob Sosnoff

Assessment of Postural Control in Multiple Sclerosis: Identification of Core Outcome Variables

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Balance impairment in individuals with multiple sclerosis (MS) is very common and associated with increased risk of falling. Although posturography is the gold standard of balance assessment, the vast number of metrics it yields presents a daunting challenge for clinicians and researchers. Numerous postural sway metrics have been shown to be sensitive to balance impairment in individuals with MS. Yet there is limited data to inform guidelines on the most appropriate postural sway metrics. This investigation assessed the accuracy and feature importance of various postural sway metrics to differentiate MS individuals as a function of physiological fall risk.

This secondary data analysis included 153 participants (50 controls and 103 individuals with MS) who underwent balance assessment (30s eyes open standing on a force platform) and physiological fall risk assessment (Physiological Profile Assessment). Participants were further classified into four subgroups based on individual's physiological fall risk (controls ($n=50$), low-risk MS ($n=34$), moderate-risk MS ($n=27$), high-risk MS ($n=42$)). Twenty common sway metrics were derived, and subsequently used to train a machine learning algorithm (random forest, 70-30 holdout validation) to predict individuals' fall risk grouping. The random forest algorithm showed good classification accuracy (>90%) using combined sway metrics. Mediolateral sway amplitude was identified as the strongest feature for fall risk prediction among moderate and high-risk MS individuals. Sway sample entropy, a sway regularity metric, was identified as the strongest feature for classification of low-risk MS individuals.

Overall, the findings indicate that sway amplitude in mediolateral direction can be used as a hallmark for increased fall risk in moderate to high-risk MS individuals, while sample entropy is a sensitive metric for differentiating healthy controls and MS individuals without elevated fall risk. These findings may set the foundation for the development of guidelines for accurate assessment of balance impairment in individuals with MS.

Submission ID: 72; Submission Group: Outcome Measures; Submitter: Ludovico Pedullà
Development and validation of the “Dual-task Impact on Daily-life Activities Questionnaire”: preliminary evaluation in people with multiple sclerosis

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Everyday activities often require to execute simultaneous motor and cognitive tasks (dual tasks-DT), with consequent possible occurrence of motor-cognitive interference. This could reduce quality of life, in particular in patients with neurological diseases. To date, there are not instruments evaluating the patients reported difficulties in performing DT in multiple sclerosis (MS).

Aim of this study was to develop and test the psychometric properties of a new instrument investigating the DT impact on daily-life activities (named DIDA-Q) in people with MS (PwMS).

We developed a 19-item questionnaire, covering daily-life activities involving motor or cognitive functions (e.g., high-speed walking, listening to someone). Participants were asked to evaluate the level of difficulty perceived when performing the listed tasks in simultaneous combination with another cognitive/motor task.

110 PwMS (77 females, age=51.1±12.4, EDSS=4.1±1.6) participated in the study. Exploratory factor analysis (EFA) using the principal component analysis extraction method with varimax rotation was carried out for initial validation. Known-groups validity was tested by assessing differences in DIDA-Q scores across patients with different severity profiles. Internal consistency was assessed by calculating Cronbach's alpha. Test-retest reliability of the instrument and the final analysis on a larger sample (n=200) will be performed as next steps.

EFA showed that the instrument yielded a three-factor solution, which cumulatively accounted for 66.4% of the total variance. Three subscales, identifying walking, cognitive and upper limb tasks, showed high internal consistency (Cronbach's alpha: 0.88, 0.91 and 0.87). As attended, patients with higher EDSS (>3.5) reported worse scores at DIDA-Q, and the difference was significant for all subscales.

These findings suggests that DIDA-Q is a brief, valid and reliable scale for measuring DT impact on daily-life activities in PwMS. It can be used to identify the most detrimental task perceived by PwMS and as outcome measure to evaluate the effects of rehabilitative treatments in MS.

Submission ID: 73; Submission Group: Rehabilitation interventions; Submitter: Ludovico Pedullà
Aerobic training as substrate for neural plastic changes in multiple sclerosis

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Aerobic training (AT) could elicit neurocognitive improvements and neural changes in people with multiple sclerosis (PwMS). Moreover, interventions based on voluntary task-oriented exercise seem to induce benefits in terms of behavioral performance and microstructural integrity in PwMS.

The present study aimed at evaluating the combined effects of AT and upper limb motor rehabilitation (ulMR) based on task-oriented exercises on behavioral, microstructural and cortical plasticity correlates in PwMS.

11 PwMS (8 females, age=47.6±9.4 years; EDSS=2.68±1.17) underwent a 2-month moderate-intensity AT (50-70% of individual maximal heart rate, three 45-minute sessions/week) by walking on a treadmill. Then, participants executed a 2-month ulMR (three 1-hour sessions/week). Before AT (T0), after AT (T1) and after ulMR (T2), PwMS were assessed in terms of: (i) behavioral performance with motor, cognitive, fatigue and mood measures; (ii) neural plasticity by means of the paired associative stimulation (PAS) protocol; (iii) microstructural integrity using diffusion tensor imaging (DTI).

At T1, PwMS significantly improved their motor performance (increased 6-minute walk test and Berg Balance Scale scores), cognitive condition (increased Paced Auditory Serial Addition Test score and decreased levels of cognitive fatigue measured by the Modified Fatigue Impact Scale) and mood status (decreased Hospital Anxiety and Depression Scale score). Moreover, at T2, participants significantly improved manual dexterity (reduced time to perform the Nine Hole Peg Test).

An occlusion of neural plasticity was observed after AT, whilst an inversion seemed to occur following ulMR, suggesting that both interventions influenced motor cortex plasticity processes.

DTI parameters calculated in the corpus callosum, corticospinal tracts and superior longitudinal fasciculi remained stable in the course of the study, implying that microstructural damage did not worsen as effect of the disease.

The present findings suggest that AT might induce positive effects on behavioral and functional brain plasticity and might preserve white matter integrity deterioration due to multiple sclerosis.

Submission ID: 74; Submission Group: Rehabilitation interventions; Submitter: Lucie Kadrnozkova
A pilot study of smart-device-based cognitive rehabilitation software for multiple sclerosis patients

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Background: Cognitive rehabilitation focuses on reducing or eliminating cognitive deficit. Cognitive impairment occurs frequently in patients with multiple sclerosis (MS). However, evidence-based recommendations for cognitive rehabilitation in patients with MS is lacking.

Objectives: To verify the feasibility of new cognitive rehabilitation software for MS patients.

Methods: A pilot qualitative study of new smart-device-based cognitive rehabilitation software included 4 relapsing-remitting MS patients (3 females, age range: 28-52 years, expanded disability status scale [EDSS] range: 5-6.5; education range: 12-15 years). Patients underwent an individual 30-minutes cognitive rehabilitation session with a trainer every week following after a 30-minutes individual physiotherapy session. Patients were evaluated using complex neuropsychological battery at baseline and 6 weeks. Structured interview and questionnaire were used to evaluate accessibility, usefulness and subjective benefits of the cognitive rehabilitation programme.

Results: At 6 weeks, we observed in all participants a slightly higher score in total recall in the Brief Visuospatial Memory Test-Revised (BVRT-R) and a lower interference score in the Prague Stroop Test. In the other neuropsychological tests, the results fluctuated or the score did not increase in all participants. In questionnaire the participants rated the tool as comprehensible and easy to handle. A limited number of variants of each task and the limited possibility of setting the task progression were evaluated as disadvantages.

Conclusion: The results of neuropsychological examination suggest the possibility of using the tool for visual memory training and reducing the effect of interference in attention tasks. After adjusting the tool according to this pilot study, the further research is needed conducted on large random sample and assessment of contribution to activities of daily living.

Submission ID: 75; Submission Group: Rehabilitation interventions; Submitter: Klaus Gusowski

MS-int@kt : subgroup analysis of an internet based training on fatigue, quality of life and gait

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Background: Persons with MS (PwMS) benefit from inpatient multidisciplinary rehabilitation with regard to fatigue and motor performance. To sustain the effects an internet based training program was introduced during rehabilitation and performed for 3 months thereafter. Primary endpoint analysis showed that the internet based training could maintain the improvements for up to 6 months.

Objectives: In order to determine which PwMS revealed the most pronounced response to therapy, we performed a subgroup analysis by stratifying PwMS according to baseline performance.

Methods: 34 PwMS participated in the training group and 30 in the control group. Performance orientated mobility assessment (POMA) for the risk of fall, 10m-walk-test (10mW) and 2 minutes-walk-test (2minW) were measured at the beginning of the inpatient rehabilitation program (T0), at discharge (T1) and 3 months after training (T2). Fatigue (WEIMuS) and quality of life

(QoL: MSIS 29 and EQ-5d) were measured at T0, T1, T2 and 6 months after discharge (T3).

Subgroups were divided in low and high performance (POMA and EQ-5d VAS: median value at T0, 10mW: 7 sec., 14 steps; 2minW 168m..

Results: The effects of rehabilitation on fatigue and quality of life were maintained at T2 and T3 in the training. Subgroup analysis of motor performance at T2 showed a significant benefit in 10mW and POMA in the low performance group, whereas in 2minW, the high performance subgroup remained highly significant. The EQ-5d VAS demonstrated highly significant changes in the whole training group as well as in the subgroup with low performance.

Conclusions: Statistically and clinically meaningful improvements of fatigue, QoL and motor performance were demonstrated after a 3 months internet based training program, with effects being more pronounced in more affected PwMS. An internet based training may be effective to maintain the positive effects of inpatient rehabilitation for at least up to 6 months.

Submission ID: 76; Submission Group: Rehabilitation interventions; Submitter: Dejana Zajc

The importance of fall prevention and teaching multiple sclerosis patients ways of getting up from the floor ABSTRACT: Dejana Zajc

Objective: At first neurological ward we were faced with patients with multiple sclerosis which in their history indicate repeatedly falls or slips at home. The most common reasons are that they are not considering biological, behavioral and environmental risk factors.

Methods: After anamnesis and initial assessment, 22 patients with multiple sclerosis, 6 male and 16 female, stated that they have experienced frequent falls and slips in last six months. They were admitted at University Rehabilitation Institute Soča for a period of at least three weeks. The timeframe for data collection was nine months. Their age ranges from 20 to 70 years old, with median age 48.6. Our emphasis within our quantitative analysis was on fall risk factors and occupational therapy intervention with supportive strategies based on set questionnaire.

Results: Weaknesses in legs were the reason for falls or slips in 55% of the participants. All patients were users of wheelchairs or various walking devices. Falls or slips were related to changing positions, walking or performing transfer. Emergency bladder emptying is also a major problem.

Conclusion: This inquiry showed the importance of falls prevention at home environment. Patients with multiple sclerosis identified the importance of risk awareness, planning and attention during task performance as best approach for fall prevention. We must be aware of patients' personal and environmental factors. 77% of participants were enrolled in the training. In the last two years we introduced the protocol of fall prevention, for all newly admitted patients. We showed them multiple options of how to get up from the floor. We also educated their relatives or significant others.

Submission ID: 77; Submission Group: Describing and understanding functioning; Submitter: Zuhail Abasiyanik
Respiratory muscle measures are correlated with cognitive function in multiple sclerosis

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Introduction: Muscular strength and endurance impairments are frequent in persons with multiple sclerosis (pwMS). These impairments are not only seen in peripheral muscles but also in respiratory muscles. Recent evidence suggest that respiratory muscle training may improve respiratory function in pwMS. Although motor system impairments are prominent in pwMS, cognitive dysfunction is also frequent which can affect the results of respiratory muscle measures since they are required high cooperation.

Aim: To examine the association between respiratory muscle measures and cognitive function in pwMS.

Methods: Fourty ambulatory pwMS were included the study. The respiratory muscle outcome measures were maximum inspiratory pressure (MIP) and maximum expiratory pressure (MEP) assessed by a manovacuometry. Cognitive function was evaluated with Brief International Cognitive Assessment for MS (BICAMS) which includes Symbol Digit Modalities Test (SDMT), California Verbal Learning Test-II (CVLT-II) and Brief Visuospatial Memory Test- Revised (BVMT-R).

Results: MIP score had moderate to high correlations with SDMT ($r_s=0.517$, $p<0.05$), CVLT ($r_s=0.411$, $p<0.05$) and BVMT-R ($r_s=0.412$, $p<0.05$). There was also significant correlation between MEP and CVLT, BVMT-R scores ($r_s=0.326-0.358$, $p<0.05$).

Conclusion: This study has suggested that respiratory muscle measures are correlated with cognitive function in pwMS. While assessing respiratory muscle function in pwMS, the cognitive function should be considered to obtain proper results.

Submission ID: 78; Submission Group: Rehabilitation interventions; Submitter: Zuhul Abasiyanik

The effects of clinical Pilates training on walking, balance, fall risk, respiratory and cognitive functions in persons with multiple sclerosis: a randomized controlled trial

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Introduction: Multiple sclerosis (MS) is a chronic-progressive and neurodegenerative disease. Thus, exercise programs are needed to maintain and increase functional status in persons with MS (pwMS). Pilates exercises designed by physiotherapist can enhance participation and functionality in pwMS.

Objective: The aim was to investigate the effects of a clinical Pilates training on balance, walking, fall risk, respiratory and cognitive functions in pwMS.

Method: Forty-two pwMS included in this randomized controlled trial. Patients were allocated into two groups with stratified randomization. Pilates exercises group ($n=21$) received therapy once a week

for 8 weeks plus home exercise programme. The home exercise program group ($n = 21$) was given written exercises that matched the aims of the Pilates exercises and the program compliance was monitored by telephone calls once a week. The assessments were done twice at the beginning and at the end of the treatment. The outcome measures included the Timed 25-Foot Walk (T25FW), Six-Minute Walk Test (6MWT), Timed Up and Go (TUG), 12-Item Multiple Sclerosis Walking Scale (MSWS-12), Sit-Up Test (SUT), Falls Efficacy Scale (FES), Activities-specific Balance Confidence (ABC) Scale, respiratory muscles assessment, Brief International Cognitive Assessment for MS (BICAMS).

Results: Data from 33 individuals were analysed [clinical Pilates group ($n = 16$), home exercise group ($n = 17$)]. While there were improvements only in the T25FWT, SMWT, TUG, SUT, MSWS-12, FES, ABC scale and inspiratory muscle strength in the home exercise program group ($p<0.05$), the significant improvements were observed in all tests in the clinical Pilates group ($p<0.05$). Clinical Pilates training was superior to home exercise program in terms of improving postural stability, walking endurance, core stabilization, respiratory muscle strength, cognitive functions, and decreasing risk of falling ($p<0.05$).

Conclusion: Clinical Pilates training may be preferred as an alternative method to MS rehabilitation for improving balance, walking, respiratory and cognitive functions.

Submission ID: 79; Submission Group: Describing and understanding functioning; Submitter: Zuhul Abasiyanik
The association between core stability and walking, balance, and falls in people with multiple sclerosis

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Introduction: Walking and balance impairments are common symptoms in people with multiple sclerosis (pwMS). Although it is well known that maintaining balance and walking requires core muscles activity, there are insufficient evidence on the association between core stability, walking, balance and falls. To design exercise programs targeting walking and balance, it is important to reveal related factors which contribute to walking and balance impairments.

Aim: The aim was to examine the association between core stability and walking, balance, and fall status in pwMS.

Method: Fourty pwMS whose disability level was 6 and below according to Expanded Disability Status Scale (EDSS) participated in the study. Curl-up test was used to assess core strength via isotonic contractions of the abdominal muscles. Postural stability (PS), limits of stability (LOS) and fall risk (FR) were assessed using a computerized posturography device. Six-minute walk test (6MWT), Timed Up and Go (TUG) and Timed 25-Foot Walk (T25FW) test were used to evaluate walking. Number of falls in the last 3 months was recorded.

Results: There were 27 female and 13 male pwMS with a mean age of 48.83, $SD=9.85$ years and mean EDSS was 3.17, $SD=1.71$. Number of falls was correlated with curl-up test ($r_s=-0.552$,

$p < 0.05$). Curl-up test was also correlated with LOS ($r_s = 0.245$), PS ($r_s = -0.417$, $p < 0.05$) and FR ($r_s = -0.352$, $p < 0.05$). Moderate to high correlations existed between curl-up test and T25FW, TUG, and 6MWT ($r_s = -0.513$ - 0.676 , $p < 0.05$).

Conclusion: The results have suggested that core stability is associated with balance, walking, and number of falls in pwMS. Core stability training may improve balance and walking thus reduce fall risk.

Submission ID: 80; Submission Group: Describing and understanding functioning; Submitter: Zuhab Abasiyanik
Lower extremity spasticity is associated with falls in persons with multiple sclerosis

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Introduction: Falls are one of the most frequent complaints in persons with multiple sclerosis (pwMS). It can result in limitations to level of activity, participation restriction and diminished quality of life. To design fall prevention approaches, it is important to illuminate modifiable risk factors which contribute to the falls. It is well known that causes of falls are multifactorial. The majority of previous investigations examining the effects of balance and walking on falls. However, a few direct studies have investigated the association between spasticity and falls.

Aim: The aim of this study was to examine the association between lower extremity spasticity and falls in pwMS.

Method: This cross-sectional study enrolled pwMS with the Expanded Disability Status Scale (EDSS) scores ranged from 0 to 4.5. Age, use of assistive device, frequency of falls in the last 3 months and fall related injuries were asked with a simple questionnaire. Spasticity in the lower extremity muscles including hip abductors, knee flexors and extensors, and plantar flexors was quantified with the Modified Tardieu Scale and Modified Ashworth Scale. The study sample was divided into two groups, fallers and non-fallers who had at least one fall during the last three months.

Result: Thirty-nine pwMS (21 female) were enrolled the study. There were 15 and 24 participants in the fallers and non-fallers groups, respectively. Severity of knee flexors and ankle plantar flexors spasticity was significantly higher in the fallers compared to non-fallers ($p < 0.05$). Number of falls had low to moderate correlations with severity of knee extensors and flexors spasticity ($r_s = 0.208$ - 0.377 , $p < 0.05$). Moderate to high correlations existed between the severity of ankle plantar flexors spasticity and falls frequency ($r_s = 0.383$ - 0.552 , $p < 0.05$).

Conclusion: This study has suggested that severity of lower extremity spasticity is associated with falls in pwMS. Fall prevention programs should include lower extremity spasticity management.

Submission ID: 81; Submission Group: Describing and understanding functioning; Submitter: Zuhab Abasiyanik
Association between Spasticity, Walking and Quality of Life in Persons with Multiple Sclerosis

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Introduction: Spasticity is a common symptom in persons with multiple sclerosis (pwMS). It can affect functionality; causing fatigue and limitations in activities of daily living. There is inconsistent evidence regarding the association between spasticity and walking function in pwMS. While pwMS report spasticity to be related to gait impairments and disability, these studies used self-reported measures which are not limited to the lower extremities and often include non-specific spasticity descriptors. On the hand, the other studies which have used clinical spasticity assessments are mostly limited to plantarflexor spasticity.

Aim: The aim was to determine the associations between clinically assessed lower extremity spasticity, walking and quality of life in pwMS.

Method: Thirty-nine pwMS (21 female) were enrolled in the study. The Expanded Disability Status Scale (EDSS) was used to assess the disability levels. Spasticity was assessed with the Modified Tardieu Scale and Modified Ashworth Scale. Perceived impact of MS on the walking ability was assessed with the 12-Item MS Walking Scale (MSWS-12). Walking speed was assessed with the Timed 25-Foot Walk (T25FW) test. Additionally, the MS International Quality Of Life Questionnaire (MusiQoL) was used to measure quality of life.

Result: The EDSS score was correlated with severity of hip abductors, knee extensors and flexors, and ankle plantarflexors spasticity ($r_s = 0.236$ - 0.492). The lower extremity muscles spasticity was also correlated with the T25FW ($r_s = 0.265$ - 0.684) and MSWS-12 ($r_s = 0.240$ - 0.597). The MusiQoL was correlated with hip abductors, knee flexors, and plantarflexors spasticity ($r_s = -0.242$ - -0.474). The plantarflexors spasticity had relatively higher correlations with the EDSS, T25FW, MSWS-12, and MusiQoL compared to other muscles spasticity.

Conclusion: This study suggests that not only plantarflexors but also the other lower extremity muscles spasticity severity were associated with reduced walking speed, increased impact of MS on the walking ability, and decreased quality of life in pwMS.

Submission ID: 82; Submission Group: Rehabilitation interventions; Submitter: Klara Novotna
New tool for home-based balance exercise in people with multiple sclerosis

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Background: Patients with multiple sclerosis (MS) frequently experience poor postural control, even in early stages of disease. For many people with MS is difficult to find available community-based exercise program to improve balance. Therefore home-based balance exercise may be appropriate tool for many adults with MS. In some recent studies interactive video games were used for improving balance but there is not possible to set individual parameteres for training.

Aim of our study is to assess effect of 1 month of home training using new exercise tool Homebalance.

Methods: We used experimental group design with control group. Participants were instructed to exercise every day for 15 minutes for 1 month. Control group did not change their physical activity. Primary outcome measures include Berg Balance Scale, MiniBest test, Falls Efficacy Scale, Timed 25 foot walk test (T25FW) and Timed Up and Go test (TUG).

Results: Total number of 39 people with MS participated in the study: 23 people in experimental group and 16 in control group. Mean age of participants in was 39,3 years (SD 9,6), mean disease duration 14,9 years (SD 8,5), with EDSS 1,5-6,5. Mean baseline Berg Balance scale 48,8 (SD 9,2), mean MiniBest test 22,1 (SD 5,8), mean T25FW 8,8 sec (SD 9,7), mean TUG 12,12 sec (SD 11,2). After intervention mean Berg Balance scale 50,6 (SD 8,5), mean MiniBest test 23,5 (SD 5,8), mean T25FW 8,5 sec (SD 8,3), mean TUG 11,5 sec (SD 9,6). In control group the mean age was 42,5 years (SD 10,6), mean disease duration was 14,5 years (SD 9,8) with EDSS 1,5-7. Mean baseline Berg balance scale 51,5 (SD 5,9), mean MiniBest test 23,1 (SD 5), mean T25FT 6,5 s (SD 3,7), mean TUG 9,6 s (SD 5,5). After 1 month mean Berg balance was 52,2 (SD 5), mean MiniBest was 23,5 (SD 3,9), mean T25FW 6,2 s (SD 3,1) and mean TUG 9,1 s (SD 4,8).

Conclusions: The new tool for balance exercise Homebalance can be beneficial for people with MS to improve balance. People with different neurological disability level from mild to severe can benefit from this type of balance training, which can be used in home setting as well as in rehabilitation clinic.

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Submission ID: 83; Submission Group: Outcome Measures; Submitter: Klara Novotna Relationship between walking performance and ADL-activities among people with MS

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Background: Symptoms of multiple sclerosis (MS) can lead to mild to severe changes in a person's abilities to perform activities of daily living (ADL). Mobility limitation (especially walking difficulties), sensory-related symptoms, fatigue, and cognitive impairments can have a significant impact on the quality of life of persons with multiple sclerosis.

Methods: Data from 157 people with MS were collected. Participants completed gait assessment: Timed 25 foot walk test and the 2 minute walk test. Neurological disability was measured by

Kurtzke scale (EDSS). For subjective evaluation of ADL-activities we used the questionnaire based on the ICF classification.

Results: The results demonstrate which activities are the most and the least restricted and provide information about relationship between the walking performance and EDSS. Performance in T25FW ≤ 6 sec was associated with no subjective perceived walking limitation. Performance in T25FW 6-7,99 sec was associated with problems with put on/off shoes, have problems to manage big grocery shopping and cope with psychological stress. Performance in T25FW ≥ 8 sec is associated with problems with manipulation with objects, poor manual dexterity, problem using public transport, personal hygiene, problem with shopping, do household work and manage daily duties.

Conclusion: People with MS with walking limitation have restriction in other activities of daily living too. Therefore complex rehabilitation care should be offered to them (including physiotherapy, occupational therapy and social worker counselling).

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Submission ID: 85; Submission Group: Rehabilitation interventions; Submitter: Minna Salakari Web-based support for patients with MS: a systematic literature review

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Background: Patient education and support are increasingly provided by web-based programs, which offer versatile support for patients with multiple sclerosis (PwMS) who are in need of timely information about their illness, treatments and self-care options.

The purpose of the study was to investigate: 1. How PwMS can be guided and supported online, 2.

What kind of guidance and support is available online, 3. What is the role of a nurse in online guidance, and 4. What can be achieved.

Material and methods: A systematic literature review was performed. Online databases (Pubmed and Cochrane) were used to find data on web-based rehabilitation and patient education in chronic diseases, especially in MS, published from January 1st 2006 to 31st December 2016. The methodological quality of the studies was evaluated with JBI guidelines. The results were analyzed by content analysis.

Results: Twenty-one randomized controlled trials (N= 4194) were included in the analysis from the United States (7), Germany (5), the Netherlands (4) and from Canada, Switzerland, China, Korea and Iran, one study from each. Six studies evaluated the effectiveness of web-based lifestyle guidance intervention, two studies the impact of interactive motivational interviews, and three studies the impact of web-based intervention with physical activity.

The pivotal online education methods are: 1. video tutorials, 2. training programs, 3. metrics and 4. online forums. Online support promoted empowerment and self-care of PwMS. Providing support was guided by the motivation and commitment of the patient and the goal of promoting health The health care professional's role was identified as an expert, instructor, motivator, facilitator, information provider and supervisor.

Conclusions: Web-based patient education and support are beneficial for the PwMS. Online patient education and support enhance to face-to-face guidance provided by the professionals online but does not replace it.

Submission ID: 86; Submission Group: Rehabilitation interventions; Submitter: Minna Salakari

Informational support for patients with MS – a new web-based model

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Background: Although there does not exist curative treatment for Multiple Sclerosis (MS), various symptoms can be alleviated by medication, rehabilitation and self-care. In addition, patient education by web-based programs is an increasingly popular way to provide support for patients with MS (PwMS).

The aim of the ABCe project was to construct an informational online support system for PwMS. The model allows nursing professionals to advance their counseling skills in supporting patient's self-care abilities. The model has been implemented on the Finnish MS Nurse Organisation's MS-ASEMA website.

Material and methods: A new a new web-based model for informational support for Pw MS was developed after performing a systematic literature review on the subject. Online databases (Pubmed and Cochrane) were used to find data on web-based rehabilitation and patient education in MS, published from January 1st 2006 to 31st December 2016 (for details see the abstract of Salakari M, Tuominen L, Holmberg J).

Results: According to the literature analysis several online education methods have been used: video tutorials, training programs, metrics and online forums. The health care professional's role has been identified as an expert, instructor, motivator, facilitator, information provider and supervisor.

Based on the synthesis of the results, an online informational support model was created. Providing support is guided by the motivation and commitment of the patient and the goal of promoting health. The model allows receiving informational support regardless of time and place.

Conclusions: The online support model supplies the basis for online patient education for health care professionals. It focuses on the patient's own desire to be informed about self-care options. The model may have the potential to improve patients' overall wellbeing.

Submission ID: 87; Submission Group: Rehabilitation interventions; Submitter: Karen Turpin

Factors Associated with Resilience Among Persons with MS: Opportunities for Intervention

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Background: Psychological resilience is a dynamic process of positive adaptation in the face of adversity, known to be important in the well-being of those living with a variety of chronic illnesses. Although individual resources (like support) and vulnerabilities (like depression) that comprise resilience have been studied in those with multiple sclerosis (MS), we know little about the broader construct of resilience as it applies to MS.

Objectives: The aim of this cross-sectional study was to assess resilience amongst persons with MS, and identify factors associated with resilience.

Methods: Participants were recruited from Western Canadian MS Clinics, and through MS Society of Canada's newsletters. Participants completed an online questionnaire, including a validated, reliable measure of resilience, the Connor-Davidson Resilience Scale (CD-RISC), along with measures assessing sociodemographic, clinical and psychosocial factors.

Results: Most respondents (N=359) were female (79.2%). Their average age was 48.2 (SD=11.7, range 21-77). The average score on the CD-RISC was 72.4 (SD=14.7, range 23-100); a score higher than some published results for general anxiety (62.4) and post-traumatic stress disorder patient populations (52.8), but lower than spinal cord injury (82.2) and diabetes (83.1). Female gender; older age; greater use of acceptance, avoidance, cognitive/palliative (thinking/belief) coping strategies; higher use of hope agency (goals) and pathway (plans) strategies; and higher scores on personal well-being autonomy, environmental mastery, personal growth and self-acceptance sub-scales were associated with higher resilience scores, together explaining 76.4% of the variance in the CD-RISC.

Conclusions: Many of the factors listed above are amenable to intervention to help build resilience. For example, persons with MS can learn how and when best to use coping strategies such as acceptance in response to stressors. The findings from this study will help MS clinicians identify those persons who may be at greater risk for low resilience, and will assist clinicians in knowing which interventions are most apt to modify that risk.

Submission ID: 88; Submission Group: Describing and understanding functioning; Submitter: Carme Santoyo
Relationship between manual dexterity and balance and gait impairment in patients with multiple sclerosis: a cross-sectional study

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Background: Impaired gait, balance and manual dexterity are frequently reported disabilities in people with multiple sclerosis (PwMS), which are increasingly prevalent with worsening disease. There has been limited research on the relationship of upper limb dysfunction with balance and gait impairment.

Objective:

- To assess the relationship between upper limb dysfunction with gait and balance impairment.
- To evaluate the changes in those functions after a multidisciplinary rehabilitation program.

Methods: Retrospective data were obtained from all patients with an EDSS ≤ 6.5 who were admitted and completed a rehabilitation period at the Neurorehabilitation Unit of Cemcat during 2015 and 2016. Patients carried out a 3 days per week 5 months long outpatient rehabilitation program and were assessed using the Motor subscale of the Functional Independence Measure (FIM), the Nine Hole Peg Test (NHPT), the Berg Balance Scale (BBS) and the Ten Meter Walking Test (TMWT) at admission and discharge. The whole sample followed physiotherapy sessions (thrice per week) and occupational therapy sessions (twice per week).

Results: 142 PwMS (45.5% relapsing-remitting, 39.4% secondary progressive, 15.6% primary progressive) were included (67.6% woman), with a mean age of 59.38 years (SD: 10.88) and a median EDSS of 6.0 (range: 1.0-6.5).

After the rehabilitation period, BBS improved in 50% of the subjects, 10MWT in 26.8%, and NHPT in 11.3% of the sample. No correlations were found between manual dexterity measurements and gait and balance (Spearman's rho $p=0.695$ and 0.724 respectively), neither between level of disability and upper limb function (Spearman's rho $p=0.763$).

Conclusions: As previously seen in literature, gait velocity, balance and hand dexterity values are worse as EDSS increases. In our cohort, changes in manual dexterity are not related with gait or balance changes after the rehabilitation treatment. Improvement in manual dexterity is significantly lower than in balance or gait function.

Submission ID: 89; Submission Group: Describing and understanding functioning; Submitter: Zuhal Abasiyanik
Upper extremity impairment in persons with multiple sclerosis with absence of clinical disability

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Introduction: Upper extremity impairment is one of the major causes of dysfunction, as well as gait disturbance, fatigue and cognitive deficit in people with multiple sclerosis (MS, pwMS). Upper extremity functions are an important predictor of overall activity and participation in the community. Upper extremity dysfunction affects performance in activities of daily living, leading to a decline in quality of life and level of independence. Several studies have shown that a high percentage of pwMS reporting upper extremity impairment over the disease course. However, it is not known well yet whether there is an upper extremity impairment in pwMS with absence of clinical disability assessed by Expanded Disability Status Scale (EDSS).

Objective: The aim was to evaluate the upper extremity function in pwMS with absence of clinical disability and compare them to healthy subjects.

Method: Nineteen pwMS with the EDSS score ≤ 1.5 and age- and sex-matched 18 healthy subjects were enrolled in this cross-sectional study. Upper extremity function was assessed with the

Manual Ability Measures-36 (MAM-36) and Nine-Hole Peg Test (NHPT), which are a patient-reported outcome measure and performance-based test, respectively.

Result: There was a significant difference between the pwMS and healthy subjects in terms of the NHPT scores ($p<0.05$). On the other hand, there was not a significant difference in the MAM-36 score between pwMS and healthy subjects ($p>0.05$).

Conclusions: This study has suggested that the pwMS with absence of clinical disability have less performance of upper extremity function compared to healthy subjects. However, perceived upper extremity ability was similar compared to the healthy subjects. Although this loss of performance does not affect the activities of daily living, early assessment and rehabilitation program for the upper extremities are important to prevent further loss of function in pwMS.

Submission ID: 90; Submission Group: Describing and understanding functioning; Submitter: Carme Santoyo
Changes in spatio-temporal gait parameters after physical rehabilitation in Multiple Sclerosis: a descriptive analysis.

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Background: Gait impairment is a significant problem in persons with multiple sclerosis (PwMS), leading to decreased activity and participation. Previous literature has shown that exercise training interventions can improve gait velocity and perimeter. However, specific characterization of changes in spatiotemporal gait parameters after physical rehabilitation has been poorly described.

Objective: To analyze changes on spatiotemporal gait parameters in PwMS after physical rehabilitation.

Methods: Data were obtained prospectively from all patients with an EDSS ≤ 6.5 who were admitted and completed a rehabilitation period at the Neurorehabilitation Unit of Cemcat during the second semester of 2017. Patients carried out a 3 days per week 5 months long outpatient physical rehabilitation program consisting of muscle, balance and gait re-education strategies. Gait pattern was evaluated using the inertial sensor G-Walk by BTS Bioengineering.

Results: Forty five PwMS (51% relapsing-remitting, 29% secondary progressive, 20% primary progressive) were included (62% woman), with a mean age of 50 years (SD: 8.91) and a median EDSS of 5.5 (range: 2.0-6.5). After rehabilitation, the following parameters showed statistically significant improvements (mean change, p value): 1. Cadence: -9.01 steps/min, $p<0.05$; 2. Velocity: -0.13m/s, $p<0.05$; 3. Stride length -0.09m, $p<0.05$; 4. Stride/high length: -5.49 %height, $p<0.05$; 5. Left and right step length: 0.10 and 0.09 % stride length, $p<0.05$; 6. Left and right propulsion: -0.93 and -0.92m/s²; $p<0.05$. No significant changes were observed in the single or double support time or the swing time.

Conclusions: Our preliminary findings showed a beneficial effect of physical rehabilitation on some of the spatiotemporal gait parameters in the cohort studied. Further analysis of this cohort will describe in depth the response to the rehabilitation treatment related with the functional system affected or the disability level.

Submission ID: 91; Submission Group: Rehabilitation interventions; Submitter: Ellen Christin Arntzen
Group-based comprehensive core stability intervention improves balance, trunk control, walking and health-related quality of life up to 24 weeks compared to standard care in persons with MS: A randomized controlled trial
 Ellen Christin Arntzen

Background: Balance, core muscles and walking are often impaired in individuals with multiple sclerosis (MS). Group interventions interlinking core stability and other prerequisites for balance and walking are needed.

Objective: Investigate the immediate and long-term effects of six weeks GroupCoreDIST; an individualized, group-based core stability intervention, compared to standard care on balance, trunk control, walking and health-related quality of life in persons with MS.

Design: Assessor-blinded randomized controlled trial.

Methods: Eighty participants (Expanded Disability Status Scores 1-6.5) were randomly allocated to GroupCoreDIST-intervention, conducted in groups of three for 60 minutes, three times per week, or to standard care (n=40/40). Assessments at baseline, weeks 7, 18 and 30. Outcomes: Trunk Impairment Scale-Norwegian Version (TIS-NV), Mini-BESTest, 2 Minute Walk-test (2MWT), 10 Meter Walk-test (10MWT), Multiple Sclerosis Impact Scale-29-NorwegianVersion (MSIS-29-NV) and Multiple Sclerosis Walking Scale-12 (MSWS-12). Statistical analysis: Repeated measures mixed models in IBM SPSS-24.

Results: One participant missed all post-tests, leaving 79 subjects for intention-to-treat analysis. Significant effects in the mean difference between groups were found at all time-points for TIS-NV; 2.63 points at 7 weeks (95%CI(1.89,3.38); p<0.00), 1.57 points at 18 weeks (95%CI(0.81,2.33); p<0.00) and 0.95 points at 30 weeks (95%CI(0.19,1.71); p=0.015); Mini-BESTest 1.91 points at 7 weeks (95% CI(1.07,2.76); p<0.00), 1.28 points at 18 weeks (95% CI(0.42,2.15); p<0.00) and 0.91 points at 30 weeks (95% CI(0.04,1.77); p=0.04) and 2MWT 16.7 meter at 7 weeks, 95%CI(8.145,25.25); p<0.00, 15.08 meter at 18 weeks 95% CI(6.39,23.77); p=0.001 and 16.38 meter at 30 weeks, 95%CI(7.65,25.12); p<0.00. 10MWT, MSIS-29-NV and MSWS-12 showed significant between-group effect at 7 and 18 weeks.

Limitations: Less physical therapy volume in the control group.

Conclusions: Six weeks GroupCoreDIST improved balance, trunk control and walking-distance at 7, 18 and 30 weeks, as well as walking-speed and health related quality of life at 7 and 18 weeks compared to standard care.

Submission ID: 92; Submission Group: Rehabilitation interventions; Submitter: Rene Streber
Effects of a behavioural internet-based after-care program on physical activity and self-concordance in persons with Multiple Sclerosis

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Background: Physical activity and exercise (PA) are an important therapeutic component of inpatient rehabilitation for persons with Multiple Sclerosis (pwMS). Internet-based interventions appear promising to enable pwMS to maintain motivation and transfer the acquired knowledge and skills for a physically active lifestyle after inpatient rehabilitation. We evaluated the combined effects of a behavioural internet-based PA promotion program after a multimodal MS-specific rehabilitation on PA levels and exercise-related self-concordance in pwMS.

Methods: In this pilot randomized controlled trial, pwMS (age ≥ 18 years, EDSS ≤ 6.0) were randomly assigned after rehabilitation to a three-month intervention (IG), comprising an exercise training module and a blended-learning PA promotion module, or to a control group (CG). The Baecke PA questionnaire and the concordance of sport- and exercise-related goals questionnaire were applied at baseline, at the end of rehabilitation and immediately post-intervention. Within- and between-group changes were analysed with a linear mixed model.

Results: 64 pwMS were included in the data analysis (n_{IG}=34, n_{CG}=30). Both the IG (1.00; 95% CI 0.46 to 1.54, p < 0.001) and the CG (0.62; 95% CI 0.06 to 1.19, p < 0.05) significantly increased PA, but no between-group differences in mean change of the sport score (0.37; 95% CI - 0.41 to 1.15, p = 0.35) from baseline to post-intervention were observed. Regarding self-concordance, significant within-group changes were present in the IG (0.97; 95% CI 0.07 to 1.86 p < 0.05) in contrast to the CG (-0.44; 95% CI - 1.39 to 0.51, p = 0.36) and between-group difference were significant (1.41; 95% CI 0.10 to 2.7, p < 0.05) from baseline to post-intervention.

Conclusion: This study provides preliminary evidence for the importance of an after-care program to sustain effects on PA but also on self-concordance as an important determinant for long-term PA levels in pwMS. Longer-lasting programs may have more sustained effects.

Submission ID: 93; Submission Group: Describing and understanding functioning; Submitter: Michela Ponzio
Analysis of met and unmet needs for people with MS
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Introduction: The measure of the 'metness' of needs to understand the level covered by public or private resources may be useful for service planning and guide optimization of care, especially in view of increased multiple sclerosis (MS) prevalence (1).

Aim: To examine the most frequent health and social care-related needs and the extent to which these are met.

Methods: A total of 1,014 people with MS attending neurology outpatient clinics, rehabilitation units and MS Society branches participated in a cross-sectional study carried out in Italy during 2017. A questionnaire was specifically developed by a multi-disciplinary team for the aim of the study.

Results: Subjects reported that needs related to health care, psychological support, access to technical aids and access to drugs

were highly to significantly met (66%, 84% and 70% respectively). Contrarily, access to a nursing home was a highly unmet need (60%). Rehabilitation, the most frequently reported need (81.2%), was also the most unmet (66.5%); moreover when met, it was often paid as an out-of-pocket expense.

Subjects reported that needs related to social care, financial support, architectural barriers, workplace adaptations, career guidance, transportation and managing bureaucracy were highly to significantly unmet needs (89.2%, 82.9%, 73.4%, 63.9%, 52.8% and 47.4% respectively). Transportation and personal assistance were the most frequently reported unmet needs related to social care. In particular, the need for personal assistance was unmet for 41.3% of subjects. However, when met, it (58.7%) was paid as an out-of-pocket expense by 43.3% of subjects.

Conclusion: The type and relevance of health and social-related needs emphasize the necessity for an interdisciplinary approach to MS. Actions resulting from the knowledge about these needs should be an essential element of the multi-professional setting. The results of this study also provide the basis for advocacy priorities related to the rights of people with MS.

Submission ID: 94; Submission Group: Rehabilitation interventions; Submitter: Charly Keytsman
Challenging the Mont Ventoux with Multiple Sclerosis: a home-based cycle and awareness project.

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Introduction: Several awareness projects including goal setting in the MS community (*Machu Picchu*, *MSRUN* project, EDSS range: 1-4) were recently performed to promote physical activity in MS. This project investigated the feasibility of a long-term (6m), home-based cycling exercise program in mildly affected persons with MS, with climbing the Mont Ventoux as goal setting.

Methods: In this awareness project, exercise capacity (maximal graded exercise test) was assessed at baseline (PRE). Next, all participants (MS, n=23; HC, n=22) received an activity tracker (Polar® M200) and were enrolled in a 6-month home-based exercise program that was remotely supervised (Polar® Coach). Training involved cycling on their personal bicycle. Following 6m of home-based training, POST measurements were performed similar to baseline. Hereafter, on September 16, 2017, the Mont Ventoux was climbed (25.7km, altitude_{start}: 1150m, altitude_{finish}: 1910m, average gradient: 4,5%, gradient range: 1-11%).

Results: Six months of home-based training induced improved VO_{2max} (+5,4%, p=0.001), workload (+11%, p<0.0001), time until exhaustion (+11%, p<0.0001), recovery heart rate (+2%, 0.0017) and lactate max (+35%, p<0.002). All persons with MS safely reached the top of the Mont Ventoux, except for two (ceased at 2km and 1km from the top because of exhaustion). The group

reached the top of the mountain in a mean time of 2h48min at a speed of 9.8 km/h. No injuries or adverse events occurred during the challenge.

Conclusion: The present awareness project studied the effect of a 6m home-based exercise program, which appeared to be feasible and provided good adherence, showed significant improvements in exercise capacity, and was able to train persons with MS to climb the Mont Ventoux safely.

Submission ID: 95; Submission Group: Outcome Measures; Submitter: Zuhul Abasiyanik

The association between fall risk and dual tasking with the timed-up and go test in persons with multiple sclerosis

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Introduction: Timed up and go (TUG) test is used commonly to evaluate mobility and fall risk in older adults and neurological disorders. Simultaneous execution of motor or cognitive task with TUG test can affect time of the test and can be related with fall risk in pwMS.

Aim: To investigate the effects of secondary motor and cognitive tasks on TUG test and its association with fall risk in pwMS.

Method: Fall history in the previous three months was questioned. The Expanded Disability Status Scale (EDSS) was calculated. The TUG test was performed alone, and with cognitive and manual tasks. The fall risk index (FR), limits of stability (LOS) and postural stability (PS) were measured using a computerized posturography tool. The participants were divided into two groups according the fall status as fallers and non-fallers.

Result: Forty pwMS were recruited the study (19 fallers). Time of TUG-alone, TUG-cognitive and TUG-manual were significantly lower in the non-fallers (p=0.001). Although, non-fallers had better score in balance tests, no significant differences was observed in FR, PS and LOS scores between the groups. Low to moderate correlations existed between number of falls, FR and PS (rs=0.206-0.390, p<0.05). Correlations between the number of falls and TUG-alone was rs=0.413, TUG-cognitive rs=0.379, TUG-manual rs=0.421.

Conclusion: The TUG-alone, TUG-cognitive and TUG-manual tests are associated with fall risk in pwMS. It has been reported in the literature that addition of a cognitive task to TUG test improved the detection of fall risk in people with neurological disorders. Although the addition of second task to TUG test don't provide specific advantages to determine fall risk, the TUG with motor and cognitive dual-task method may use to detect fall risk in pwMS.

Submission ID: 96; Submission Group: Outcome Measures; Submitter: Ilse Evers

Diet may modify MS-related quality of life

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Currently no curative treatment for Multiple Sclerosis (MS) is available, which sparks the interest in the effect of diet and lifestyle on the progression of disease. We investigated attitudes towards diet and dietary supplements and the association between diet quality and impact of MS on quality of life (QoL) in a survey among MS patients from a database of the Dutch National MS Fund. A total of around 700 surveys were collected. Preliminary data of 461 respondents are reported here. Of these responders, 94% was willing to change their diet if that would have an impact on disease progression. More than one third reported to be on a diet, with a sugar-free and a low carbohydrate diet reported most frequently. Participants following a diet scored significantly higher on the Dutch Healthy Eating Index score and its subscores for vegetables, fruits, fiber, fish, saturated fat and salt. These participants more often had a healthy BMI, used significantly lower inhibitory drugs and reported a better QoL. In general, participants scoring the highest on overall diet quality and intake of vegetables, fruit, and fish experienced less psychological impact of MS on daily life, whereas those with the highest scores for vegetables and fiber experienced less physical impact of MS on daily life. Over 80% of participants were using a dietary supplement; most often vitamin D, vitamin B12 and n-3 fatty acids. This study indicates the important role of diet among people with MS in the Netherlands. It also suggests that patients with a better diet quality experience less impact of MS. The results of the survey warrant further investigation into the role of diet in well-controlled nutritional intervention studies.

Submission ID: 97; Submission Group: Rehabilitation interventions; Submitter: Marie Lynning

Trends in use of Complementary and Alternative Medicine among people with Multiple Sclerosis in Denmark

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Background: It is known that Complementary and Alternative Medicine (CAM) is popular among People with Multiple Sclerosis (PwMS). However, there is limited knowledge about use of CAM over time within this patient group.

Objective: The aim of this study was to explore trends in use of CAM among PwMS in Denmark from 2012-2017 with regards to overall CAM use, use of specific CAM modalities and factors associated with CAM use, following the definition of CAM presented by The National Center for Complementary and Integrative Health.

Methods: The survey "Living with MS in Denmark" was carried out in 2012 and 2017. Both years the survey included samples of 400 PwMS who were interviewed via telephone. Calls were made to randomly selected telephone numbers from the member database of the Danish MS Society until 400 interviews had been completed. In total, 761 telephone numbers were called in 2012 and 978 in 2017. The interview samples were representative of the MS population in Denmark for the interview year in terms of age, sex, region of residence and year of diagnosis. Descriptive and comparative analyses were performed using χ^2 -tests and logistic regression.

Results: Analyses showed that overall CAM use rose from 42% in 2012 to 49% 2017. However, this change was not statistically

significant. There was a significant rise in the use of herbal medicine, yoga and meditation from 2012 to 2017. In 2012 as well as in 2017, use of CAM was significantly associated with age (less use with higher age). Use of CAM was associated with time since diagnosis in 2012 (less use with longer time diagnosis) but not in 2017. Likewise, CAM use was associated with level of education in 2012 (higher use with higher level of education) but not in 2017.

Conclusion: The use of CAM among people with MS has remained widespread from 2012 to 2017. The prevalence of use has increased for a few CAM modalities.

Submission ID: 98; Submission Group: Rehabilitation interventions; Submitter: Jennifer Freeman

Standing up in multiple sclerosis (SUMS): A multi-centre randomised controlled trial evaluating the clinical and cost effectiveness of a home-based self-management standing frame programme in people with progressive multiple sclerosis

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Background: Severely impaired people with progressive MS spend much of their day sitting. In response, secondary physical and psychosocial complications can occur. Effective self-management strategies, feasible to implement within people's homes, are needed to improve/maintain mobility and its associated complications. This is challenging, particularly in the latter stages of disease. This study evaluates the use of a home-based, self-managed standing frame programme.

Methods: A pragmatic, multi-centre, definitive randomised controlled trial with blinded outcome assessments at baseline, 20 and 36 weeks post baseline and full economic evaluation. Those allocated to the intervention group were asked to stand for a minimum of 30 minutes three times weekly over 20 weeks. The primary clinical outcome was motor function (Amended Motor Club Assessment) and primary economic endpoint was quality-adjusted life years. Participants recorded adherence to the standing programme in a diary, together with adverse events.

Primary Analysis: Intention-to-treat approach, utilising analysis of covariance, comparing AMCA scores at week 36 between allocated groups, adjusting for baseline AMCA and stratification factors (baseline EDSS category, geographical region).

Results: 140 people with progressive MS (mean [sd]: age 59.1 years [9.4], Expanded Disability Status Scale 7.3 [0.6]; 64% female, 69% secondary progressive, 71% daily wheelchair user) were recruited from eight centres, of whom 12 withdrew. Provisional analysis suggests that the adjusted AMCA at week 36 is statistically significantly higher in the standing frame group (n=61) compared to the control group (n=61) (adjusted between-group difference 4.7 [95% confidence interval 1.9 to 7.5]).

Discussion: This is the first large scale multi-centre trial to assess the clinical and cost effectiveness of a home based, self-managed standing frame programme in people severely impaired by progressive MS. Our provisional results indicate that the standing frame intervention was feasible to implement and resulted in statistically significant benefits in motor function compared to usual care alone.

Submission ID: 99; Submission Group: Rehabilitation interventions; Submitter: Kirsten Hanehøj

The effect of acupuncture on cytokine levels in MS patients.

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Background: Cytokines have been found to play a role in the disease activity in MS. Previous studies indicate that acupuncture can affect cytokine levels in patients with other inflammatory diseases. This study aims to investigate the effect of acupuncture on cytokine levels in people with MS.

Materials and Methods: A double-blind RCT study was performed. Sixty-five people with Relapsing Remitting Multiple Sclerosis were randomized into three groups (acupuncture, sham acupuncture and a reference group). Participants in the acupuncture group and the sham group received six treatments of acupuncture or sham acupuncture respectively during a period of four weeks. Two Chinese acupuncturists with a six-year education in Traditional Chinese Medicine and an education in western medicine conducted the acupuncture treatments using Streitberger placebo-needle set. The serum levels of seven cytokines (six pro inflammatory and one anti-inflammatory cytokine) were measured in all participants at baseline, after two and four weeks of treatment and finally one month after end of treatment. The effect of treatment on changes in cytokine levels from baseline to first, second and third measurements was tested using an analysis of variance with treatment as a fixed effect for each cytokine.

Results: In this study, we could not demonstrate that acupuncture has a measurable effect on the plasma levels of the seven measured cytokines. The study will be supplemented with a qualitative add-on study carried out on the participants in the acupuncture group regarding their experiences of treatment and effects of acupuncture.

Submission ID: 100; Submission Group: Rehabilitation interventions; Submitter: Hilary Gunn

Balance Right in Multiple Sclerosis (BRiMS): Preliminary results of a randomised controlled feasibility trial

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Background: Balance, mobility impairments and falls are common problems for people with MS. Our ongoing research has led to the development of "Balance Right in MS (BRiMS)", a 13-week home and group-based programme of exercise and educational activities intended to improve balance/ encourage safer mobility. This study aimed to provide the necessary data to inform the conduct and design of a definitive trial.

Methods: Randomised controlled feasibility trial undertaken at four sites across the United Kingdom. Eligibility criteria included: confirmed diagnosis of secondary progressive MS, EDSS ≥ 4.0 – ≤ 7.0 and self-report of \geq two falls in the preceding six months. Participants were randomised to either BRiMS plus usual care or usual care alone. Assessments were undertaken at baseline, 15 and 27 weeks post-randomisation. Measures included feasibility data, outcomes proposed for the anticipated definitive trial, measures of adherence and economic data. Telephone interviews with 13 participants and a therapist focus group (n=4) explored acceptability of the programme and trial procedures.

Results: Fifty-six participants (mean age 59.7 years [SD 9.7], 66% female, median EDSS 6.0 [IQR 6.0-6.5]) were recruited in five months; 30 were block randomised to the intervention group. The groups were comparable on all outcome measures at baseline. Ten participants withdrew during the study, seven from the intervention group. Worsening of MS-related symptoms unconnected to the trial was the most common reason (n=5) for withdrawal. A total of 1215 falls were reported over the 27 week trial period, with substantial variation between individuals (range 0-459). Of these, 126 falls (8%) were reported as injurious. Qualitative feedback indicated that trial processes and participant burden were acceptable. Participants and therapists highlighted suggestions to improve the utility and accessibility of BRiMS.

Conclusion: Preliminary evaluation suggests that trial procedures are feasible and acceptable. Further development of BRiMS is required to address logistical issues and enhance user-satisfaction.

Submission ID: 101; Submission Group: Rehabilitation interventions; Submitter: Jennifer Freeman

“I’m in a very good frame of mind”: the experience of standing frame use in people with progressive multiple sclerosis

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Background: People with severe multiple sclerosis (MS) often find it difficult to stand independently, spending most of their day sitting down. Disabling complications resulting from immobility can be minimised if physical activity is increased. This qualitative study explored the impact of a home-based, self-managed standing programme using an Oswestry standing-frame on people with severe MS and their carers.

Methods: We report on the qualitative component of a multi-centred randomised controlled trial (RCT) evaluating the effectiveness of a home-based standing programme. We explored the experiences of 12 people with progressive MS (six female, aged 35 – 71 years) and eight carers (four female), who used an audio diary to record their thoughts and feelings about using a standing frame over 36 weeks. Recordings were transcribed verbatim and data analysed thematically. Data was triangulated with informal exit interviews from 126 persons participating in the RCT.

Results: Four themes emerged: (1) ‘Feeling like the old me’ encompasses the sense of normality gained from standing, and the physical, psychological and social benefits experienced; (2) ‘Noticing a difference’ captures the variety of changes people reported in their function as well as wide ranging symptoms such as spasms, strength, bladder and bowel function; (3) “I want to do it right” reflects the value placed on having guidance and support in establishing a standing programme that worked for them; (4) “You have a good day, you have a bad day” highlights the issues faced by people living with a progressive and fluctuating condition in implementing a self-management programme.

Conclusions: The use of a standing frame enabled people to incorporate regular standing within their lives, which was an activity many hadn’t achieved for some time. Associated with this they reported wide ranging physical, psychological and social benefits. Guidance and support is important to consider with programmes of this nature.

Submission ID: 102; Submission Group: Outcome Measures; Submitter: Fanny Van Geel

Walking-related performance fatigability in people with Multiple Sclerosis: Clinical manifestation and test-retest reliability of the assessment method.

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Background: People with Multiple Sclerosis (PwMS) often report fatigue and walking difficulties. Walking-related fatigability has been measured during the six-minute walking test (6MWT) in PwMS, older adults and other pathologies by calculating differences in gait speed between the first and the last minute. Our research group previously proposed a walking distance index (DWI) expressed as percentage, with -15% as discriminative threshold. However, psychometric properties of the DWI are not reported yet, and the manifestation of walking fatigability by other symptoms is still not well understood.

Methods: Nineteen PwMS (EDSS [1-6]) performed the 6MWT two times (3-5 days in between) and completed the Symptom Inventory (SI) before (pre), immediately after (post), after 10 (post10’), 20 (post20’) and 30 min (post30’). The SI contains 11 symptoms commonly present in MS. Rating per symptom was made by 0-10 VAS. They also underwent a short clinical objective screening for spasticity, balance and strength at the same time slots. More data collection is still ongoing.

Preliminary Results: The average DWI was $-11,88 \pm 12,39\%$ and $-10,65 \pm 10,25\%$, with a six-minute walking distance of $491,57 \pm 138,80\text{m}$ and $515,74 \pm 137,54\text{m}$ at test day 1 and 2 respectively. Preliminary correlation analyses indicated that the DWI has a good test-retest reliability (chronbach’s alfa: 0.95, ICC: 0.90 $p < 0.001$, Spearman: 0.71, $p = 0.001$). Walking fatigability manifestation is associated with a significant increase in perceived general fatigue, sensitivity and muscle weakness at post and post10’. Perceived gait pattern problems were significantly increased until post20’. Perceived balance problems and motor fatigability only significantly increased post. There was no significant change in objective outcomes.

Discussion and conclusion: The DWI during the 6MWT is a reliable measure. Walking fatigability does manifest itself in other symptoms, until 20 minutes after the 6MWT. Future research is recommended to investigate the clinical profile and underlying factors of walking fatigability in detail.

Submission ID: 103; Submission Group: Rehabilitation interventions; Submitter: Lorena Catena

Impact of exoskeleton-assisted gait training on walking and brain plasticity in people with Multiple Sclerosis

Lorena Catena

Background: Gait impairment is a common cause of disability in people with Multiple Sclerosis (pwMS). The primary aim of this study is to assess the effect on balance and gait impairment of robot-assisted gait training (RGT) vs conventional therapy (CT) in pwMS. The secondary aim is to analyze neurophysiological changes before and after either treatment.

Methods: A randomized controlled study was performed enrolling 20 patients with progressive MS (EDSS score 3.5-7). Subjects were allocated into two groups of 10:

1) the Robotic Gait Training group (RGT_experimental group) underwent robot-assisted gait training with an EXOSKELETON device; 2) the Conventional physical therapy group (CT_control group) performed treadmill and over-ground walking training. Both groups received 12 training sessions of 45 minutes each (including rest and stretching), 3 days/week for four consecutive weeks. They were evaluated before (T0) and immediately after treatment (T1), using the following measures: spatio-temporal parameters of gait, Berg Balance Scale, 6-minute walking test,

Timed up and go test, MSQOL-54, Fatigue Severity Scale, Falls Efficacy Scale, Activities Balance Confidence score and brain plasticity response to transcranial magnetic stimulation (TMS), via a rPAS protocol.

Results: After treatment, all subjects showed an improvement in gait and balance, with greater effect in the RGT group than in CT, especially in the Berg Balance Scale ($p < 0.04$), Timed up and go test ($p < 0.05$) and Falls Efficacy Scale ($p < 0.03$). Moreover, while no subject showed any neuroplasticity response to TMS, at baseline, the RGT group (though not the CT group) recovered such response at T1.

Conclusions: This pilot study suggests a therapeutic role for the robotic gait training with EXOSKELETON in pwMS. The training impact on gait capacity is likely mediated by the enhancement of brain plasticity. A longer follow-up is warranted in order to assess the carryover effect of training.

Submission ID: 104; Submission Group: Rehabilitation interventions; Submitter: Jennifer Freeman
Investigating referral patterns to Physiotherapy and Occupational Therapy: A clinical audit.

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Background: The 'Multiple Sclerosis Management Guidelines' (NICE, 2014), recommend specialist Physiotherapy (PTs) and Occupational Therapy (OTs) input in the management of fatigue, balance and mobility problems, spasticity, cognitive impairment and pain. However, little evidence exists regarding referral levels to these services.

Objective: To review patterns of PT and OT referral from neurologists and MS specialist Nurses.

Methods: A retrospective audit was undertaken. Using an MS Database (IMED), clinic letters were reviewed from Neurologists and MS Clinical Nurse specialists working in a large regional UK Hospital. Patients were included if they were: aged ≥ 18 years, with a confirmed diagnosis of MS, and seen in clinic between December 2017-18. Notes were audited using a standardised data extraction form. Diagnostic, symptomatic and demographic information was extracted, alongside whether a PT/OT referral was made. Descriptive statistics and chi squared tests described the sample and examined associations between referral patterns and extracted variables.

Results: Of the 1359 notes screened, 774 met the inclusion criteria. The sample comprised 71.6% females, mean age of 52.2 years (± 49.5), EDSS mode 6.0 (range 0-8.5). Regarding disease type: 61.9% relapse remitting, 25.3% secondary progressive, 6.7% primary progressive, 0.3% benign, 5.8% unconfirmed. Overall, 29.5% ($n=228$) were referred to PT and 1.4% ($n=11$) to OT. 69.1% were not referred to either profession. PT referral was significantly associated with balance impairment, weakness, spasticity and EDSS category (≥ 4.0 or < 4.0) (all variables $p < 0.0001$), with most referrals scoring EDSS 6.0 (32.7%, $n = 55$). An increase in PT referrals occurred with increasing age (peaking at 39.1% in the 71-80 age group) and co-morbidities.

Conclusion: Most people were not referred to either PT or OT. Referral rates varied across individual clinicians. Greater awareness is needed about the benefits of referral to PT/OT and further

work is required to explore the barriers and facilitators to optimise this.

Submission ID: 105; Submission Group: Describing and understanding functioning; Submitter: Lars Hvid
Alterations in lower limb neuromuscular function across the adult life span in persons with multiple sclerosis

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Introduction: Multiple sclerosis (MS) and aging (≥ 60 years) have separately been shown to impair lower limb neuromuscular function (e.g. muscle strength) and physical function. At the same time, about 1/3 of all MS patients are >60 years. Nonetheless, no studies have compared neuromuscular function across the adult life span in MS patients. Thus, the purpose of the present study was to compare lower limb neuromuscular function in young (20-44 yrs), middle-aged (45-59 yrs), and old adults (60+ yrs) with and without MS.

Materials and Methods: Participants: MS_young [$n=26$, age 37 ± 6 yrs, EDSS score 2.4 ± 1.5]; MS_middle [$n=29$, age 52 ± 4 yrs, EDSS score 2.5 ± 1.5]; MS_old [$n=13$, age 64 ± 4 yrs, EDSS score 3.2 ± 1.6]; HC_young [$n=6$, age 28 ± 10 yrs]; HC_middle [$n=9$, age 47 ± 2 yrs]; HC_old [$n=10$, age 69 ± 6 yrs]. Maximal isometric knee extensor strength (KE) was assessed using isokinetic dynamometry. Regression analysis (gender adjusted) was carried out between age and KE muscle strength.

Results: Compared to MS_young, KE muscle strength was increasingly lower in MS_middle and MS_old ($2.44 \pm 0.52 > 1.82 \pm 0.50$ (-25%) $> 1.68 \pm 0.60$ (-31%) Nm/kg, $p < 0.05$). Compared to HC_young, KE muscle strength was the same in HC_middle and lower in HC_old ($2.50 \pm 0.41 = 2.64 \pm 0.47$ (+6%) $< 1.73 \pm 0.37$ (-31%) Nm/kg, $p < 0.05$). KE muscle strength differed between MS and HC in middle-aged only (-31%, $p < 0.05$). Age and KE muscle strength associations were observed in MS ($r^2=0.41$, $p < 0.05$) and HC ($r^2=0.39$, $p < 0.05$), yet with a steeper decline in MS vs HC (loss of KE muscle strength per decade: -0.33 vs -0.19 Nm/kg). Associations were also observed in MS_mild (EDSS < 3.5 ; $r^2=0.36$, $p < 0.05$) and MS_moderate (EDSS ≥ 3.5 ; $r^2=0.31$, $p=0.06$), and with a steeper decline in MS_moderate vs MS_mild (-0.38 vs -0.31 Nm/kg per decade).

Conclusion: Age-related alterations in lower limb muscle strength occur earlier in life in MS vs HC, and at an accelerated rate of decline.

Submission ID: 106; Submission Group: Outcome Measures; Submitter: Jan-Patrick Stellmann

Cortical atrophy patterns and cognitive domains in MS
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Background: Cognitive impairment (CI) is a common problem in multiple sclerosis (MS) and assumed to represent a clinical read-out for the neurodegenerative aspect of the disease. Global magnetic resonance imaging (MRI) outcomes such as total brain volume disregard the topological organisation of the cortex and correlate only moderately with CI. Local cortical atrophy patterns might be more specific but a comprehensive, domain-specific atlas of cognitive dysfunction is not available.

Objective: To identify correlation patterns between an extensive neuropsychological assessment and cortical thickness in 99 patients with MS (mean age 39 years, 62% female, 81 % relapsing-remitting MS, mean disease duration 7.4 years, mean EDSS 2.5).

Methods: Patients underwent structural MRI and neuropsychological testing including the following domains: attention (7 subtests), memory (9 subtests), spatial processing (2 subtest) and executive functioning (5 subtests). We used FreeSurfers general linear models, to identify clusters of association between each neuropsychological test and cortical thickness. Results were combined to provide cortical association maps for each cognitive domain and also a general atlas summing up all associations. A subset of significant findings could be validated against an independent cohort of 30 relapsing-remitting MS patients and 29 healthy controls.

Results: We found specific patterns of associations for the majority of subtests and for all domains. Combining results from all analyses, we observed the strongest association between CI and cortical thickness in both temporal lobes, peri-insular regions and within the primary visual system. In healthy controls, only a region within the pars opercularis on the right showed a significant correlation with symbol digit modality test. Six out of 25 regions were validated with $r \geq 0.39$ in the independent MS cohort.

Conclusion: CI in MS patients shows a distinctive pattern of association with cortical thickness. Our atlas might improve the specificity of MRI in clinical and especially cognitive rehab trials.

Submission ID: 107; Submission Group: Rehabilitation interventions; Submitter: Jan Spaas

Carnosine in Multiple Sclerosis and Experimental Autoimmune Encephalomyelitis

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Background: Carnosine, a dipeptide composed of β -alanine and histidine, is present in many tissues throughout the body and ~99% of carnosine is found in skeletal muscle tissue. Here, it has several physiological functions (e.g. Ca^{2+} handling, intramyocellular buffering) that correspond with multiple sclerosis (MS)-related (muscular) dysfunctions. Due to its antioxidant properties, carnosine is also considered a neuroprotective and antisenescent

compound. We present a series of three consecutive studies investigating the role of carnosine in MS and Experimental Autoimmune Encephalomyelitis (EAE), an animal MS model.

Methods: Study 1 compared muscle carnosine content between MS patients (n=24) & healthy individuals (n=22, m. vastus lateralis), and between EAE & control animals (both n=40, m. tibialis anterior). Study 2 evaluated the effects of carnosine and β -alanine intake (24d) on muscle carnosine content and clinical disease course in a monophasic EAE rat model (n=39). Study 3 evaluated the effects of carnosine intake (35d) on clinical disease course in a chronic EAE mouse model (n=20).

Results: Muscle carnosine content was reduced in EAE (-46 to -60%, $p < 0.001$) and MS (-25%, $p = 0.03$) (study 1). Carnosine and β -alanine intake restored muscle carnosine levels in EAE ($p < 0.01$, study 2). Finally, carnosine appears to affect the disease course (delayed hind quarter paralysis onset, reduced peak and cumulative disease score) in monophasic and chronic EAE models (study 2 & 3).

Conclusion: Muscle carnosine is reduced in MS and EAE, and carnosine intake restores this in EAE. Carnosine intake appears to improve hind quarter paralysis in EAE. Future studies will further investigate the effects of carnosine (loading) in MS and EAE.

Submission ID: 108; Submission Group: Outcome Measures; Submitter: Davide Cattaneo

Balance Assessment to Unravel Participation Restrictions in Multiple Sclerosis

Davide Cattaneo, Tiziana Lencioni, Elisa Gervasoni, Denise Anastasi, Ilaria Carpinella, Elisabetta Groppo, Marco Rabuffetti, Johanna Jonsdottir, Marco Rovaris, Maurizio Ferrarin

A recent study found that 77% of People with Multiple Sclerosis (PwMS) have participation restrictions which are linked to gait and balance disorders. However, dynamic balance disorders are difficult to assess in clinical practice.

We performed three studies to profile balance disorders during gait of PwMS. The first one was aimed to develop and compare different indexes to describe dynamic balance using instrumented gait analysis. We assessed 14 PwMS aged (Mean \pm Standard Deviation) 49.25 \pm 8.0 years, with an Expanded Disability Status Scale (EDSS) score of 5.4 \pm 1.25 points and we found that indexes related to Head motion and Body Centre of Mass motion seem valid to describe dynamic balance control. In a second study we developed a new assessment tool based on wearable sensors to evaluate the balance and gait adaptability in a clinical environment. Ten PwMS (mean age of 49.5 \pm 17.7 years, all with EDSS lower than 6.5) were assessed using Inertial Measurement Units while performing balance tasks. Our results showed that PwMS, when compared to healthy subjects, show more impairment in trunk control than in indexes related to step frequency and regularity.

In the third, ongoing study, we are focusing on subject's ability to walk in everyday life environment and to verify which of the indexes provided by wrist-worn actigraphic devices are more associated to participation restrictions.

In conclusion, dynamic balance assessment can be used as a guidance for clinicians to detect PwMS having balance disorders that are associated with participation restrictions and to analyze changes in balance control in the clinical environment and during the activities of daily living.

Submission ID: 109; Submission Group: Rehabilitation interventions; Submitter: Marie-Louise Jørgensen
Serum brain-derived neurotrophic factor is not a mediator of neuroplasticity induced by resistance training in persons with multiple sclerosis

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Introduction: Resistance training (RT) is a highly potent training regime in eliciting neuroprotective adaptations (neuromuscular activity, brain volume) in persons with multiple sclerosis (pwMS). Brain-derived neurotrophic factor (BDNF) is a potential mediator of such neuroprotective adaptations, with increases reported in acute levels following a single session of aerobic exercise and in chronic levels following combined exercise (aerobic + RT). Yet, no studies have examined the effects of high-intense progressive RT alone on BDNF in pwMS. Thus, the aim of the present study was to examine the acute and chronic effects of RT on serum levels of BDNF in pwMS.

Materials and Methods: Relapse-remitting MS patients (interferon treatment) were randomized into a training group (TG: n=16, age 44±11 yrs, EDSS 3.0±1.5 (median±IQR)) undergoing 24 weeks of RT (2 sessions/week) or a control group (CG: n=15, age 46±12 yrs, EDSS 3.0±1.5). Pre and Post the 24-week period, composite thigh muscle strength (knee extensor + knee flexor) muscle strength (MVC) and neuromuscular activity (electromyography, EMG), along with chronic (resting) and acute serum BDNF levels (0, 15, 45, 75, 120 min following the third and second-last training session, respectively), were assessed.

Results: At Pre, CG and TG were comparable for all parameters. Pre-to-Post increments were observed in MVC and EMG in TG but not in CG (between-group Δ : 0.90 Nm/kg and 10.4 μ V, respectively). No Pre-to-Post changes were observed in chronic (resting) BDNF levels in TG (142[83:292] vs 159[67:219] pg/ml) or in CG (131[48:296] vs 97[54:211] pg/ml). Also, no changes were observed in acute BDNF levels following a single RT session at Pre in neither TG nor CG, and no Pre-to-Post changes were observed in TG.

Conclusion: Neither acute nor chronic BDNF levels increased following progressive high-intense RT in pwMS, and were thus not mediating the observed neuroplasticity reported in the same study participants.

Submission ID: 110; Submission Group: Rehabilitation interventions; Submitter: Simonetta Rossi
The Lymphatic Drainage as a useful tool for the well-being in MS People: a case series

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Study design: case series

Objective: The aim of this study is to verify the effect of the lymphatic drainage in the treatment of chronic neurodegenerative diseases as Multiple Sclerosis. Specifically the treatment with Lymphatic Drainage is proposed to influence disorders that affect the quality of life with the goal of improving the personal wellbeing.

Background: Multiple Sclerosis is a neurodegenerative disease that involve motor and non-motor symptoms such as pain, fatigue, sleep disturbances, anxiety, depression, constipation etc. These disorders, directly or indirectly dependent by the primary pathology, negatively affect the quality of life of the person, compromising the

emotional state and the compliance, and consequently the personal well-being. Lymphatic drainage, which involves both the lymphatic system and the parasympathetic system, can therefore be helpful in the treatment of these problems, not closely related to the physical aspects of the disease but related to qualitative ones as literature data suggest.

Methods and Measures: For the study were selected 5 inpatients with Multiple Sclerosis, without relapsing for at least 3 months and in stable clinical conditions; participants in the study should not have conditions indicated as contraindications of Lymphatic Drainage. Patients were evaluated before and after the treatment; the measurement of the lower limb circumference and the assessment scale including the McGill Quality of Life Questionnaire (MGQOLQ), the Edmonton Symptom Assessment Scale (ESAS), Douleur Neuropathique en 4 Questions (DN4) and the Hospital Anxiety and Depression Scale (HADS), were administrated. Every patient received 10 sessions, one hour each, to treat neck, abdomen and lower limbs on alternate days.

Results: By the first data's elaboration there are: a reduction of the circumference of the lower limbs in all patients, an increase of the quality of life's score of at least one point in all subjects in the MGQOLQ, an improvement of the symptoms evaluated by ESAS, a decrease of the perception of the neuropathic pain in DN4 and a modification of the feeling of anxiety and mood in HADS.

Conclusions: From the results obtained, there are obvious improvements in the quality of life and in the well-being perception in the subjects involved in the study, but the lack of a control group, the reduced sample of selected patients, the great variability of the results and the lack of studies providing guidelines more specific to the application of the treatment, do not allow to give evidence with certainty the improvements observed.

Submission ID: 111; Submission Group: Rehabilitation interventions; Submitter: Joke Raats
Clinical effects of an individualised technology-supported task-oriented upper limb training program in MS

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Background: Converging evidence suggests that task-oriented practice is an effective way to promote functional recovery of upper limb function in neurological diseases such as stroke and Multiple Sclerosis (MS). Evidence on the required training dosage, and how to determine this individually, is, however, unknown in Multiple Sclerosis.

Methods: People with MS (n=20, EDSS range 4-8) were divided into three groups, receiving task-oriented training at 100% (n= 7) or 50% (n= 8) of their individual determined maximal capacity in number of repetitions, or usual occupational therapy (n=5) for one hour, five days/week, during eight weeks. Effects in different the groups were evaluated using different upper limb capacity and perceived performance measures. In addition different measure on body function and structure level were used to evaluate the secondary effects.

Results: Mixed model analyses revealed significant improvements (p<0.05) over time on the Box and block test (BBT), Action

Research Arm Test and the Manual Ability Measure-36. The average change in the task-oriented groups were respectively, 5.5 blocks, 2 and 2.7 points for these three outcome measures. Significant interaction effects (group* time) were found for BBT and static fatigue index during a sustained handgrip strength. Multiple comparisons for these two measures revealed only a significant improvement in the task-oriented group training at a higher intensity compared to the other groups.

Conclusion: All participants were able to perform the task-oriented training at their maximum training capacity without any adverse effects. Several improvements over time were found, but not clearly depending on the percentage of training capacity. However, the results on the BBT and sustained handgrip strength may suggest a superiority of task-oriented training at 100% of the individual maximum capacity.

Submission ID: 113; Submission Group: Describing and understanding functioning; Submitter: Davide Cattaneo
Thermoregulatory response to six minute walk test in people with Multiple Sclerosis

Giampiero Merati, H.C. Gunga, E. Gervasoni, M. Maggioni, A. Stahn and D. Cattaneo

The increase in core body temperature (CBT) is considered one of the physiologic response leading to fatigue onset during exercise in People with Multiple Sclerosis (PwMS). However, the time adaptation of CBT to exercise has not been frequently addressed, due to the need of unpractical rectal or expensive sensors.

Six PwMS (EDSS: 5,2±1,1 [mean±SD]) and 7 BMI- and age-matched control subjects were enrolled. CBT was continuously (0,5 Hz) monitored by a validated wearable and completely non-invasive skin surface head sensor, with a heat-flux approach (Double Sensor) during a standard 6 minutes walk test (6MWT) (constant room temperature: 24°C).

As expected, the distance covered in the 6MWT was significantly lower ($p<0,001$) for PwMS patients (325±81 m) compared to control subjects (682±69 m). In the first half (3 min) of the 6MWT CBT significantly increased in both PwMS (+0,4±0,2°C; $p=0,004$ vs baseline) and control subjects (+0,8±0,2°C; $p=0,004$ vs baseline and $p=0,01$ vs MS patients). Conversely, CBT was significantly reduced during the second half of 6MWT in control subjects (-0,2±0,3°C, $p=0,05$ vs first half of 6MWT), whereas remained the same in PwMS (0,0±0,1°C, $p=ns$ vs first half of 6MWT).

PWMS seem to develop an altered thermoregulatory response to the 6MWT: CBT increases (although to a lesser extent) as in control subjects in the first half of the test but does not decrease thereafter. This suggests a reduced early metabolic adaptation and a compromised late sudo-motor response to the increment of CBT. Finally, the double sensor approach seems suitable in estimating the time course of CBT during a functional endurance test in PwMS, and may be useful to monitoring disease stages and predicting its progression.

Submission ID: 114; Submission Group: Rehabilitation Interventions; Submitter: Simonetta Rossi
Sailing in MS Patients as a part of individual rehab project
Simonetta Rossi, A. Vendramin, R. Stabile, G. Marcassa

Background: Sailing in a two small sailboats (Hansa 303) is an innovative and specific rehabilitation activity for MS patients as a part of individual rehab project that produces positive outcomes on general health for the participants. The activity is supported by local committee "Lega Navale Italiana", no profit organization, and IRCCS San Camillo Hospital.

Methods and Measures: In 3 years sailing activity (May-September) 20, in and out, MS patients (11 F, 12 M), relapsing remitting or secondary progressive form, were enrolled (FIM M 62 BARTHEL 37, EDSS between 5.0-8.0). The program including weekly lessons about sailing ships and sailing cruises in the Venetian lagoon; practical activities in the presence of light breezes (4-6 knots, Beaufort scale). 64 total sessions, 3,2 sessions each patient. A Likert scale, a psychometric scale commonly involved in research that employs questionnaires, was administered before and after the training.

Results: In the end of the training, all subjects improved the ability to sail independently in winds of moderate strength on water, and measurable improvements in their psychologic health. Four of them decided to continue the activity signing up to a local sailing club and one of them started races and received from Italian Sailing Federation a special award because constancy in training despite fatigue that characterizes this pathology.

Conclusions: in our experience the proposal was advanced of integrating sport therapy into a Rehab centre within the context of multi-modal therapeutic programs, as a strategy to improve the quality of live and social re-integration.

Submission ID: 115; Submission Group: Rehabilitation Interventions; Submitter: Johanna Jonsdottir
Virtual reality for rehabilitation in clinic and in continuity of care, Protocollo HEAD-Multicenter study: Feasibility and efficacy for persons with Multiple sclerosis.
Johanna Jonsdottir

Continuity of care is an issue in health care for persons with Multiple Sclerosis(PwMS). The present multi-center study investigates the feasibility and efficacy of an innovative approach(Human Empowerment Aging and Disability-HEAD) based on virtual reality with short video clips of RAI programs within the context of neuromotor rehabilitation in clinic(Clinic-HEAD) and in continuity of care(Home-HEAD) for persons with Multiple Sclerosis, Stroke and Parkinson.

Methods: Within the HEAD multicenter study 26 PwMS(mean age 51.3±16.4, EDSS range 3-6) were recruited during recovery(Clinic-HEAD). Clinic-HEAD consisted of 12 sessions of 1-hour-HEAD rehabilitation, including motor, cognitive and dual task activities in a virtual reality environment incorporated into short video clips. At discharge from the clinic half of the participants brought the system home and continued with tele-monitored rehabilitation(Home-HEAD) 5 days per week for 3 months. Evaluation of motor, cognitive and participation factors was carried out at baseline(T0), following ClinicHEAD(T1), and following three months of Home-HEAD(T2). Analysis of outcome of Berg Balance Scale, 2-Minutes Walking Test(2MWT), 10-Meters Walking Test, Box and Block Test(BBT) and SF-12 was done using Wilcoxon tests (.05, two tailed) at T0 and T1 for all PwMS, and at T1 and T2 for the Home-HEAD group.

Results: Clinic-HEAD resulted in a significant increase in gait resistance(2MWT, $p<.05$) and a trend for improved dexterity(BBT,

$p=.10$). As for continuity of care, so far 7 PwMS have finished the Home-HEAD protocol with maintenance of results obtained in the clinic.

Conclusion: Preliminary data supported the feasibility of the HEAD virtual reality protocol in rehabilitation and in continuity of care in PwMS.

Submission ID: 116; Submission Group: Describing and understanding functioning; Submitter: Megan Landean
The Relationship Between Brain Derived Neurotrophic Factor (BDNF) and Risk for Falls in Individuals with Multiple Sclerosis

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Background: Falls and concerns with balance are significant issues in people with MS. Despite the growing body of literature regarding falls and fall risk in MS, there is still much to learn about the underlying factors most related to falls in this population. Recently, an increasing amount of research has been conducted to determine the links between BDNF and outcomes related to cognition and mobility. BDNF is a growth factor important for the development and maintenance of the nervous system. BDNF may represent a good marker of fall risk due to it being an indication of cognitive function plus overall neural function and compensation to associated neuronal damage caused by the disease.

Objective: This study aimed to determine whether BDNF levels were related to fall risk in MS.

Participants and Methods: Eighteen individuals with MS (30-75yrs old) were included in the study. Participants underwent a blood draw and completed the short form Physiological Profile Assessment (PPA). The PPA analyzes five physiological functions commonly linked to falls. Serum BDNF levels were assessed by ELISA.

Results: The average BDNF level was 37,180.02pg/ml (\pm 12438.84pg/ml). The fall risk assessment (PPA) had a mean total score was 2.16 (\pm 1.75). There was a significant correlations of BDNF and anterior-posterior sway ($\rho = -0.776$) and a trend for both reaction time ($\rho = -0.437$) and proprioception ($\rho = -0.323$) with the concentration of BDNF.

Conclusion: BDNF levels were found to play a possible role in anterior-posterior sway, proprioception, and reaction time. Higher BDNF was indicative of improved performance in each of these physiological functions strongly associated with fall risk. It remains to be seen if reductions in physiological fall risk are coupled with increases in BDNF.

Submission ID: 117; Submission Group: Describing and understanding functioning; Submitter: Lousin Moudjian
Entraining to auditory stimuli during walking and its effect on synchronisation and gait pattern in multiple sclerosis: a case control study.

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Background: Motor dysfunctions are prevalent in persons with multiple sclerosis (PwMS), often manifested in walking difficulties. Novel rehabilitation mechanisms provided at higher training intensities are warranted. Evidence has shown that motor entrainment to music improves motricity in sports performance, while the effect of auditory cueing is well-known in Parkinson's disease. In this context, entrainment is understood as the underlying process that couples the motor and auditory systems.

Aims: To investigate if PwMS compared to healthy controls (HC) a) can entrain to auditory stimuli (music and metronome) at different tempi during walking, and b) what are the effects of the entrainment on synchronization and gait pattern.

Methods: The experimental session consisted of two blocks of auditory conditions (music and metronome). Within each block, participants were asked to walk to six conditions of preferred walking speed (PWS), PWS+ 2; 4; 6; 8; 10%. The conditions had a duration of three minutes, and were separated by three minutes of rest. The synchronisation parameters were captured by so-called D-jogger software and the spatio-temporal parameters with portable sensors.

Results: 28 PwMS [age 52.03 \pm 11.2; 21F:7M] and 28 HC [age 52.1 \pm 11.4; 21F:7M] participated. Seven PwMS used a rollator and two had an AFO. Average 6MWT was 452 \pm 132m. Significant differences were found in the music block between group in stability of synchronisation (resultant vector length: 0.69 SE 0.04 and 0.84 SE 0.04) and Cadence (steps/minute: 109 SE 2.3 and 120 SE 2.4) in PwMS and HC respectively. These findings are consistent in the metronome block.

Conclusion: These preliminary results suggest that entrainment and stable synchronisation to both auditory stimuli occurred during walking in PwMS and are consistent with the HC. This applies also at higher tempi. The results demonstrated that music and metronome can be used to provide more intensive walking training.

Submission ID: 118; Submission Group: Rehabilitation interventions; Submitter: Linard Filli

Predicting responsiveness to fampridine (Fampyra®) in gait-impaired people with multiple sclerosis

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Multiple sclerosis (MS) leads to walking impairment in up to 75% of patients. The only approved medical treatment for improving MS-associated walking dysfunction is prolonged-release (PR) fampridine (4-aminopyridine, Fampyra®). Despite significant walking improvements induced by PR-fampridine, a

substantial proportion of patients do not respond to this drug. Potential predictors of responsiveness to PR-fampridine are virtually unknown.

Initial response to PR-fampridine was analyzed in 55 patients with MS using a randomized, placebo-controlled study design (FAMPKIN, clinicaltrials.gov; NCT01576354). Drug efficacy was assessed by changes in the Timed 25-Foot Walk (T25FW), 6-Minute Walk Test (6MWT) and the 12-item MS walking scale (MSWS-12). Potential predictors of patients' responsiveness (age, disease duration, T25FW, 6MWT, physical activity, EDSS score, MS type, gender, concomitant MS therapies) were analyzed by multiple correlation analysis and binary logistic regression. Changes in drug response were monitored in 32 patients over 3 years.

The best single predictor of initial drug response was walking endurance (6MWT) at baseline that was negatively correlated with initial responsiveness to PR-fampridine ($n=55$; $R: -0.541$; $p<0.001$). A logistic regression model including 6MWT and T25FW baseline performances predicted PR-fampridine responders ($n=15$; $\geq 15\%$ improvement in T25FW or 6MWT induced by PR-fampridine) and non-responders ($n=40$) with an accuracy of 85.5%. A distance of 211m in the 6MWT at baseline best separated responders (mostly less than 211m) from non-responding patients. Decline in walking function over 3 years correlated with increased drug responsiveness over the same period ($R=-0.634$; $P=0.001$).

The present results indicate that PR-fampridine is particularly efficient in patients with more severe MS-related walking deficits and that progression of disability might increase drug responsiveness. Knowledge upon valid predictors of responsiveness to PR-fampridine will further optimize the treatment of walking-disabled people with MS and save health care costs by stratifying presumable responders from non-responding patients.

Submission ID: 119; Submission Group: Rehabilitation interventions; Submitter: Gemma Conesa
Efficacy of group transdisciplinary neurorehabilitation treatment in Multiple Sclerosis Progressive

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Background: Across the lifespan, MS will produce multiple deficits that, through its interaction, will produce a complex pattern of progressive disability. For this reason, the handling of this disability in Progressive MS (PMS) in people over 15 years of age is essential. From our center, this type of disability we give answer with group transdisciplinary neurorehabilitation treatment (TNT-G).

Objectives:

- Increase autonomy and encourage independence in Advances Activity Daily Life
- (AADL).
- Improve family and social roles by prolonging functional capacity.
- Improve the life quality (QL).

Methods: Twenty-nine PMS patients, over 15 years of evolution, between 45 and 70 years old with moderate impairment were included.

Initial and final evaluation is done by: Health Questioner short form (SF-36) to assess the QL; to evaluate the disability, we use FIM Functional independence measurement, and Extended Scale of the State of Disability (EDSS) to assess the deficit.

TNT-G is implemented 3 times per week during 6 months, by: occupational therapist, neuropsychologist, logopedist, nursing, physiotherapy and social work and includes:

Prevention: Assessment for the patient and family.

Modification: Act on symptomatology diversity.

Compensatory: Use support and technology products.

Results: Statistically differences were found between the beginning and the end of the treatment. Results show: maintenance in EDSS score (5,89); increase in perception of general health (SF-36): 47,58 vs 51,89; about disability level, an improvement in expression (5.6 vs 6.2) and social interaction (5.1 vs 6.2) was achieved (FIM), although there wasn't significant improvement in overall FIM score: 97,93 vs 98,93.

Conclusions: The neurorehabilitation group therapy offered in our center is effective for MS patients. The expression and social interaction improve, the level of autonomy and AADL increases.

The results of the evaluations pre and post, show there is an improvement, especially in life quality, which is the main objective of treatment neurorehabilitation.

Submission ID: 120; Submission Group: Rehabilitation interventions; Submitter: Cecilie Hyrup Fuglsang
MS Life Logging: How wearables can play a role in MS (disease) management

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Background: There is currently a rapid development in the spread of technology and with the introduction of portable technologies (wearables, pace, pulse and sleep monitors) it has become possible for private individuals to monitor their health through collected data.

People with MS (PwMS) live with a chronic illness, which, throughout their lives, require them to be aware of the state of their health as well as being in continuous contact with the healthcare system. Studies indicate, that the course of illness can be affected by environmental factors and life-style, however, there is currently no research into how wearables may be a tool for PwMS to act upon developments in their illness. Wearables also have the potential to be implemented as patient-reported information in a clinical context and could be a part of targeted treatment for PwMS.

Objective: The aim of this project is to investigate how the daily lives of MS patients may benefit from the development in health-technology and whether wearables can be useful in a clinical context.

Methods: The project focuses on three aspects; 1) the perspective of the patients in regards to their everyday lives with MS, 2) the perspective of the healthcare professional and what is meaningful data to bring into the clinical context, and 3) the validity and research potential of different types of wearables. Each aspect is investigated qualitatively (focus group interviews and individual interviews). The project also includes a trial period where MS patients are equipped with a wearable for two months, with the objective of learning whether the use of wearables is of value to

the individual, whether the output can be used in health care consultations, and finally to assess the validity and research potential of different wearables.

The project has commenced and runs until the autumn of 2018.

Submission ID: 121; Submission Group: Outcome Measures; Submitter: Andrea Tacchino

Long term motor-cognitive monitoring in MS

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The overall approach of treating neurodegenerative chronic diseases such as MS is changing, promoting a new management of the care pathways in which unobtrusive monitoring programme through an m-health intervention could supplement traditional therapeutic programmes. In particular, there is a growing interest in using smartphone sensing to infer human dynamics and behavioural health. Several studies pointed out correlation between self-reported activity and phone usage and self-reported mood. A further step is to use phone sensors data to depict a user's profile and check meaningful variations.

To pursue this goal, a devoted Android app collecting social and motion features extracted from personal smartphone registers (Call Logs, Apps Usage -social e communication apps-, Screen Brightness, GPS and accelerometer) has been installed on the personal smartphone of 15 users for 1 month acquiring data 24hours/7days. Data are acquired in background without interfering with the normal phone usage and without requiring user intervention. Data are transmitted wireless to a remote server, processed every 24h to extract selected features saved anonymously in a database. Anomaly detection algorithms have been implemented to identify changes in the daily trend or unexpected events in data sets. Unlike standard classification tasks, anomaly detection is often applied to unlabelled data such as those at our disposal, considering only the internal structure of the data set.

Results showed a good predisposition to the system and reliability in detecting smartphone use and the distribution of activity along the day. Moreover, as expected, generally people spent most of the time in few places: usually two (home and work).

In conclusion, the first step of the study (the user test phase) seems to show the minimal requirement for a more extensive feasibility study of the device.

Submission ID: 122; Submission Group: Describing and understanding functioning; Submitter: Jiri Motyl
Influence of sleep duration on cognitive assessment

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Background: Research of relationship between sleep disorders and cognition in people with multiple sclerosis (MS)

flourished in the last years. No relation between subjective sleep disturbance and objective cognitive functioning in MS was found. Subjective sleep disturbance seems to be related to subjective cognitive dysfunction, moderated by fatigue and depression. Contrary, objective sleep disturbance relates to objective cognitive dysfunction.

Objective: To analyse the relation between measured cognitive functioning and the self-reported duration of sleep the night before.

Methods: We examined 265 patients (70.6% females, mean age: 44.4±7.3, median EDSS: 2.5, median years of education: 14) after the first demyelinating event suggestive of MS or with clinically definitive MS (from the original ASA and SET studies) who underwent neuropsychological assessment (BICAMS, MSFC, BDI-II, FSS, MSNQ). Patients were asked about sleep duration in the night before the assessment.

Results: Of the total 265 patients, 196 (73%) reported sleep duration in the night before the assessment (M=6.5 hours, SD=1.6), 20 patients (10.2%) were evaluated as having significantly shorter sleep (4.1 and less hours, 1.5 SD below the mean). No relationship between objective cognitive functioning and sleep duration the night before the assessment was found. People with extremely shorter sleep duration did not differ in objective cognitive functioning.

Weak relationship between reported sleep duration and fatigue (FSS: $r=-0.123$, $p<0.05$, $1-\beta=0.51$) and depression (BDI-II: $r=-0.137$, $p<0.05$, $1-\beta=0.58$) was found. Statistical power analysis revealed low power of these results.

Conclusions: In our large MS cohort we have found no influence of current sleep duration on assessed objective cognitive performance. Our analysis tends to support results of relationship between sleep quality, depression and fatigue. The more precise combined measure of sleep duration, sleep quality and longer sleep pattern is yet to be analysed in our MS cohort.

Submission ID: 123; Submission Group: Describing and understanding functioning; Submitter: Anne Sophie Michelsen

Lower limb isometric and dynamic muscle strength in older adults with and without multiple sclerosis – implications for physical function

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Introduction: Lower limb muscle strength is reduced in young/middle-aged adults with multiple sclerosis (MS) versus healthy controls (HC), and in old HC versus young HC. This reduction is particularly evident during high-velocity dynamic contractions. As lower limb muscle strength is a cornerstone in retaining physical function, the combination of MS and aging - which is largely unknown - may likely have debilitating consequences. The purpose of the present study is to examine lower limb muscle strength and physical function in older MS and HC.

Materials and Methods: Cross-sectional study design: Older MS (n=9 (n=5 women), age 65±5 yrs, EDSS 3.4±1.7) vs Older HC (n=9 (n=8 women), age 70±6 yrs). Knee extensor (KE) and

plantar flexor (PF) muscle strength were assessed at 0, 180, and 300 deg/s using an isokinetic dynamometer. Physical function was evaluated by timed 25-ft walk test (25FT), 5x sit-to-stand (5STS), and 9-step stair ascend (9SA).

Results: Lower PF muscle strength were observed in MS vs HC at 180 deg/s (0.36 ± 0.09 vs 0.55 ± 0.15 Nm/kg, -23%, $p < 0.05$) and 300 deg/s (0.32 ± 0.06 vs 0.40 ± 0.13 Nm/kg, -20%, $p < 0.05$). In contrast, no differences were observed between MS and HC in PF muscle strength at 0 deg/s (0.87 ± 0.27 vs 1.08 ± 0.31 Nm/kg, -19%), or in KE muscle strength at 0 deg/s (1.46 ± 0.55 vs 1.66 ± 0.26 Nm/kg, -12%), 180 deg/s (0.64 ± 0.23 vs 0.77 ± 0.11 Nm/kg, -17%), or 300 deg/s (0.48 ± 0.11 vs 0.54 ± 0.09 Nm/kg, -11%). 25FT, 5STS, and 9SA differed between MS and HC (+18%, +28%, and +41%, respectively, $p < 0.05$). Overall, only muscle strength at 180 and 300 deg/s correlated to measures of physical function (PF: $r = 0.50-0.68$; KE: $r = 0.47-0.59$; $p < 0.05$).

Conclusion: PF – but not KE – dynamic muscle strength was lower in MS vs HC. As muscle strength at higher dynamic contraction velocities are more strongly related to physical function, it may be an area to target in rehabilitation.

Submission ID: 125; Submission Group: Describing and understanding functioning; Submitter: Yonca Zenginler
Body Composition, Muscle Strength and Physical Activity Level in Multiple Sclerosis and Healthy Population: A pilot study

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Background: Multiple sclerosis (MS) leads to muscle weakness, coordination, and balance problems, as well as gradual limitation of functioning. All these disability conditions lead further to immobilization associated with profound changes in body composition and muscle weakness. The aim of this study was to compare the body composition, upper and lower extremity muscle strength and physical activity in patients with MS and healthy controls.

Methods: Ten MS patients (mean age: 37.4 ± 10.96 , female:8, male:2) and twelve age-matched healthy adults (mean age: 42.08 ± 9.45 , female:9, male:3) were included to the study. Body fat ratio (%), body muscle ratio (%) and Body Mass Index (BMI) were measured with bioelectrical impedance (Omron® BF-510). Quadriceps muscle strength was measured with J-tech Commander dynamometer and hand grip strength was measured with Jamar dynamometer. Each test was performed three times and best value was noted. Physical activity level was evaluated with International Physical Activity Questionnaire-Short Form (IPAQ-sf).

Results: Outcome measures of the subjects are presented in Table 1. Body fat and visceral fat were found higher in both MS and healthy group compared with normative values. None of the participants were reported vigorous physical activity (>3000 MET/week). Right, and left quadriceps muscle strength and hand grip strength were found lower in MS group compared with control group. There was no significant difference in BMI, body fat, body muscle, visceral fat and physical activity level between MS and control group

Conclusion: The results of this pilot study showed that body composition is negatively changed and participation in physical activity decreased in both MS and healthy people. Body fat has been identified as a significant predictor of mortality and shows nutritional and health-living status. For this reason, it is important to measure the body composition and physical activity level in the evaluation of MS patients.

Table 1. Outcomes measurements for multiple sclerosis and healthy controls.

	Multiple Sclerosis N=10	Healthy Control N=12	P value
BMI (kg/cm ²)	27.4±4.97	26.38±5.19	0.644
Body fat ratio (%)	38.12±6.64	32.6±9.85	0.147
Body muscle ratio (%)	26.8±3.1	29.8±4.82	0.129
Visceral fat (kg)	7.4±3.3	7.25±3.1	0.739
Right Quadriceps Strength (Kg/Newton)	11.1±2.9	25±5.33	<0.0001
Left Quadriceps Strength (Kg/Newton)	10.86±3.23	25.6±5.89	<0.0001
Hand Grip Strength (Pound)	30.55±7.3	70.30±17.02	<0.0001
(IPAQ-sf) (MET/week)	1018.2±828.35	618.91±675.65	0.113

Submission ID: 126; Submission Group: Describing and understanding functioning; Submitter: Douglas Wajda
The Relationship Vitamin D and Risk for Falls in Multiple Sclerosis

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Background: Falls and concerns with balance are significant issues in people with MS. Recently, an increasing amount of

research has been conducted to determine the links between vitamin D and outcomes related to mobility in multiple populations. Vitamin D plays many vital roles in the body and has been linked to poorer physical performance in healthy individuals. Based on the ease of supplementing vitamin D, and the common practice of doing so in individuals with MS, it is reasonable to assume that vitamin D is a worthwhile modifiable outcome to explore in relation to fall risk in MS.

Objective: This study aimed to determine whether vitamin D levels were related to fall risk and falls in MS.

Participants and Methods: Eighteen individuals, between the ages of 30 and 75, with MS were included in the research study. Participants underwent a blood draw and completed the Physiological Profile Assessment (PPA). 25(OH)D was assessed by ELISA following a blood draw. The PPA is a measure of physiological function and provides a predictive score for future fall risk based on five physiological factors commonly related to falls.

Results: The average 25(OH)D level was 44.36ng/ml (\pm 26.89ng/ml). The fall risk assessment (PPA) had a mean total score was 2.16 (\pm 1.75). No correlations were observed between vitamin D levels and PPA score. A secondary analysis examining fallers v. non-fallers showed a trend for lower levels of vitamin D in fallers.

Conclusion: Individuals with lower serum 25(OH)D levels showed to be at a higher risk for falls when compared to those with higher concentrations of 25 (OH)D based on fall history. The results of this pilot study show that vitamin D plays a potential role in falls in MS and these outcomes would be advantageous to explore further in future investigations.

Submission ID: 127; Submission Group: Describing and understanding functioning; Submitter: Rita Bertoni
Modified Functional Walking Categories and walking aid: which is the best predictor of participation restrictions in People with Multiple Sclerosis?

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Introduction: Gait velocity influences the ability of a person to move in different outdoor or indoor contexts and has accordingly been classified through the Modified Functional Walking Categories (MFWC).¹ At present no studies have examined the relationship between community ambulation classified through the MFWC, the use of walking aid and a measure of participation in People with Multiple Sclerosis (PwMS).

Method: 149 PwMS attending a rehabilitation center were evaluated. Gait velocity was assessed with 10 Meter Walking Test and community ambulation was classified with the MFWC; usual walking aid was registered at the time of clinical evaluation. Participation was measured with the Community Integration Questionnaire (CIQ). Statistically significant univariate demographic and clinical variables associated with CIQ total score were entered in a multivariate logistic model to assess the multiple relationships.

Results: Participation restrictions were more frequent in Limited Household Walkers (72.3%) and in Non Ambulant PwMS (93.7%). PwMS with a secondary progressive type of

disease, longer disease duration and using walking aids tended to be classified in these categories. At preliminary analysis MFWC and walking aid resulted as univariate predictors of participation restrictions. Multivariate analysis on total CIQ score revealed that the use of a walking aid (OR=2.65), being male (OR=2.94) and older (OR=1.06) increased the likelihood of having participation restrictions. The same variables predicted home and social participation, while only age influenced productive participation.

Conclusion: Gait velocity classified as MFWC and walking aid both influence participation. Walking aid seems to play a bigger role in predicting general, home and social participation restrictions in PwMS while other unknown factors seem to be involved in productive participation.

Submission ID: 128; Submission Group: Outcome Measures; Submitter: Renee Veldkamp
Test-retest reliability of motor and cognitive dual task cost in Multiple Sclerosis during various tasks

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Background: Simultaneous performance of motor and cognitive tasks can lead to worse performance on one or both tasks, indicating cognitive motor interference (CMI). Previously, diverse dual-tasks have been used. However, psychometric properties were scarcely reported, making it not yet suitable as experimental outcome.

Objective: To investigate the between-day reliability of the motor and cognitive dual-task costs (DTC) during diverse CMI test conditions in persons with MS (pwMS) and age-gender matched healthy controls (HC).

Methods: Thirty three pwMS (EDSS 2.94 \pm 0.8) and 31 HC were tested and retested on 3 single cognitive, 4 single motor and 12 cognitive-motor dual-tasks. Cognitive tasks were counting backwards by seven, titrated digit span backwards and auditory vigilance. Motor tasks were walking at self-selected speed, walking over obstacles, walking crisscross and walking 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) with a two-way random effect with absolute agreement (ICC_{2,1}) and Spearman correlation coefficients were calculated for normally and non-normally distributed data, respectively.

Preliminary results: DTC values ranged from 3.7% to 16.8% for walking speed and from -5.0% to 17.2% for amount of correct answers. Reliability depended on the test condition, thus on type of motor and cognitive task used. For DTC_{motor}, ICCs ranged from 0.25 to 0.82 and spearman correlations from 0.7 to 0.9. For DTC_{cogn}, spearman correlations ranged from 0.02 to 0.59. The most reliable dual-task conditions were 'subtraction obstacles' and 'digitspan walk'. There were no clear and systematic differences in reliability between pwMS and HC.

Conclusion: In general, reliability of the DTC_{motor} (ranging from moderate to excellent) was good, while that of the DTC_{cogn} was

only weak to moderate. The difference may be related to the larger range of variability in DTC_{cogn} compared to DTC_{motor} and needs further investigation.

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Functional capacity and basic motor skills in patients with multiple sclerosis and its relation to the anthropometrical status and body composition parameters

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Background: Patients with multiple sclerosis (MS) have many potential factors (spasticity, immobilization, glucocorticoids use) which can deteriorate the anthropometrical status and body composition.

Aim: To assess the functional capacity and basic motor skills in patients with MS and to correlate them with disability and anthropometrical status and body composition parameters.

Methods: Timed Up and Go Test (TUG), and six-minute walk test (6MWT) were performed in 33 patients with MS before and after 4 weeks of physiotherapy. Body mass index (BMI), waist to height ratio (W/HtR), and waist-to-hip ratio (WHR) were assessed in this group. Body composition was evaluated by bioelectrical impedance analysis (BIA) and fat mass (FAT), fat free mass (FFM) and predicted muscle mass (PMM) were expressed as percentage of body mass.

Results: After physiotherapy, there was a significant improvement in functional capacity assessed by TUG in either distance ($p < 0.01$) and Borg's scale ($p < 0.05$). Basic motor skills (assessed by 6MWT) also significantly improved ($p < 0.001$). Positive significant correlations were found between the results obtained in both tests (either before and after physiotherapy) vs. FFM and PMM, whilst worse results in functional capacity and basic motor skills correlated significantly with W/HtR, and FAT ($p < 0.05$). Clinical status (EDSS) were significantly related to the body composition parameters with the same manner as the results in the TUG and 6MWT.

Conclusions: Functional capacity and basic motor skills may be significantly improved during the physiotherapy, but they are related to the anthropometrical status and body composition of MS patients. Moreover, disability status is also significantly related to this parameters. Body composition deterioration seems to be the important target for the therapeutic intervention in MS patients.