

Abstracts from the RIMS 2009 Conference

Research Challenges in Multiple Sclerosis Rehabilitation

Platforms

(P01) "Not Only for Children": Effect of New Virtual Reality Games on Balance in Multiple Sclerosis Patients

Background: Abnormalities in balance control are common in patients with multiple sclerosis (MS) and are associated with an increased risk of falls. Impairments in visual, somatosensory, and/or vestibular input can further contribute to instability. The new generation of wireless computer games could offer innovative rehabilitation tools to improve balance and stability in MS patients. **Objective:** The objective of this study was to determine the effect of the use of new-generation computer games, specifically the Nintendo Wii (Nintendo, Kyoto, Japan), on balance parameters in patients with MS. **Methods:** MS patients followed at the MS Center, Sheba Medical Center, Tel Hashomer, Israel, were assessed during a single session. Inclusion criteria were clinically definite MS, Expanded Disability Status Scale (EDSS) score ≤ 5.0 , and no significant cognitive impairment. Following playing guidelines, each subject completed the training mode for tennis (Wii sports computer game) while standing. Each game session lasted 15 min with a 1-min rest break every 5 min. Balance was evaluated using the Functional Reach Test (FRT) and the Four Square Step Test (FSST) before and after the game session. Data were analyzed using a paired *t* test, and the level of statistical significance was set at $P < .05$. **Results:** Study participants were 32 MS patients, 19 females and 13 males, with a mean age of 43.6 ± 10.6 years, a mean disease duration of 6.9 ± 4.7 years, and a mean EDSS score of 3.1 ± 0.9 ; all patients had mild pyramidal and cerebellar involvement. Compared with baseline, significant improvements were observed for both balance tests after the training session. The results for the FRT in centimeters increased from 30.3 ± 4.6 to 32.9 ± 5.03 ($P = .03$), indicating a 9.1% improvement. The results for the FSST in seconds decreased from 10.3 ± 3.6 to 8.7 ± 2.6 ($P = .04$), representing a 17.5% improvement. **Conclusion:** Active virtual reality games have an immediate beneficial effect on balance performance after a single practice session. This improvement could be related to simultaneous auditory and visual feedback that reinforces multisensory integration and leads to better motor stabilization of balance. The use of new-generation computer games as rehabilitation tools for patients with MS is recommended.

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(P02) Effect of Visuoproprioceptive Training on Risk of Falls in Multiple Sclerosis

Background: Lack of balance is among the most disabling symptoms of multiple sclerosis (MS), affecting about

three-quarters of patients over the course of the disease. Imbalance predisposes to loss of equilibrium and consequently to falls. **Objective:** The objective of this study was to investigate the effectiveness of a novel visuoproprioceptive feedback training program in improving balance and reducing the risk of falls in people with MS. **Methods:** MS patients with unrestricted walking ability and healthy age- and sex-matched controls were recruited for this pilot study. To allow assessment of postural strategy, each subject performed a test in bipedal and monopodal stance using a computerized postural recording device (Delos Postural Proprioceptive System; Delos, Turin, Italy). In order to avoid any bias due to physiological performance variability, both groups underwent a baseline postural assessment (T0) followed by a run-in period lasting 6 weeks without any rehabilitative intervention (for MS patients) or specific training (for healthy volunteers). Then, two additional assessments before (T1) and at the end (T2) of the training period were performed. The training protocol consisted of 12 sessions (twice per week), each lasting 45 min. MS and healthy subjects performed static and dynamic exercises in both bipedal and monopodal stance, with and without a translating Freeman-like board. During the exercises, a visual trace and a visual feedback (posturogram) were shown on the computer screen. Patients underwent neurologic examination (Expanded Disability Status Scale [EDSS] and Multiple Sclerosis Functional Composite [MSFC] score); the Fatigue Severity Scale (FSS) and the Dizziness Handicap Inventory (DHI) were also administered. **Results:** We recruited 40 consecutive patients and 10 healthy volunteers. Twenty-eight MS patients (16 females, 12 males) satisfied the inclusion criteria and completed all the planned training sessions. Between the T0 and T1 assessments, no significant changes in risk of falls were observed in the two groups. After the training period, healthy volunteers had an improvement in the monopodal test in the closed-eyes condition alone ($P = .008$ by Wilcoxon test). The MS group had a significant reduction in risk of falls in bipedal stance and the closed-eyes condition (mean [range], 4.6% [0–69.0%] vs. 0% [0–37.0%]; $P = .001$ by Wilcoxon test), as well as in monopodal stance in both the open-eyes (42.8% [0–92.3%] vs. 15.7% [0–66.3%], $P < .001$) and closed-eyes (69.6% [41.9–95.0%] vs. 52.6% [11.0–95.3%], $P < .001$) conditions. Improvements in walking ability, as measured by the 25-Foot Timed Walk test (7.5 [4.6–13.7] vs. 6.3 [4.6–12.8] seconds, $P = .001$), and in DHI score (34 [16–86] vs. 30 [0–66], $P = .05$) were observed. No changes in EDSS and FSS scores were observed. **Conclusion:** Visuoproprioceptive training is effective in improving balance disorders due to MS, significantly reducing the risk of falls. The visual input may stimulate proprioceptive flows at high frequency in order to reprogram postural control. The duration of beneficial effect as well as the exact mechanisms underlying clinical improvement need further evaluation.

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(P03) Robot-Assisted Rehabilitation of the Upper Limb in People with Multiple Sclerosis: A Usability and Intervention Study

Background: Training duration and training intensity are considered to be key factors for successful neurologic rehabilitation in multiple sclerosis (MS). Rehabilitation robotics show promise in augmenting repetitive exercise training. Neither the optimal training modality nor the effects on upper-limb function in patients with MS are known yet. Appropriate movement tasks and tests for the haptic PHANTOM end-effector robot were designed in a virtual environment, focusing on accuracy, object manipulation, and speed. **Objectives:** The objectives of the study were 1) to assess the clinical applicability of the robotic system in MS patients with arm and hand dysfunction; and 2) to evaluate the effects of robot-assisted training on upper-limb motor control and function. **Methods:** A usability study and a randomized clinical crossover trial were performed. First, user feedback was collected from MS patients ($n = 20$) completing the System Usability Scale and Visual Analogue Scales on the feasibility of using the PHANTOM and designed movement tasks. Second, MS patients with arm and hand dysfunction due to muscle weakness received robotic therapy for 4 weeks (30 min, 3 d/wk) in addition to their conventional therapy, with no additional therapy received during another 4 weeks (control period); the order was chosen at random. The outcome measures were as follows: 1) virtual (robot) movement tests to quantify motor control; 2) the Motricity Index, Jamar, and MicroFET handheld dynamometer to evaluate muscle strength; and 3) the Nine-Hole Peg Test, Purdue Pegboard, ARAt, and TEMPAs to assess upper-limb function. **Results:** Users provided very positive feedback. At baseline, there was no clear association between recorded robotic parameters (eg, total time needed to accomplish a test) and upper-limb muscle strength ($r = -0.02$ to -0.58) or function ($r = -0.01$ to -0.69). After the intervention period, MS patients generally performed better on the robotic tests ($P \leq .05$). The latter did not result in a significant improvement in arm strength or function, except for hand-grip force as measured with the Jamar ($P = .01$). **Conclusion:** The 4-week robot-assisted training program with the PHANTOM had only limited positive results. However, in the present study additional robotic therapy time was limited (6 hours), while an end-effector robot was used without measurements of the quality of movement. A similar study with another robotic device (the ARMEO) and a more intensive training protocol is now being prepared.

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(P04) Preliminary Results of Robot-Based Rehabilitation of Upper Limbs in Multiple Sclerosis

Background: Alteration of upper-limb motor coordination is one of the most disabling consequences of multiple sclerosis (MS), as it significantly affects the performance of many activities of daily living (ADLs) during the progression of the disease. At present, no motor rehabilitation methods have

been proven to be effective in reducing ataxic symptoms of the upper limb. **Objective:** The goal of this pilot study was to conduct a preliminary evaluation of the feasibility of a rehabilitation protocol, based on robot therapy, for the improvement of upper-limb motor coordination in a group of MS patients. **Methods:** Seven subjects with MS (four females and three males, mean age 46.0 ± 11.8 years) went through a training protocol of eight sessions. In each training session, patients were required to grasp the handle of a robot (Braccio di Ferro) and perform center-out reaching movements starting from the same central position toward virtual targets presented on a screen in two directions (45° and 135° with respect to the horizontal axis, respectively). During the movements, the robot generated a position-dependent resistive force and a velocity-dependent disturbing force perpendicular to the instantaneous movement direction of the handle. Each subject was evaluated before and after the treatment by means of 1) the clinical tests Nine-Hole Peg Test and Tremor Severity Scale, 2) quantitative parameters extracted from the reaching trajectories during the robot-therapy sessions, and 3) a transfer test consisting of tracking an 8-shaped figure by moving the robot handle. **Results:** After the eight-session treatment, all patients demonstrated significant improvements in the velocity, linearity, and smoothness of their reaching movements. This amelioration was also present in other kinds of movement, not executed during the sessions, as indicated by the results of the transfer test, which revealed a reduction of the duration and an increase in the smoothness of the tracking movement after the training. Results on the Nine-Hole Peg Test showed a clinically relevant improvement in the treated arm of four out of seven patients, suggesting a transfer of the therapy effect to tasks more related to ADLs. **Conclusion:** The preliminary results of this pilot study suggest that robot therapy can be applied to MS patients in a clinical setting and could be beneficial for the reduction of the upper-limb motor-coordination deficit. After the evaluation of these seven patients, we have modified the robot handle to allow the movement of the hand. Moreover, we have designed a more functional training protocol that includes not only reaching tasks but also the manipulation and the movements of real objects. Our main goal will be to compare the effect of the functional training protocol with those obtained with the program consisting of reaching virtual targets. At present, the first subject has completed the functional training program.

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(P05) Efficacy of Robot-Assisted Gait Training in Patients with Multiple Sclerosis: A Randomized Controlled Study

Background: Difficulty in walking is a major feature of multiple sclerosis (MS), and mobility is the activity of daily living on which patients place the most value. A promising intervention to help improve gait function is task-repetitive gait training. **Objective:** This prospective, blinded, randomized controlled study of gait retraining tested the poten-

tial efficacy of using a robot-assisted gait trainer (Lokomat; Hocoma, Zurich, Switzerland) for treadmill training in a group of stable MS patients during an inpatient rehabilitation stay and to evaluate the persistence or decline of the gains in mobility after a 9-month follow-up period. **Methods:** Fifty-eight patients (mean Expanded Disability Status Scale [EDSS] score, 5.8 ± 1.1) were randomized to receive either nine sessions of robot-assisted gait training (RAGT) or the same amount of conventional walking training (CWT) over a 3-week period. Twenty-five patients from the RAGT group and 24 patients from the CWT group completed the study. All patients also participated in a multimodal rehabilitation program. Besides mobility measures such as the Rivermead Mobility Index (RMI), the maximum walking distance over 3 min, and the timed 10-m walk, other relevant features such as balance (Berg Balance Score), fatigue (Würzburger Erschöpfungsinventar), spasticity (Modified Ashworth Score), and well-being (visual analogue scale [VAS]) were also measured. In addition, we recorded the locomotor activity with an actigraph 1 week before the rehabilitation stay and 2 and 9 months later. **Results:** After 3 weeks, all patients in both treatment groups had improved significantly on all measures, but no overall differences between the two treatment options were observed. The more severely handicapped patients (walking speed <0.66 m/s) experienced a significantly greater improvement in mobility as measured with the RMI in the RAGT group than in the CWT group ($P < .05$); however, there was a trend for those in the CWT group to increase their walking speed more than those in the RAGT group. **Conclusion:** RAGT seems to have the potential to increase general mobility as assessed with the RMI in MS patients with severe walking disabilities. However, an increase in walking speed will probably be more easily obtained with a traditional walking training program. After 9 months, mobility as measured with an actigraph declines independently of the walking training method chosen.

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(P06) Efficacy of Attentional Verbal-Auditory Rehabilitative Training in Multiple Sclerosis Patients: A Randomized Controlled Clinical Trial

Background: Cognitive impairment is frequent in multiple sclerosis (MS), occurring in 40% to 70% of patients. It can occur early in the disease course and is sometimes the first symptom to appear. The potential negative impact of cognitive impairment makes early detection important. Recent studies have shown that selective training for specific attentional impairments is useful. **Objective:** The objective of this study was to evaluate the efficacy of a specific hierarchical verbal-auditory training method compared with a non-hierarchical attentive training method and assess the impact of the two treatments on learning ability in MS patients. **Methods:** Sixty-four MS outpatients with cognitive disturbances evidenced by the Brief Repeatable Battery of Neuropsychological Tests (performance 1–2 SD below the mean in at least two of the tests) were selected according to the following criteria: clinically definite MS, stable phase of the disease for 3 months before inclusion, and nonsteroidal

treatment in the 4 weeks before inclusion. Patients with visual deficits, severe motor disorders (Expanded Disability Status Scale [EDSS] score >7), severe depression (Beck Depression Inventory [BDI] score >19) or other psychiatric history, and drug abuse were excluded from the study. Twenty participants were enrolled in the study and were randomly assigned to either the experimental or the control group. All participants underwent neuropsychological assessment consisting of attention and memory tests at baseline and after 5 and 10 weeks. Both groups received eight training sessions, each lasting 40 min, over 4 weeks. During these sessions, the experimental group was treated with an auditory attentional program based on hierarchy and modularity concepts of attention (sustained, selective, divided, and alternate attention). The control group received a nonhierarchical and nonmodular auditory attentional program, with randomized exercises on different attentional components. **Results:** Significant improvements on all tests immediately after treatment and at follow-up were observed in the experimental group. Attentional abilities of the experimental group immediately after treatment were better than in the control group, with the difference approaching statistical significance. During follow-up, neither group maintained the attentional improvement. Thus memory deficits improved significantly immediately after training in both groups but not over time. **Conclusion:** Hierarchical verbal-auditory training for neuropsychological deficits may be a viable way of improving learning in MS patients immediately after treatment. Both types of training programs are beneficial for MS patients with cognitive impairment. Improvement of attentional difficulties contributes to the storage and encoding of new information that occur in the learning process of MS patients.

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(P07) Influence of Resistance Training on Muscle Morphology in Inpatients with Multiple Sclerosis

Background: Muscle strength of the lower extremity is reduced in patients with multiple sclerosis (MS). The mechanisms underlying the observed strength deficit are probably of both morphological (peripheral) and neural (central) origin. Regarding morphological mechanisms, Kent-Braun et al.¹ showed a 30% reduction in the fat-free cross-sectional area of the anterior compartment of the lower leg in MS patients as compared with healthy subjects, indicating loss of muscle mass. Furthermore, at the muscle fiber level, histochemical analysis of biopsies from the tibialis anterior showed a reduction in the muscle fiber area (average, 26%) in MS patients compared with healthy subjects. This finding was supported by Garner and Widrick.² Muscle fiber type composition has also been shown to differ in MS patients compared with healthy controls. Kent-Braun et al.¹ reported a shift from type I fibers toward a greater proportion of types IIa and IIax fibers. This shift resembles the pattern seen in immobilized healthy subjects.³ It is known that resistance training can improve the muscle fiber area and affect the fiber type composition in healthy subjects.⁴ However, no studies have examined the effects of resistance training on muscle fiber area and composition in patients with MS

undergoing resistance training. **Objective:** The objective of this study was to determine the effects of progressive resistance training (PRT) of the lower body on muscle fiber area and fiber type composition in the vastus lateralis in patients with relapsing-remitting MS. **Methods:** A two-arm, 12-week randomized controlled trial including a follow-up period of 12 weeks was conducted. Thirty-eight MS patients (Expanded Disability Status Scale Score [EDSS], 3–5.5) were randomized to a PRT group (n = 19) or a control group (n = 19). The patients in the exercise group completed a biweekly 12-week lower-body PRT program and were encouraged to continue training on their own after the program. The control group continued their usual daily activities during the trial period. After the trial, the control group completed the PRT intervention. Both groups were tested before and after the 12-week trial and at 24 weeks, with muscle biopsies from the vastus lateralis. **Results:** Histochemical analysis of the muscle biopsies is under way, and the results will be presented at the conference. **Conclusion:** It is important to test the hypothesis that appropriate exercise can reverse muscular impairments seen in patients with neurodegenerative and inflammatory diseases. MS patients engaged in intense PRT have been shown to gain muscle strength and functional capacity. Studies such as this one that apply a mechanistic approach are needed to better understand these adaptations.

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(P08) Prevalence of Dysphagia in Multiple Sclerosis: An Italian Multicenter Study

Background: Dysphagia is a very disabling symptom in patients with multiple sclerosis (MS) and has been reported to affect 30% to 40% of this population. **Objective:** The aim of this study was to evaluate the frequency of dysphagia in MS patients using a previously validated questionnaire (DYMUS) in a multicenter study. **Methods:** Thirteen Italian centers participated in the study. Consecutive patients were enrolled, and a previously validated and published ad hoc questionnaire, DYMUS (10 items), was administered. Clinical and demographic data were gathered during the

same session. The questionnaire was administered to all consecutive patients during a 3-month period. **Results:** The study enrolled 1813 patients: 1240 females and 573 males. The mean Expanded Disability Status Scale (EDSS) score was 3.5 (SD 2.3), the mean age was 43.5 (SD 11.6) years, and the mean disease duration was 9.8 years. Regarding disease type, 71.2% of patients had relapsing-remitting, 22.2% had secondary progressive, and 6.6% had primary progressive MS. The frequency of dysphagia was 31.3%. Compared with the no-dysphagia group, patients in the dysphagia group were significantly older (mean age, 46 vs. 42 years), had higher EDSS scores (mean score, 4.5 vs. 2.7), and had longer disease durations (mean, 13.8 vs. 11 years). Moreover, the dysphagia group included a significantly higher proportion of subjects with secondary progressive and primary progressive MS than the no-dysphagia group. No significant difference in gender composition of the two groups was observed. **Conclusion:** This is the largest study performed to date in this field. The DYMUS questionnaire seems to be very useful in the clinical evaluation of MS patients and emphasizes the relevance of dysphagia in the clinical history of the disease.

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(P09) Educational Program as Decision Aid to Enhance Informed Choice in Multiple Sclerosis Immunotherapy

Background: Immunotherapy has beneficial effects on relapse rates and disease progression in relapsing multiple sclerosis (MS). However, its effectiveness is limited, and it is associated with considerable side effects and costs. In a former project, we developed two decision aids for patients with MS based on the principles of evidence-based patient information. The decision aids were evaluated within randomized controlled trials. The first decision aid on immunotherapy consisted of a comprehensive information brochure including an interactive worksheet. Although the decision aid led to more critical evaluation of immunotherapy, it did not affect decision autonomy or immunotherapy decisions. In contrast, the second decision aid, an educational program on relapse management, significantly increased decision autonomy, altered decisions regarding steroid therapy, and reduced physician contacts. **Objective:** The objective of this project was to develop and pretest an educational program on immunotherapy to complement the updated and expanded information brochure on immunotherapy. **Methods:** Based on a systematic literature review, an updated 120-page brochure has been developed. Five focus groups of MS patients were developed to discuss relevant issues and pretest crucial parts of the educational program. The program was then pretested and subsequently adapted in three different patient groups in rehabilitation settings. Comprehension, feasibility, and psychological effects of the program were assessed. **Results:** The final educational program consists of three parts. The first part, a 2-hour group session, primarily focuses on the relevance and the critical appraisal of studies on the efficacy of immunotherapies. Important concepts of evidence-based medicine are presented and discussed. Also, the principal outline of the brochure

is presented. In the second part, participants have 2 weeks to work through the brochure and the worksheet. The final part is a 4-hour group session including group work and participants' presentations and discussions to further understand the information given in the brochure and to recognize relevant issues of the individual decision processes. Also, patient-physician discussion of immunotherapy is addressed using role playing. Preliminary results of the pretests show that the program is feasible and that participants are able to understand the complex information without experiencing negative psychological side effects. **Conclusion:** Initial results of the focus group studies will be available soon. A randomized controlled trial to evaluate the program's efficacy will begin in the summer of 2009.

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(P10) Effects on Disability of Inpatient versus Outpatient Rehabilitation for People with Multiple Sclerosis: A Randomized Study

Introduction: In recent years, interest has grown in neurorehabilitation for people affected by multiple sclerosis (MS). It has been clearly demonstrated that neurorehabilitation can reduce disability and improve quality of life in MS. Rehabilitation settings include home-based, hospital inpatient, hospital outpatient, and ambulatory-based services. The aim of this study was to compare the effects of two different neurorehabilitation settings, inpatient and outpatient, on disability in MS patients. **Methods:** A randomized controlled trial was conducted involving patients with progressive and relapsing MS who were referred to the Multiple Sclerosis Center of Catania University, Italy. We selected 90 patients, but the randomization was carried out for only 72 patients, because 8 did not join the study, 6 refused the hospital setting, and 4 had concomitant diseases. Of the 72 patients, 24 were randomly assigned to the inpatient treatment group (Group A), 24 to the outpatient treatment group (Group B), and 24 to the control group (Group C). The three groups were well matched for age, disease duration, and severity of disability, as measured by the Expanded Disability Status Scale (EDSS) and the Functional Independence Measure (FIM). Patients in Groups A and B were treated for 6 consecutive weeks, 5 days a week. Patients in Group A were treated twice a day, in the morning and in the afternoon; patients in Group B were treated once a day, in the morning. Patients in Group C did not receive rehabilitative therapy and were placed on the waiting list. All therapists were previously trained in order to administer homogeneous treatment. Each rehabilitative program was tailored to the individual on a multidisciplinary basis. The rehabilitative plan was created before starting treatment with specific ad hoc meetings including the patient, neurologist, physiatrist, physical therapist, speech therapist, occupational therapist, and psychologist. All patients were evaluated at enrollment (T0) and at discharge after 6 weeks (T1). FIM variation was used as an outcome measure. All statistical analyses were performed using the Wilcoxon signed rank test. In addition, patients were asked for their assessment of the effects of

treatment (subjective improvement vs. no improvement). **Results:** In the two treatment groups, the mean \pm SD total FIM score increased from 91.0 ± 10.3 to 98.3 ± 15.5 in Group A ($P = .01$) and from 89.8 ± 20.9 to 98.7 ± 17.4 in Group B ($P < .0001$). In Group C, total FIM score was virtually unchanged (from 90.8 ± 14.9 to 90.7 ± 14.9). The score for the subitem self-care increased significantly in both Group A (27.0 ± 4.8 to 30.7 ± 6.1 ; $P = .0004$) and Group B (28.2 ± 9.2 to 31.8 ± 7.8 ; $P < .0001$). The score for the subitem mobility increased from 12.0 ± 3.7 to 14.6 ± 4.0 in Group A ($P = .0006$) and from 12.4 ± 5.9 to 15.4 ± 4.4 ($P = .0003$) in Group B. Moreover, in both treatment groups, each patient attributed his or her own subjective improvement to the rehabilitative treatment. **Conclusion:** Both inpatient and outpatient neurorehabilitation had a positive impact on disability in MS patients. Benefits were observed in activities of daily living such as self-care and mobility. Despite the greater amount of rehabilitative therapy in the inpatient setting, no statistically significant differences were found between outpatients and inpatients in terms of functional independence.

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(P11) Responsiveness of Physical Functioning Measures in People with Multiple Sclerosis Who Are Ambulatory

Background: Multiple sclerosis (MS) tends to progress over time, but the course of the disease is both unpredictable and individual. It is important to identify early decline, using responsive measures, in order to plan interventions to maintain functioning. Previous studies of the responsiveness of outcome measures are rare. **Objective:** The objective of this study was to examine clinically significant deterioration in the physical functioning measures in relation to both participants' own perceived change in health and to a clinician's ratings. In the present study, the emphasis was on finding measures that would enable comparison between the deteriorated and stable groups. **Methods:** Participants were selected from a population-based cohort of people with MS ($n = 277$) living in Central Finland in 2000. Various clinical measures of physical functioning along with self-reported performance in self-care, mobility, and domestic life were used in a 2-year prospective longitudinal study ($n = 109$). The International Classification of Functioning, Disability, and Health (ICF) was used as a framework for the study. Clinically meaningful change was described using multiple anchor-based estimates (receiver operating characteristic curve, minimally important change). To determine whether a participant's score had changed, two external criteria were applied: 1) the participant's perception of change by a single item of the RAND Short Form Health Status Survey (SF-36) that indicates perceived change in health; and 2) the change in Expanded Disability Status Scale (EDSS) score, representing the clinician's perspective. **Results:** At baseline, the study comprised 120 people with MS who were ambulatory ($EDSS \leq 6.5$). Eleven participants were subsequently lost to follow-up. The agree-

ment between the participants' perceptions and the clinician's ratings in classifying the participants as deteriorated, stable, or improved was 46% ($\kappa = 0.16$). Overall, 51% showed deterioration according to the participant's own perception (RAND SF-36), compared with 26% as rated by the clinician (EDSS). Regardless of the external criterion applied, the physical functioning measures most responsive to deterioration were as follows: self-reported performance in self-care, mobility, and domestic life measured by the Functional Status Questionnaire (FSQ); distance and change in heart rate during the 6-min walk test; 10-m walk test velocities, stride length, and cadence; repetitive squatting test; and Box and Block test scores. **Conclusion:** The agreement between participants' perceptions and the clinician's ratings in classifying the participants as deteriorated, stable, or improved was poor. Since a single gold standard for chance is lacking, the use of two external criteria is favorable. The present study clearly showed the relative responsiveness of different measures in the subsample who deteriorated. The minimal clinically important difference quantifies the minimal difference that a person with MS or a clinician considers clinically important and thus indicates a relevant change in the physical functioning of the people with MS.

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(P12) Aerobic, Anaerobic, and Flexibility Training in Multiple Sclerosis: A Longitudinal Study

Background: Several studies have been conducted on the effects of exercise training in multiple sclerosis (MS) patients. Interestingly, anaerobic training has rarely been used. It remains unclear whether physical capacities are modified independently by the type of training (aerobic, anaerobic, or flexibility). **Objective:** This study was conducted to examine whether aerobic, anaerobic, and stretching exercises modify strength in patients with MS during a maximal voluntary contraction (MVC) test, a maximum aerobic power (VO_{2max}) test, and a torso and shoulder muscle-tendon flexibility test. **Methods:** A group of 10 MS patients (mean age, 44 ± 6 years; weight, 59 ± 7 kg; height, 58 ± 7 cm) was enrolled in two different types of training lasting 8 months: 1) resistance strength exercises with stretching between sets; and 2) aerobic exercises on a bicycle followed by stretching. **Results:** The data were analyzed with ANOVA Friedman and Dunn post hoc tests. The results showed an increase in shoulder (+8%; $P < .05$) and torso (+12%; $P < .01$) muscle-tendon flexibility and a decrease in lower-limb strength (-27%; $P < .01$). No statistically significant differences were observed for lower-limb VO_2 and upper-limb strength. **Conclusion:** In this sample of patients with MS, the stretching associated with aerobic or anaerobic training improved muscle-tendon flexibility. Training had a conservative effect on VO_{2max} and upper-limb strength, and no positive effect was observed on lower-limb strength (MVC). The improved flexibility indicates that this type of

training (a mix of aerobic and anaerobic exercises) could be offered to patients with MS to sustain their quality of life.

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(P13) Needs of Individuals with Multiple Sclerosis and Their Close Support People

Background: It is known that health-care services that focus on the needs of patients and their families significantly improve health outcomes and client satisfaction. However, the needs of individuals with multiple sclerosis (MS) and their close support people are not clearly understood in the German-speaking world. In Switzerland, for instance, such needs have not been systematically identified, and it is not known how well services offered by the current health-care system meet the needs of this population. **Objectives:** The overall objectives of this study were to describe the illness- and therapy-related needs of individuals with MS and their close support people across the illness trajectory; investigate the relationships between MS patients' needs, age, and illness; and determine whether these needs were being met through the health-care services offered to people with MS and their families in Switzerland. **Methods:** Individuals with MS across the entire illness trajectory and their close support people participated in this cross-sectional study. Data were collected with the following instruments: a researcher-designed needs-assessment scale, the Hospital Anxiety and Depression Scale (HADS-D), the Pictorial Representation of Illness and Self-Measure (PRISM), and the Häusliche Pflege Skala (HPS); the latter was completed by the support people only. Related factors such as self-management, illness-related problems, and sociodemographic and clinical data were also assessed. A total of 2500 questionnaires were distributed to MS patients and their close support people by the Swiss MS Association in the summer of 2008. Data were analyzed with descriptive and inferential statistics. **Results:** A total of 878 MS patients and 615 close support people returned the questionnaires. The response rate of the MS patients was 35% and of close support people was 70.1%. Information was the primary need identified by MS patients and close support people. Information deemed important included the illness in general, symptoms, treatment, recent research findings, and alternative therapies. Both MS patients and close support people identified counseling as their most unmet need. MS patients who had a depression score of 11 or higher, were newly diagnosed, and were severely handicapped had more unmet needs than other participants. MS patients with higher depression scores expressed a greater need for support services. Support for MS patients through partners was rated as adequate by 91% of MS patient participants. A high concordance was found in the evaluation of current and future problems between MS patients and their close support people. Problems with walking, reduced physical and cognitive functioning, and fatigue were among the top five current problems. Paresis, dependency, and reduced cognitive functioning were identified by both MS patients and close support people as among the five most threaten-

ing problems for the future. The support currently offered to people with MS and their families by community services seems to meet most needs identified in this study. **Conclusion:** Individuals with MS and their close support people have a broad array of needs across the illness trajectory. Illness-related information is especially important, and current research results must be available in an easy-to-understand format. Information about alternative medicine is also of great interest. Community services meet most of the needs of MS patients and close support people; however, some needs, such as counseling, remain unmet. Future health-care services should be better adapted to meet the needs of Swiss individuals with MS and their close support people, especially in the areas of symptom experience and management and counseling.

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Study supported by the Swiss Multiple Sclerosis Society.

(P14) Impact of Fatigue on Rehabilitation Outcome in Multiple Sclerosis Patients

Background: Fatigue is one of the most common and disabling symptoms among individuals with multiple sclerosis (MS). It often has a severe impact on motor and social activities of these patients, and it is believed that it could interfere with rehabilitation outcomes. **Objective:** The aim of this study was to determine whether inpatient rehabilitation can improve fatigue in MS and whether fatigue can be considered a negative predictor of clinical and functional rehabilitation outcome in MS patients. **Methods:** We considered 64 subjects with MS who underwent a rehabilitation program in our Neurorehabilitation Unit. We measured fatigue symptoms with the Fatigue Severity Scale (FSS), which was administered before and after rehabilitative treatment. We defined fatigue as an FSS score ≥ 36 and nonfatigue as an FSS score < 35 . To determine clinical outcome of rehabilitation, we used the Expanded Disability Status Scale (EDSS) and the Functional Independence Measure (FIM) for the functional evaluation of these patients. **Results:** In our cohort, rehabilitation resulted in a significant improvement in FSS score in 39 patients; this difference was statistically significant ($P < .0001$). However, fatigue seems to have had no impact on the clinical and functional outcome of rehabilitation. In fact, despite significant improvement in both EDSS and FIM in our 64 subjects, Mann-Whitney analysis showed that fatigue did not influence either outcome measure: $z = -0.725$ for EDSS ($P = .468$) and $z = -0.838$ for FIM ($P = .402$). **Conclusion:** Fatigue does not affect the efficacy of rehabilitation, in spite of its subjective clinical impact on MS patients' daily lives. Rehabilitation can significantly reduce fatigue reported by people with MS.

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(P15) Musclefun Test: Functional Evaluation in People with Multiple Sclerosis

Introduction: A vibratory stimulus is perceived in skeletal muscles by muscle spindles, specialized receptors involved

in the stretching reflex (myotatic reflex) and functionally connected with group Ia myelinated fibers. Previous studies showed that mechanical vibrations (10–200 Hz) administered to the muscle belly or tendon can powerfully stimulate muscle spindle primary endings and evoke afferent discharge along Ia fibers, leading to an enhancement of the stretching reflex. This response has been termed the *tonic vibration reflex* (TVR). **Objective:** The aim of this study was to evaluate the neuromuscular effects of whole-body vibration (WBV) in subjects with multiple sclerosis (MS) by analyzing surface electromyography (sEMG) responses of the vastus lateralis and vastus medialis muscles (Mu.Scle.Fun Test). **Subjects/Methods:** Two groups of randomly selected subjects were recruited: a group of 21 patients with relapsing-remitting MS (RRMS group; 8 males and 13 females) and a group of 14 healthy subjects (control group). Vibration treatment was administered on a vibrating platform (Nemes Bosco-System) using an isometric half-squat position. The sEMG activity by target muscles was recorded while maintaining this position for 30 seconds: the initial 10 seconds without WBV, the next 10 seconds with WBV at 25 Hz, and the final 10 seconds again without WBV. **Results:** This study demonstrated that WBV increased sEMG activity in both groups of recruited subjects. Statistical analysis showed a greater increase in the MS group than in the control group (t test; $P < .002$). **Discussion:** The muscle spindles of patients with MS respond to the vibrations with a greater afferent discharge along Ia fibers compared with healthy subjects, probably as a result of an increase in γ tone, which occurs in MS as a consequence of pyramidal tract damage. **Conclusion:** Confirmation of these preliminary results is needed to show that the Musclefun Test could represent a new diagnostic resource to optimize MS motor treatment and follow-up.

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(P16) Effectiveness of an Information Aid for Newly Diagnosed Multiple Sclerosis Patients: The SIMS Trial

Background: People with multiple sclerosis (MS) express a desire for more information about their disease and to be involved in decisions about their care. **Objective:** The objective of this study was to assess the effectiveness, in terms of patient knowledge and satisfaction with the information received, of a structured add-on informational interview conducted within 15 days of communicating an MS diagnosis. **Design/Setting:** The SIMS Trial (ISRCTN 81072971) is a multicenter (six Italian MS centers), phase III, prospective, randomized, allocation-concealed, controlled trial comparing the study intervention with usual practice in 120 newly diagnosed people with MS. **Study Intervention:** Add-on interview conducted by trained neurologists, during which information about MS is presented with the aid of a specifically designed CD. The information is tailored to individual needs; the patient is also given a booklet containing all the information provided. **Control Intervention:** Current practice at each center as regards communication of MS diagnosis. **Trial Outcomes:** Primary end points,

assessed 1 and 6 months after diagnosis disclosure, are knowledge and satisfaction with diagnosis communication as determined by the "MS Knowledge Questionnaire" and by the instrument "Comunicazione medico-paziente nella sclerosi multipla" (revised). Secondary end points are changes in the Hospital Anxiety and Depression Scale and in the Control Preference Scale. Attrition, number of consultations, and number of visits to the MS center over the study period are also examined. **Results:** The SIMS Trial is conducted according to the Good Clinical Practice Guidelines of the EU (ICH Topic E 6 [R1]–Guideline for GCP). The investigators' meeting took place in February 2008, and by September 2008 the study protocol was approved by the ethics committees at all participating centers. One-hundred thirty patients have been screened and 87 randomized so far. Three patients have withdrawn from the study, and three refused the informational interview. Detailed baseline data and preliminary results will be presented.

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Study supported by *Fondazione Italiana Sclerosi Multipla (Grant 2007/R/19 to A. Solari)*.

Posters

(S01) Impact of Neurorehabilitation on Immune Parameters in Multiple Sclerosis

Background: Little is known about the reaction of the immune system to physical training in multiple sclerosis (MS). Changes have been described related to aerobic training that may indicate an immunomodulatory effect. **Objective:** This study was conducted to determine the impact of neurorehabilitation on immune parameters in MS. **Methods:** In 12 stable MS patients (average Expanded Disability Status Scale score, 3.3 ± 0.8 ; age, 43.2 ± 9.1 years; time since first MS symptom, 10.1 ± 6.1 years; duration of disease activity, 7.2 ± 2.0 years; long-term immunomodulatory drug treatment), the following immune parameters were measured: IgG and IgG subclasses, IgA, IgM, IgE, immune cell population membrane markers CD3, CD4, CD8, and CD19, and cytokines IL-2, IL-6, and IL-10. Plasma immunoglobulins were measured by laser nephelometry, cytokines were measured by enzyme-linked immunosorbent assay systems, and membrane markers were stained by monoclonal antibody conjugated with fluorochromes and analyzed by flow cytometry. Patients underwent neurorehabilitation (stimuli of sensorimotor learning in sitting, standing up, sitting down, standing, and walking were applied) twice a week for 1 hour for a period of 2 months. A two-sample Wilcoxon signed rank test was used to evaluate changes, and *P* values were adjusted for multiple comparisons using the Bonferroni correction. **Results:** The following significant changes in immune parameters after neurorehabilitation were observed: IgG increased from a median of 9.75 to 10.13 g/L ($P = .002$, adjusted $P = .06$), IgG1 increased from a median of 6.23 to 6.30 g/L ($P = .006$), absolute number of CD3+CD8+ (T-cytotoxic cells) increased from a median of 0.3 to 0.43

$\times 10^9/L$ ($P = .007$), and CD19+ B cells decreased from a median of 8% to 7.6% ($P = .002$, adjusted $P = .05$).

Conclusion: Neurorehabilitation in MS appears to initiate an activation of humoral specific immunity.

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Study supported by grants from the Ministry of Health of the Czech Republic (IGA 1A/8628-5) and the Academy of Sciences of the Czech Republic (AV0Z10300504).

(S02) Postural Control in Early Clinically Isolated Syndrome

Background: Multiple sclerosis (MS) patients frequently experience poor postural control affecting balance and gait in addition to cognitive impairment, even at the early disease stage. As postural control is attentionally demanding, it is essential to test stability during a cognitive task. **Objective:** The objective of this study was to evaluate postural control parameters in patients with clinically isolated syndrome (CIS) within up to 3 months from onset. **Methods:** CIS patients were assessed during a single session. Inclusion criteria were as follows: age 20 to 45 years, assessment within 3 months from onset of neurologic symptoms, brain magnetic resonance imaging (MRI) suggestive of MS, and no cognitive impairment. Postural control was evaluated by quantifying movement of the center of pressure (COP) during standing under three conditions: eyes open (EO), eyes closed (EC), and under modified Stroop test (MST). Each test lasted 30 seconds and was repeated three times with a 1-min break between tasks. Twenty age- and sex-matched healthy subjects served as controls. Data were analyzed using the unpaired *t* test, and $P < .05$ was considered significant. **Results:** Fifty CIS patients, 35 females and 15 males, with a mean age of 33.8 ± 0.2 years participated in the study. Postural control was normal in 60% of patients, below average (1–2 SD) in 20%, and poor (>2 SD) in 20%. Postural sway differences ($P < .01$) were detected between CIS patients and healthy subjects. In CIS patients the average total COP variabilities in millimeters for EO, EC, and MST were 64.4 ± 3.7 , 85.4 ± 6.4 , and 69.7 ± 4.3 , respectively, compared with 44.4 ± 2.7 , 58.8 ± 4.9 , and 48.5 ± 4.4 in healthy subjects. The effect of the cognitive task resulted in reduced performance that was similar in both groups. **Conclusion:** Postural instability was detected in 40% of CIS patients using targeted measuring equipment within 3 months of the onset of neurologic symptoms. Identification of postural abnormalities in the early stage is important in order to establish proper intervention programs.

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(S03) Effectiveness of Aerobic and Anaerobic Training in Patients with Multiple Sclerosis: Correlation Between Perceived Fatigue and Biological Parameters

Background: Fatigue is one of the most common symptoms in multiple sclerosis (MS), affecting 75% to 95% of

patients, although it is often neglected or underestimated. For fatigue to be diagnosed, it must be experienced during at least 50% of the total number of days for at least 6 consecutive weeks. The pathogenesis of this disabling symptom is not well known. It does not appear to be related to gender or disease duration or to imaging parameters. Sometimes it is associated with disease exacerbations and remissions, and typically it is worsened by increased ambient temperature. Some studies suggest that this may be due to the interruption of certain cortico-subcortical circuits. Various cytokines seem to be implicated in the perception of fatigue, including interferon- γ (IFN- γ), tumor necrosis factor alpha (TNF- α), interleukin-6 (IL-6), soluble intercellular adhesion molecule (sICAM), and interleukin-2 (IL-2). Several studies have shown the effectiveness of training in an aquatic environment, using a treadmill, or with aerobic exercises to improve tolerance to fatigue and to continued effort. However, little research has been conducted comparing aerobic with anaerobic training and investigating the correlation between variation in fatigue perception and cytokine profile. **Objective:** The goal of this study was to determine which of the two training methods (aerobic or anaerobic) is more effective in reducing the perception of primary fatigue induced by MS and to examine the correlation between reduction of fatigue perception and modification of cytokine expression. **Methods:** In this crossover study, two training programs were implemented, one including predominantly isotonic exercises and one with exercises performed with an aerobic device (bicycle or treadmill). Seventeen female MS patients with low levels of neurologic impairment were divided in two groups and participated in both programs, switching from the aerobic to the anaerobic training or vice versa. The two training programs were separated by a 1-month rest period. At the beginning and end of each training period, self-administered questionnaires were completed to assess the perception of fatigue (Fatigue Severity Score [FSS], Modified Fatigue Impact Scale [MFIS]) and quality of life (Multiple Sclerosis Quality of Life [MSQOL-54/F]), and blood samples were collected. Blood levels of fatigue-related cytokines (IFN- γ , TNF- α , IL-6, IL-6 receptor, sICAM, IL-2, IL-2 receptor) were evaluated with plasma protein dosage and with gene expression analysis in peripheral blood mononucleated cells. **Results/Conclusion:** Analysis of variation of cytokine gene expression and fatigue perception may lead to the discovery of a biological substrate involved in the pathogenesis of fatigue in MS. The impact of the two different training programs on perception of fatigue will allow selection of the best training strategy in MS patients.

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Study supported by SUISM, University School of Motor & Sport Sciences, University of Turin, Italy, and CRESM, Multiple Sclerosis Center, H. San Luigi Gonzaga, Orbassano (Turin), Italy.

(S04) Occupational Therapy Intervention with Patients Affected by Multiple Sclerosis

This project concerns the inclusion of occupational therapy in rehabilitative work with patients affected by multiple scler-

osis, in any phase of the disease. Following are specific aspects of the project: 1) taking charge of the patient from the beginning of the disease, with a special emphasis on autonomy in activities of daily living (ADLs), quality of life, elimination of architectural barriers, evaluation and prescription of assistive devices, and evaluation of ability to regain a driver's license; 2) an interdisciplinary approach with the participation of different professionals (occupational therapist, physical therapist, psychologist, neurologist, and physiatrist); 3) definition of a "therapeutic contract" with the patient to define and share the aims of each intervention, in order to accurately express the individual rehabilitation project instead of executing generic techniques. The general aims of the project from the very beginning of the disease were as follows: 1) to reduce or limit the effects of fatigue on the performance of ADLs; 2) to improve psychophysical efficiency and quality of life; 3) to reduce disability and handicap; 4) to enable the patient to attain an appropriate perception of his or her body and to establish a harmonious relationship with the environment; 5) to control the functional aspects of disease development, immediately addressing emerging neurologic problems, integrating the regained or residual motor skills into functional activities, teaching alternative strategies for achieving independence, selecting assistive devices for patients with severe disabilities, and finding solutions to environmental problems.

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(S05) Electrotherapy for Treatment of Cysts in People with Multiple Sclerosis

Background: Many people with multiple sclerosis (MS) develop cysts, or small masses in the skin tissue, probably due to the body's inability to correctly absorb injected medication. Formation of cysts seems to depend on the type of fat tissue involved, the injection site, and the frequency and depth of puncture. In people with MS, cysts are the main secondary effect of medication injection, which can also cause cutaneous injuries such as redness, loss of elasticity, hardness, itching, and burning. Cysts can appear singly or in groups and have different shapes and sizes, ranging from 3 to 7 cm long. Cysts and cutaneous injuries are problematic for people who must inject their medication daily and can even result in the patient giving up the treatment, sometimes against the neurologist's advice. Electrotherapy has been shown to reduce or even eliminate cysts and improve the condition of injured skin. **Objective:** The objective of this study was to evaluate the effectiveness of electrotherapy with a given intensity, frequency, and duration for decreasing or eliminating cysts and other secondary effects of medication injection. **Methods:** This was a cross-sectional descriptive study involving seven people admitted to our hospital during the study period. We assessed the results mainly by cyst size and degree of pain, as indicated by the nursing department and physical therapists, as well as ultrasonographic verification by a physician. **Results:** This project is still in process. Although we still do not have all the results, we can see that the cysts decreased in size or fragmented, and some even disappeared, as confirmed on ultrasound. Reduction in size is difficult to see in some areas,

mainly the abdomen and buttocks. All patients showed improvement in the condition of the skin as well as decreased pain with touch, injection, and medication penetration. **Discussion:** Many factors can affect the results of treatment, including injection frequency and injection site. The difficulty in seeing reduction in size of cysts in the abdomen and buttocks in this study may be due to the increased fat tissue in those zones compared with other injection sites such as the arm or leg, resulting in either less absorption of the medication because of the scarcity of blood capillaries or refraction of the ultrasonic wave, preventing it from reaching the cysts.

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(S06) Home-Focused Rehabilitation Process for Patients with Multiple Sclerosis

Patient History: We present the case of a 38-year-old man who was diagnosed with multiple sclerosis (MS) 18 years ago. His Expanded Disability Status Scale (EDSS) score is 6.5. Currently, he is able to walk about 20 m with a walker. Otherwise, he uses a powered wheelchair. He is a professional biologist and currently works part-time from his home. **Methods:** Data were obtained through the Functional Independence Measure (FIM), the Canadian Occupational Performance Measure (COPM), our internal Activities of Daily Living (ADL) Test, the Modified Fatigue Impact Scale (MFIS), and a self-esteem questionnaire. We used a client-centered approach and studied his living arrangements. When the patient was engaged in the rehabilitation process, especially in daily activities that were important to him, he tried to be as successful as possible. The treatment process from initial assessment through discharge is based on the patient's evaluation of his effectiveness, efficiency, and satisfaction with his progress and performance. **Results:** During 5 weeks of rehabilitation at our institute, the patient's FIM score stayed the same. The COPM showed significant improvement in performance and satisfaction due to the prescription of a powered wheelchair, which enabled the patient to engage in social activities more independently. To improve the safety of his daily activities, we advised him to use grab rails and a shower stool in his bathroom. The MFIS showed that his greatest problem was fatigue, which strongly affected his abilities. The self-esteem questionnaire showed improved self-confidence. **Conclusion:** The rehabilitation team can be successful only by considering the needs of the patient, including his environment as well as the activities that are important and fulfilling to him. Early recognition of the need for assistive technology can significantly improve the patient's quality of life.

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(S07) Neuropsychologist, Speech/Language Therapist, and Occupational Therapist Intervention in Two Multiple Sclerosis Cases

Background: We present two actual cases of multiple sclerosis (MS) and describe the benefits of multidisciplinary treatment. A neuropsychologist, a speech/language therapist, and an occupational therapist worked together to

improve these patients' quality of life, collaborating with the families to adapt the patients' environments and activities of daily living (ADLs) to their cognitive abilities. These patients are experiencing a significant process of cognitive degeneration, and they need continuous adaptation in their cognitive treatment. The pattern of neuropsychological deficits observed in MS is characterized by impairment of memory, attention, information processing, and executive functioning. This work deals with executive functioning: problems with planning, mental and behavioral flexibility, and mental slowing. **Objectives:** The objectives were to determine the appropriate professional intervention of the neuropsychologist, speech/language therapist, and occupational therapist in the cognitive aspects of primary progressive MS; to accompany and guide the patients, as well as their families or caregivers, throughout the evolution of the disease; and to determine how to adapt the environment and the ADLs to the cognitive abilities of the patients. **Methods:** We used medical information about two actual cases of primary progressive MS: their neurologic clinical history, evaluations of the three different clinicians, and Functional Independence Measure (FIM) results. Each professional treatment program included two sessions per week for 6 months. The objectives were then revised to continue the intervention or modify it if necessary. We met with the families to discuss the disease course and the changes needed to increase the efficacy of treatment. **Conclusion:** The results have been very positive for the patients as well as the caregivers. The caregivers have acquired the professional judgment and the guidance needed to live with a person with a cognitive handicap. They calmly shared with the professionals their worries and approaches to solving daily problems.

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(S08) Botulinum Toxin for Dysphagia Associated with Multiple Sclerosis

Objective: The objective of this study was to evaluate the efficacy of botulinum neurotoxin type A (BoNT/A) for severe oropharyngeal dysphagia associated with multiple sclerosis (MS). **Patients/Methods:** BoNT/A was injected percutaneously into the cricopharyngeal muscle of 14 dysphagic MS patients under electromyographic control. Patients were evaluated by clinical, videofluoroscopic, and electromyographic examinations at weeks 1, 4, 12, 16, 18, and 24 after BoNT/A injection. **Results:** All patients showed a significant improvement in swallowing. **Conclusion:** No specific treatment for oropharyngeal dysphagia related to MS has been described to date. Our preliminary findings suggest a potential benefit from BoNT/A treatment in dysphagia associated with MS.

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(S09) Gait Analysis Before Treatment with Botulinum Toxin in Multiple Sclerosis Cases

Background: Botulinum neurotoxin type A (BoNT/A) is widely used for focal treatment of spasticity in subjects

affected by stroke, cerebral palsy, and similar disorders. Little is known about the effectiveness of BoNT/A in multiple sclerosis (MS). Criteria for clinical and instrumental decisions, indispensable for appropriate use of BoNT/A in focal treatment of spasticity, are still unclear in this patient population. The difficulty is due to the varying clinical evolution of MS and range of disease symptoms, making it difficult to identify the spastic component that contributes to disability.

Objective: The objective of this study was to identify tools that could guide therapy and predict the outcome before BoNT/A treatment. The primary goal was to increase patient autonomy in walking. **Methods:** Fifty-eight MS patients were selected for possible BoNT/A treatment. All patients could walk at least 10 m. Each patient underwent clinical evaluation and observational gait analysis; polyelectromyography (BTS Pocket EMG, 16 EMG channels and 8 foot-switch channels; BTS Bioengineering, Italy); stabilometry (1 force platform); and, in selected cases, kinematic and kinetic measurement (BTS GaitEL, 6 TVC, 2 force platforms). Exclusion criteria were as follows: gap between increased muscle tone and muscular recruitment during walking; hypoactivity of agonist muscles and normal activity or hypoactivity of antagonist muscles; appropriate activity of agonist muscles and normal activity or hypoactivity of antagonist muscles; dynamic EMG pattern with a generalized muscular recruitment deficit (weakness); clinical ataxia and spasticity but without significant hyperactivity dynamics. **Results:** After analysis of the results, 24 patients were candidates for the BoNT/A treatment: 62% had a predominantly spastic pattern, and 38% had a pattern with spasticity and slight atactic disease. **Conclusion:** The results of this study show that clinical evaluation is insufficient for appropriate patient selection for neuromuscular block with BoNT/A in walking subjects with MS. Thus diagnostic examination with dynamic polyelectromyographic analysis of walking is necessary to avoid inappropriate treatments that would worsen rather than improve patient autonomy.

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(S10) Spasticity and Functional Surgery in Multiple Sclerosis: A Case Report

Background: Functional surgery is widely used for treatment of spasticity in people affected by stroke, cerebral palsy, traumatic brain injury, and cerebrovascular diseases. In multiple sclerosis (MS), the varied clinical evolution and simultaneous presence of other significant problems (ataxia, fatigue, tremor, and cognitive and proprioceptive disorders) could negatively affect the outcome. **Objective:** We present a case report on upper-limb functional surgery in a 57-year-old man with MS. **Methods:** The patient was examined in our spasticity clinic because of left upper-limb deformity. Clinical evaluation showed finger flexor and wrist flexor spasticity with myotendinous retraction. This condition led to reduced functioning, pain, and postural and hygiene problems. Movement analysis was impossible because of the finger and wrist deformity. The patient had no cerebellar tremor or cognitive or sensory disorders.

After interdisciplinary evaluation, the following surgical procedures were performed: transfer of the flexor digitorum superficialis tendons to the flexor digitorum profundus tendons; transfer of the flexor pollicis longus to the abductor pollicis longus; lengthening of the wrist flexor; and lengthening of the biceps. After surgery, the patient spent 3 weeks in our unit for rehabilitative treatment. **Results:** Postoperatively (at 3 months' follow-up), the patient showed improved posture and active movement, as well as resolution of his hygiene and pain problems. **Conclusion:** In selected MS patients, with careful clinical evaluation and polyelectromyography when possible, functional surgery can be a useful therapeutic strategy not only terminally but also during clinical evolution of the disease.

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(S11) Self-Evaluation of a Fatigue-Management Program

Background: Fatigue is a common problem for people with multiple sclerosis (MS), and fatigue management is a traditional occupational therapy intervention. **Objective:** The main objective of this study was to determine the effectiveness of a fatigue-management program in terms of self-evaluated fatigue in a sample of MS patients. **Methods:** *Patients:* Seven female MS patients treated with interferon beta-1b (IFN β -1b) participated in the study. Their mean age was 39 ± 8.6 years; MS duration, 9 ± 8.6 years; Paced Auditory Serial Addition Test (PASAT) score, 48.7 ± 12.1 ; Beck Depression Inventory (BDI) score, 9 ± 5.12 . *Assessment tools:* Modified Fatigue Impact Scale (MFIS) and visual analogue scale (VAS). *Procedure:* People with MS were invited to participate in a fatigue-management program based on the work of Packer (1995). The course consisted of 6 weeks of structured 2-hour classes taught by an occupational therapist. Patients were assessed before and after the program with the MFIS and VAS. *Analysis:* Statistica software (StatSoft, Inc, Tulsa, OK, USA) was used for analysis. **Results:** The mean MFIS scores before and after the program were 37 ± 8 and 29 ± 11 , respectively. A *t* test showed that the difference was statistically significant ($P = .045$). Before the program, the mean VAS scores for morning and afternoon fatigue were 3.5 ± 2.1 and 6.3 ± 3.5 , respectively. After the program, the mean VAS scores for morning and afternoon fatigue were 2.3 ± 2.2 and 4.6 ± 2.2 , respectively. The *t* test showed statistically significant differences for morning fatigue ($P = .09$) and afternoon fatigue ($P = .03$) at the $P < 0.1$ level. **Conclusion:** The results of this study show that the fatigue-management program is effective in reducing fatigue in daily life as indicated by self-perception of fatigue and the impact of fatigue on some aspects of daily functioning.

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(S12) Predictors of Efficacy of Short-Term, Intensive Inpatient Motor Rehabilitation in Patients with Multiple Sclerosis

Objectives: The objectives of this study were to validate previously identified clinical predictors of efficacy with regard to impairment and disability of a short-term (3–4 weeks), intensive (two sessions per day) inpatient rehabilitation program in a sample of 67 patients with multiple sclerosis (MS). **Materials and Methods:** Sixty-seven consecutive patients hospitalized in our Neurorehabilitation Unit beginning in November 2007 were recruited for this study. Disability level was measured at the beginning and at the end of the rehabilitation treatment using the Expanded Disability Status Scale (EDSS), while impairment was measured with the Functional Independence Measure (FIM) and Barthel Index (BI). Rehabilitation was considered to be effective if it was associated with an improvement of the EDSS score of at least 0.5 point (if baseline EDSS was >5.5) or of 1.0 point (if baseline EDSS was ≤ 5.5) and/or an improvement as measured by the FIM of at least 5 points. Logistic regression models were used to evaluate predictors of efficacy of rehabilitation for impairment and disability. **Results:** According to our predefined EDSS outcome measure, 37 (55.2%) of the patients benefited from rehabilitation, while according to the FIM outcome measure, the proportion increased to 56.9%. If we consider as effective an improvement on at least one of the two scales, 70% of the patients improved. A higher disability and impairment level at the beginning of the rehabilitative treatment was confirmed to be predictive of greater efficacy of rehabilitation, while disease course, age, and sex were not confirmed as predictors. **Discussion:** These data confirm that an intensive inpatient rehabilitation program can result in a short-term relevant improvement on clinical and functional outcome measures. We also confirmed that, among clinical predictors, the severity of impairment and disability is more important than the disease course. **Conclusion:** A more focused patient selection process for rehabilitative treatment will aid in improving the disability and impairment of MS patients and in economical use of health-care resources.

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(S13) Vesicourethral Dysfunction, Sexual Dysfunction, and Quality of Life in Multiple Sclerosis

Background: The most common lower urinary tract symptoms (LUTS) in multiple sclerosis (MS) are irritative, obstructive, or mixed (combination of irritative and obstructive). Symptoms of sexual dysfunction are also commonly reported in patients with MS. They include anorgasmia or hyporgasmia, decreased vaginal lubrication, and reduced libido in women; and impotence or erectile dysfunction, ejaculatory dysfunction and/or orgasmic dysfunction, and reduced libido in men. **Objective:** The aim of our study was to determine the impact of LUTS on quality of life (QOL) in patients with MS. **Methods:** We examined a group (28 subjects; 21 female and 7 male) of consecutive chronic progressive MS

patients who regularly received care at the IMFR rehabilitative center of Udine, Italy, between June and December 2008. The patients were evaluated with the Expanded Disability Status Scale (EDSS), Mini-Mental State Examination (MMSE), Beck Depression Inventory (BDI), Anxiety Scale of Cognitive Behavioural Assessment (CBA), 12-item Short Form Health Status Survey (SF-12), and QUALIVEEN questionnaire (a new urinary-disorder-specific health-related quality of life inventory). We studied the correlation between vesicourethral symptoms and sexual symptoms (evaluated by the Multiple Sclerosis Intimacy and Sexuality Questionnaire-19 [MSISQ-19]) and the relation between anxiety and depression scores and the QUALIVEEN questionnaire. **Results:** Our results show that LUTS are related to sexual dysfunction (Spearman $\rho = .512$; $P = .025$, 2-tailed). However, patients with higher scores on the QUALIVEEN showed elevated anxiety ($\rho = .590$; $P = .05$, 2-tailed) and depression ($\rho = .703$; $P = .001$, 2-tailed). **Conclusion:** In our patient sample, LUTS resulted in a decrease in QOL and an increase in anxiety and depression.

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(S14) Fatigue in Multiple Sclerosis: Effect of a Physical Training Program

Background: Deconditioning plays a key role in the impaired exercise tolerance of people with multiple sclerosis (MS), who limit their physical activity in order to minimize fatigue. **Objectives:** The objectives of this study were as follows: 1) evaluate the benefits of physical training for cardiopulmonary and metabolic functions and its impact on fatigue; 2) determine whether the benefits obtained endured after the training. **Methods:** Nineteen MS patients (mean Expanded Disability Status Scale [EDSS] score <3 ; mean age 42.82 ± 11.30 years) completed an 8-week aerobic training program, a 2-month detraining period, and an 8-week retraining program. The subjects' perceived effect on fatigue was assessed with the Fatigue Severity Scale (FSS) and the Modified Fatigue Impact Scale (MFIS). Pulmonary function was measured with a body plethysmograph. Aerobic fitness was assessed through a stress test on a cycloergometer to determine VO_{2peak} and anaerobic threshold, monitoring ECG, SpO_2 , and the subjective effort with the Borg scale. The parameters of peak torque, power, total work, and fatigue index of ankle flexor and extensor were studied through standardized isokinetic testing. **Results:** We observed a decrease of 16% for the FSS score after training and an increase in the total MFIS score after detraining, more significant for the physical functions. A better aerobic performance and an increase in the maximal workload (16%) were seen at the end of training. The energy cost of gait, two or three times higher than predicted values, was not modified by training, but speed was increased, which was undoubtedly important for the patients' quality of life. We observed lower values for the ankle muscle parameter at the beginning of training but an increase in torque and a normalization of the fatigue index at the end of training. **Conclusion:** In this sample of MS patients, we observed a lower impact of fatigue on activities of daily living (ADLs) and a better performance after the aerobic train-

ing program; the benefits did not endure after 2 months of detraining. This confirms that regular aerobic physical activity is necessary to modify the impact of fatigue on MS patients.

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(S15) Efficacy of an Executive Function Intervention Program: A Placebo-Controlled Trial

Background: Among the cognitive functions disturbed in multiple sclerosis (MS), a decrease in executive control is associated with the greatest reduction in quality of life (QOL). Although physical rehabilitation has been proved to be possible in MS, the evaluation of evidence-based rehabilitation programs for the treatment of deficits in cognitive and especially executive functions is still in its earliest stage.

Objective: The objective of this study was to evaluate the effectiveness of treatment for executive deficits and its interaction with mood variables, QOL, and white-matter impairments. **Methods:** This was a placebo-controlled study lasting 12 months. Patients with relapsing-remitting MS ($n = 53$) were recruited from the hospital or had participated in an earlier study and joined a group-based cognitive intervention group (CIG; $n = 16$), a placebo group (PG; $n = 17$), or a control group (CG; $n = 20$). Participants in the two treatment groups either completed a cognitive intervention program or self-trained with a nonspecific attention computer program after the baseline testing (T1). The treatment phase lasted 6 weeks, after which the monitor testing (T2) took place. The follow-up (T3) was scheduled 1 year after T1. The three groups were fully comparable with regard to demographics and baseline verbal intelligence level. The data of patients showing a deficit in experimental executive function control tasks were excluded from further analysis. The impairment of the superior longitudinal fascicle (SLF) and the uncinate fascicle (UF) was determined by diffusion tensor imaging (DTI) analyses. **Results:** To date, not enough patients have passed T3 to derive reliable results. Intergroup comparison regarding executive functioning yielded a greater improvement in the CIG than in the PG and the CG from T1 to T2 as reflected by a lower number of mistakes on a verbal working-memory task ($P = .017$). Additionally, the CIG showed a trend toward a significant decrease in fatigue symptoms ($P = .089$), whereas the level of mood disturbances did not change in the PG and CG. A significant association was found between the degree of benefit from treatment in general and fiber integrity ($P < .05$). **Conclusion:** The group-based cognitive intervention program evaluated in this study can improve executive functioning and may also improve mood status in patients with MS. The degree of improvement in executive functioning appears to depend on the degree of baseline fiber impairment. We look forward to the results of follow-up testing to evaluate long-term benefit from treatment.

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(S16) Duloxetine for Treatment of Multiple Sclerosis-Related Symptoms: A Multicenter Study

Background: Duloxetine hydrochloride, a dual reuptake inhibitor of serotonin and norepinephrine, was evaluated for therapeutic efficacy and safety/tolerability in the treatment of depression in multiple sclerosis (MS) patients. In MS the rate of depression approaches 50% over the course of the patient's life. **Methods:** In a 12-week multicenter, open study, MS patients receive duloxetine at a dosage of 60 mg daily. The study involves patients of both sexes, and inclusion criteria are age >18 years, definite MS (Poser criteria), stable phase of the disease without relapses or a worsening of >1 point on the Expanded Disability Status Scale (EDSS) in the last 3 months, Beck Depression Inventory (BDI) score >11 , any clinical course, and a Mini-Mental State Examination (MMSE) score <26 . Exclusion criteria are the previous use of duloxetine, kidney or liver disease, and pregnancy. The primary outcome measure is BDI score, and benefit is defined as remission at the end point. Secondary measures include the Chicago scale, the Patient Global Impression of Improvement, Fatigue Severity Score (FSS), visual analogue scale (VAS) for pain, and VAS for urinary disturbance. Safety is evaluated by recording rates of discontinuation and treatment-emergent adverse events and by measuring vital signs. Subjects are evaluated after 4 weeks (T1) and 12 weeks (T2). **Results:** To date, 71 patients have been enrolled in the study. Thirty-eight patients have completed the study period (T2), and 12 subjects dropped out because of side effects or noncompliance. Nausea was the most common adverse event. Interim analysis showed that 26 of the 38 patients experienced an improvement in mood symptoms (BDI). **Conclusion:** These data indicate that duloxetine seems to be well tolerated and safe. Final results for efficacy using the primary and secondary outcome measures will be presented.

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(S17) Influence of Systematic Cryotherapy on a Function of Locomotion in a Group of Multiple Sclerosis Patients

In Poland, we use systematic cryotherapy as a component of treatment for people with multiple sclerosis (MS). We carried out a pilot study of this treatment modality using the Timed Up and Go Test. We administered this test on the first, fifth, and tenth days of cryotherapy, three times each day: before cryotherapy, immediately after cryotherapy, and after 5 min of warm-up. The study group consisted of 20 patients with MS who were able to walk either with or without assistance. The time needed to do the test decreased in all patients, and all patients experienced improvement in muscle tension and stability.

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(S18) Efficacy of TheraTogs in Ambulatory Patients with Multiple Sclerosis

Background: TheraTogs (TheraTogs, Inc, Telluride, CO, USA) are a type of orthosis composed of an inner foam

layer that grips the skin and a Velcro-sensitive outer layer to which clinicians and caregivers can affix elastic strapping. The elastic strapping creates proprioceptive stimulation of the weak muscles and improves inhibition of their antagonists. The AISM Rehabilitation Center began to use this orthosis 1 year ago. Patients with multiple sclerosis (MS) start using the orthosis after the rehabilitation program. In ataxic patients, the aim is to improve trunk stabilization and ambulation, while in patients with spasticity, the purpose is to improve the recruitment of the weak muscles during gait or, in the case of nonambulatory patients, to improve the sitting posture. All patients report a feeling of comfort, and the physicians observe an immediate beneficial effect on base of support and on static and dynamic alignment. **Objective:** The objective of this study was to evaluate the immediate effectiveness of TheraTogs for impaired gait in people with MS. **Materials and Methods:** The study will involve 25 MS patients with an Expanded Disability Status Scale (EDSS) score of ≤ 6.5 . Patients with physical fatigue measurable with the Modified Fatigue Impact Scale (MFIS) (physical score $>20/36$) and/or without the necessary caregiver assistance with wearing the aid at home are excluded from the study. Before and after wearing this aid, all patients are filmed and undergo the Ambulation Index and Timed Walking Test (primary outcomes) and stabilometric and baropodometric evaluation with the Physical Support System platform (secondary outcomes). Finally, a visual analogue scale (VAS) for subjective evaluation of the aid's effectiveness is administered. **Preliminary Results:** Currently, 17 subjects have been enrolled in the study (14 females and 3 males; mean age 52). Seven subjects (6 females and 1 male) have ataxia, 6 subjects (5 females and 1 male) have spasticity in both lower limbs, and the remaining 4 subjects (3 females and 1 male) have hemiparesis. All patients had changes in secondary outcomes but not in primary ones. The final results will be presented with statistical analysis.

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(S19) Postvoid Residual Urinary Evaluation in Multiple Sclerosis Patients

Background: Over 80% of people with multiple sclerosis (MS) have symptoms of lower urinary tract dysfunction during the disease course, and 96% of patients with a disease duration of more than 10 years complain of a urinary symptom. About 10% of patients report that urinary symptoms are among the first symptoms of the disease, and up to 5% report urinary symptoms as the only ones. Urinary retention is one of the most prevalent symptoms, and usually it is not perceived by the patient. Urinary retention can lead to lower and upper urinary tract complications. Urinary dysfunction can have a significant impact on the patient's quality of life. MS specialists must perform comprehensive evaluations to effectively manage these potentially life-disrupting symptoms. **Objective:** The objective of this study was to identify MS patients with urinary retention who were being followed up at home by the rehabilitation service and to evaluate the correlation between symptoms and postvoid residual (PVR) volume. These in-home patients either have high disability or live in rural areas and thus have difficulty

with access to hospitals. **Methods:** Rehabilitation physicians will use a bladder scanner to assess 500 MS patients (symptomatic and asymptomatic for urinary disorders) being followed up at home by the AISM Rehabilitation Center. They will also record age, disease duration, Expanded Disability Status Scale (EDSS) score, symptoms (with a standardized questionnaire), current bladder management (therapy, aids), number of urinary-tract infections in the last year, and urologic examinations. The recorded data will undergo multifactorial variance statistical analysis. **Preliminary Results:** To date, data have been collected for 373 patients (262 female, 111 male). Their mean age is 56.38 ± 12.32 years, and their mean EDSS score is 6.4 ± 1.6 . Of these 373 patients, 330 subjects (88.5%) had symptoms of urinary dysfunction. At least one retention symptom was present in 203 patients, with a mean PVR volume of 136.95 ± 127.63 mL, but 86 patients did not have a PVR. Of the 166 patients who were asymptomatic for retention and urinary dysfunction, 90 had a PVR, with a mean volume of 270.09 ± 108.76 mL.

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Study supported by Astra Tech.

(S20) Efficacy of Physical Therapy in Multiple Sclerosis as Measured with the Modified Fatigue Impact Scale and Ambulation Index: A Retrospective Study

We performed a retrospective review of 500 medical records of multiple sclerosis (MS) patients from the outpatient service to evaluate the validity of outcome measures routinely used in the physical therapy service. All records of outpatients followed by the AISM Rehabilitation Center who underwent physical therapy from 2006 to 2008 and were evaluated before and after treatment with the Modified Fatigue Impact Scale (MFIS) and the Ambulation Index (AI) were reviewed. The number of assessments recorded was 295 in 209 patients. Of the 209 patients, 133 were female and 76 were male. The mean age was 51.6 ± 11.68 years, the mean Expanded Disability Status Scale (EDSS) score was 4.98 ± 1.79 , and 185 patients were ambulatory. In nonambulatory patients (24 assessments in 24 subjects), neither scale showed a significant increase. In ambulatory patients (271 assessments), significant changes were observed in AI score ($P < .05$), time to walk 7.5 m ($P < .01$), MFIS total score ($P < .009$), MFIS physical score ($P < .002$), and MFIS social score ($P < .008$). Changes in MFIS cognitive score were not significant. In conclusion, physical therapy has a positive impact on fatigue, and the MFIS seems to be a good outcome measure in ambulatory patients. The AI and MFIS seem to be not indicated for use in nonambulatory patients.

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(S21) Efficacy of Hydrokinesotherapy for Multiple Sclerosis Patients

Background: The efficacy of hydrokinesotherapy for multiple sclerosis (MS) patients is supported by principles related

to water's physical characteristics and the biological effects of water on the body, such as temperature's effect on muscle tone and the effects of reduced gravity on balance and motor performance. Land therapy is also effective, but the stimulation techniques are based on different principles. Little research has been conducted comparing the two techniques in terms of treatment efficacy for spasticity, coordination, balance, motion, fatigue, and psychological conditions, or even effects on physiological parameters such as cardiovascular, respiratory, and temperature measurements. **Objectives:** The objectives of this study were to evaluate the efficacy of hydrokinesitherapy for activity (physical effort endurance), spasticity, coordination, balance, cenesthesia, fatigue, and psychological conditions, as well as its effects on some cardiovascular physiological parameters such as respiration and temperature, after a cycle of 10 weekly sessions, and to compare the results with those of land therapy. **Methods:** Patients enrolled in the study underwent a rehabilitation treatment program that included an initial cycle of 10 weekly sessions of hydrokinesitherapy, each lasting 45 min (T0–T1). After 2 months during which the patient did not undergo any physical therapy, the patient began a 10-session cycle of land therapy with the same length and frequency as the hydrotherapy (T2–T3). Patients were evaluated at the beginning and at the end of each training cycle, water (T0–T1) and land (T2–T3), by a physiatrist who was blind to the type of treatment. All participants were assessed with the Ashworth scale, the Berg scale, the Multiple Sclerosis Impact Scale (MSIS-29); the Short Form Health Status Survey (SF-36), the Barthel Index, the Hauser Ambulation Index, the Modified Fatigue Impact Scale (MFIS), the 2-min Walk Test (2MWT), and vital parameters (temperature, PA frequency, saturation before and after every session). **Results:** Significant improvement was observed in the MFIS and 2MWT after water treatment ($P = .001$). **Conclusion:** In agreement with previous studies, our data show the efficacy of hydrokinesitherapy in terms of not only physical but also psychological status. However, like other chronic diseases, MS requires careful evaluation to determine the best form of treatment. Hydrokinesitherapy is a useful and effective component of multidisciplinary rehabilitative treatment for MS patients.

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(S22) Assumption of Social Responsibility of Patients with Multiple Sclerosis in the Marche Region and Analysis of Their Needs

Introduction: Social services are important in determining the activities needed to help people deal with conditions of disability, need, and personal or family problems. Through a collaborative project, we have determined the needs of people with multiple sclerosis (MS) who are under the responsibility of the social services units of health departments in the region of Marche, Italy, and the responses to those needs. **Objective:** The objective of this study was to identify the types of requests made of social services units by people with MS and the responses to those requests. **Methods:** Data were collected about people with MS directed to our institutions from January 2005 to October

2008. Data were collected by completion of a questionnaire by the social workers of the health departments. **Results:** The social services units assumed responsibility for 190 MS patients during the study period, 129 women and 61 men with a mean age of 55. Of the 190 patients, 153 were declared disabled, of which 115 have been recognized as people with handicaps under Act No. 104 of 5 February 1992. Only 30 patients have asked for protection under Act No. 68 of 1996 by inclusion in the protected employment lists. Of the 190 patients, 33 are employed, 58 are unemployed or homemakers, and 99 are retired. The patients have made the following requests of social services: 1) 41 people have asked for information about housing assistance; 2) 16 people have asked for information about elimination of architectural barriers to handicapped access and the possibility of benefits under Act No. 13 of 1989; 3) 7 people have been housed in protected housing or day centers; and 4) 6 people have found jobs. Regarding the first request, the social workers have alerted the social services office of the patient's community of residence for the assumption of responsibility and benefits. Regarding the second request, the social workers have provided information about receiving assistive devices to overcome architectural barriers to access, have directly contacted companies that provide the required aids, and have requested the prescription of aids, in cooperation with the physiatrist. Regarding the third issue, the services have directly contacted those in charge of the protected housing and day centers, directly housing the patients who have made the request. Regarding employment, the patients have been referred to the proper employment offices for inclusion on the protected employment lists; in some cases, direct employment has been arranged with private and public firms. **Conclusion:** The results of this study show that requests for housing assistance are especially prevalent. The most likely reason is the older age of the study sample, which often corresponds to greater disability, with consequent loss of independence and social isolation. In addition, present-day families have fewer members and are more geographically dispersed than in the past, making assisting the disabled even more difficult. Finally, some cultural and environmental factors result in poor sensitivity to the need for the disabled to preserve a social role and active participation. The initial results of our project are encouraging. Our objective for the future is initiating at the start of the illness personalized assistance projects tailored to individual needs and adapted to the course of the illness, ensuring longer social participation and improved quality of life.

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(S23) Stabilometric Assessment of Sensory Impairments and Effect of Rehabilitation on People with Multiple Sclerosis

Background: Postural control is considered a complex motor skill derived from the interaction of multiple sensorimotor processes. The two main functional goals of postural control are postural orientation and postural equilibrium. Postur-

al orientation involves the active control of the alignment of body segments with respect to gravity and the support surface. To achieve these goals, the central nervous system must coordinate sensory strategies. Sensory information from somatosensory, visual, and vestibular systems must be integrated to interpret complex sensory environments. As the sensory environment changes, people need to reweigh their relative dependence on each of the senses. The ability to reweigh sensory information depending on the sensory context is important for maintaining stability when an individual moves from one sensory context to another. **Objective:** The experimental objective of this study was to evaluate balance under different sensory conditions and the effects of balance retraining in a sample of people with multiple sclerosis. **Methods:** A descriptive study and a randomized controlled trial were arranged. A consecutive sample of 53 subjects was assessed by means of clinical and instrumental tests. The inclusion criteria were the ability to stand independently for more than 30 seconds and the ability to walk for 6 m. A subgroup of 44 subjects was randomized into an experimental group or a control group. Group 1 received balance rehabilitation to improve motor and sensory strategies. Group 2 received balance rehabilitation not involving the use of sensory strategies. Following evaluation of balance disorders and group allocation, each subject received intensive practice with a multidimensional exercise program. Because of the high variability of symptoms, a tailored rehabilitation program was developed based on each group's specific protocol. For both groups, the principles of the motor learning approach were used. The Berg Balance Scale, The Dynamic Gait Index, and fall frequency were used to assess balance impairments, while the Dizziness Handicap Inventory and the Activities-Specific Balance Confidence scale were used to assess handicap and the level of balance confidence. To assess the impact of the treatment on sensory strategies, a stabilometric assessment was carried out under six sensory conditions. **Results:** We found a reduction in frequency of falls after treatment that showed statistically significant differences among groups ($P < .0001$). The stabilometric assessment demonstrated a statistically significant time per group interaction. Vestibular condition improved more with respect to other sensory conditions in the experimental group. **Conclusion:** Subjects with MS showed relevant impairment in sensory strategy and postural control. Rehabilitation appeared to be effective in improving the use of sensory strategies and reducing the frequency of falls.

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(S24) Updated Short and Graphic Ability Score (SaGAS)

Objective: Many patients begun on immunomodulating substances 15 years ago will soon reach disability levels not precisely defined by the Expanded Disability Status Scale (EDSS), the most commonly used assessment tool for patients with multiple sclerosis (MS). Among the shortcomings of

the EDSS are its restrictive emphasis on ambulation in the critical range (EDSS score 4–8), its limited sensitivity to changes, and its inadequate evaluation of upper-limb function. The MS Functional Composite (MSFC), proposed as an alternative, does not assess the hands separately, evaluates only a short walking distance (25 feet), and poorly defines the clinical significance of a z score. Thus there is an urgent need for a straightforward assessment tool that considers hand function separately, measures walking endurance precisely, and can be expressed using a clearly defined, clinically relevant interval scoring system. **Methods:** To meet this need, we added to the Nine-Hole Peg Test (NHPT) for left and right hands and 10-m Timed Walk (TMTW), the pre-existing components of our Short and Graphic Ability Score (SaGAS), the 3-min walking distance (3MWD) and simplified the scoring system by using a scale from 1 to 150 points on which a difference of 10 points represents a clinically meaningful change. **Subjects:** This study involved 903 consecutive patients (EDSS score, 1.5–7.0) with definitive MS who were being treated in our rehabilitation clinic; the patients were assessed at the beginning and at the end of their rehabilitation stay. **Measures:** The performances in time or distance on the four measures were expressed as a logarithmic function in four subscores (sS) ranging from 0 to 150. To take into account only clinically relevant changes, the subscores were constructed in such a way that any interval of 10 units corresponds to a change of 20% in the TMTWsS, the NHPTsS, and the 3MWDsS. The SaGAS was computed as the mean of the four subscores: $SaGAS = (TMTWsS + 3MWDsS + NHPTsS \text{ left hand} + NHPTsS \text{ right hand})/4$. **Results:** The correlation coefficients between the SaGAS and the EDSS ($r = -0.87$), the Nottingham Activities of Daily Living Index ($r = 0.89$), and the Rivermead Mobility Index ($r = 0.91$) were all statistically significant ($P < .001$). The SaGAS was significantly more sensitive than the EDSS for the changes occurring during the rehabilitation stay (16.3% vs. 7.9%; $P < .001$) as well as after 1-year follow-up for 472 patients (22.7% vs. 16.5%; $P < .05$). **Conclusion:** The updated SaGAS is a simple, valid, and sensitive non-physician-based measure that is an alternative to the MSFC and is a welcome complement to the EDSS for moderately disabled patients for whom the "gold standard" fails to provide comprehensive assessment.

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(S25) Role of Robot-Assisted Gait Training in People with Multiple Sclerosis

Background: Interest is growing in robot-assisted gait training for patients with central nervous system disorders such as stroke, brain injury, spinal cord injury, and multiple sclerosis (MS). Only a few published effect studies have been published, however, and most of them were not controlled or randomized. **Objective:** On the basis of a literature review, we aimed to summarize the published evidence regarding robot-assisted gait training in MS. **Methods:** Using "robot" and "multiple sclerosis" as keywords, we searched the PubMed and Web of Knowledge databases. **Results:** Two studies were found: 1) Beer et al. (*Mult. Scler.* 2008) studied the effect of 3 weeks of robot-assisted gait

training compared with conventional walking training in 35 MS patients with Expanded Disability Status Scale (EDSS) scores between 6 and 7.5. Although the patients with robot-assisted gait training improved significantly on 20-m walking velocity, 6-min walking distance, and strength of the left and right quadriceps muscles, the only improvement for which a statistically significant difference was found from the conventional therapy group was the strength of the right quadriceps muscle. 2) Lo et al. (*Neurorehabil. Neural Repair* 2008) compared body-weight-support treadmill training with and without robot assistance in a crossover study involving 13 MS patients. After six training sessions of each intervention, significant improvements were observed in the timed 25-foot walk (31%), the 6-min walk treadmill test (38.5%), and the EDSS score (1 point). Again, no significant differences were found between treadmill training with and without robotic assistance. **Conclusion:** The evidence in currently available published articles indicates that while robot-assisted locomotor training can improve gait function in patients with MS, the effect does not seem superior to those of existing training methods. Given the cost of the robot devices, this raises a question about their efficiency. Technical improvements may enhance the efficacy of the robot systems.

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(S26) Effect of Lokomat on Spasticity in Multiple Sclerosis

Background: At the National MS Centrum in Melsbroek, we had the opportunity to have a Lokomat (Hocoma, Zurich, Switzerland) in our therapy room for 1 month. The time period was too short to accomplish a detailed study, but we monitored the presumed effect of walking with the Lokomat on spasticity in people with multiple sclerosis (MS). **Methods:** The study included 17 people with MS who met the inclusion criteria. While the patient exercised on the Lokomat, we measured the resistance of the spasticity in the hips and the knees in flexion/extension at three different speeds. The measures were obtained before and after the training session. **Results:** The results are in progress.

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(S27) Improving Balance Control Using a Tongue-Placed Tactile Biofeedback Device in Patients with Multiple Sclerosis: A Pilot Study

Background: The treatment of balance disturbances is frequently unsatisfactory and time-consuming. Traditional techniques usually have a treatment duration of about 20 daily sessions. **Objective:** The present study introduces a new biofeedback system designed to improve balance control in patients with multisensory dysfunction (somatosensory, visual, and vestibular) such as those with multiple sclerosis (MS). The aim of this pilot study was to evaluate the efficacy of this system despite a short treatment duration. **Methods:** Among 25 consecutive MS patients, a group with the following characteristics was selected: 1) secondary progressive MS, 2) Expanded Disability Status Scale (EDSS) score

between 3.5 and 5.5, 3) absence of clinical exacerbation or pharmacologic modification during the previous 4 weeks, and 4) presence of balance disorder at the initial clinical assessment. All the patients were treated for 10 sessions over 5 days (two daily sessions of 21 min each with a 4-hour break) in a dark and quiet room. The patients were situated in the corner of the room, not touching the wall. On the superior surface of the tongue, the therapist applied the biofeedback device: a small accelerometer that highlighted the head position and generated a continuous perceptible but painless biofeedback stimulus. The intraoral interface was connected to a computerized controller system. During the session, the patient received the electrical impulse through the interface, trying to maintain the stimulus in the middle of the tongue depending on postural modifications. The training consisted of standing without shoes and with eyes closed in a standard position, then with feet close to the midline, and then in the Romberg or modified Romberg position. The exercise sequence was performed first on the floor and then on a latex pillow. The last part of the training was done on an elastic feedback pillow only in a standard position. Each component of the training took 3 min. The degree of difficulty of the training was adjusted for each patient depending on clinical features. The assessment at the beginning and at the end of the treatment consisted of clinical (Tinetti Balance Scale and Berg Balance Scale) and kinematic evaluation (NeuroCom SMART Balance Master; NeuroCom International, Inc, Clackamas, OR, USA). **Results:** Eight patients who met the enrollment criteria participated in the study. After 5 days of treatment, an improvement in the results of clinical and kinematic evaluation was observed in the patients with vestibular and somatosensory deficits. **Conclusion:** In conditions of sensory disturbance, the central nervous system can use tactile information as functional compensation. These preliminary results indicate that this new technical device is useful to treat balance disorders in MS patients. Randomized controlled studies are needed to confirm these results.

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(S28) Multidimensional Assessment and Rehabilitation Pathways in a Residential Setting

Introduction: In patients with multiple sclerosis (MS), cognitive and sociorelational deficits are often less considered in the rehabilitative context than motor deficits. Evaluating the relevance of these aspects in a residential setting could be the first step in an integrative pathway toward a more complete and tailored treatment program. **Objective:** The objective of this study was to perform a multidimensional psychological assessment of 13 patients diagnosed with MS and analyze the results. **Methods:** The participants in this study had Expanded Disability Status Scale (EDSS) scores of ≥ 4.5 ; illness durations of 3 to 20 years; and predominantly primary progressive rather than secondary progressive MS. Psychological assessment included both cognitive functions (either laboratory or naturalistic tasks) and sociorelational abilities. **Results:** The most frequent cognitive profile (46%) was characterized by concomitant impairment of attention,

memory, and executive functioning (planning). A less frequent profile featured deficits in memory and executive skills. Attention, planning of visuospatial sequences, and auditory-verbal short-term memory were the most involved cognitive processes. The naturalistic tasks were better able to detect problem-solving difficulties in everyday life. Eighty percent of the study participants showed disturbances in the sociorelational dimension; in fact, they showed a low level of self-determination regarding decisions about the future. The perception of quality of life was particularly limited with respect to satisfaction with well-being (38.5%), financial status (46%), and living environment (38.5%). **Conclusion:** The results of this study highlight the usefulness of a multidimensional and naturalistic assessment in deciding about rehabilitation priorities (cognitive vs. relational disorders; deficit compensation vs. disability modification) and in planning activities supporting cognitive-behavioral independence in a residential setting for patients with MS.

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(S29) MusicArTherapy in the Globality of Languages for People with Multiple Sclerosis

Background: MusicArTherapy in the Globality of Languages (MAT-Gol; Guerra Lisi, 2000, 2008; Stefani et al., 2007) is designed to foster expression in all languages, both verbal and nonverbal, and is based on the pedagogical and therapeutic aspects of the arts. Emphasizing the crucial role of communication, it takes a holistic approach, considering the patient's full expressive potential and promoting the safe and autonomous manipulation of materials. **Objective:** The objective of this study was to evaluate the effectiveness of MusicArTherapy in people with multiple sclerosis (MS), focusing on increasing expressive-communicative skills and stimulating proprioception. **Methods:** Eighteen consecutive patients with chronic progressive MS (12 females, 6 males; Expanded Disability Status Scale [EDSS] score, 4–8) were assigned to four experimental groups, each consisting of four or five patients. Each group underwent three weekly 1-hour MAT-Gol sessions (a total of 12 sessions in 1 month). The types of activities were as follows: four graphic-pictorial sessions (with musical synesthesia, with olfactory synesthesia, with finger paints, with tissue paper); two manipulation sessions (tactile stimulation with flour and with colored sugar); two writing-narration sessions; and four music sessions (two of active listening and musical instrument playing and two of passive listening for relaxation). At the end of each session, patients performed guided self-interpretations of the artistic works produced. A satisfaction questionnaire was administered to all participants. **Results:** The sequence of activities allows the patients to acquire familiarity with the various expressive forms, provides time for socialization required to reduce their inhibitions, and

enables them to personally develop each form of stimulation. The therapy resulted in an increase in personal dynamic experimentation. A great expressive freedom and communicativeness emerged as patients overcame their initial inhibitions relating to working with the materials and speaking about their own experiences and their interpretations of their artistic productions. The satisfaction questionnaire showed top scores in 100% of cases. **Conclusion:** MAT-Gol is a promising approach to rehabilitation in MS patients. Future studies will include more specific functional and psychological measurement scales.

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(S30) Effect of Hypogravity Exercise on Clinical Scales and Proinflammatory Index in People with Multiple Sclerosis

Objective: To evaluate and analyze fatigue levels, functional independence, and the degree of autonomy in patients with multiple sclerosis (MS) with specific clinical scales correlated to the serum levels of specific inflammatory markers of demyelination (tumor necrosis factor alpha [TNF- α], interleukin-6 [IL-6], reactive oxygen metabolites [d-ROMs]). **Design:** We investigated the effectiveness of hypogravity treatment in bringing about clinical improvement in MS patients and its possible anti-inflammatory effect. **Subjects:** Twenty-two patients (10 male, 12 female; average age, 49 years) with relapsing-remitting MS were enrolled in the study. **Methods:** Each patient followed an 8-week outpatient therapeutic exercise program in a hypogravity environment (swimming pool). At the beginning and at the end of the treatment, the patients were evaluated with a series of clinical scales (Functional Independence Measure [FIM], Barthel Index, Fatigue Severity Scale [FSS]) and underwent peripheral blood testing for inflammatory markers. The patients were divided into two subgroups: group A underwent treatment twice a week and group B, three times a week. **Results:** A substantial improvement was observed on all clinical scales, with significant differences found in the FIM ($P < .0001$) and Barthel Index ($P < .0001$) values and reduction of FSS values ($P > .05$). In addition, a corresponding reduction was observed in serum levels of specific inflammatory markers of the demyelinating process: TNF- α ($P < .05$), IL-6 ($P < .001$), and d-ROMs ($P > .05$). **Conclusion:** This initial treatment in a hypogravity environment resulted in significant clinical improvement in the disability level of these subjects and a considerable increase in autonomy and self-sufficiency. A reduction of the chronic inflammatory state that characterizes patients with MS was also evident.

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