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Is the Clock Drawing Test Appropriate for Screening for Mild Cognitive Impairment? – Results of the German Study on Ageing, Cognition and Dementia in Primary Care Patients (AgeCoDe)

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Key Words
Mild cognitive impairment · Clock Drawing Test

Abstract
Background: Individuals with mild cognitive impairment (MCI) are at high risk of developing dementia and are a target group for preventive interventions. Therefore, research aims at diagnosing MCI at an early stage with short, simple and easily administrable screening tests. Due to the fact that the Clock Drawing Test (CDT) is widely used to screen for dementia, it is questionable whether it is suited to screen for MCI. ***Methods:*** 3,198 primary care patients aged 75+ were divided into two groups according to their cognitive status, assessed by comprehensive neuropsychological testing: individuals without MCI and individuals with MCI. The CDT scores, evaluated by the scoring system of Sunderland et al. [J Am Geriatr Soc 1989;37:725–729], of both groups were compared. Multivariate analyses were calculated and the sensitivity and specificity of the CDT to screen for MCI were reported. ***Results:*** Significant differences were found for CDT results: MCI patients obtained worse results than cognitively unimpaired subjects. CDT has a significant impact on the diagnosis of MCI. However, sensitivity and specificity as well as receiver operating characteristic analyses are not adequate, meaning that the CDT could not be named as an exact screening tool. ***Limitations:*** Applying different CDT versions of administration and scoring could yield different results. ***Conclusions:*** CDT does not achieve the quality to screen individuals for MCI.

Introduction

It is very important to maintain physical as well as mental health into advanced age. Regarding dementing illness, interventions currently known cannot heal dementia, but ensure the patients' comfort and improvement (or at least stagnation) of cognitive performance [1].

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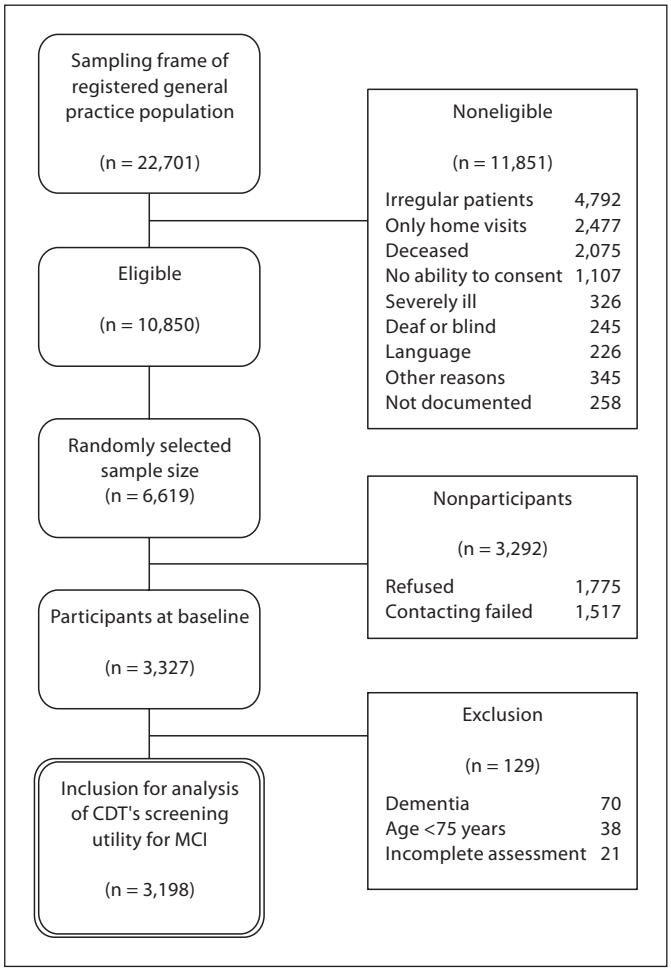

Fig. 1. Sampling frame and sample.

That is why diagnosing cognitive impairment at an early stage is a great matter of concern, at the stage of mild cognitive impairment (MCI), because patients diagnosed with MCI are at 31–44% higher risk of developing dementia compared to normal control groups [2, 3]. It is therefore essential to establish efficient diagnostic tests administered easily and simply, in order to screen for cognitive impairment before onset of dementing symptoms.

The Clock Drawing Test (CDT) has been widely used and is seen as a favorite cognitive screening instrument for the diagnosis of dementia [4, 5]. Just a few studies on the CDT's utility in screening for MCI have been published, particularly with inconsistent results [6–8]. Furthermore, studies suffer from methodological problems regarding the sample selection and operationalization of MCI. Some studies even used the Clinical Dementia Rating Scale [9] to operationalize MCI [7, 10–12].

This study aims at examining the applicability and quality of the CDT as a diagnostic screening instrument for MCI on the representative basis of primary care patients aged 75+. MCI is defined by Winblad et al. [13], whose definition is widely accepted in the community.

Methods

Sample

The sample consists of subjects participating in the baseline assessment of a prospective longitudinal study on early detection of MCI and dementia in primary care. The study was conducted in 6 centers in Germany (Bonn, Düsseldorf, Hamburg, Leipzig, Mannheim, Munich) representing an urban area with a total population ranging between about 300,000 (Mannheim) and 1.8 million (Hamburg). The subjects were recruited between January 1, 2003 and November 30, 2004. In each center, 19–29 general practitioners (GPs) participated in the recruitment process – 138 GPs altogether. Inclusion criteria for GP patients were an age of 75 years and over, community dwelling, the absence of dementia in the GP's view and at least one contact with the GP within the last 12 months. Exclusion criteria were consultations only by home visits, residence in a nursing home, a severe illness which the GP deemed fatal within 3 months, an insufficient knowledge of the German language, deafness or blindness, inability to consent, and not being a regular patient of the participating practice. On average, each practice comprised 24 patients. Information on the sampling frame, eligible subjects, and respondents is given in figure 1.

A total of 3,327 selected GP patients were interviewed in their homes by trained investigators (medical doctors, psychologists, gerontologists) to obtain information on the cognitive status, current physical and mental health, medication, lifestyle and risk factors. Of the 3,327 interviewed subjects, 129 (3.9%) were excluded from the following analyses: 70 (54.3%) were classified as demented, 38 (29.4%) fell short of the age limit of 75 years and 21 (16.3%) had incomplete assessments. Therefore, results are based on the data of the remaining 3,198 patients.

Data on age and gender were collected in order to compare participants and nonparticipants of the study. Participants were somewhat younger than nonparticipants (mean 80.10 vs. 80.69 years; $t = 5.450$, $p \leq 0.001$). Of all participants, 65.4% were female, and among nonparticipants, 68.6% were female ($\chi^2 = 5.542$, $p = 0.019$).

Instruments

Clock Drawing Test. Research literature provides over a dozen different versions of administration and scoring systems of the CDT [5]; however, no version has been consistently accepted. In this study, the most recent German CDT version of Ihl et al. [14] was used as follows.

(1) Patients are presented a blank sheet of paper and are instructed: 'Please draw a clock face with all numbers and put the hands towards 11.10.' Cognitive demands are enhanced by patients drawing a clock face with their own in comparison to predrawn circles. If patients are instructed to set the hands at 11.10, recommended by Shulman [5], great demands are made on them,

Table 1. MCI criteria and their operationalization

MCI criteria	Operationalization
1 Exclusion of dementia according to DSM-IV or ICD-10	– Criteria of SIDAM according to DSM-IV
2 Preserved baseline activities of daily living or only minimal impairment in complex instrumental functions	– No/only one impairment, measured by the scale for the assessment of activities of daily living of SIDAM
3 Evidence of cognitive decline – Subjective cognitive impairment (measured by self-rating or informant report) and – Impairment on objective cognitive tasks (mean – 1 standard deviation based on age- and education-specific norms)	– Question of subjective memory impairments was positively answered – At least one of the following SIDAM subscales under age- and education-specific norms → memory → orientation → intellectual abilities → higher cortical functioning

because visual-spatial functions as well as inhibition of the instinct to put the hands towards 10 instead of 2 are required in order to fulfill the task.

(2) The clock is assessed by the investigator according to the scoring system of Sunderland et al. [4], modified by Ihl et al. [14]. This scoring system is easily applicable by the investigators, since models exist to assign a specific number of points (maximum 10, minimum 1) to clock drawing. The higher the score, the higher the cognitive abilities are rated.

Structured Interview for the Diagnosis of Dementia of the Alzheimer Type, Multi-Infarct Dementia and Dementias of Other Etiology according to ICD-10 and DSM-IV. For neuropsychological assessment, the Structured Interview for the Diagnosis of Dementia of the Alzheimer Type, Multi-Infarct Dementia and Dementias of Other Etiology according to ICD-10 and DSM-IV (SIDAM) [15, 16] was applied. SIDAM can reveal different grades of cognitive impairment up to dementing illness and can be used for the diagnosis of MCI [17]. Therefore, SIDAM consists of neuropsychological cognitive tests as well as questions concerning clinical evaluation. The neuropsychological test battery covers different areas of cognitive functions grouped into four subscales: orientation, memory, intellectual abilities and higher cortical functioning (verbal abilities, calculation, constructional abilities and language). The eventual SISCO score is calculated based on 55 items, including 30 items of the Mini-Mental State Examination [18]. In order to evaluate impairment in cognitive functioning, age- and education-specific norms are applied [19, 20]. Clinical evaluation and diagnosis is provided by surveying patients and, if necessary, informants. Therefore, data on sociodemographic characteristics, potential risk factors for cognitive impairment and possible personality change are collected. Furthermore, a scale for the assessment of activities of daily living with 14 items is included.

Subjective Cognitive Deficits. Subjective complaints were measured before cognitive testing by asking the question proposed by Geerlings et al. [21]: 'Do you feel like your memory has gotten worse?' (Answer: yes/no/I don't know).

Operationalization of MCI. MCI was diagnosed according to the criteria of Winblad et al. [13]. These consensus criteria proposed by the International Working Group on MCI and their operationalization are shown in table 1.

The required diagnostic criterion of cognitive complaints is still a controversial issue. The present study therefore applied the original as well as the modified concept of MCI. The original MCI concept was defined according to the criteria of Winblad et al. [13] (MCI-original) described above. For the modified MCI concept (MCI-modified), the criteria of Winblad et al. [13] were also applied, omitting the criterion of subjective cognitive impairment.

Winblad et al. [13] recommended the classification of 4 subtypes: single amnestic MCI, multidomain amnestic MCI, single nonmemory MCI, and multidomain nonamnestic MCI. Operationalization of the subtypes is based on SIDAM subscales and was done in an analogous manner for MCI-modified. 'Single amnestic MCI' was diagnosed if subjects had impairments in memory but not in any other area of cognitive functioning. If memory and at least one other cognitive domain were impaired, 'multidomain amnestic MCI' was diagnosed. Subjects with impairment of one single domain other than memory received the diagnosis of 'single nonmemory MCI'. Finally, subjects were diagnosed with 'multidomain nonamnestic MCI' if they had objective deficits in at least two cognitive domains other than memory.

Analyses

The data were entered in the centers via an internet-based remote data entry system into a central ORACLE version 9 database. The statistical analyses were performed using SPSS version 15.0 (Statistical Package of Social Science Inc., Chicago, Ill., USA). A p value less than 0.05 was considered statistically significant.

Prevalence rates of MCI concepts were calculated using the relation of subjects with a diagnosis of MCI and the whole sample (n = 3,198; subjects with and without MCI). Differences in mean age and gender distribution between participants and nonparticipants and in CDT scores between subjects with and without MCI were analyzed using the Mann-Whitney U test and χ^2 test.

In order to assess the CDT's quality of differentiation between patients with MCI and cognitively healthy subjects, multiple logistic regression models were calculated with MCI diagnosis as the dependent variable. Besides the CDT score the explanatory variables were age, gender, education (according to the revised version of the international CASMIN educational classification [22]) and living situation (alone vs. not alone).

Furthermore, the receiver operating characteristic of the CDT was analyzed. The sensitivity, specificity, and the Youden index [23] for optimal cutoff point differentiation (MCI vs. cognitively healthy) will be reported.

Results

Sample Characteristics

Results are based on the data of the 3,198 patients. The sociodemographics of these study subjects are presented in table 2.

MCI-original was diagnosed in 15.0% (n = 479) of the subjects; MCI-modified (without the criterion of subjective cognitive complaints) was diagnosed in 24.6% (n = 786) of the subjects (table 3).

Regarding the original subtypes, prevalence was highest for single nonmemory MCI-original (8.8%), followed by multidomain amnestic MCI-original (2.4%) and single amnestic MCI-original (2.0%), and was lowest for multidomain nonamnestic MCI-original (1.8%). By comparison, the prevalence of the MCI-modified subtypes was similarly highest for single nonmemory MCI-modified (15.0%), followed by multidomain nonamnestic MCI-modified (3.4%) and single amnestic MCI-modified (3.1%), and was lowest for multidomain amnestic MCI-modified (3.0%) (table 3).

CDT Results of Individuals with and without MCI

More than half of the subjects (55.0%, n = 1,758) achieved a maximum performance score of 10 points in the CDT. 13.2% (n = 421) of all individuals achieved 9 CDT scores, 18.7% (n = 597) 8 CDT scores, 5.3% (n = 170) 7 CDT scores, 4.5% (n = 145) 6 CDT scores, 2.0% (n = 65) 5 CDT scores, 0.8% (n = 26) 4 CDT scores, 0.1% (n = 2) 3 CDT scores, 0.2% (n = 6) 2 CDT scores, 0.1% (n = 3) 1 CDT score and 0.2% (n = 5) of the subjects achieved 0 points.

Table 3 shows the differences in CDT scores between individuals with and without MCI. Cognitively unimpaired individuals had significantly higher scores in the CDT than individuals with MCI, both according to the original criteria of Winblad et al. [13] and to the modified criteria. The CDT scores of the MCI subtypes (MCI-original and MCI-modified) are also significantly lower than the scores of the non-MCI subjects.

Results of the Logistic Regression Analysis

The logistic regression model (table 4) revealed that two variables were significantly associated with the diagnosis of MCI: CDT score and education level. A one-point increase in CDT score was associated with a 7.5% decrease in the probability of MCI-original diagnosis and a 7.1% decrease for MCI-modified diagnosis. A middle as well as high level of education was associated with an increase in the risk for MCI diagnosis for both concepts (original and modified).

Table 2. Sociodemographic characteristics of the sample (n = 3,198)

Age groups	
75–79 years	1,711 (53.5)
80–84 years	1,186 (37.1)
85+ years	301 (9.4)
Gender	
Female	2,092 (65.4)
Male	1,106 (34.6)
Marital status	
Single	200 (6.3)
Married	1,366 (42.7)
Divorced	192 (6.0)
Widowed	1,440 (45.0)
Level of education[a]	
Low	1,976 (61.8)
Middle	879 (27.5)
High	343 (10.7)
Living situation	
Living alone	1,634 (51.1)
Living not alone	1,564 (48.9)

Figures in parentheses are percentages.
[a] International CASMIN educational classification [22].

Quality of Differentiation

The area under the curve was 0.595 ($p < 0.001$) for diagnosing MCI-original by using the CDT; the area under the curve was 0.616 ($p < 0.001$) for the diagnosis of MCI-modified. There is a 60–62% probability of MCI patients achieving a lower CDT score than cognitively healthy individuals.

In order to identify the best CDT cutoff point for differentiation between individuals with and without MCI (original and modified), different indicators of specific cutoff points (sensitivity, specificity, Youden index) have been calculated: table 5 shows the best cutoff point at a CDT score of 9 points for both diagnosis of MCI-original and MCI-modified, according to the maximum Youden index which reflects the ratio of sensitivity and specificity. Depending on a diagnosis of MCI-original or MCI-modified, at this cutoff point, CDT has a sensitivity of about 58.2 or 59.4% and a specificity of about 57.3 or 59.7%.

Discussion and Conclusion

The purpose of the study was to examine whether the CDT is suited for screening MCI, as diagnostic utility has been shown for the diagnosis of dementia.

Differences in CDT Scores according to MCI

The mean CDT score for MCI patients (according to the original or modified MCI concept) was lower than for

Table 3. CDT scores of individuals with MCI and without MCI

MCI concept	Individuals with MCI		Individuals without MCI		Z	p
	n (%)	MR (SD)	n (%)	MR (SD)		
MCI-ori	479 (15.0)	8.47 (1.80)	2,719 (85.0)	9.05 (1.40)	–7.312	<0.001
MCIamn-ori	65 (2.0)	8.42 (1.50)			–3.983	<0.001
MCImamn-ori	77 (2.4)	7.90 (2.16)			–5.443	<0.001
MCInom-ori	280 (8.8)	8.70 (1.65)			–3.827	<0.001
MCImnom-ori	57 (1.8)	8.14 (2.09)			–3.528	<0.001
MCI-mod	786 (24.6)	8.44 (1.78)	2,412 (75.4)	9.13 (1.32)	–10.753	<0.001
MCIamn-mod	98 (3.1)	8.52 (1.53)			–4.473	<0.001
MCImamn-mod	110 (3.4)	7.73 (2.22)			–7.779	<0.001
MCInom-mod	481 (15.0)	8.64 (1.62)			–7.037	<0.001
MCImnom-mod	97 (3.0)	8.15 (1.97)			–5.502	<0.001

MCI-ori = Original MCI concept; MCIamn = single amnestic MCI; MCImamn = multidomain amnestic MCI; MCInom = single nonmemory MCI; MCImnom = multidomain nonamnestic MCI; MCI-mod = modified MCI concept; MR = middle range; Z = test statistic of Mann-Whitney U test.

Table 4. Logistic regression model of MCI diagnosis (n = 3,198)

	Coefficient	Odds ratio	p value
Y = diagnosis of MCI-original: yes/no			
CDT score	–0.283	0.753 (0.708–0.802)	<0.001
Gender	0.001	1.001 (0.784–1.279)	0.993
Age (ref. = 75–79 years)			
80–84 years	–0.167	0.846 (0.678–1.056)	0.140
85+ years	0.270	1.310 (0.949–1.807)	0.101
Education (ref. = low)[a]			
Middle	1.082	2.951 (2.367–3.680)	<0.001
High	1.016	2.761 (2.001–3.811)	<0.001
Living situation	0.061	1.063 (0.849–1.331)	0.593
Constant	0.262	1.300	0.412
Nagelkerkes R^2		0.091	
Log likelihood		2531.335	
Y = diagnosis of MCI-modified: yes/no			
CDT score	–0.344	0.709 (0.670–0.750)	<0.001
Gender	0.116	1.124 (0.913–1.383)	0.272
Age (ref. = 75–79 years)			
80–84 years	–0.191	0.826 (0.687–0.994)	0.043
85+ years	0.108	1.114 (0.838–1.482)	0.458
Education (ref. = low)[a]			
Middle	1.037	2.820 (2.337–3.404)	<0.001
High	1.019	2.769 (2.103–3.648)	<0.001
Living situation	–0.023	0.977 (0.809–1.180)	0.809
Constant	1.460	4.308	<0.001
Nagelkerkes R^2		0.118	
Log likelihood		3302.338	

Figures in parentheses are 95% CIs.

[a] Level of education (international CASMIN educational classification) [22].

Table 5. Variables of quality related to specific cutoff points of the CDT

Cutoff point x/y	Sensitivity	Specificity	Youden index
For diagnosis of MCI according to Winblad et al. [13]			
10	1.000	0.000	0.000
9/10	0.582	0.573	0.155
8/ 9	0.447	0.704	0.151
7/ 8	0.221	0.884	0.105
6/ 7	0.144	0.933	0.077
5/ 6	0.069	0.973	0.042
4/ 5	0.027	0.989	0.016
3/ 4	0.015	0.997	0.012
2/ 3	0.015	0.997	0.012
1/ 2	0.008	0.999	0.007
0/ 1	0.004	0.999	0.003
For diagnosis of MCI according to modified criteria of Winblad et al. [13]			
10	1.000	0.000	0.000
9/10	0.594	0.597	0.191
8/9	0.458	0.727	0.185
7/8	0.224	0.898	0.122
6/7	0.150	0.944	0.094
5/6	0.073	0.979	0.052
4/5	0.033	0.993	0.026
3/4	0.011	0.997	0.008
2/3	0.010	0.998	0.008
1/2	0.005	0.998	0.003
1	0.003	0.999	0.002

Cutoff point x/y = CDT score 1 to x – MCI/CDT score y to 10 – without MCI.

cognitively unimpaired persons. Thus, MCI patients scored significantly worse on the 10-stage CDT rating scale [4, 14] than subjects without MCI. These results are consistent with studies of Seigerschmidt et al. [11], Ravaglia et al. [24], Zhou and Jia [7] and Babins et al. [25], although they applied different scoring systems.

The highest CDT scores could be found among MCI patients for persons with single nonmemory MCI. Only 2 former studies examined CDT scores for different but only 3 MCI subtypes and presented comparable results [6, 24]. Ravaglia et al. [24] identified the lowest CDT scores for persons diagnosed with multidomain MCI (criteria of MCI according to Petersen et al. [26]) in comparison to normal control groups and single MCI subtypes. Findings for multidomain amnestic and multidomain nonamnestic MCI, independent of the MCI concept, are similar in this study. These results can be caused potentially by a higher amount and degree of cognitive symptoms. Accordingly, persons with multidomain MCI attained the worst results in tests concerning memory, attention, language, frontal functions, abstract reasoning and visual-spatial praxis compared to normal control groups and single MCI subtypes [24]. The higher the severity of cognitive impairment, the better the CDT detects it. Chiu et al. [12] and Ravaglia et al. [24] actually argue that cognitive symptoms need to be at the level and intensity of dementing symptoms to be diagnosed by the CDT.

The results of multivariate analysis indicate that the CDT is significantly associated with the diagnosis of MCI, checking for different confounding variables (age, gender, education and living situation; table 4). A one-point increase in CDT score is associated with a 7.5 or 7.1% decrease in the probability of MCI diagnosis (original or modified). Chiu et al. [12] also revealed the CDT's significant effect on the diagnosis of MCI (on the basis of the scoring system of Rouleau et al. [27]). Referring to the elderly age groups, increasing age is associated with an increase in MCI diagnosis in this study. Both Luck et al. [28] and Chiu et al. [12] demonstrate that MCI is diagnosed more often in older age groups than in the youngest age group.

In this study, prevalence rates of 15.0% for MCI-original and 24.6% for MCI-modified were found among primary care samples of patients aged 75 years and older. Prevalence rates varied between 3 and 36% in a study of Busse et al. [29], since different concepts and operationalizations of MCI were applied. Generally, by applying the MCI-modified criteria (without the criterion of subjective cognitive impairment), more subjects are diagnosed with MCI than by applying the MCI-original criteria, and sensitivity is thus increased. Accordingly, MCI-modified is more suitable to detect a high-risk group of MCI patients [2] in order to initiate preventative interventions. In contrast, using MCI-original criteria creates better specificity [2]; increased specificity reduces false-positive rates and thus unnecessary and costly interventions.

Cutoff Score

In this study, CDT provides a significant 60–62% probability (receiver operating characteristic) for lower CDT scores of MCI patients in comparison to CDT scores of cognitively healthy individuals. Chiu et al. [12] and Babins et al. [25] calculated the area under the curve of the CDT as also being between 0.61 and 0.69.

On closer examination of indicators of quality, the best combination between sensitivity and specificity – the Youden index – could be identified for the cutoff score of 9 points, irrespective of the concept of MCI. According to this, the maximum score (10) indicates persons being cognitively healthy. Concerning the recommendation of Blake et al. [30], a good diagnostic instrument should have a sensitivity higher than 80% and a specificity of at least 60% to yield high discriminatory power. These numbers could not be reached at any of the assumed cutoff points in this study. Only Scanlan et al. [10] and Yamamoto et al. [6] could meet the demands of Blake et al. [30], but only on the basis of scoring systems other than those of Sunderland et al. [4].

Yamamoto et al. [6] specify planning deficits as less conceptual deficits as a reason for bad CDT performance of MCI patients. Other authors noticed mistakes in hand-setting primarily among MCI patients [12, 25, 31]. Therefore, hands should have more importance when diagnosing MCI. This recommendation is verified by the scoring system of this study: 9 points are regarded as a cutoff point for diagnosing MCI and are only assigned when slight mistakes in setting the hands are noticeable. Hence, in order to diagnose MCI on the basis of the CDT, a scoring system is needed which attaches more importance to hand-setting. In addition to that, the scoring system should be more sensitive with a higher amount of maximum scores, so that small differences in performance among individuals are detectable more easily.

Limitations

Since 93% of the German elderly population are in regular contact with their GP, a representative sample comprising primary care patients was investigated. However,

certain limitations caused by methodological characteristics must be considered in interpreting the results. In particular, only 50.3% (3,327) of the subjects of the randomly selected sample (n = 6,619) underwent a complete clinical investigation. There is a possible bias in accepting versus refusing the research invitation caused by significant differences in age (between participants and nonparticipants) or the perceived potential presence of cognitive impairment by subjects refusing participation in studies. Moreover, generalization of results is limited due to the fact that MCI could also occur in younger elderly (<75), who are not represented in our study.

Besides possible limitations caused by sample characteristics, bias could also be evoked by test attributes themselves. In the present study, the impact of the various CDT versions on the actual test results with regard to formal administration and scoring system was not considered. Hence, previous findings concerning these test characteristics are mentioned subsequently. A predrawn circle, for instance, is supposed to reduce the influence of education [32]. Furthermore, setting the hands at a specific time other than 11.10 could also yield different findings. In this present paper, the scoring system of Sunderland et al. [4] and Ihl et al. [14] was chosen because of the easy applicability. Compared to our study, Yamamoto et al. [6] attained higher discriminatory power by using the scoring system of Cahn et al. [33]. In contrast, the scoring system of Shulman et al. [34] shows worse power in the differentiation of subjects diagnosed with MCI and cognitively healthy persons [35].

As an agreement has not yet been reached as to how MCI and the subtypes should be generally operationalized [36], MCI was measured by using the SIDAM and its subscales [28, 29]. The operationalization of the subtypes of MCI by using just SIDAM subscales is subject to certain limitations due to the fact that neuropsychological assessment in more detail could not been provided in this large epidemiological study.

Conclusions

Although there are significant differences in CDT performance between persons with the diagnosis of MCI and cognitively healthy persons (according to the scoring system of Sunderland et al. [4], 9 CDT scores or less indicate the presence of MCI), the attained quality of differentiation is not sufficient to apply the CDT as a screening instrument. The CDT is not able to differentiate several MCI subtypes. At best, minimal impaired CDT performance could be a warning sign, but differential diagnosis requires a more thorough assessment of cognitive symptoms.

With respect to the ageing society, cognitive impairment and dementia challenge health and social services. This study underlines the need for further research into short, simple and easy-to-administer instruments for MCI screening.

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References

1 Kurz A, Diehl J, Riemenschneider M, Perneczky R, Lautenschlager N: Mild cognitive disorder. Questions of definition, diagnosis, prognosis and therapy. Nervenarzt 2004;75:6–15.
2 Busse A, Hensel A, Guhne U, Angermeyer MC, Riedel-Heller SG: Mild cognitive impairment: long-term course of four clinical subtypes. Neurology 2006;67:2176–2185.
3 Zanetti M, Ballabio C, Abbate C, Cutaia C, Vergani C, Bergamaschini L: Mild cognitive impairment subtypes and vascular dementia in community-dwelling elderly people: a 3-year follow-up study. J Am Geriatr Soc 2006; 54:580–586.
4 Sunderland T, Hill JL, Mellow AM, Lawlor BA, Gundersheimer J, Newhouse PA, Grafman JH: Clock drawing in Alzheimer's disease. A novel measure of dementia severity. J Am Geriatr Soc 1989;37:725–729.
5 Shulman KI: Clock-drawing: is it the ideal cognitive screening test? Int J Geriatr Psychiatry 2000;15:548–561.
6 Yamamoto S, Mogi N, Umegaki H, Suzuki Y, Ando F, Shimokata H, Iguchi A: The clock drawing test as a valid screening method for mild cognitive impairment. Dement Geriatr Cogn Disord 2004;18:172–179.
7 Zhou A, Jia J: The value of the Clock Drawing Test and the Mini-Mental State Examination for identifying vascular cognitive impairment no dementia. Int J Geriatr Psychiatry 2008;23:422–426.
8 Ehreke L, Luppa M, Konig HH, Riedel-Heller SG: Is the Clock Drawing Test a screening tool for the diagnosis of mild cognitive impairment? A systematic review. Int Psychogeriatr 2009;20:1–8.
9 Hughes CP, Berg L, Danziger WL, Coben LA, Martin RL: A new clinical scale for the staging of dementia. Br J Psychiatry 1982; 140:566–572.

10 Scanlan JM, Brush M, Quijano C, Borson S: Comparing clock tests for dementia screening: naive judgments vs formal systems – what is optimal? Int J Geriatr Psychiatry 2002;17:14–21.
11 Seigerschmidt E, Mosch E, Siemen M, Forstl H, Bickel H: The clock drawing test and questionable dementia: reliability and validity. Int J Geriatr Psychiatry 2002;17:1048–1054.
12 Chiu YC, Li CL, Lin KN, Chiu YF, Liu HC: Sensitivity and specificity of the Clock Drawing Test, incorporating Rouleau scoring system, as a screening instrument for questionable and mild dementia: scale development. Int J Nurs Stud 2008;45:75–84.
13 Winblad B, Palmer K, Kivipelto M, Jelic V, Fratiglioni L, Wahlund LO, Nordberg A, Backman L, Albert M, Almkvist O, Arai H, Basun H, Blennow K, de Leon M, DeCarli C, Erkinjuntti T, Giacobini E, Graff C, Hardy J, Jack C, Jorm A, Ritchie K, van Duijn C, Visser P, Petersen RC: Mild cognitive impairment – beyond controversies, towards a consensus: report of the International Working Group on Mild Cognitive Impairment. J Intern Med 2004;256:240–246.
14 Ihl R, Grass-Kapanke B, Lahrem P, Brinkmeyer J, Fischer S, Gaab N, Kaupmannsennecke C: Development and validation of a test for early diagnosis of dementia with differentiation from depression (TFDD). Fortschr Neurol Psychiatr 2000;68:413–422.
15 Zaudig M, Mittelhammer J, Hiller W, Pauls A, Thora C, Morinigo A, Mombour W: SIDAM – A structured interview for the diagnosis of dementia of the Alzheimer type, multi-infarct dementia and dementias of other aetiology according to ICD-10 and DSM-III-R. Psychol Med 1991;21:225–236.
16 Zaudig M, Hiller W: SIDAM-Handbuch. Strukturiertes Interview für die Diagnose einer Demenz vom Alzheimer Typ, der Multiinfarkt- (oder vaskulären) Demenz und Demenzen anderer Ätiologie nach DSM-III-R, DSM-IV und ICD-10. Bern, Huber, 1996.
17 Zaudig M: A new systematic method of measurement and diagnosis of 'mild cognitive impairment' and dementia according to ICD-10 and DSM-III-R criteria. Int Psychogeriatr 1992;4(suppl 2):203–219.
18 Folstein MF, Folstein SE, McHugh PR: 'Mini-mental state'. A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 1975;12:189–198.
19 Busse A, Aurich C, Zaudig M, Riedel-Heller S, Matschinger H, Angermeyer MC: Age- and education-specific reference values for the cognitive test of the SIDAM (Structured interview for the diagnosis of dementia of the Alzheimer type, multi-infarct dementia and dementias of other etiology according to ICD-10 and DSM-IV). Z Gerontol Geriatr 2002;35:565–574.
20 Luck T, Zaudig M, Wiese B, Riedel-Heller SG: SIDAM: Alters- und bildungsspezifische Normen des kognitiven Leistungsteiles nach der neuen CASMIN-Bildungsklassifikation. Z Gerontopsychol Psychiatr 2007;20:31–38.
21 Geerlings MI, Jonker C, Bouter LM, Ader HJ, Schmand B: Association between memory complaints and incident Alzheimer's disease in elderly people with normal baseline cognition. Am J Psychiatry 1999;156:531–537.
22 Brauns HSS: Educational Reform in France, West-Germany and the United Kingdom. Zuma-Nachrichten 1999;44:7–44.
23 Youden WJ: Index for rating diagnostic tests. Cancer 1950;3:32–35.
24 Ravaglia G, Forti P, Maioli F, Servadei L, Martelli M, Brunetti N, Bastagli L, Mariani E: Screening for mild cognitive impairment in elderly ambulatory patients with cognitive complaints. Aging Clin Exp Res 2005;17:374–379.
25 Babins L, Slater ME, Whitehead V, Chertkow H: Can an 18-point clock-drawing scoring system predict dementia in elderly individuals with mild cognitive impairment? J Clin Exp Neuropsychol 2008;30:173–186.
26 Petersen RC, Doody R, Kurz A, Mohs RC, Morris JC, Rabins PV, Ritchie K, Rossor M, Thal L, Winblad B: Current concepts in mild cognitive impairment. Arch Neurol 2001;58:1985–1992.
27 Rouleau I, Salmon DP, Butters N, Kennedy C, Mcguire K: Quantitative and qualitative analyses of clock drawings in Alzheimer's and Huntington's disease. Brain Cogn 1992;18:70–87.
28 Luck T, Riedel-Heller SG, Kaduszkiewicz H, Bickel H, Jessen F, Pentzek M, Wiese B, Koelsch H, van den BH, Abholz HH, Moesch E, Gorfer S, Angermeyer MC, Maier W, Weyerer S: Mild cognitive impairment in general practice: age-specific prevalence and correlate results from the German study on ageing, cognition and dementia in primary care patients (AgeCoDe). Dement Geriatr Cogn Disord 2007;24:307–316.
29 Busse A, Bischkopf J, Riedel-Heller SG, Angermeyer MC: Mild cognitive impairment: prevalence and predictive validity according to current approaches. Acta Neurol Scand 2003;108:71–81.
30 Blake H, McKinney M, Treece K, Lee E, Lincoln NB: An evaluation of screening measures for cognitive impairment after stroke. Age Ageing 2002;31:451–456.
31 Esteban-Santillan C, Praditsuwan R, Ueda H, Geldmacher DS: Clock drawing test in very mild Alzheimer's disease. J Am Geriatr Soc 1998;46:1266–1269.
32 Juby A, Tench S, Baker V: The value of clock drawing in identifying executive cognitive dysfunction in people with a normal Mini-Mental State Examination score. CMAJ 2002;167:859–864.
33 Cahn DA, Salmon DP, Monsch AU, Butters N, Wiederholt WC, Corey-Bloom J, Barrett-Connor E: Screening for dementia of the Alzheimer type in the community: the utility of the Clock Drawing Test. Arch Clin Neuropsychol 1996;11:529–539.
34 Shulman KI, Gold DP, Cohen CA, Zucchero CA: Clock-drawing and dementia in the community – a longitudinal study. Int J Geriatr Psychiatry 1993;8:487–496.
35 Beinhoff U, Hilbert V, Bittner D, Gron G, Riepe MW: Screening for cognitive impairment: a triage for outpatient care. Dement Geriatr Cogn Disord 2005;20:278–285.
36 Werner P, Korczyn AD: Mild cognitive impairment: conceptual, assessment, ethical, and social issues. Clin Interv Aging 2008;3:413–420.