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ICF model implementation in an interdisciplinary intervention for intraparenchymal hemorrhage (IPH) with focus on neuropsychological functioning: a case report

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ABSTRACT. Spontaneous intraparenchymal hemorrhage (IPH) is relatively common and has a very important impact on clinical outcomes, motor and functional abilities and it may affect different cognitive domains. A 60-year-old male was admitted in post-acute phase, at Istituti Clinici Scientifici Maugeri IRCCS, to undertake neuro-motor treatment for a period of 4 months. The patient was affected by IPH. The clinical presentation revealed left hemiparesis, mild dysphagia, cognitive deficits (attention, visuospatial abilities and executive functions), psychiatric symptoms, emotional dysregulation and previous difficulties in medication management. The patient received an intensive cognitive, motor, speech and occupational rehabilitative intervention. Neuropsychological, motor, speech and occupational assessment and computerized tomography were performed before and after rehabilitative training to evaluate changes after the interdisciplinary intervention. The patient showed an improvement in cognitive, motor, speech and functional performances as well as in emotional aspects. After 1 year at home, the patient performed an outpatient visit that shown the substantial maintenance of the performances reached after the rehabilitative intervention. Rehabilitative interventions after IPH should always be provided by interdisciplinary teams in order to reach the best possible clinical outcomes and to maintain them over time.

Key words: *intraparenchimal hemorrhage, cognitive rehabilitation, interdisciplinary intervention, case report.*

RIASSUNTO. Implementazione del modello ICF in un intervento interdisciplinare per pazienti con emorragia intraparenchimale con focus sul funzionamento neuropsicologico: un caso clinico.
L'emorragia intraparenchimale spontanea è una condizione clinica relativamente comune e ha un importante impatto sui risultati clinici, sulle abilità motorie, funzionali e sulle funzioni cognitive. Un uomo di 60 anni, con emorragia intraparenchimale spontanea già precedentemente trattata chirurgicamente, è stato ricoverato presso Istituti Clinici Scientifici Maugeri IRCCS, in fase post acuta, al fine di intraprendere un percorso riabilitativo interdisciplinare della durata di 4 mesi. Al ricovero il paziente presentava emiparesi sinistra, lieve disfagia, deficit cognitivi (attenzione, abilità visuo-spaziali e funzioni esecutive), sintomi psichiatrici (modificazioni comportamentali), disregolazione emotiva e pregresse difficoltà nella gestione della terapia farmacologica. A seguito della valutazione delle diverse aree di funzionamento, il paziente è stato sottoposto ad un trattamento riabilitativo cognitivo, fisioterapico, logopedico ed ergoterapico intensivo. Le valutazioni neuropsicologiche, fisioterapiche, logopediche, occupazionali e la tomografia

Introduction

Spontaneous intraparenchymal hemorrhage (IPH) refers to the rupture of damaged small arteries or arterioles. Recognition of risk factors, early distinction from an ischemic event and identification of clinical characteristics that can worsen IPH complications are important in improving the outcomes (1). IPH has a low percentage of incidence between the cases of stroke (from 6.5% to 19.6%) but is associated with the greatest rate of mortality (1).

IPH also has a great impact on functional abilities and cognitive functions and it may affect different cognitive domains such as attention, executive functions and memory. According to the aim of the present study, the focus will be on the impairment related to right cerebral hemisphere damage. People who had a right-side stroke can manifest difficulties with depth perception and with judging where they are in relation to their surroundings. This makes it difficult to locate objects, walk up or down stairs, bring food to their mouth, or get dressed (2,3). The right side of the brain is also related to intuitive thinking, so reasoning and problem solving may be affected. Moreover, right hemisphere damage can cause impairments in different cognitive domains, such as memory, attention, executive functions and also communication abilities (3). So far, evidence from literature has suggested that, after an acquired brain injury, comprehensive psychological and neuropsychological programs which address the cognitive and interpersonal functioning should be implemented through individualized interventions and be integrated into an interdisciplinary approach (2).

Therefore, we proposed a personalized, intensive and short-term training program by adopting a multidimensional approach. We used an integrated approach that includes diagnostic and rehabilitative procedures: psychotherapy to support patient's psychological disease-related issues and to improve treatment adherence, cognitive training by using strategies to improve residual abilities and to recover the impaired cognitive functions (2), speech therapy for the evaluation of eventual communication issues and swallowing function, physiotherapy and occupational therapy for the physical and disability disease-related consequences (4). All these aspects were considered within the framework of the International

computerizzata sono state effettuate a inizio ricovero e prima delle dimissioni al fine di valutare gli eventuali cambiamenti avvenuti a seguito dell'intervento riabilitativo effettuato. Il paziente ha mostrato miglioramenti in tutte le aree valutate e trattate. Inoltre, dopo un anno dalle dimissioni è stato possibile osservare un sostanziale mantenimento del livello funzionale ottenuto durante il ricovero. Gli interventi riabilitativi interdisciplinari, per pazienti con emorragia intraparenchimale, dovrebbero essere sempre effettuati al fine di raggiungere i migliori esiti clinici possibili e per far sì che tali miglioramenti possano essere mantenuti nel tempo.

Parole chiave: emorragia intraparenchimale, riabilitazione cognitiva, intervento multidisciplinare, caso clinico.

Classification of Functioning, Disability and Health (ICF) that was used to assess and quantify the disease-related issues, to plan the interdisciplinary intervention and to supervise the patient's rehabilitative pathway (5-6).

The primary aim of this case report was to describe a specific neuropsychological treatment after right cerebral hemisphere IPH within an intensive and interdisciplinary rehabilitative intervention. The secondary aim was to describe the outcomes of the interdisciplinary rehabilitative program by radiological, neuropsychological and ICF evaluation at discharge and a further outpatient ICF evaluation after one year.

Case Description, assessment and intervention

A 60-year-old male right-hand patient was admitted in 2018 to the Clinical Scientific Institutes Maugeri, IRCCS – Neuromotor Rehabilitation Unit after a right IPH, surgically treated, resulting in left hemiparesis. His medical history included hypertension, dyslipidemia and mild chronic kidney disease. Because of left hemiparesis, mild dysphagia, cognitive deficits and psychiatric symptoms, the patient underwent a 4-months neuro-motor treatment at our rehabilitative Institute. The patient signed an informed consent for all procedures and explanations at hospital admittance and a further informed consent for the publication of the case.

The instrumental examinations confirmed the diagnosis of left hemiparesis after right IPH. Indeed, electroencephalography (EEG) results showed theta-delta activity in right frontal, temporal and parietal regions. Computerized Tomography (CT) showed parenchymal hypodensity in the cortical and subcortical structures of the right parietal lobe with blurred linear central hyperintensity and a residual hematic hyperdensity (T_0) (Figure 1).

At baseline evaluation, the patient was awake, partially oriented at temporal and spatial level, and he was motivated concerning the treatment and collaborating.

Psychological assessment and intervention. The patient is from Northern Italy and he is the owner of a construction of residential and non-residential buildings firm. He has eight years of education, he is married, and has two daughters. At psychological interviews, he referred that he had severe difficulties to manage the pharmacological treatment for hypertension as prescribed before the hemorrhage. Moreover, he lived an intense period of psychophysical stress (i.e., the grief for his father's death). He was conscious of his clinical condition and his health history. He was a non-smoker and he referred occasional alcohol assumption. Mood deflection was appropriate to his clinical condition. The socio-familiar context appears to be supportive. A brief cognitive behavioral psychotherapy was provided focusing on reducing psychiatric symptoms, anxiety, depression and on medication adherence improvement. Furthermore, the psychological intervention was also focused on maintaining and increasing a high motivation for the interdisciplinary treatment.

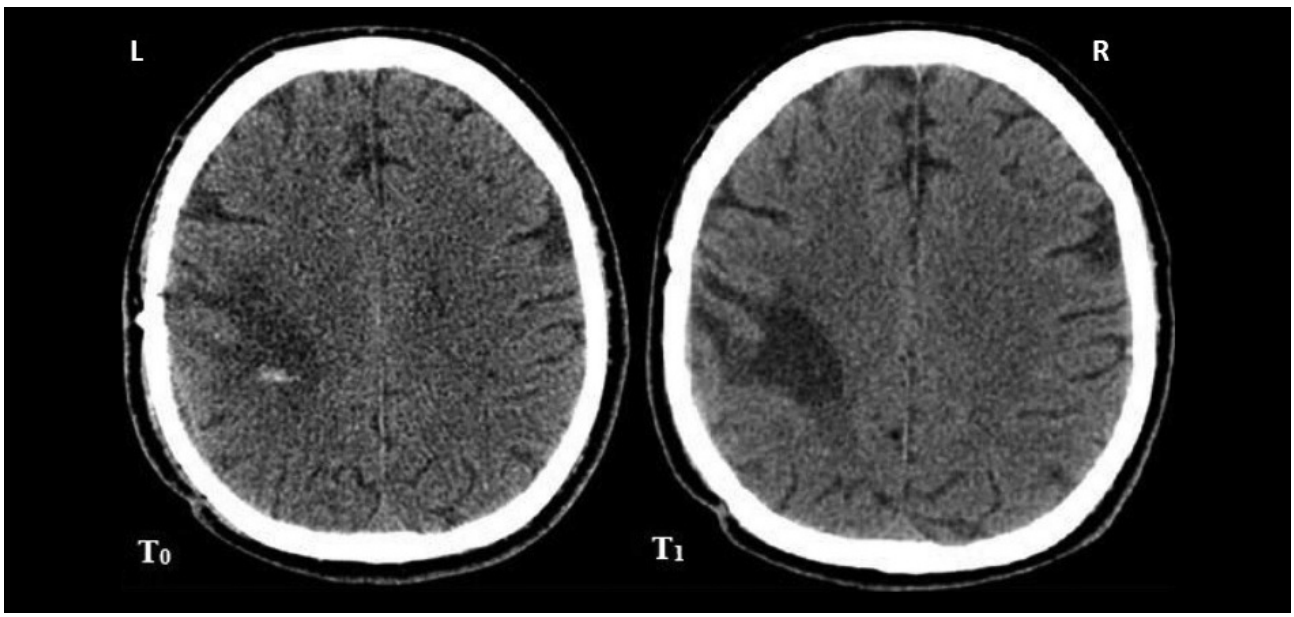

Figure 1. ***CT at the admission (T_0) at the Maugeri rehabilitative center and at discharge (T_1)***
T_0 showed parenchymal hypodensity in the right parietal lobe with blurred linear central hyperintensity and a residual hematic hyperdensity. T_1 showed reabsorption of the residual hematic hyperdensity in the right parietal lobe

Neuropsychological assessment and intervention. It was performed by using a set of standardized tests (7) for different cognitive domains (see Table I). Neuropsychological evaluation (T_0) showed a framework of visual-spatial and attention deficits. In particular, the most critical aspects were visual-spatial memory (both short and long term memory), visual-spatial exploration, selective and divided attention and praxis abilities. Executive functions were impaired (conceptualization, mental flexibility, motor programming, sensitivity to interference and inhibitory control), too. Nevertheless, there were some residual cognitive abilities, such as verbal short and long-term memory, verbal fluency and language.

Cognitive rehabilitation was provided over a period of 4 months, for 30 sessions. Each session lasted 30/40 minutes. It was performed with paper and pencil or computer exercises for spatial orientation, praxis, visual-spatial abilities and attention. Paper and pencil exercises were taken by Feuerstein Instrumental Enrichment (FIE) standard (8). The patient conducted exercises focused on point organization, spatial orientation, comparisons and analytic perception. The patient performed FIE schedule during the rehabilitative session and also independently (supervised during the following session). These exercises were administered in order to improve monitoring abilities, inhibition of irrelevant information and problem-solving strategies (8-9). Computer exercises, focused on alert ability, selective, divided and sustained attention, were administered through the CogniPlus program. This latter is a training battery in which every exercise is tailored to a specific deficit and it is up-to-date with scientific knowledge. It is able to identify the patient's ability levels and to adapts automatically to it (10). The program allows also a performance monitoring of every training with graphs and results tables, in order to enhance consciousness about cognitive difficulties but also to increase motivation toward cognitive rehabilitation. Overall, exercise gradually increased in term of difficulty along the rehabilitative sessions (Table II). Each session was accompanied by emotional support and psycho-educational interventions to improve the problem-solving ability and emotional self-regulation.

Table I. ***Neuropsychological evaluation before (T0) and after (T1) cognitive rehabilitation training (7)***

	Range	NV	AS (T_0)	AS (T_1)	ES (T_0)	ES (T_1)
Screening Test						
Mini Mental State Examination	0-30	≥23,8	**23,25**	**29,25**	**CI**	**No CI**
Short Term Memory						
Digit Span (Verbal)	0-9	≥3,75	**6,00**	**6,00**	**4**	**4**
Corsi's block-tapping test (Visual-Spatial)	0-9	≥3,5	**3,00**	**4,00**	**0***	**2**
Verbal Long Term Memory						
Prose memory (Short story)						
Mean of recalled items	0-28	≥8	**21,50**	**17,50**	**4**	**4**
Rey's 15-Word						
Immediate Recall	0-75	≥28,53	**35,30**	**43,30**	**2**	**4**
Delayed Recall (15')	0-15	≥4,69	**5,70**	**7,70**	**1**	**3**
Visual-Spatial Long Term Memory						
Rey complex figure - Delayed Recall (10')	0-36	≥9,47	**6,00**	**13,00**	**0***	**3**
Attention						
Progressive Matrices	0-60	≥31	**24,75**	**34,75**	**0***	**1**
Trail Making Test						
Test A sec.		≤93	**n.a.**	**88,00**	**n.a.**	**1**
Test B sec.		≤282	**n.a.**	**92,00**	**n.a.**	**4**
B-A sec.		≤186	**n.a.**	**4,00**	**n.a.**	**4**
Executive Functions						
Frontal Assessment Battery	0-18	≥13,5	**8,30**	**11,30**	**0***	**0***
Language						
Word Fluency		≥17,35	**31,50**	**23,50**	**4**	**2**
Semantic Fluency		≥25	**45,00**	**50,00**	**4**	**4**
Perceptual, Constructional and Visual-Spatial Abilities						
Clock Drawing Test						
Free Drawn (FD)	0-15	≥7,57			**2**	**4**
Rey complex figure- Copy	0-36	≥28,88	**11,00**	**27,00**	**0***	**0***
Logical Reasoning						
Raven's Progressive Matrices	0-48	≥20,73	**22,50**	**24,50**	**1**	**1**

NV, Normative Value; AS, Adjusted Scores; CI, Cognitive Impairment; ES, Equivalent Scores correspond to a five-point interval scale divided as follows: 0 indicates a performance to the worst 5% of the population; 4 indicates scores higher than the median value of the whole sample; 1. 2 and 3 are obtained by dividing into three equal parts the area of the distribution between 0 and 4;
*=Impaired scores; n.a., not assessable

Table II. ***Summary of rehabilitation activities performed with the patient***

Cognitive Functions	Rehabilitation activities
Selective Attention	Exercises aimed at improving the ability to analyze the training material by developing appropriate strategies for its use (e.g. identification of visual or acoustic targets in series of verbal or non-verbal stimuli presented on paper or computer screen) with or without interference or interruptions.
Sustained Attention (Concentration)	Performing gradually longer and more complex tasks without interruptions and with as few errors as possible (e.g. numerical progressions forward or backward, lists of words with certain semantic or phonological characteristics, computerized video games).
Divided Attention	Exercises that require simultaneous attention to different information (e.g. computerized video games simultaneously with mental activities such as answering questions or solving simple calculations) with a focus on respecting the priorities of one task on the other.
Executive Functions and reasoning abilities	Planning and solution of simple problems (analysis of characteristics, inferences, classifications, logical sequences, analogies, differences) with verbal and visual material. Planning and solution of complex functional problems (explaining the effects and causes of a situation, or the means and purpose of a strategy, solving practical problems related to everyday life).
Praxis and visual-spatial abilities	Improve visual-spatial perception and visual-spatial mental representation abilities. Increase the variety of analysis strategies of perceptive reality (analytical and systematic, summative, confrontational and exclusion). Improve the visual-spatial orientation, first using criteria related to the subject and the present situation and, secondly, external, generalizable and universally recognizable criteria (front, back, above, below and cardinal points).

Physiotherapeutic assessment and intervention. The first motor assessment revealed a left hemiparesis. The upper limb showed a predominant proximal motor deficit (1/5 Medical Research Council Scale for Muscle Strength – MRC Scale) (11) and signs of impaired fine motor skills. In the ipsilateral lower limb was present a hyposthenic active motility (2,5/5 MRC Scale). The trunk control in the sitting position was poor with a tendency to retropulsion, while the standing position and walking were not assessable.

The motor rehabilitation intervention was focused on the lower limbs muscular strength's improvement and the recovery of motor and proprioceptive control of the left upper limb and trunk. Subsequently, balance and proprioception training was introduced to achieve and maintain an upright position. In the last part of the hospitalization, the rehabilitation treatment consisted mainly of a walking and going up/down stairs training. Physiotherapeutic rehabilitation was provided over a period of 4 months, for 75 sessions. Each session lasted 60 minutes.

Speech assessment and intervention. The patient underwent to an assessment of language and swallowing function: the absence of aphasia was tested by the Italian version of Aachener Aphasie Test (AAT) (7) and the evaluation of swallowing function showed the presence of moderate dysphagia (Dysphagia Outcome and Severity Scale – DOSS, score=4) (12), confirmed by videofluoroscopy. The daily treatment of 30 minutes for a total of 27 sessions, for dysphagia was aimed at the recovery of safe and efficient swallowing, in particular for solid consistency.

Occupational assessment and intervention. The patient underwent an overall assessment of independence and disability, which highlighted the need for direct assistance in all activities of daily living (ADL), in transfers to and from the wheelchair, in bed positioning and in the wheelchair use/push. The functional evaluation of the injured upper limb denoted serious alteration, with deficits in hand strength and grip, and feeble motor signs at the proximal and intermediate level. The daily treatment, of 60 minutes for a total of 70 sessions, of occupational therapy was aimed at the recovery of personal independence, training to and from wheelchair transfer, positioning in bed and correct posture in a wheelchair (Figure 2, label ICF d465). In addition, a specific treatment was dedicated for the reconditioning of the damaged upper limb, starting from the structural rebalancing to the functional use (Figure 2, label ICF d445).

Results

After four months of rehabilitation treatment (T_1), CT showed reabsorption of the residual hematic hyperdensity in the right parietal lobe (Figure 1). ICF scores are presented in Figure 2.

Neuropsychological results. At the second psychometric evaluation (Table I), the patient showed improvements in visual-spatial memory, selective and divided attention (ICF b140, b144). Some residual deficits persist in executive functions, visual-spatial exploration and praxis abilities (ICF b156, b164).

Physiotherapeutic results. Concerning motor aspects, the patient achieved an increase in overall muscle strength (ICF b730) and an improvement in the motor control of the whole left side of the body (ICF b7302) with a slight residual deficit of left hand fine motility (ICF b7301). The upright station was reached without supports, conversely, walking, climbing and descending stairs needed a stick (ICF d450, d4551).

Speech results. After 30 sessions of speech therapy, the training was interrupted because the patient regained a

normal diet; the only need still present was extra time for meals (DOSS score=6/7) (ICF b510).

Occupational results. The patient achieved total independence in all ADLs except personal hygiene, which required a minimal level of assistance (ICF d5, d510, d520, d540). During the hospitalization, there was no more necessity to use the wheelchair since the patient regained the upright station without support. With regard to the upper limb, compared to admission, the patient regained greater awareness and acquired a natural use in functional activities with proximal and distal engagement (ICF d560).

At 1-year follow-up, a slight impairment persisted in the power (ICF b7301) and hand and arm use (ICF d445) of the left upper limb, and in the attentional/perceptual functions (b140, b156, b164). Nevertheless, the outcomes achieved after hospital discharge were maintained and improvements were observed in the emotional status (ICF b152), in the motor functions (ICF b760, d410, d450, d455, d4551, d465) and in the ADL and self-care (ICF b530, b620, d230, d5, d510). These results had a relevant impact on his everyday life once at home. In fact, the patient has substantially maintained the improvements obtained during the hospitalization. After discharge the patient underwent a physiotherapeutic treatment of 20 sessions, mainly focused on gait and balance stabilization. Moreover he attended Nordic walking tours organized by a center for people with disabilities. As to left upper limb the treatment was focused on loosening superior trapezius muscular contraction.

During the 1-year outpatient follow up visit, a satisfying recovery of socio-familiar and working life was reported. Specifically, the patient has resumed his work with

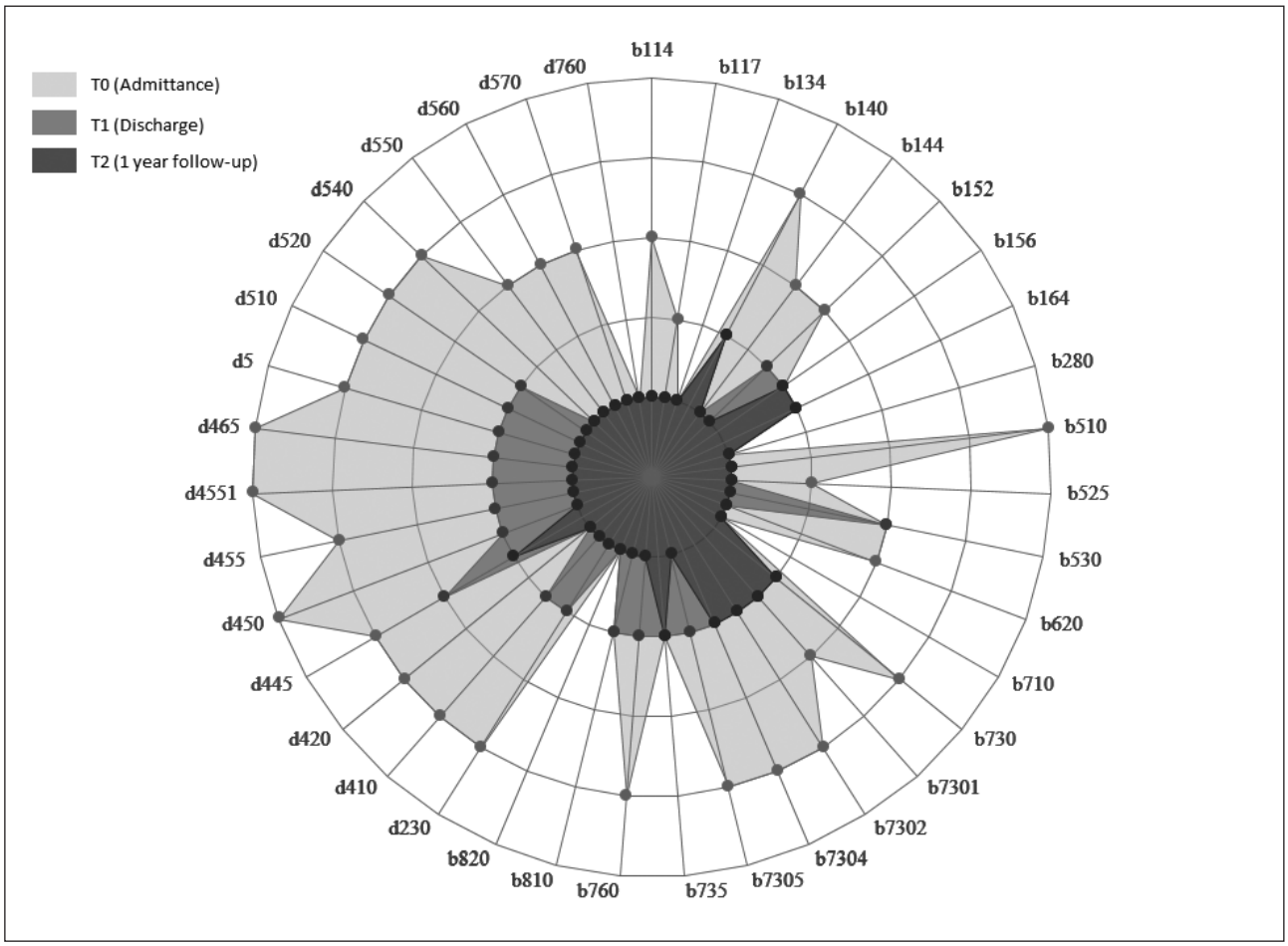

Figure 2. ***Graphic representation of the patient's disability at hospital admission and at discharge after the rehabilitative intervention. The wider the area within the profile, the higher the level of disability***

ICF category description: b114 (Orientation functions), b117 (Intellectual functions), b134 (Sleep functions), b140 (Attention functions), b144 (Memory functions), b152 (Emotional functions), b156 (Perceptual functions), b164 (Higher-level cognitive functions), b280 (Sensation of pain), b510 (Ingestion functions), b525 (Defecation functions), b530 (Weight maintenance functions), b620 (Urination functions), b710 (Mobility of joint functions), b730 (Muscle power functions), b7301 (Power of muscles of one limb), b7302 (Power of muscles of one side of the body), b 7304 (power of muscles of all limbs), b7305 (Power of muscles of the trunk), b735 (Muscle tone functions), b760 (control of voluntary movement function) b810 (Protective functions of the skin), b820 (Repair functions of the skin), d230 (Carrying out daily routine), d410 (Changing basic body position), d420 (Transferring oneself), d445 (Hand and arm use), d450 (Walking), d455 (exercise tolerance function) d4551 (Climbing), d465 (Moving around using equipment), d5 (Self-care), d510 (Washing oneself), d520 (Caring for body parts), d540 (Dressing), d550 (Eating), d560 (Drinking), d570 (Looking after one's health) and d760 (Family relationships) (13)

some differences: he did not renew the license to drive the truck but he maintained the organizational management of his firm. Furthermore, he learnt to use the computer and to perform his work related procedures by using it. His driving license is still suspended but he referred the willingness to get a disable driving license. Improvements in emotional and family relationships were also reported as well as a betterment in mood and adherence to medical prescriptions. As to everyday activities the patient referred that he did not feel any pain and he regained complete autonomy of movement by foot and he is able to resume some playful activities such as mountain walks.

Discussion and Conclusion

The present work outlines how cognitive deficits, which are common after a brain vascular event, are an important target for rehabilitation because as highlighted in literature they can be associated with a reduced quality of life and they interfere with motor and other types of recovery interventions (4). Rehabilitative interventions should always consider different areas (motor, occupational, cognitive, etc.) and should be therefore provided by interdisciplinary teams in order to reach the best possible clinical outcomes (14,15).

Our interdisciplinary approach by using pharmacological therapy, cognitive, motor, occupational and speech rehabilitation fostered a global recovery of compromised abilities. Therefore, this multidisciplinary and intensive intervention may be considered a sound example of a successful care and rehabilitative approach for patients affected by brain vascular events resulting in manifold kinds of impairments. Moreover, this report underlines also the potentialities of the ICF model to adopting a holistic and ecologic care approach. In particular, ICF enables to detect the keystone points for connecting the disease classification, the clinical care pathways, as well as the individualized rehabilitation project and program. Thus, ICF allows to consider not only the patient, rather the interaction between the individual and her/his environment, adopting a biopsychosocial perspective (5-6). Indeed, this classification "*provides a shared language within the multidisciplinary teams supporting a comprehensive assessment of an individual with a disability and facilitating treatment planning, which may aim to improve physiological function, maximize activity, alter the environment or support patient adjustment, all with a view to reaching a goal focused on participation*" (5).

The current holistic rehabilitative treatment allowed an improvement in disease awareness, pharmacological adherence and lifestyle changes that contributed to improve patient's autonomy and quality of life. Although rehabilitation goals were achieved and considerably sustained after one year, long-term healthcare assistance with interdisciplinary interventions might be useful to maintain the actual level of functioning and to support eventual future improvements.

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