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Cognitive Screening Tests as an Early Method of Detecting Cognitive Dysfunctions

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Abstract

Cognitive impairment is an increasingly common problem in aging societies. With age, cognitive functions are naturally weakened. However, this process may lead to more serious deficits such as mild cognitive impairment (MCI) and dementia. Identification of patients at high risk, early diagnosis of cognitive impairment and monitoring of the patient's condition, as well as taking appropriate action is very important. Cognitive impairment is detected using neuropsychological screening tests that enable the detection of cognitive impairment in the early stages. The most commonly used tools for the initial assessment of cognitive functioning are: Mini Mental State Examination (MMSE), Montreal Cognitive Assessment (MoCA), Clock Drawing Test (CDT), Addenbrooke's Cognitive Examination (ACE III). Early detection of MCI gives the opportunity to quickly implement appropriate interventions, which can slow down or limit the development of cognitive impairment. Early diagnosis allows to find the cause and reduce the adverse effects of modifiable factors that contribute to the development of dementia. Among these factors, there are: reduced levels of folic acid, diabetes and depression. Early diagnosis also gives the opportunity to plan the patient's care appropriately, including the patient's conscious participation in making such decisions. Cognitive screening tests are also used to monitor the progress of the disease, which allows you to respond appropriately and modify the treatment plan adequately to the patient's condition and cognitive deficits.

Key words: *the elderly, cognitive impairment, memory impairment, cognitive screening tests.*

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Definition and epidemiology

The growing number of elderly people in the society and the prolongation of life lead to the increasing incidence of cognitive disorders. Aging of the human organism causes certain changes in cognitive functioning, including natural age-associated memory impairment (AAMI), mild cognitive impairment (MCI) and early forms of dementia (including stages of Alzheimer's disease) [6, 7]. The natural process of aging is associated with the impairment of cognitive functioning, the speed of information processing decreases, memory, visual-spatial functions and executive functions deteriorate. The most noticeable for patients is memory impairment, with age the ability to encode new information in memory and access to new information decreases. In a naturally aging organism, not all cognitive functions are impaired, e.g. vocabulary may even improve with age. Important elements of strengthening memory are preventive measures to maintain the best functioning of cognitive processes [8].

Mild cognitive impairment (MCI) is characterized by a deterioration in cognitive functioning with an increased severity than expected in regards to the given age and educational level of the patient. The presence of MCI increases the risk of future dementia [9, 10], which is defined as a complex of chronic and progressive mental disorders, most often occurring in the course of brain diseases with undifferentiated etiology [7]. Dementia is characterized by memory impairment and a decline in intellectual performance compared to a patient's previous state [11]. The occurrence of cognitive dysfunctions may be influenced by modifiable (e.g.: lifestyle, mental activity, education, and cardiovascular stress) and non-modifiable (e.g. age) risk factors [12]. The prevalence of dementia in the elderly population is estimated at about 10% [14]. In 2011, McKhann et al. estimated the global incidence of dementia at around 30 million, with an upward trend to 60 million in 2030, and even up to 114 million in 2050 [13]. It is also estimated that 47 million people worldwide currently suffer from dementia, and by 2050 this number could triple [15]. As it can be seen, it is estimated that the number of people suffering from dementia

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syndromes will increase year by year, which makes them not only a significant medical problem, but also a social and economic problem.

Criteria for diagnosis by cognitive screening tests

In order to detect cognitive functioning disorders in the elderly, neuropsychological cognitive screening tests are used, which allow to initially assess the level of cognitive activity of the patient. The tests in a simple and quick way give a numerical result, which assesses the general condition of the patient in regard to cognitive functioning. The most popular are: Mini Mental State Examination (MMSE), Montreal Cognitive Assessment (MoCA), Clock Drawing Test (CDT), California Verbal Learning Test (CVLT), Trail Making Test (TMT) and becoming more and more popular among clinical neuropsychologists Addenbrooke's Cognitive Examinations (ACE III) [19, 20, 21].

Conducting neuropsychological tests is often hard work not only for the examiner, but above all for the tested person. The test results are influenced by, among others: disturbances in the senses such as vision or hearing (therefore it is important that the test subjects have reading glasses and hearing aids, if they use them every day), medications taken, mood, and willingness to participate in research. If the patient is subjected to several tests, those are performed day after day in order not to tire the patient. It is important that each test is performed by the same person, in the same room and at the same time of the day [22].

The most commonly used test is MMSE. This tool is used not only in the clinical diagnosis of patients, but also widely used in research in the field of neuropsychology. The obtained numerical result of this test shows the level of cognitive functioning of the patient. The final result is the sum of points from all subtests, in which the following are evaluated: orientation in time and place, remembering, attention with counting, word recall, and language functions: naming and repeating, writing and also construction praxia, i.e. copying 2 figures [23]. 30 points is the maximum score that can be obtained on this test. The norm is considered to be

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a result equal to or greater than 28 points. A score in the range of 24–27 indicates mild cognitive impairment and below 24 may indicate an ongoing dementia process. The test result is influenced by factors such as age and level of education. Therefore, if the patient obtains 24 points from the test or less, further diagnostics is required to verify the cognitive test result: confirm or exclude dementia [23, 24]. Research clearly shows that approximately 51% of primary healthcare entities use the MMSE test in practice [25]. Another cognitive screening test is the Montreal Cognitive Assessment (MoCA). It was developed by Nasreddine in Montreal for the detection of mild cognitive impairment (MCI). The following are assessed: visual-spatial, executive and linguistic functions, attention, fluency, naming, memory, and orientation [26, 27]. Similarly as in the MMSE test, patients can score a maximum of 30 points. A result equal to or greater than 26 is considered correct. A score between 25 and 18 is evidence of MCI and less than 18 of dementia. At the end of the test, the number of years of study of the patient must be taken into account. If the examined person has 12 or less years of education, an additional point is awarded [27, 28]. The studies validating this test clearly show the high sensitivity and specificity of this scale in the detection of MCI in the early stages of Alzheimer's disease. At the same time, the research shows the advantage of MoCA over the MMSE test, which is the most common screening test used as a screening tool by clinicians [26, 29]. The Clock Drawing Test has in recent years become a very popular screening tool in many clinical areas for a wide range of cognitive impairment and severity. CDT is used not only to detect mild cognitive impairment [30, 31]. It is also useful for the early detection and prediction of dementia, diagnosis of disorders in this area of neurological origin (e.g. in Parkinson's disease), post-accident brain trauma, in the course of mental disorders (depression, schizophrenia), metabolic diseases and due to hospitalization of general diseases. Although earlier CDT was used simultaneously for screening purposes, the current research suggests using this tool to monitor the course of dementia of varying severity [31]. Four variants of CDT are used in cognitive screening: two Shulman variants, one Watson modification and one

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Sunderland modification. Each of these versions is characterized by high sensitivity and specificity in detecting cognitive disorders in the elderly. There is an error classification for each variation of this test. After the completion of the examination, the degree of cognitive impairment is determined using this error classification [31, 32].

The ACE III scale is an extended tool for cognitive screening and detecting cognitive dysfunctions at an early stage. It is also used for the differential assessment of dementia syndromes and (similarly as MoCA and CDT) helpful in monitoring the disease progression [33]. The ACE-III test is a short examination that takes 15–20 minutes and assesses basic cognitive functions [34]. The test examines five domains, each of which is assessed separately, and the sum of the points scored gives the final result. The examined person may receive a maximum of 18 points for attention, 26 points for memory and language, 14 points for fluency, and 16 points for visual-spatial functions. A maximum of 100 points can be obtained by a test subject, which distinguishes this test from other cognitive screening tests (for an example in the MoCA test and the MMSE test, a maximum of 30 points can be scored). The higher the test result is achieved by the patient, the better his cognitive functioning [35]. ACE-III is a test that is easy to carry out, both for the subject and the examiner, and most importantly, it demonstrates high utility and accuracy in detecting MCI and dementia of varying severity [35, 36]. Research shows that the ACE-III test is a reliable tool for the detection of cognitive dysfunction and dementia [35], it shows high sensitivity and specificity. Compared to MMSE, the ACE-III test is more sensitive in detecting dementia [34].

The California Verbal Learning Test (CVLT) by Delis et al. [37] is one of the most popular tests used in the world for the diagnosis of learning and various dimensions of verbal memory [38]. It was adapted for use in Polish with a full psychometric study by Łojek and Stańczak [39]. Only the examiner and the test subject should be in the room at the time of the examination. The entire test must be performed during one meeting. The California Language Learning Test should only be performed and evaluated by psychologists, including clinical neuropsychologists. Persons tested

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during the CVLT test at a steady pace are read a list of 16 words related to each other into 4 semantic categories. Before each reading of the word list, the test subject is told to remember as many words as possible on the shopping list for the day. The Monday shopping list is read five times. Before each reading, the test subject is asked to remember as many words as possible and repeat them in any order after the tester has read the list. In the further part of the test, the Tuesday shopping list is read out once with different words (representing intentional interference). Before reading the Tuesday list of words, the test subject is asked again to remember and repeat as many items from this list as possible. Then the examined person is asked to recall the Monday list (short postponement), and then again after a longer postponement (after a break of about 20 minutes). In the last stage of the examination, the test subject is presented with a list of words to be recognized. From among 44 items, the examined person has to indicate words from the Monday list. In addition to the main indicators, which include: the number of recalled words after each reading, the number of recalled words after the short and long delay and the number of words recognized from the last part of the test. The CVLT also counts the error rates for each reminder and word recognition [39, 40]. The individual indicators of the CVLT test allow for the analysis of neuropsychological functions such as: general verbal memory performance, verbal short-term memory, long-term memory, resistance to interference, effectiveness of learning strategies, mechanical learning, creating a learning plan, learning using semantic categorization of stimuli, differentiation the verbal material being prepared [38].

Trail Making Test (TMT) is one of the most widely used and popular neuropsychological tests in clinical trials. This may be due to the fact that it is one of the few instruments that is sensitive to, for example, brain injuries. TMT provides information on: mental flexibility, visual scanning, executive functions, visual search and processing speed [41, 42]. It also studies the field search function, and in particular the interhemispheric functioning. TMT consists of two separately assessed parts (Part A and Part B). The Trail Making Test aims to assess psychomotor speed – part

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A, and in part B – cognitive flexibility and visual-spatial working memory [43]. In TMT part A the test subject is to draw a line as quickly as possible, which continuously and sequentially connects 25 digits circled and placed on a sheet of paper. In TMT part B, the requirements are similar, with a small difference: the test subject must connect alternating numbers with letters of the alphabet as quickly as possible with a continuous line in the following order: (1 – A – 2 – B – 3 – C etc.) [41, 42, 43].When assessing the test results, one should take into account the time measured in seconds as well as the number of errors made by the examined person. The cut-off time for TMT part A is 40 seconds and for TMT part B is 92 seconds [41]. In order to accurately assess the correctness of executive functions, scientists propose to pay attention to the ratio of test execution time B – A; this will allow to exclude the so-called psychomotor component tested in TMT part A. Summing up, the longer the relative time of TMT part B in relation to TMT part A, the automatically worse the result evaluating the so-called cognitive flexibility [43]. And when the time of performing part B is twice as long as part A, it indicates a dysfunction of the frontal cortex [41].

Importance of cognitive screening tests in the elderly

Epidemiological studies show that even 15–30% of people over 60 years of age are affected by mild cognitive impairment (MCI). This percentage increases with age and amounts to: 18.7% in people aged 60–70 years, 21% in people between 71–80 years of age and as much as 29.4% in people aged over 81 [44, 45]. As previously mentioned, MCI increases the risk of developing dementia in the future. Overall, about half of people diagnosed with MCI will develop dementia within the next 3 years. From the moment of diagnosis of mild cognitive dysfunction, 6–15% of patients develop dementia every year [46]. In the light of the above statistics, early detection of MCI becomes more and more important. Despite the limited treatment options for dementia, the need for early diagnosis and diagnosis of the onset of the disease in the asymptomatic phase is

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emphasized. Diagnosis is often made too late or not made at all, to the detriment of the patient. Fast and early diagnosis enables early implementation of interventions that may slow down or limit the progression of cognitive disorders [47]. Research has shown that there are modifiable factors, such as diabetes mellitus, decreased levels of folic acid, which, if not controlled, may lead to the development of dementia (though there is no clear evidence that eliminating these factors completely protects against this) [48, 49]. One of the modifiable factors is also depression, which affects an increasing percentage of the population and promotes the occurrence of cognitive disorders, both in acute depressive episodes and in remission [50]. It is recommended that after the diagnosis is made, the information about MCI should be communicated to the patient carefully, so that it does not cause fear and anxiety [50, 51]. It is recommended in the conversation with the patient to discuss the prognosis for the development of the disease, as well as the long-term treatment plan. Moderate physical exercise and cognitive training should be recommended [52]. Patients should be advised that mild cognitive impairment does not necessarily progress to dementia. Early diagnosis of MCI gives the opportunity, especially for the immediate family, to plan the care over the patient accordingly as the dementia will progress. It also allows the patient to consciously participate in making such decisions. People suffering from dementia are not able to function independently and need (often round the clock) care of third parties [46]. Many clinicians recommend monitoring patients with MCI for cognitive functioning over time, preferably every 6 months [52, 53, 54]. In people over 60 years of age, despite the increasing risk of mild cognitive disorders, they are often not correctly diagnosed [55], and even 4 years pass from the first symptoms appearing in a senior to the moment of obtaining a correct diagnosis [56]. The scary fact is that as many as 81% of patients with symptoms of cognitive dysfunction are not diagnosed at all [57]. The fundamental challenge in European countries (including Poland) is the implementation of the mechanism of performing neuropsychological screening tests by primary care physicians during follow-up visits to the office in a group of

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patients over 60 years of age in order to increase the detection of MCI. A big issue is that most of these doctors underestimate the importance of early diagnosis in this area. Another obstacle in the implementation of the aforementioned standards is the lack of adequate preparation of family doctors to diagnose MCI and dementia [57]. As already mentioned, screening testing should use neuropsychological tests with high psychometric properties, and at the same time the duration of which would be a maximum of 15 minutes [58].

Conclusion

Aging of the population is an increasing problem for today's society. Along with this, the number of people suffering from cognitive dysfunction increases. Although it is a physiological process and it progresses with age, it can turn into more serious deficits, such as MCI and dementia. Mild cognitive impairment (MCI) increases the likelihood of dementia, is characterized by cognitive decline, and is not always properly diagnosed. Dementia, on the other hand, leads to a decline in intellectual performance and memory impairment. Early recognition of these conditions can protect an elderly person from complications caused by cognitive dysfunction. Neuropsychological testing is one of the fastest screening methods for detecting these disorders. Great emphasis should be placed on screening tests by primary care physicians during the control examinations of elderly people in the office. This would increase the detectability of the MCI at an early stage. We can distinguish tests such as: MMSE, MoCA, Clock Drawing Test, ACE III. Additionally, the popular tests that are used in extended neuropsychological diagnostics are: CVLT and TMT A and B. Early detection of any abnormalities allows for modifying factors that may contribute to the development of MCI and dementia, including Alzheimer's disease. The modification of incorrect factors may also affect the patient's treatment process as well as improve their efficiency and functioning in everyday life. The modifiable factors include, for an example, depression, diabetes, and reduced levels of folic acid. Cogniti-

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ve screening tests may also be used for monitoring the progress of the disease, and thus the patient's condition and deficits. Tests should be performed every six months to efficiently and professionally monitor the possible deterioration of the patient's condition and the development of dementia. It is estimated that in 2050 the number of people suffering from dementia will triple. This growth will bring with it major challenges for all areas of medicine, as well as for the economy and society as a whole.

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