ARTYKUŁ POGLĄDOWY / REVIEW PAPER
Otrzymano/Submitted: 01.10.2024 • Zaakceptowano/Accepted: 19.12.2024

Effective diagnostic tools for quick assessment of cognitive function. A review promoting the CDT, 6-CIT, AMTS, and AMT4 tests

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Abstract

Cognitive disorders accompanying medical conditions have posed a diagnostic challenge for physicians for years. As society ages and neurodegenerative diseases rise, the need for early detection through proper diagnostic tools grows. Medicine requires early detection methods for neuropsychological disorders to identify dementia or mild cognitive impairment linked to aging, metabolic, neurological, and neuroinfectious diseases. Additionally, there's a pressing need for swift cognitive function evaluation in acutely ill patients, necessitating the utilization of suitable tests, considering variations in sensitivity and specificity based on the patient's status. Quick cognitive function tests include the Clock Drawing Test (CDT), Six-Item Cognitive Impairment Test (6-CIT), Abbreviated Mental Test Score (AMTS) and 4-item Abbreviated Mental Test (AMT4). These tests have been translated into multiple languages and their clinical utility has been confirmed in numerous studies. This review outlines their features, advantages, disadvantages, and examines their clinical application and challenges in current practice. *Geriatria 2024;18:234-239. doi: 10.53139/G.20241825*

Keywords: Cognitive Tests, Cognitive Function, Cognitive impairment; Cognitive assessment, Dementia, Mild Cognitive Impairment

Introduction

The utilization of cognitive screening tools by physicians brings numerous benefits. It helps prevent the oversight of cognitive impairments, and the use of a brief, standardized tool with appropriate norms helps minimize interpretative errors caused by factors such as age, education, and other factors. Although no single cognitive assessment tool, when used independently, can establish a diagnosis, it allows for the identification of cognitive deficits and serves as a starting point for conducting a differential diagnosis using advanced methods [1]. From a clinical standpoint, cognitive screening assessments are crucial in facilitating the early identification and monitoring of changes in prevalent conditions such as dementia, delirium, and various neuropsychiatric and neurological disorders [2]. Cognitive screening tools that are easy to administer and have high sensitivity and specificity are essential. Moreover, there is a need for instruments that are universally applicable across different cultures and easy to implement in various settings. The Mini-Mental State Examination (MMSE) is the most widely used tool for detecting cognitive impairment [3,4].

This article provides an overview of several alternative cognitive tests: the 4-item Abbreviated Mental Test (AMT4), the Clock Drawing Test (CDT), the Six-Item Cognitive Impairment Test (6-CIT), and the Abbreviated Mental Test Score (AMTS). The aim of this review is to present brief tests of cognitive function, including some that are less well-known. Although the selected screening tests are quick and easy to use, knowledge about them is limited among specialists from fields other than neurology. This motivated us to undertake research on these tests. Our work aims to raise awareness of these tools, highlighting their advantages, disadvantages, and applications across different clinical scenarios. An increased level of knowledge among clinicians regarding these tools may lead to their more frequent use in everyday practice.

Clock Drawing Test (CDT)

The Clock Drawing Test is a screening examination that assesses disorders of visuospatial, constructional, and frontal-executive functions. Performing this task involves both sides of the visual field [5]. The evolution

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of the CDT from a rarely used tool for detecting aphasia and constructional apraxia to one of the most widely utilized and versatile cognitive screening tests makes its history a topic of interest for researchers, clinicians, and medical historians [6].

To administer the test, first instruct the patient to sketch a circle, then arrange numbers within it to resemble a clock face. Finally, ask the patient to draw the clock hands indicating a specific time, most commonly 11:10, which tests the patient's ability to recognize that the minute hand should point to the number 2 rather than 10 (assessing frontal/executive function). In some versions of the test, the circle is already drawn at the beginning [5]. The CDT meets all the criteria for a good cognitive screening test. It is quick, well-tolerated by patients, and easy to evaluate. It is not significantly influenced by education, language, or culture. The test demonstrates reliability in both Test-Retest and Inter-Rater evaluations. It also exhibits high levels of sensitivity and specificity—Shulman reports that across the scales he examined between 1983 and 1998, the average sensitivity and specificity were 85% [2]. The CDT correlates well with other measures of cognitive dysfunction and the results of other tests, while also showing a high predictive value. It assesses a broad range of cognitive functions, including executive functions.

Despite the development of numerous scoring systems, no consensus has been reached regarding which method is the most accurate. Different assessment methods follow various administration and evaluation principles, leading to heterogeneous outcomes and difficulties in comparing the utility of the systems [7,15].

It is widely accepted that the CDT is a valuable tool for detecting severe and moderate stages of dementia. However, there is controversy regarding its effectiveness in detecting Mild Cognitive Impairment (MCI) and early stages of dementia [7]. Comparisons of average CDT scores between healthy individuals and those diagnosed with MCI in most studies did not reveal significant differences, suggesting that the CDT should not be used as a screening tool for MCI [8]. The Shulman scoring system, which is the most frequently studied and highly sensitive, has been recognized by the authors of a systematic review and meta-analysis as the most useful in cognitive function assessments. The Sunderland scoring system, with a specificity of 87.9%, is the most accurate for detecting cognitive impairment. After thoroughly examining various scoring systems, the authors recommend the widespread use of the CDT in neurological diagnosis [9].

A study analyzing the diagnostic utility of the Mini-Cog and CDT in detecting cognitive impairment revealed lower diagnostic utility for the CDT compared to the Mini-Cog. Furthermore, both tools are unsuitable for assessing individuals with low educational levels, as they require basic graphomotor skills, limiting their applicability among illiterate individuals or those without basic education [10]. The issue of the impact of educational level on the usability of the test contradicts the findings of a previous study by Shulman, which suggested that the tool's effectiveness is independent of the patient's educational level [2]. This issue warrants further investigation to draw definitive conclusions.

A review by Tan and colleagues on the utility of the CDT in distinguishing Alzheimer's Disease (AD) from other types of dementia—frontotemporal dementia (FTD), vascular dementia (VaD), dementia with Lewy bodies (DLB), and dementia due to Parkinson's disease (PDD)—showed that in most studies, quantitative analysis of CDT results allowed differentiation between AD and PDD, DLB, and VaD. An exception was the group of patients with FTD, who consistently achieved significantly higher scores than those with AD. The study suggests that qualitative analysis of the CDT may be helpful in the differential diagnosis of AD and other types of dementia [11].

In contrast, a study by Duro and colleagues presents different results regarding the potential for differentiating types of dementia based on total CDT scores. In their research, patients with DLB and AD consistently scored lower than other groups. However, qualitative error analysis confirmed the CDT's potential for recognizing AD. Based on these results, the authors confirmed the CDT's potential as a screening tool for cognitive function, particularly in detecting AD and DLB. They highlighted the effectiveness of the Cahn scoring system, which includes qualitative error analysis [12].

The results of the CDT conducted during the acute phase of a stroke can serve as a prognostic factor for the patient's cognitive abilities, functional status, and degree of disability in the following year and their return to normal life activities [13]. A study assessing cognitive function in patients a few days after ischemic or hemorrhagic stroke, admitted to a stroke unit, showed that a pathological CDT result during the acute phase doubled the risk of cognitive dysfunction within a year in patients without prior impairment. Identifying patients at risk of worsening cognitive function after a stroke is essential for choosing appropriate rehabilitation methods (both physical and cognitive) and for making prognostic con-

siderations regarding the patient's level of functioning/independence after hospitalization [14].

The clinical utility of the CDT in assessing patients with chronic focal brain lesions is limited. In one study, over half of the patients, despite having brain lesions verified by computed tomography, were not correctly diagnosed using the CDT. The lesions were caused by acquired brain damage due to stroke, traumatic brain injury (mostly closed), brain tumors, or brain aneurysm surgery. The CDT result did not allow for the detection of the location and lateralization of brain damage [15]. A study on knowledge of cognitive disorder diagnosis in the elderly among primary care physicians in Poland showed that the CDT was the most popular cognitive test among the surveyed physicians [3].

In summary, the Clock Drawing Test is a valuable tool for the effective detection of cognitive dysfunction; however, it is not suitable for screening for mild dementia or Mild Cognitive Impairment (MCI). Emphasis should be placed on the importance of qualitative assessment, which, when complementing quantitative evaluation, makes the CDT a comprehensive and complex tool for assessing cognitive functions [7].

Six-Item Cognitive Impairment Test (6 CIT)

The Six-Item Cognitive Impairment Test is a brief questionnaire used to assess overall cognitive function. The 6-CIT consists of three questions related to time orientation (the patient must state the current year, month, and time), two questions involving simple calculations (the patient is required to list the months in reverse order and count backward from 20), and one question concerning short-term memory (the patient is tasked with learning a short address phrase composed of five expressions and repeating it at the end of the test). Each question has a designated weight, with a total score of 28. The test utilizes reverse scoring (fewer points = better result) [16]. Scoring categories are as follows: (I) 0-4: no cognitive impairment; (II) 5-9: inconclusive result requiring further diagnostic evaluation; (III) 10 or more: cognitive impairment requiring further assessment.

Due to its brevity and ease of use, the 6-CIT has been suggested as an alternative to the MMSE. The MMSE has a sensitivity of 79.7% and specificity of 86.4% (cutoff 23/24), while the 6-CIT has a sensitivity of 82.5% and specificity of 90.9% (cutoff 10/11). Lowering the cutoff to 9/10 increases sensitivity to 90.2% but decreases specificity to 83.3% [17]. This test has been shown to be a reliable method for detecting cognitive dysfunction in hospital settings [18]. Another advantage of the 6-CIT over the MMSE is its insensitivity to education level [19]. Additionally, the 6-CIT is easily translatable into other languages without losing its diagnostic accuracy [20]. The short duration of the 6-CIT (approximately two minutes) is another notable advantage.

It is worth noting the potential use of the 6-CIT in detecting delirium. Given its consideration of both short-term memory and spatial orientation, the test appears promising in this regard. In a study involving 470 participants, 184 of whom had delirium, the 6-CIT demonstrated the highest AUC (0.876), with an optimal cutoff for delirium screening set at 8/9 (sensitivity 89.9%, specificity 62.7%). The Month of the Year Backwards (MOTYB) test, assessed in a binary manner, also performed well (sensitivity 84.6%, specificity 58.4%). In discriminant analysis, the 6-CIT was the only test that distinguished between patients with delirium and those with dementia without delirium [21]. Despite the numerous advantages of the 6-CIT, the risk of incorrect diagnosis and failure to detect cognitive impairment should be considered. Adequate training of primary care physicians in conducting cognitive function screening is crucial [20].

Abbreviated Mental Test Score (AMTS)

The Abbreviated Mental Test Score is a screening tool designed for the assessment of cognitive functions, including episodic, semantic, and working memory, particularly among older individuals [24]. Developed in 1972 for hospitalized patients, it has since been modified by various researchers for different populations. Comprising 10 items, the AMTS involves questions and commands that assess various aspects of cognitive function, such as orientation in time and space, memory, mathematical abilities, and language comprehension. Patients are awarded points based on their responses, with a maximum score of 10. A score of 6 or below suggests cognitive issues that warrant further assessment [22,23,31].

Different countries have developed their own versions of the AMTS, tailored to suit specific populations and cultural contexts. The AMTS has proven to be a valuable tool for assessing cognitive function in elderly patients, with a modified local version showing effectiveness in Hong Kong [25]. A study conducted on elderly patients validated this local version against clinical diagnoses, revealing significant associations between incorrect answers and abnormal cognitive function. A cutoff score of six on the AMTS was found to be optimal

for identifying abnormal cognitive function, boasting high sensitivity and specificity. The Polish version of the AMTS also serves as a valuable tool for assessing cognitive function in elderly individuals, offering accessibility and ease of administration. However, discrepancies between the English and Polish versions highlight the need for validation in the Polish population, along with potential modifications to improve reliability and cultural relevance [23].

Recent studies have also highlighted various clinical applications of the AMTS, such as postoperative cognitive changes following surgical procedures [24,30], delirium diagnosis [32], and dementia screening [26].

One of the primary advantages of the AMTS is its simplicity and ease of administration, enabling quick cognitive assessments, especially in busy clinical settings. Healthcare professionals can administer the test rapidly, facilitating timely evaluations and enhancing patient care [27]. Unlike some cognitive tests, the AMTS does not require reading, writing, or drawing, which reduces potential biases associated with visual or mobility impairments in elderly patients. This feature enhances the test's applicability across diverse patient groups [31].

However, the AMTS has several limitations. While it provides a general assessment of cognitive function, it lacks specificity in pinpointing the exact cause of cognitive impairment. Conditions such as Alzheimer's disease or vascular dementia may present similar cognitive deficits, making it challenging to differentiate between them based solely on AMTS scores [34]. Furthermore, the AMTS may not be suitable for detecting subtle cognitive changes in the early stages of cognitive decline, as it is primarily designed to identify more pronounced impairments [33]. Additionally, the AMTS focuses primarily on cognitive functions and does not account for emotional factors, which can play a significant role in a patient's overall well-being and cognitive performance. Transient factors like fatigue, stress, or hearing problems can also influence scores, leading to incorrect assessments [30].

Cultural and demographic factors can significantly affect the validity and reliability of the AMTS [22-26,28]. Wu et al. (2003) highlighted the influence of cultural backgrounds on test performance, emphasizing the need for culturally sensitive cognitive assessment tools [28]. Different cultural norms and values may impact how individuals respond to test items, necessitating adjustments for diverse populations. Additionally, Allain et al. (1996) demonstrated the impact of demographic factors such as age, gender, education level, and living conditions on AMTS scores [29]. These variables can introduce biases in test results, affecting the accuracy of cognitive assessments in diverse populations.

In conclusion, while the AMTS remains a valuable cognitive screening tool, clinicians should consider its advantages, limitations, and cultural factors when using it in clinical practice. Future research should focus on developing culturally sensitive assessment tools and addressing demographic factors to improve the accuracy of cognitive evaluations across diverse patient populations [23,25,26].

4-item Abbreviated Mental Test (AMT4)

The 4-item Abbreviated Mental Test (AMT is a shortened, four-item version of the original AMTS test. It consists of four questions: (I) How old are you? (II) What is your date of birth? (III) Where are we now? (IV) What year is it? [35]. For each correct answer, the patient receives one point, with a perfect score of 4 points indicating normal cognitive function. Any score below 4 suggests cognitive impairment and warrants further diagnostic evaluation. The AMT4 is quick, easy to administer, and requires no special training for medical staff, making it particularly beneficial in time-sensitive situations such as hospital emergency departments or emergency situations requiring a rapid initial assessment [36].

One key application of the AMT4 is in the detection of delirium. Delirium affects more than 15% of hospitalized patients but often goes undetected by medical personnel, potentially leading to severe complications such as chronic cognitive deficits and even death [37]. In hospital emergency settings, a quick and simple test is needed to identify or rule out delirium with high sensitivity and specificity. The AMT4 can be used for this purpose, either on its own or as part of the 4AT test. The 4AT test also assesses the patient's alertness, attention, and any sudden changes in consciousness or cognitive function, scoring the patient on a 12-point scale. A score of 4 or higher on the 4AT indicates the presence of delirium. Like the AMT4, the 4AT is a quick test (around 2 minutes) and requires no special training for medical staff [38].

Studies show that at a cutoff point of 3/4, the AMT4 has high sensitivity (80%) and specificity (88%) for detecting cognitive impairment and delirium. It also correlates strongly with the original 10-item AMT, which shows similar sensitivity and specificity at a cutoff point of 7/10 [35,39]. Meta-analyses indicate a high reliability quotient of 7.69 for a positive AMT4 test result, making it one of the best rapid tests for detecting cognitive dysfunction

[40]. In contrast, the 4AT has demonstrated a sensitivity of 76% and specificity of 94% for detecting delirium [38]. The 4AT test was designed so that patients unable to answer the doctor's questions or unable to assess their cognitive function would also test positive. This reduces the risk of false-negative results, allowing medical procedures for delirium to be implemented promptly [37,38].

Despite their advantages, neither the AMT4 nor the broader 4AT should be used as definitive diagnostic tools. They provide a rapid initial assessment of cognitive disorders but are not detailed enough for a conclusive diagnosis. A significant proportion of patients may receive a false-negative result. Additionally, the brevity of the 4AT may fail to detect issues like pathological drowsiness, which can develop over the next several minutes. As such, these tools should be seen as preliminary screening methods before a more thorough clinical evaluation [36,38].

The AMT4 test is a useful and simple tool in the hospital emergency department, but knowledge of it among physicians is limited. No validation studies have yet been conducted in Poland, determining the usefulness of this test in the clinical setting of Polish health care. It is advisable to perform such studies in the future, and to promote and expand physicians' knowledge of the AMT4 test.

Conclusions

This review article presents four cognitive function tests with specific applications in diagnosing central nervous system disorders. They have been subjected to a number of validation studies that have confirmed their clinical usefulness. They are a valuable aid in the daily work of the clinician, but it is important to keep in mind their significant limitations. These tests should not be used as the only tool for assessing cognitive impairment; at a convenient time, the diagnosis should be expanded accordingly, to obtain a more complete clinical picture of the patient. Each of the presented tests has a specific application, its advantages and disadvantages, which should be kept in mind when selecting tools for the neurological and mental evaluation of the patient.

Conflict of interest
None

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