Neuropsychological rehabilitation of acquired, non-progressive cognitive-behavioral disorders in evidence-based clinical recommendations

Rehabilitacja neuropsychologiczna nabytych, niepostępujących zaburzeń poznawczo-behawioralnych w zaleceniach klinicznych opartych na dowodach

Katarzyna Ewa Polanowska

Clinical Neuropsychology Laboratory, 2nd Department of Neurology, Institute of Psychiatry and Neurology, Warsaw, Poland

Key words
neuropsychological rehabilitation, neurorehabilitation, guidelines, recommendations

Abstract
Introduction: Neuropsychological rehabilitation is an important area of neurological rehabilitation. Its techniques are studied in terms of effectiveness and subjected to collective analyses in order to identify the best interventions.

Objective: The purpose of the article is to present current clinical recommendations for neuropsychological rehabilitation among adult patients with acquired, non-progressive brain damage usually caused by a stroke or head injury.

Data sources: The recommendations are based on the latest scientific papers containing systematic reviews and meta-analysis of studies on the rehabilitation of patients with cognitive dysfunctions and/or behavioral abnormalities.

Conclusions: To date, the highest recommendation and the status of practice standards in neuropsychological rehabilitation have been achieved by therapeutic techniques of 5 post-stroke disorders (attention deficits, mild memory deficits, left-sided visual neglect, aphasia, global decline in cognitive-behavioral functioning) and 5 post-traumatic disorders (attention deficits, mild memory deficits, mild and moderate executive dysfunctions, abnormalities in social functioning and interpersonal communication, global decline in cognitive-behavioral functioning). These techniques may be used independently or introduced in combination with interventions of a lower recommendation level, classified as practice guidelines or practice options. The use of lower grade recommendations should also be considered in situations where there are no standard techniques for specific forms of disorders. In the case of deficits for which no recommendations have yet been made, further research is necessary. This applies to agnosia, profound memory disorders and amnesia, as well as profound executive dysfunctions.

Słowa kluczowe
rehabilitacja neuropsychologiczna, neurorehabilitacja, wytyczne, zalecenia

Streszczenie
Wprowadzenie: Rehabilitacja neuropsychologiczna jest ważnym działem rehabilitacji neurologicznej. Jej techniki są badane naukowo pod względem efektywności i poddawane analizom zbiorowym, żeby wyodrębnić najsłutniejsze z nich.

Cel: Celem artykułu jest przedstawienie aktualnych zaleceń klinicznych w obszarze rehabilitacji neuropsychologicznej prowadzonej u dorosłych chorych z nabytym i niepostępującym uszkodzeniem mózgu, spowodowanym najczęściej udarem lub urazem głowy.

Źródła danych: Zalecenia pochodzą z najnowszych opracowań naukowych, zawierających systematyczne przeglądy i metaanalizy badań nad rehabilitacją chorych z dysfunkcjami poznawczymi i/lub nieprawidłowościach zachowania.

Wnioski: Jak dotychczas najwyższą rekomendację i status praktycznych standardów w rehabilitacji neuropsychologicznej zyskały techniki terapii 5 zaburzeń poudarowych (deficyty uwagi, lekкие zaburzenia pamięci, lewostronne zaniedbywanie wzroku, afazja, ogólne obniżenie funkcjonowania poznawczo-behawioralnego) i 5 zaburzeń poursazowych (deficyty uwagi, lekкие zaburzenia pamięci, lekкие i umiarkowane dysfunkcje wykonawcze, nieprawidłowości funkcjonowania społecznego i komunikacji interpersonalnej, ogólne obniżenie funkcjonowania poznawczo-behawioralnego). Techniki te mogą być stosowane samo-
INTRODUCTION

“...Behavioral dysfunctions impair the patient more frequently than sensory and motor deficit, because they disrupt mental, communicative and emotional interaction with the environment...”[A]. They may dominate the clinical picture or be the only disturbances that impair the performance of social roles and/or the independent life of the patient. It is therefore not surprising that therapy in this sphere of functioning referred to as neuropsychological rehabilitation has a rich tradition (dating back to nineteenth-century speech therapy) and is an integral element of neurological rehabilitation.

Neuropsychological rehabilitation comprises a variety of actions aiming to decrease cognitive, emotional and personality deficits following brain damage and increase the patient’s potential in terms of his/her mental, social, vocational, recreational, and/or daily activity[4-6,13]. Although usually associated with the improvement of cognitive functions (attention, memory, perception, cognitive organization of movement, language, visual-constructive, and executive skills), it also involves interventions aimed at improving emotional functioning and the modeling of behaviors[5,7].

Neuropsychological rehabilitation is carried out in the most justified and structured way in patients with acquired and non-progressive brain damage, the effects of which may be reduced as a result of both spontaneous recovery (compensatory neuroplasticity typical for the first few weeks and months after brain damage)[9-10] and therapeutic intervention (experience-dependent neuroplasticity)[4,11]. The largest recipient groups for such rehabilitation are patients after stroke, affecting mainly the elderly[11], and patients after traumatic brain injury (TBI), to which young people are most at risk[14-16]. There are also patients who have suffered brain damage caused by neuroinfection, hypoxic-ischaemic pathology (e.g. after sudden cardiac arrest[17,18]), the development and treatment of non-cancerous and benign tumors[19] as well as patients suffering from epilepsy.

Since neuropsychological rehabilitation relies upon the cooperation of patients with the therapist (and/or other participants of the therapeutic process, e.g. with the family), it is not suitable for use with people unable to interact and undertake therapeutic tasks. It is also not justified in people with the impairments of consciousness, which – proceeding with generalized disturbance of mental processes – prevents active and intentional interaction with others. Such rehabilitation is also not offered to patients with progressive cognitive impairments or dementia syndrome.

AIMS AND STAGES OF NEUROPSYCHOLOGICAL REHABILITATION

Neuropsychological rehabilitation should be introduced as soon as the patient’s general condition stabilizes and he/she is able to consciously participate in treatment. Before starting, the goals of therapy should be set based on the current evaluation of the patient’s cognitive performance and analysis of the patient’s functional and adaptation problems occurring in everyday life. These targets should be:— specific (addressed to particular disorders and/or functional problems);— realistic (possible to achieve);— time-defined (described in terms of the approximate time needed for their development);— measurable (possible to be assessed in a neuropsychological functional examination and/or test);— staged (modified depending on the clinical condition, phase of the brain injury, patient’s important needs and the effects of previous interventions).[5,6,11]

The adoption of specific goals is the basis for the decision regarding the form and methods of rehabilitation. In brain injuries where there is an acute phase and recovery process, an important criterion in method selection is the time that has passed since the onset of the damage. It is considered that early (so-called “acute”) rehabilitation in the first weeks – especially in the first quarter since the brain damage – and typically performed in hospital, is primarily intended to strengthen the brain’s spontaneous recovery processes, which are most dynamic shortly after falling ill and are responsible for the majority of functional benefits. Behavioral methods of activating and directing these processes involve undertaking activities that engage the impaired functions as well as preventing undesirable reactions and compensations. At this stage, depending on the patient’s condition, the therapy may take the form of individual, general cognitive stimulation (this applies to people with a syndrome of profound disturbances, generalized deficits and/or those with somatic complaints). Alternatively, it may involve specific training of functions (which applies to patients with less severe disorders and those able to cooperate actively), usually combined with psychoeducation and emotional support for the patient and his family.

In the later stages of rehabilitation (“post-acute”), the condition of most patients is stable enough to intensify activities and steer them onto the im-

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[A] Blażejewska-Hyżorek B., Czermuszenko A. Czlonkowska A., Drozdowski W., Gąscecki D., Kaźmiernik R., et al. Management of stroke. Guidelines from the Expert Group of the Section of Cerebrovascular Diseases of the Polish Neurological Society (Polish: Postępowanie w udarze mózgu. Wytyczne Grupy Ekspertów Sekcji Chorób Naczyniowych Polskiego Towarzystwa Neurologicznego). Neurrol Neurochir Pol 2012; 46 (Supl. 1): S1-S114 (quotation: S97).
important aspects of functioning. Therapy then takes the form of individual and/or group interventions, combined with educating the patients on their acquired disorders and the possibilities for overcoming them. Depending upon the severity of the neurological syndrome, this may be carried out in hospital, an outpatient or home environment. It is believed that training performed in the first six months and even up to a year following brain injury can still stimulate the already weakening self-repair mechanisms, and contribute towards improvement through learning. According to some scientists, the formation of necessary skills should proceed from an improvement of more basic functions (e.g. maintaining alertness, sustained attention) to higher-order skills (e.g. divided attention, working memory), for which the former are a fundamental component. One year after becoming sick, when the brain’s self-repair processes have likely ceased, rehabilitation can serve to further develop skills (if specific training is still effective), or to compensate for persistent deficits and support the patient in adaptation to life with a disability.

It is recommended that patients progress smoothly to subsequent stages of rehabilitation, so the therapy – as long as it is needed – is continuous. Currently in Poland, neuropsychological rehabilitation is guaranteed only to patients treated in inpatient departments of neurological rehabilitation (5 days of therapy per week, minimum 30 minutes daily for 6, 9, 12 or 16 weeks, depending on the severity of neurological disorders, the time since being discharged from the treatment center for the acute phase of brain damage and the presence of underlying conditions). Unfortunately, such treatment does not fall within the scope of the services provided in departments of systemic rehabilitation or those provided at home, outpatient or day clinics, to which people with brain damage may also be assigned.

RECOMMENDATIONS FOR NEUROPSYCHOLOGICAL REHABILITATION

The relationship between the cause of brain damage and its clinical consequences has an influence upon the specific character of rehabilitation needs in different groups of patients. In patients after stroke, the most common and most disabling cognitive dysfunctions are aphasia-type language and verbal communication deficits (strokes within vascularization of the left middle cerebral artery) and attention-perceptual disorders referred to as left visual or visual-spatial neglect (strokes in the basin of the right middle cerebral artery). Meanwhile, in patients after TBI, especially from a road traffic accident, there is often a frontotemporal pathology, manifested by executive, attention-memory dysfunctions and/or personality changes. Consequently, the rehabilitation of these afore-mentioned disorders is the main focus of the scientific research.

In an effort to optimize therapeutic activities, neuropsychological techniques are more and more often evaluated in terms of their efficiency, hoping to identify the most effective forms of intervention. Systematic reviews of studies and their collective meta-analyses are the basis to formulate recommendations in the field of evidence-based cognitive rehabilitation and related activities.

Although there are studies available in Poland regarding therapy for cognitive functions in adult patients (e.g. English: Guidelines for the management of stroke), in their classification, a high level of recommendation means that the research indicates probable effectiveness of the given intervention (footnote C), leading to the status of a practice standard of therapeutic procedure. An average level of recommendation means that the research indicates probable effectiveness of the given intervention (footnote C), leading to the status of a practice standard of therapeutic procedure. An average level of recommendation means that the research indicates probable effectiveness of the given intervention (footnote C), leading to the status of a practice standard of therapeutic procedure.
The guidelines developed by Ciccone’s team can be supplemented with conclusions drawn from the work of other expert groups (including the Cognitive Rehabilitation Task Group of the European Federation of Neurological Societies, EFNS)33, and also results of meta-analyses relating to particular cognitive disorders14,34 or specific forms of intervention35-37.

Practice standards in neuropsychological rehabilitation

The status of practice standard in neuropsychological rehabilitation means that each patient suffering from disorders specified in the recommendations who is able to actively cooperate in the therapy should be given the chance to benefit from these recommended forms of intervention. Presently, nine purely behavioral techniques of individual restitutive and/or compensatory therapy, typically applied in combination with meta-cognitive strategies aimed at developing the patient’s self-awareness as regards the acquired dysfunction, have attained this level of recommendation14,29,33. These techniques are listed in Table 1.

As Table 1 illustrates, in patients who have developed an attention deficit as a result of stroke or TBI, therapy should directly improve the disturbed functions in order to restore them as much as possible. In the case of fundamental attention deficits, which are expressed in intensity (reduced readiness to react, disturbances in alertness and vigilance)39, it is recommended to combine sustained attention training with acoustic warning stimulation (significant stimuli preceded by a sound signal) and a strategy of the patient’s self-instruction to be alert39. This combination should not only encourage better performance of the exercises, but also increase the probability of the therapy’s effects being generalized to daily activity29,33,39,40.

In the field of specific syndromes of attention disorders, such as left visual neglect after stroke (asymmetry of visual attention distribution towards stimuli located in the surrounding space to the disadvantage of the left side), visual scanning training is most commonly recommended29. This requires the patient to deliberately explore more and more complex visual material, during which various techniques of drawing attention to and/or deliberately directing the eyesight towards the neglected (left) side of the space are offered to him33,41.

In the case of mild post-stroke or post-TBI memory impairments, compensatory techniques are considered to be most effective, aimed at decreasing the distorting effect of the deficit on the patient’s everyday activity14. In compensation, which involves registering and checking important information, analog aids can be used (e.g. writing down a list of things to do in a calendar) and electronic appliances (e.g. audio-visual notifications on a mobile phone). For people with relatively isolated memory impairment, their use should minimize the effects of problems with remembering what needs to be done in the future (prospective memory) and with recollecting information about past events (retrospective memory). In addition, as part of influencing the memory processes themselves, it is recommended to learn mnemonics such as visualization and associations related to memorized material29,33,14,34,42. However, it is noted that benefits from additional processing of memory information are most likely in people with a slight memory deficit and a large cognitive reserve14. Hence, their introduction should be considered on an individual basis.

In people with left-hemisphere stroke, the standard should be therapy for aphasia and limb apraxia. In the field of aphasic syndromes (language impairments manifested in activities of listening, speaking, writing and reading), various cognitive-linguistic interventions are advised which are aimed primarily at improving the reception and formation of verbal messages, although – in milder aphasias – it is also important to improve written language. In the case of aphasic types not related with speech fluency disorders (referred to as fluent aphasias: Wernicke’s, transcortical sensory, anomic), it is sufficient to give language training alone, such as: exercises in understanding speech, naming objects/activities/phenaomena, production of speech with an appropriate grammatical, logical and content structure. However, therapy programs for patients with aphasias with speech dysfluency (known as non-fluent aphasias: Broca’s, transcortical motor, mixed, mixed transcortical) should include language exercises as well as articulation and/or prosodic exercises, as for instance in melodic intonation therapy (using melodic-rhythmic patterns for speech initiation and execution and increasing the extent of expression)13,44. Together with the appropriate choice of language tasks, their intensity is an important factor, as demonstrated by studies of constraint-induced aphasia therapy (focusing on improving spoken language whilst limiting all forms of non-verbal communication)45. This is reflected in the thesis that even short-term but intense therapy of aphasia is a better choice than regular therapeutic sessions stretched over a period of time46-48.

In turn, in apraxia (abnormalities in planning and cognitive organization of movement activities) specific gesture training is advised, to recognize and make adequate use of gestures19, together with exercises aimed at rebuilding habits and motor skills33,50. These exercises, due to their nature, should be performed as part of occupational therapy, ideally using real objects and tools whilst maintaining a natural situational context. When planning the therapy, one should remember potential limitations arising from the frequent coexistence of limb

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14 Low level of recommendation: studies of Class II (clinical observations) or III (clinical series without concurrent controls, single-subject designs), directly pointing to the effectiveness of the intervention and providing evidence for its possible effectiveness.29-32
apraxia with language disorders (possible consequences: difficulty in understanding verbal commands, verbal description of functional problems, self-instruction for movement activities) and/or basic motor deficits (e.g. difficulty in engaging limbs suffering paresis in ambidextrous activities).

In people with post-TBI abnormalities in social communication, conversation training and/or facial expression recognition training are recommended. They aim to improve the patient’s interpersonal skills and therefore counteract the social isolation caused by inadequate speech and emotional response. However, considering that injuries to the brain’s prefrontal areas often lead, in addition to personality changes, to general disorganization of the patient’s performance, it is also important to improve thinking skills. With mild and moderate executive dysfunctions (problems with planning and organizing cognitive and practical activity), it is recommended to apply interventions aimed at improving self-awareness of acquired dysfunctions and learning strategies for self-control and self-regulation of one’s own behavior. It is worth practicing these strategies in formal training, such as problem-solving training or goal-directed behavior management. They teach patients to handle issues in stages, adapting actions to changing circumstances, detecting and correcting errors, and predicting the effects of one’s own performance.

In a situation where the result of TBI or stroke is a generalized decline in cognitive functioning, patients should be offered complex, holistic rehabilitation programs including individual training for disturbed functions, group therapies on self-awareness of the condition and emotion-sal functioning together with education on how to deal with the consequences of the disorder.

Practice guidelines in neuropsychological therapy

Techniques with the status of practice guidelines (Table 2) should be used in addition to or as an extension to a standard procedure or offered when there are no methods with a higher level of recommendation.

As is apparent in Table 2, the presented guidelines consist of therapies for more profound cognitive impairments than indicated in practice standards (often aimed at important aspects of everyday functioning) as well as behavioral and non-behavioral interventions which look to enhance the effects of routine therapies and training with the use of computer programs. However, in terms of the latter, it is noted that patients do not perform computer exercises completely independently, despite their automation. In addition to the gen-
erally accepted advantage of training conducted under the supervision of a professional over independent activities, as an element of a more complex program of rehabilitation.

The quality of the scientific evidence (data indicating probable efficacy) supports the supplementation of the above guidelines with the non-behavioral, non-invasive technique of repetitive transcranial magnetic stimulation (rTMS) in patients with post-stroke chronic, non-fluent aphasia. Research shows its addition to standard speech and language training can increase the efficacy of rehabilitation, thanks to concomitant interactions at the cognitive and neurophysiological levels. The pro-therapeutic importance of rTMS is attributed to the reduction of differences in the levels of activity of the cerebral hemispheres caused by damage to one of them. In the case of aphasia, these differences are expressed by too low excitability of the hemisphere affected by the stroke, i.e. left (activation depression of the persistent cortical areas, including the components of the language system) and overactivation of the structurally intact right hemisphere (right-hemispheric hyperactivation, with the greatest excitability of structures opposite to the stroke location). According to previous studies, this activation “balancing” should be administered by way of inhibiting right hemisphere activity with low-frequency (≤ 1 Hz) rTMS, applying the stimulation coil to the head over the inferior frontal gyrus (the region opposite to Broca’s area, usually damaged in non-fluent aphasia). However, it should be noted that although the method is non-invasive, it cannot be used in people with contraindications to magnetic stimulation; it is sometimes poorly tolerated by patients; and should only be used by appropriately qualified personnel (licensed doctors or trained medical workers, working under a doctor’s supervision).

Table 3 shows that, in addition to the even wider use of modern electronic technologies (computer programs, virtual reality) in therapy planning, it is also worth considering: the principle of errorless learning (the selection of tasks and aids which eradicate the possibility of incorrect answers and corrections associated with trial and error learning), the functionality of proposed exercises (aimed at everyday and/or important life activities), group improvement of cognitive functions and/or the modulation of social behavior. However, it is noted that with severe cognitive-behavioral disorders the expected benefits from such interventions may not be realized when the activities are not practiced directly. Therefore, patients with serious cognitive syndromes should be offered therapies of the highest ecological value, understood as the incorporation of therapeutic activities to the reality of the patient’s life and that of their family.

Additional meta-analyses, where relatively few and small studies were identified, support the inclusion among rehabilitation options of therapy for acalculia and a combination of standard therapy of neglect syndrome with techniques of transcranial brain stimulation.
**Table 3**

| Cognitive Impairments | Brain Damage         | Therapeutic Practice Options (Rehabilitation Stage)                                                                 |
|-----------------------|----------------------|------------------------------------------------------------------------------------------------------------------|
| **Attention and perception** |                      |                                                                                                                 |
| Left visual neglect   | Right-Hemisphere Stroke | Using electronic technologies in visual scanning training                                                      |
| Deficits of visual perception without neglect | Right-Hemisphere Stroke | Training of visuospatial abilities and visual organization skills (early stage of rehabilitation)             |
| **Memory**            |                      |                                                                                                                 |
| Mild memory deficits  | TBI                  | Group therapy                                                                                                   |
| Severe memory deficits | TBI                  | Errorless learning strategy to acquire specific skills and knowledge                                           |
| **Language and spatial relations** |                      |                                                                                                                 |
| Acalculia             | Stroke TBI           | Re-education in terms of knowledge of numbers, arithmetic exercises                                            |
| **Social communication** |                      |                                                                                                                 |
| Language impairments and social communication deficits | TBI | Group therapy                                                                                                   |
| Cognitive and language deficits | Left-Hemisphere Stroke TBI | Computer-based tasks in addition to a standard program of therapy                                              |
| **Executive functions** |                      |                                                                                                                 |
| Mild and moderate executive dysfunction | TBI | Group interventions serving to improve self-awareness of disease symptoms, problem-solving abilities, behavioral self-control and emotional self-regulation (later stages of rehabilitation) |
| Severe executive deficits with limited awareness of disease and inability to compensate for deficits | TBI Stroke | Functional training for everyday skills, applying the principle of errorless learning                            |
| Cognitive-executive deficits | Stroke | Metacognitive strategy training as an element of occupational therapy (early stage of rehabilitation)          |
| **Cognitive functioning** |                      |                                                                                                                 |
| Functional cognitive disorder | TBI Stroke | Integrated program of individually selected and targeted trainings to increase independence in home and work life |
| Functional cognitive disorder | TBI Stroke | Group-based interventions targeted at increasing functional self-awareness, independence and/or general improvement of mental well-being as a component of comprehensive-holistic therapeutic programs |

Understanding the number system and counting, it is recommended to gradually rebuild in patients the knowledge of numbers and their relations and also to improve their counting skills by performing more and more difficult arithmetical tasks.33

Meanwhile, in people with poststroke left visual neglect one may consider combining cognitive training with rTMS56,57 or with transcranial direct current stimulation (tDCS)57. The methods differ in terms of impact on brain processes; while both may be used in order to inhibit the undamaged (potentially overactive) left hemisphere (low-frequency rTMS; cathodal tDCS: ≤ 2 mA), only tDCS is used to enhance activation of the damaged hemisphere, i.e. right one (anodal tDCS: ≤ 2 mA)54. However, the decision to use these methods should be taken in the context of their existing low level of recommendation and the possible workload and discomfort caused by the treatments54,55.

**Limitations and shortcomings in existing recommendations**

Despite the growing number of studies on techniques of neuropsychological rehabilitation, the body of evidence remains small and the research too heterogeneous (different forms and parameters of trainings, various clinical characteristics of the subjects) to try to estimate the minimum “doses” of therapies needed to obtain functional benefits (among others, duration of exercises, frequency and number of therapeutic sessions) or to specify interventions in terms of their detailed rules and stages of the procedure.

Another insufficiently explored area is the effectiveness of standard therapies of various cognitive impairments in patients with coexisting health problems. Clinical observations indicate that psychological characteristics with a particularly unfavorable impact on therapies include: executive dysfunctions associated with disorganization and lack of insight into one’s illness, aggression, irritability, anxiety or depression. Their presence, for instance, in people with memory impairments can impede the implementation and independent use of even simple compensatory techniques. In turn, negative somatic factors include: pathological fatigue, pain, visual disturbances, epileptic seizures57.
Beyond the need for further research in those areas with established recommendations, for many other neuropsychological deficits guidelines have not yet been created at all due to either a shortage of studies or their low methodological value. This problem concerns such rare disorders as alexithymia (an inability to identify/express feelings), which is an important part of the neuropsychological deficits guidebook in terms of standard recommendations, for many other neuropsychological deficits guidebook guidelines and options of therapeutic procedure. The primary objective of the therapeutic programs should be to maximize the patient’s independence and improve their quality of life.

SUMMARY

Neuropsychological rehabilitation is an important part of the neuropsychological rehabilitation process in adult patients with acquired and non-progressive brain injury. Training of cognitive functions and interventions that model emotional reactions and social behavior should serve to restore important skills and/or compensate for remaining impairments, and to adapt patients to the consequences of their condition. Rehabilitation programs should be created following current recommendations in terms of standards, guidelines and options of therapeutic procedure. The primary objective of the therapeutic programs should be to maximize the patient’s independence and improve their quality of life.

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Address for correspondence
Katarzyna Ewa Polanowska, Ph.D. 2nd Department of Neurology, Institute of Psychiatry and Neurology, Sobieskiego Str. 9, 02-957 Warsaw, Poland tel.: +48 22 458 28 45 e-mail: kpolanow@ipin.edu.pl