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Clin Rehabil 2007; 21; 603

DOI: 10.1177/0269215507075495

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Effects of an intensive rehabilitation programme on patients with Huntington's disease: a pilot study

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Received 31st May 2006; returned for revisions 9th October 2006; revised manuscript accepted 26th November 2006.

Objective: To investigate the effects of an intensive, inpatient rehabilitation programme on individuals affected by Huntington's disease.

Design: A pilot study. Within-subjects design.

Setting: Inpatient rehabilitation home of the Italian welfare system.

Subjects: Forty patients, early and middle stage of the disease, were recruited to an intensive, inpatient rehabilitation protocol.

Interventions: The treatment programme included respiratory exercises and speech therapy, physical and occupational therapy and cognitive rehabilitation exercises. The programme involved three-week admission periods of intensive treatment that could be repeated three times a year.

Main measures: A standard clinical assessment was performed at the beginning of each admission using the Zung Depression Scale, Mini-Mental State Examination (MMSE), Barthel Index, Tinetti Scale and Physical Performance Test (PPT). Tinetti and PPT were also used at the end of each admission to assess the outcomes in terms of motor and functional performance.

Results: Each three-week period of treatment resulted in highly significant ($P < 0.001$) improvements of motor performance and daily life activities. The average increase was 4.7 for Tinetti and 5.21 for PPT scores. No carry-over effect from one admission to the next was apparent but at the same time, no motor decline was detected over two years, indicating that patients maintained a constant level of functional, cognitive as well as motor performance.

Conclusions: Intensive rehabilitation treatments may positively influence the maintenance of functional and motor performance in patients with Huntington's disease.

Introduction

Huntington's disease is a severe neurodegenerative disease caused by a CAG repeat expansion of gene *IT15* on the short arm of chromosome 4.^{1–3} The age at onset is on average between the third and fourth decade of

life and the disease duration about 15–20 years.^{4,5} Drug therapies provide purely symptomatic benefits often accompanied by unwanted side-effects.^{4,6}

The clinical picture changes during the course of the disease and different patterns may be observed. Choreic movements are the major motor feature, especially at onset, resulting in disturbance of gait and exaggeration of gesture and facial expression.⁷ Dystonia is also present, with impaired control of voluntary movements resulting in slowness and muscle contraction, distorting different segments of the

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body resulting in characteristic postures.^{4,7,8} Bradykinesia, hypokinesia, akinesia and rigidity are other important and frequent features in early and advanced stages of the disease.^{6,8-10} Posture, balance and gait impairment progressively worsen as a consequence of both voluntary and involuntary movement disturbances and can lead to frequent falls.¹¹⁻¹³ A wide range of psychiatric anomalies may also occur at any stage¹⁴⁻¹⁹ and progressive cognitive impairment is present with decline of intellect, disturbance of memory and reduced capacity for conceptual thought.²⁰⁻²² Dysarthria is a common symptom, presenting as slurred speech. At a later stage, a marked weight loss is an integral manifestation of the disease as well as dysphagia resulting in poor respiratory control, choking and asphyxia. A consequent, most frequent cause of death is pneumonia due to aspiration of food.^{23,24}

There is very little research examining the effectiveness of rehabilitation for people with Huntington's disease. In a recent review of the current literature examining the outcomes of physiotherapy, occupational therapy and speech interventions for these patients, Bilney and colleagues identified only a very limited number of journal articles reporting rehabilitation outcomes at an observational level, often limited by small sample size, poor data about disease severity, cognitive and functional ability in patients, and failure to use well-known and validated measurement tools for measuring therapy outcomes.²⁵ Despite these shortcomings, the authors concluded that the studies examined in their review showed some evidence to support physiotherapy for the management of motor and balance impairments and respiratory exercise for the management of eating and swallowing difficulties.

Rehabilitation in Huntington's disease has also received a solid scientific foundation and theoretical support in recent mice model studies suggesting that environmental stimulation delays the degenerative loss of cerebral volume in mice.²⁶⁻²⁹ This remarkable effect of environmental enrichment in delaying the onset of the disease in affected mice suggested a possible positive impact of rehabilitation programmes on human patients too.

Considering that there was some evidence to support rehabilitation for people with Huntington's disease, we designed a research protocol in order to get a first reference of the effect of rehabilitation therapy in these patients. Our study has the following unique features: (1) in contrast to other studies that have only

looked at outpatient or less intensive programmes, it is an intensive inpatient programme; (2) it examines the effectiveness of a multidisciplinary programme with an interdisciplinary approach (therapists working together as a team, sharing professional skills with each other and teaching each other basic competencies of own discipline)³⁰; (3) it looks at physical outcomes as well as psychosocial aspects (mood, behaviour in familial and social life), and (4) it takes a longitudinal approach.

In the present paper we report the effects of the first two years of rehabilitation treatment including respiratory exercises and speech therapy, physical and occupational therapy and cognitive rehabilitation exercises in a sample of Huntington's disease patients and the quantitative evaluations of the outcomes.

Methods

Subjects

Forty patients (17 men and 23 women) were enrolled in the study. The participants were recruited among the patients referred to the outpatient clinic of the Neurology Department at the University Hospital 'A. Gemelli' in Rome. Criteria for the inclusion of patients in the programme were as follows:

- 1) Willingness of the patient to join the study.
- 2) Early and middle stage of the disease, corresponding to stages I-III of the Shoulson & Fahn Rating Scale. The scale divides disease severity into five stages (from I = initial symptoms to V = totally impaired) defined by the patient's score on the Total Functional Capacity (TFC) section of the Unified Huntington's Disease Rating Scale (UHDRS), a research tool that has been developed by the Huntington Study Group to provide a uniform assessment of the clinical features and course of Huntington's disease. The TFC scale details level of function in the domains of workplace, finances, domestic chores, activities of daily living and requirements for unskilled or skilled care.³¹⁻³⁴ Stages I-III include patients with worsening motor symptoms (jerking and twitching of the head, neck, arms and legs, staggering when they walk), with slurred speech and difficulties in swallowing. Their thinking and reasoning skills are gradually

diminishing with the effect of making it difficult for them to hold a job and to carry out household responsibilities.

- 3) Absence of current severe psychiatric disease based on DSM IV (Diagnostic and Statistical Manual of Mental Disorders) including schizophrenia, major depression, aggressive behaviour and/or suicidal ideation as assessed through a clinical psychiatric interview with the patients and the patient's medical history collected with patient and carers.³⁵
- 4) An acceptable mental performance, with mild or no dementia, definable as the ability to understand the study plan and to give consent, the ability to understand and perform the exercises explained by the therapists, an MMSE score >20 .³⁶

All patients were symptomatic and received a diagnosis of Huntington's disease prior to enrolling in the study (from <1 to >10 years before). The diagnosis was then confirmed by a clinical neurologist with specific expertise in movement disorders, based on the presence of unequivocal extrapyramidal movement disorder (e.g. chorea, dystonia, bradykinesia, rigidity, abnormal ocular movements) on examination, in a subject at risk for Huntington's disease, estimated by the rater with a diagnostic confidence $>99\%$ according to a key item of the UHDRS,^{34,37} a positive family history of the disease and/or the documentation of the presence of the mutation by genetic testing, which was available for the majority of patients (82.5%). CAG repeat length ranged from 40 to 54, corresponding to the number of the CAG repeats (range 39–54) reported in Italian patients.^{38,39} According to the most recent studies, repeats of 40 or above cause the disease with complete penetrance; repeats of 50 or above are associated with an onset in young age (<21 years).^{40–42}

Regarding the correlation between the size of the CAG repeat expansion and the age at onset, several studies indicate that other genetic (modifier genes) and environmental factors contribute to the variability in age at onset.^{43–45} In contrast, no relationship exists between the number of CAG repeats and the rate of clinical decline.^{46,47} The progression of symptoms remains uncertain, especially in the early and middle stages.^{31,47}

The participants and their families were informed in detail about the aims and the protocol of the study and the ISTC/CNR ethical committee reviewed and approved all the project's procedures.

Timing of treatment and patient assessment

The patients who fulfilled the inclusion criteria were recruited to the study. Starting from a day best suited to the patient within the first three years of the study, each patient was admitted to the rehabilitation home for three weeks of intensive treatment that could be repeated three times a year. The rehabilitative treatment was performed in an intensive regimen for 8 hours a day for five days and 4 hours a day for one day per week (mornings only on Saturday; Sunday free).

At the first admission the patient's basic information was collected such as age at symptom onset, year of diagnosis and disease duration, clinical characteristics of the disease, and drug intake. At the beginning of each admission a standard clinical assessment was performed using the following measures:

- Zung Depression Scale: a 20-item questionnaire covering affective, psychological and somatic symptoms associated with depression. A total score is derived by summing the individual item scores, and ranges from 20 to 80. Most people with depression score between 50 and 69, while a score of 70 and above indicates severe depression.⁴⁸
- Mini-Mental State Examination (MMSE): a brief cognitive examination designed to assess the overall cognitive status of patients. MMSE tests five areas of mental status (orientation; registration; attention and calculation; recall; language) and is scored on a scale of 30, with 0 being profoundly impaired and 24–30 normal for most adults.³⁶
- Barthel Index: an instrument scoring 10 basic activities of daily living items performed by the patient (0–100).⁴⁹
- Tinetti Scale: a 28-point scale measuring sitting and standing balance, the ability to stand from a sitting position and the smoothness of gait. Higher scores indicate better performance.⁵⁰
- Physical Performance Test (PPT): a standardized nine-item test that measures performance on functional tasks (writing a sentence, simulating eating, putting on and removing a jacket, lifting a book to place it on a shelf, picking up a coin, turning 360 degrees, walking, stairs climbing). Many items are timed assessing not only the accuracy but also the speed of performing the task. Maximum score is 36 and lowest scores indicate poorest performance.⁵¹

Tinetti Scale and Physical Performance Test were also administered at the end of each admission to

assess the outcomes in terms of motor and functional performance.

Qualitative data regarding the evaluation of the rehabilitation experience by the patients and their caregivers were also collected through an appropriately devised questionnaire. The results give interesting information about rehabilitation effect beyond the physical outcomes and will be reported elsewhere.

Treatment procedures

On the basis of the above assessment, an individualized treatment programme of exercises was set up. The exercises were performed both individually and in a group format. The treatment programme included respiratory exercises and speech therapy, physical and occupational therapy and cognitive rehabilitation exercises.

Respiratory rehabilitation was aimed at increasing the efficiency of breathing and coughing as a prevention of lung infections. Visual and tactile stimulation from common objects was used as an aid to make it easier for the patient to continue the exercises at home (blowing a tissue at varying distances, blowing to inflate a ball, or to make soap bubbles etc.).

Respiratory treatment was jointly conducted by the physiotherapist and the speech therapist as increasing the breathing efficiency may be associated with exercise of the face and mouth muscles that are essential for swallowing, chewing and eating, maintaining facial expression and the mobility necessary for communication.

Other core areas of the rehabilitation practice were: gait, balance and transfers training, strengthening, co-ordination and postural stability. The exercises were mainly directed to the trunk, upper and lower limbs and face and were completed in lying, sitting and standing positions. Some exercises involved the use of an exercise bike (a stable bicycle, fixed to the floor, that patients can mount for pedalling in a safe way), a step, a treadmill, rolling table (a small wooden table put on a rolling ball to balance on), exercise weights, wall bars and all the common gym equipment. Other exercises focused on postural training (for instance, transferring body weight from one leg to the other or walking with hands clasped behind the back) or aimed at maintaining muscle flexibility and strength (mat exercises). All the exercises were aimed at prevention of falls and recovery of correct walking, body control, movement co-ordination and equilibrium maintenance,

optimizing motor performance and encouraging a more confident attitude towards the body.

The occupational therapy, through individually tailored exercise programmes, was aimed at 'adaptive' improvement (i.e. learning new strategies to perform tasks made progressively difficult, if not impossible, by the disease progression). By means of activities stimulating memory, planning strategies and prolonging concentration patients were taught strategies for swallowing, or walking or standing up in a safe way, promoting safety in the environment and autonomy in eating, personal hygiene and dressing. Cognitive rehabilitation exercises were mainly directed to improve attention, memory, oral and written language. The rehabilitation programme for attention started with a training period aimed at prolonging the individual attention span through specific exercise (i.e. looking for letters or figures in a complex pattern). During the training period (phase 1) the exercise was performed without distracting elements, while after the training (phase 2) 'distractors' such as music or background noises were added.

Rehabilitative intervention for general memory used metacognitive strategies (i.e. teaching methods to facilitate memorizing) as well as external aids commonly used in everyday activities (i.e. calendars, diary). Rehabilitative intervention for verbal memory focused on semantic as well as visual components. Rehabilitation programmes for oral language were based on dialogues stimulating the patient's ability to use and correctly interpret metaphors, synonyms and proverbs and the capacity to summarize stories or someone's spoken words. Written language also played an important role in the rehabilitation plan for its relevance in communication.⁵²⁻⁵⁶ Patients were carefully observed by the therapists and the course of therapy modified as their performance of the exercises improved and they became more independent in their activities.

Outcome measures

We considered two measures of the treatment effect on motor performance: the effect on balance and gait and the change in performing functional tasks. Scores for these variables were available at the beginning (BF = before treatment) and at the end (AT = after treatment) of each admission.

Cognition, depression and functionality in daily living activities were assessed only at the beginning of

each admission. We reviewed depression and function only at the beginning of each admission because we did not expect, in three weeks, relevant changes to be detected by the instruments used.

Statistical analysis

Scores for all the considered variables were analysed through analysis of variance. Level of significance was set at $P \leq 0.05$. Because there was a different number of patients for each admission this rules out the possibility of analysing treatment and admission for all patients enrolled at the start. In order to do a more complete analysis of the effect of the two factors and to capture all benefits of the within-subjects design, five separate analyses of variance were made on different groups of admissions (1–2, 1–3, 1–4, 1–5, 1–6). This means that for analyses 1–2, admissions 1 and 2 were considered, and for analyses 1–3 the first three admissions were taken into account and so on. Each analysis of variance was made on a different number of subjects.

Tinetti and Physical Performance Test scores were analysed considering as factors 'treatment' (before/after) and 'admissions', while for Zung, Barthel Index and the Mini-Mental State Examination, which were available only at the beginning of each admission, only the factor 'admissions' was considered. The instruments we used (Tinetti and Physical Performance Test) are widely known and used in research and we considered them to be reliable. All analyses were conducted by the Systat statistical package (SPSS Inc., Chicago, USA).⁵⁷

Results

The sociodemographic and baseline clinical characteristics of the 40 patients (17 men and 23 women) enrolled in the study are summarized in Table 1. No significant effect of sex and stage of disease was detected in any of the variables as assessed through analysis of variance. The CAG repeat length was available for 33 patients with a mean of 45.4 (3.5), corresponding to a condition of full penetrance of the disease and to an age at onset that can vary from 20 to >50 years.^{40,58} Our patients had a mean age at onset of 43.2 (10.7) years, ranging from 21 to 61 years. Their baseline functional characteristics (Table 1) clearly reflect the selection criteria for inclusion in the

Table 1 Baseline sociodemographic, clinical and functional characteristics of the Huntington's disease patients enrolled in the protocol over a three-year period ($n = 40$)

Patients	Values
Male: female (n)	17:23
Age (years)	43.2 (3.3)
Education (years)	10.2 (3.3)
Age at onset (years)	43.2 (10.7)
Disease duration (years)	8.8 (4.0)
CAG repeat length ($n = 33$)	45.4 (3.5)
Barthel Index: 0 (bad) to 100	86.3 (19.0)
MMSE: 0 (bad) to 30	24.9 (3.3)
Zung: 20 (good) to 80 ($n = 39$)	34.3 (8.1)
Tinetti Scale: 0 (bad) to 28	17.0 (6.6)
PPT: 0 (bad) to 36	23.1 (7.4)
Shoulson Stage: I to V (n)	
I	11
II	11
III	18

Unless otherwise stated, values are means (SD).

SD, standard deviation; CAG, repeat length triplets number ($n \geq 40$, pathological range); MMSE, Mini-Mental State Examination; Zung, Zung Depression Scale; PPT, Physical Performance Test. Shoulson, Shoulson & Fahn disease stages (from I – initial stage to V – end stage).

study group (Shoulson stage I–III). Zung scores ranged from 22 to 54 indicating a condition from normal to mildly depressed and the cognitive level was satisfying for the inclusion criteria reported above (Mini-Mental State Examination mean score was 24.9, SD 3.3).

Regarding the rehabilitation outcomes, mean scores for depression (Zung), cognition (Mini-Mental State Examination) and daily living functionality (Barthel Index) are presented in Tables 2, 3 and 4. Overall, no significant changes were found in the three measures across admissions for each combination examined, indicating that patients maintained the initial level and did not deteriorate beyond the baseline scores over the time. Moreover the two significant differences for depression indicate a score reduction for the admissions examined 1–2 and 1–3 (34.55 versus 32.39; 35.68, 33.64, 31.68) which corresponds to an amelioration of the psychological state (Table 2).

Mean scores for Tinetti and Physical Performance Test are presented in Tables 5 and 6. Results were analysed through six different analyses of variance: the first one only considering the factor 'treatment' and the other five considering both factors, 'treatment' and

Table 2 Depression mean scores (Zung) as measured at the beginning of each admission and statistical results (analysis of variance)

Admissions examined	Mean time past from baseline (months)	No. of cases	Admission						Overall means	Main effect of admission $F(df), P$
			1	2	3	4	5	6		
1	Baseline	39	34.30							
1-2	6.4	31	34.55	32.39					33.47	$F(1,30) = 6.4, *$
1-3	12.6	25	35.68	33.64	31.68				33.67	$F(2,48) = 5.2, **$
1-4	18.3	19	35.58	34.74	31.95	34.26			34.13	$F(3,54) = 1.8, ns$
1-5	22.1	14	37.07	36.64	33.29	34.71	33.71		35.08	$F(4,52) = 1.9, ns$
1-6	24.3	9	36.22	36.78	31.56	36.67	34.89	37.33	35.57	$F(5,40) = 1.8, ns$

df, degree of freedom.

* $P = 0.05$; ** $P = 0.01$; ns, not significant.**Table 3** Cognition mean scores (MMSE) as measured at the beginning of each admission and statistical results (analysis of variance)

Admissions examined	Mean time past from baseline (months)	No. of cases	Admission						Overall means	Main effect of admission $F(df), P$
			1	2	3	4	5	6		
1	Baseline	40	24.90							
1-2	6.4	31	24.81	24.90					24.85	$F(1,30) = 0.1, ns$
1-3	12.6	25	24.60	24.56	24.88				24.68	$F(2,48) = 0.3, ns$
1-4	18.3	19	24.05	24.21	24.95	25.05			24.57	$F(3,54) = 1.7, ns$
1-5	22.1	16	23.13	23.50	24.06	24.31	23.63		23.72	$F(4,60) = 1.2, ns$
1-6	24.3	11	23.18	22.82	23.64	24.09	23.55	22.64	23.32	$F(5,50) = 0.9, ns$

df, degree of freedom; ns, not significant.

Table 4 Activity of daily living mean scores (Barthel Index) as measured at the beginning of each admission and statistical results (analysis of variance)

Admissions examined	Mean time past from baseline (months)	No. of cases	Admission						Overall means	Main effect of admission $F(df), P$
			1	2	3	4	5	6		
1	Baseline	40	86.30							
1-2	6.4	31	88.23	87.10					87.66	$F(1,30) = 0.6, ns$
1-3	12.6	25	87.80	86.20	86.60				86.87	$F(2,48) = 0.3, ns$
1-4	18.3	19	90.26	86.58	85.53	85.00			86.84	$F(3,54) = 2.0, ns$
1-5	22.1	16	89.69	86.25	85.00	83.75	85.00		85.94	$F(4,60) = 1.6, ns$
1-6	24.3	11	92.27	86.82	85.91	88.18	85.46	91.36	88.33	$F(5,50) = 1.9, ns$

df, degree of freedom; ns, not significant.

Table 5 Means and statistical results for Tinetti scores: overall means, main effect of two factors examined (treatment and admission) in series of patients with different number of consecutive admissions (analysis of variance)

Admissions examined	No of cases	Admission						Overall means		Main effect of treatment F(df), P	Main effect of admission F(df), P
		1	2	3	4	5	6	BT	AT		
1	40	1700	2130							F(1,39) = 81.9, P < 0.001	
1-2	31	1716	2168	16.45	20.77			16.81	21.22	F(1,30) = 103.5, P < 0.001	F(1,30) = 1.0, ns
1-3	25	16.72	21.32	16.48	21.40	14.84	19.60	16.01	20.77	F(1,24) = 108.2, P < 0.001	F(2,48) = 2.8, ns
1-4	19	16.21	21.00	16.05	21.37	14.16	19.68	15.32	20.45	F(1,18) = 167.4, P < 0.001	F(3,54) = 1.5, ns
1-5	16	15.63	20.50	16.56	21.19	13.81	19.00	15.19	19.94	F(1,15) = 185.7, P < 0.001	F(4,60) = 1.6, ns
1-6	11	17.18	21.82	17.18	22.18	15.64	20.73	15.97	20.79	F(1,10) = 165.1, P < 0.001	F(5,50) = 1.6, ns

BT, before treatment; AT, after treatment; df, degree of freedom; ns, not significant.

Table 6 Means and statistical results for Physical Performance Test (PPT) scores: overall means, main effect of two factors examined (treatment and admission) in series of patients with different number of consecutive admissions (analysis of variance)

Admissions examined	No of cases	Admission						Overall means		Main effect of treatment F(df), P	Main effect of admission F(df), P
		1	2	3	4	5	6	BT	AT		
1	40	23.10	27.90							F(1,39) = 70.8, P < 0.001	
1-2	31	23.65	28.55	22.03	27.10			22.45	28.00	F(1,30) = 94.8, P < 0.001	F(1,30) = 3.9, ns
1-3	25	23.00	28.40	22.12	27.36	21.44	26.40	22.24	27.45	F(1,24) = 93.1, P < 0.001	F(2,48) = 2.3, ns
1-4	19	21.74	28.05	21.37	27.16	21.42	27.26	22.32	27.48	F(1,18) = 142.9, P < 0.001	F(3,54) = 0.2, ns
1-5	16	21.44	27.81	22.00	26.94	21.13	26.94	21.85	27.20	F(1,15) = 183.2, P < 0.001	F(4,60) = 0.5, ns
1-6	11	22.36	28.00	22.55	28.00	21.82	26.36	21.52	26.71	F(1,10) = 177.2, P < 0.001	F(5,50) = 1.6, ns

BT, before treatment; AT, after treatment; df, degree of freedom; ns, not significant.

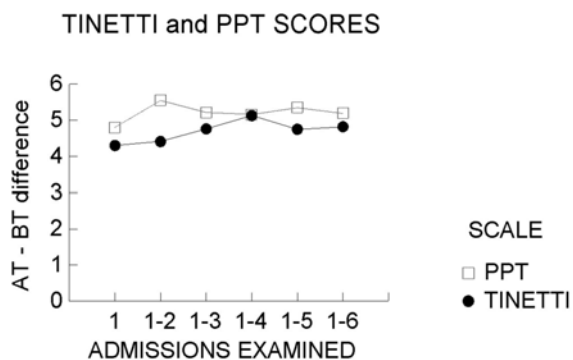


Figure 1 Tinetti and Physical Performance Test (PPT) mean differences before and after treatment, across admissions examined.

'admission'. The means after treatment were always better than those before treatment, suggesting a positive effect of treatment on motor and functional performance. The overall effect of treatment on motor performance was always significant ($P < 0.001$, F and df shown in Table 5 and 6). Each admission produced a gain in Tinetti and Physical Performance Test scores. The average increase before and after treatment was +4.7 for Tinetti and +5.21 for Physical Performance Test scores. The mean improvements considered for the first single admission and for each combination examined (1-2, 1-3 . . . 1-6) are graphically illustrated in Figure 1. In contrast, the overall effect of 'admission' was always non-significant. While some caution must be present with negative results, the absence of the main effect of 'admission' and of the interaction 'treatment*admission' strongly suggests a long-term maintenance of the baseline levels.

Discussion

This is the first study examining the effects of an inpatient, intensive rehabilitation treatment on patients with Huntington's disease. Rehabilitation in Huntington's disease poses many difficulties: it is a progressive disease, with no known cure, characterized by different patterns of symptoms and demanding a multidisciplinary approach with many different disciplines and professionals involved; it is a rare disease (the prevalence in Western countries is between 30 and 70 affected individuals per million inhabitants)⁷ and a very limited

number of patients can be involved in a research protocol. These and other aspects of the disease influenced the organization of our study in many different ways.

First, the 40 patients enrolled in our study came from 12 Italian regions. The impossibility of activating, training and coordinating outpatient programmes in 12 different regions largely determined the choice to study the rehabilitation therapy effects through an inpatient programme. For the same reason, a randomized controlled study was impossible at this stage.

Out of the 40 patients included in the study, 11 patients underwent all six possible consecutive admissions in two years. The other participants had a variable number of subsequent admissions either due to the enrolment in the study group at different time during the first three years of the study or to the organizational difficulties of families in accompanying the patient three times a year to the rehabilitation home so far from their residence, or to an unforeseeable sickness (for instance a cold season accident) affecting the patient and making a new admission impossible at the fixed time. Notwithstanding all these difficulties, the rehabilitation programme influenced in a positive manner these patients with Huntington's disease as shown by the significant treatment effect on motor performance as assessed with Tinetti and Physical Performance Test and for all combinations of admission examined. The different number of admissions was independent of specific characteristics of the patients: if we compare the 11 patients who attended all six admissions with the other 29 patients, no differences emerge either for sociodemographic variables or for clinical variables.

The individually tailored exercise programmes resulted in immediate highly significant improvements of motor performance and functionality in activities of daily life. The absence of a significant effect for 'admission' seems to indicate that patients maintained a constant level of functional, cognitive as well as motor performance for at least two years. Although the lack of a control group in our study is a weakness that suggests caution, the maintenance of a baseline level over such a period should be stressed, since Huntington's disease is characterized by a constant decline in performance and clinical instability.^{7,14,59} In the future we plan to set up a new study with a randomized controlled design.

Among our results, we also want to stress the significant improvements in depression scores (Zung) registered for admissions 1-2 and 1-3 and a trend towards amelioration of mood state in the other com-

binations examined, although it was not statistically significant (probably due to the low number of patients with more consecutive admissions).

Overall, the results of our study on Huntington's disease are in line with those published on similar disorders, such as Parkinson's disease. Significant, immediate improvements are reported after programmes of exercise administered in different settings, either at home or in hospital, individually or in a group format.^{60,61} A recent systematic review of rehabilitation for Parkinson's disease suggests that interventions can have positive effects on patients' lives in many different ways.⁶² Notwithstanding the difficulties of drawing effectiveness conclusions from different studies, the authors note that the non-pharmacological interventions have a useful, adjunctive role that is not disputed by the available evidence. Moreover, just as in our study, it is also common experience that only a marginal part of the gain is maintained after the end of rehabilitation treatment^{62,63} and continuous treatment may be needed to maintain the improvements.

The qualitative evaluations of the rehabilitation experience by the patients and their caregivers (how they evaluated the outcomes and which changes, if any, they noticed) as well as the meaning of Zung score improvements in terms of patients' quality of life, will be explored in a forthcoming paper.

The results obtained in our study show that involving individuals affected by Huntington's disease in an intensive, residential, multidisciplinary rehabilitation programme positively influences their motor and functional performance and results in an overall stable condition at least for two years. The disease is still progressive and incurable but it may be lived in a better condition.

The value of non-pharmacological interventions in helping people with Huntington's or similar chronic degenerative diseases has been underestimated in comparison with the benefits of pharmacological therapies. The heterogeneity of the therapy methods and of the outcome measures used in the various studies make it difficult to find conclusive evidence of benefit for any form of paramedical intervention. However, it has been remarked that this lack of evidence is not a proof of lack of effect.⁶⁴ Larger, scientifically robust studies are needed in order to assess the efficacy of non-pharmacological interventions in chronic, neurodegenerative diseases. Nowadays, as populations age, the development of rehabilitative strategies aimed at delaying the progression of motor dysfunction and improving autonomy may have eco-

nomie benefits as it might be possible to postpone the need for institutionalization of such patients.⁶⁵

Over the last 15 years geneticists and psychologists have been able to explore the field of predictive medicine using Huntington's disease and to build up a positive model of a genetic testing protocol. In the field of rehabilitation, the beneficial effects of treatment evidenced for these patients in our study could contribute to the design of a rehabilitative model for the physical and psychological components of chronic neurodegenerative disorders.

We hope our experience may ameliorate patients' way through the illness and change the stereotypical view in medical training of Huntington's disease as a hopeless disease and of rehabilitative medicine as a less qualitative approach.

Acknowledgements

This project was supported in part by a grant from the Presidency of Italian National Research Council to MF and in part by a grant from the Ministry of Health to GJ (Project RF02, no. 239).

The authors thank all the patients who participated in the study and their families; the professional staff of Home Care 'Nova Salus' for investing their energies and competence in this project; the No-profit Association A.I.C.H.-Roma Onlus for collaboration; Dr Belinda Bilney for reviewing the manuscript before submission.

Conflict of interest

None declared.

Clinical messages

- An intensive, residential, multidisciplinary rehabilitation programme determines significant immediate improvement of motor and functional performance in Huntington's disease patients.
- Continuous treatment may be needed to maintain the improvements.
- Larger randomized controlled studies are required to assess the long-term cost-effectiveness of multidisciplinary rehabilitative treatments for these patients.

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