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Original research article

Is the Clock Drawing Test useful in the screening assessment of aged patients with chronic heart failure?

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ABSTRACT

Purpose: Cognitive impairment is one of the most common geriatric deficits in old patients with heart failure (HF), but there has been a lack of study on the utility of the Clock Drawing Test (CDT) when used with this group of patients. The aim of the study was to assess the usefulness of the CDT in the geriatric assessment of aged outpatients with chronic HF.
Patients and methods: A cross-sectional analysis of the results of the comprehensive geriatric assessment (CGA), including the CDT, of 92 aged outpatients with heart failure was conducted.
Results: We found a high prevalence of five examined geriatric problems. The majority of the patients presented signs of cognitive deterioration of different patterns and severity on the Clock Drawing Test. All the CDT scoring systems correlated significantly with the Mini-Mental Test Examination results.
Conclusions: It seems reasonable to perform the routine CGA with the CDT examination in all aged heart failure patients.

1. Introduction

Populations worldwide are ageing. It is said that by 2050 the percentage of aged people in communities will reach up to 16% [1]. Advanced age, in terms of both successful ageing as well as senescence, is associated with an inevitable accumulation of some deficits and diseases [2]. Chronic heart failure (HF) is one of the most frequent cardiovascular chronic conditions in the old adults [3]. In older adults with multimorbidity, HF is often found to be an index condition that determines patients' short and long-term prognosis [4].

The crucial question seems to be how to optimize symptom and drug management, and thus reduce social and economical burden in aged heart failure patients.

An important problem is cognitive impairment (CI). The risk for CI and exposure to or occurrence of cardiovascular risk factors increases with age [3,5]. According to the 'heart failure-cognition' paradigm, the association between HF and acute and chronic cognition deterioration is evident and well-proven [3,6]. Cognitive problems accompanying heart failure encompass the progressive chronic cognitive deterioration corresponding to the mild cognitive impairment of different modalities (multi-domain, amnestic, and non amnestic) and dementia, as well as an acute onset delirium. The most plausible mechanisms include reduced ejection fraction and hemodynamic abnormalities resulting in a decreased cardiac output with cerebral hypoxia, impairment of brain autoregulation and microemboli, all in all, altogether with small vessel disease leading to ischemic brain damage and cognitive dysfunction [7,8]. It has been shown that patients with HF and CI are at a higher risk for drug errors, unnecessary doctors' appointments and hospital admissions, higher rates of re-hospitalization, greater need for home-care, institutionalization or long-term care, and risk of death. What is more, they tend not only to not adhere to the drug regimens prescribed to them or follow the diet and lifestyle modification, but also neglect initial symptoms and signs of heart failure decompensation [7].

Furthermore, it is widely known that if older adults suffer from geriatric deficits and disabilities, it in unison negatively affects their self-care independence, mood and well-being, and the quality of life [2]. As current medicine research has made it possible to treat symptoms of the patients with cognitive deficits corresponding diagnosis of dementia pharmacologically and non-pharmacologically, it is of great importance to screen for and treat dementia as soon as possible [9]. A large selection of cognitive screening tests is available [6,10,11]. From the clinicians' point of view, an optimal tool has to be an easy-to-use, simple to perform and analyze, and time-efficient instrument [11]. The Clock Drawing Test (CDT) is a cognitive screening tool that is used to detect deterioration of the visuoconstructive and visuospatial skills.

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Nevertheless, it has been proven that the process of correct clock drawing and clock setting require not only intact space perception and constructional skills, but also auditory comprehension, numerical knowledge, semantic memory, abstract thinking, concentration and frustration tolerance, and accurate executive functioning [12–14].Recognizing the CDT clinical utility and its neuropsychological modalities, we decided to check the applicability of the Clock Drawing Test in the geriatric screening assessment of aged patients with chronic heart failure, with a particular emphasis on functional deficits and executive function deterioration due to cognitive impairment. The aim of the analysis was to evaluate the usefulness of the Clock Drawing Test as a first-line screening tool for distinction between aged heart failure patients with and without the most common geriatric problems, i.e. mood disorders, executive function impairment, malnutrition, falls, and functional impairment. An additional aim was to analyze the frequency of occurrence of those five geriatric problems in the heart failure outpatients population of older adults. We hypothesized that aged patients with HF who revealed any abnormalities on the CDT examination, would be at greater risk for geriatric problems, including executive function impairment and functional dependence.

2. Patients and methods

The results are part of a prospective observational, multicomponent study on functional and cognitive performance of aged patients with chronic heart failure.

The subjects were recruited from the patients of the outpatient clinic of the tertiary-care teaching hospital.

Inclusion criteria:

- age $\geq$60 years,
- presence of stable chronic heart failure at the time of examination,
- Mini
- Mental State Examination (MMSE) result $\geq$ 20 points,
- informed consent.

Exclusion criteria:

- neoplastic diseases,
- diagnosis of dementia.

The presented analysis was based on the cross-sectional medical data of 92 patients at the age of 60 years and older with stable chronic heart failure at the time of examination. HF-related symptoms were classified by the New York Heart Association (NYHA) Functional Classification from I to III [15]. The study was performed according to the Helsinki Declaration with the approval of the Ethics Committee. Written consents were obtained from all examined patients.

2.1. Study procedures- the elements of the comprehensive geriatric assessment

All the subjects had a comprehensive geriatric assessment (CGA) performed. It included the screening assessment for cognitive impairment, mood disorders, functional deficits and disabilities, malnutrition and falls.Cognitive functions were screened with the use of the Mini-Mental State Examination and the Clock Drawing Test [16,12]. MMSE is a screening tool commonly used for the routine assessment of cognitive functions in the elderly, invented and introduced by Folstein et al. in 1975. The questionnaire consists of 10 domains with the items testing the subject's temporal and spatial orientation, attention and calculation, working memory and registration, visuospatial and language functions, and the ability to follow a simple 3-stage command. It is scored from 0 to 30 points maximum, with the lowest scores being indicative of cognitive impairment [16]. In the presented analysis we included the subjects who achieved $\geq$ 20 MMSE points. If the subject was rated below 27 MMSE points in accordance with the National Institute for Health and Care Excellence (NICE) 2011 guidelines, cognitive impairment was suspected [9]. None of the analyzed subjects had a previous diagnosis of dementia nor had been treated with acetylcholinesterase inhibitors nor/and mementine nor had taken any neuroleptic drugs.The Clock Drawing Test is a well-known cognitive screening instrument which focuses on the assessment of visuoconstructive and visuospatial skills [12]. In our study, the subjects were first given the pre-drawn circle 14 cm in diameter and asked to "place the numbers on the circle to make it look like a clock" (Sheet 1). When they did their best, the subjects were given the next two pre-drawn clock faces and were asked to set the specific time (3:00 and 11:10 o'clock, respectively Sheet 2 and 3). They were not allowed to look at a watch or another clock for help. There was no time limit for the tasks.The modified Sunderland et al., Shulman et al., Goodglass and Kaplan, and Watson et al. criteria were employed in the analysis [17,12,18–20]. The completed sheets were rated independently by the three geriatricians involved in the study. In the case of discordant results between the raters, a consensus approach was implemented. As we were finally presented with three different CDT- sheets for evaluation, i.e. the pre-drawn circle with the numbers being put on by the subject, and the two pre-drawn clock faces with 3:00 and 11:10 o'clock being denoted, we decided to evaluate it as two tasks. It means that in both the modified Sunderland et al. and modified Shulman et al. scales, the subjects were given two scores. The points were given for drawing the clock face in a pre-drawn circle (Sheet 1) and then putting the clock hands in the pre-drawn clock faces, considered separately for 3:00 o'clock (Sheet 1 + 2) and 11:10 o'clock (Sheet 1 + 3). Goodglass and Kaplan, and Watson et al. scoring systems were then employed. The Goodglass and Kaplan method was used only for the evaluation of the position and length of the clock hands (Sheet 2 and 3), and the Watson et al. method was used only for the assessment of the proper clock face representation (Sheet 1). All the used original CDT error classifications were presented in Table A.1 (Supplementary material). Abnormal results were as follows: $\leq$8 points for the Sunderland et al. scoring system, $\leq$ 3 points for the modified Shulman et al., $\leq$ 2 points for the Goodglass and Kaplan, and $\geq$ 1 point for the Watson et al. scoring system.

Mood was screened with the Geriatric Depression Scale (GDS) [21]. The GDS questionnaire, which was introduced for older adults by Yesavage et al. in 1983, comprises of 30 "yes" or "no" questions about the subject's mood over the last week before the examination [21]. Mood disorders were suspected if the subject reached 11 out of 30 points maximum or was treated with antidepressant drugs.

Functional performance was assessed with the Activities of Daily Living Scale (ADL, Katz scale) and the Instrumental Activities of Daily Living Scale (IADL, Lawton scale) [22,23].The Activities of Daily Living Scale is a short screening instrument, invented by Katz et al. in 1970, assessing subject's independence in six basic activities of every-day life such as: dressing, toileting, transferring, eating, bathing, incontinence [22]. Functional disability was suspected if the subject was scored at $\leq$ 4 out of maximum 6 points in ADL scale.

The Instrumental Activities of Daily Living Scale was set by Lawton et al. in 1969 for evaluation of subject's independence in eight items such as: ability to use the telephone, shopping, food preparation, housekeeping, laundry, mode of transportation, responsibility for own medication, ability to manage their finances

[23]. Functional impairment was identified if the patient was scored at ≤ 24 out of maximum 27 points in the IADL scale. xecutive function impairment was defined as any limitation in one or more out of three selected items in the IADL, which were the ability to use the telephone, handle the finances and manage medications.Nutrition screening and assessment was done with the use of the Mini-Nutritional Assessment (MNA) scale [24]. The MNA tool was developed in 1990′s and currently has been the most well-known nutrition tool for the elderly. The questionnaire comprises of 18 questions regarding subject's appetite and weight, mode of feeding, amount of food and fluid intake, fruit, vegetables, and protein intake, self-view of nutrition status, presence of pressure sores or skin ulcers, neuropsychological problems and reduced mobility, as well as the basic anthropometric measurements (incl. weight, height, body-mass index, mid-arm and calf circumference) [24]. Malnutrition was suspected if the subject was rated at ≤23.5 out of maximum 30 points in the screening Mini-Nutritional Assessment scale.The assessment of falls occurrence in the last 12 months was done.The number of chronic concomitant diseases and drugs was calculated based on patients' medical data.

2.2. Statistical analyses

The normal distributions were tested with the Shapiro-Wilk normality test. Means were compared with U Mann-Whitney test and presented as median (Q1;Q3); proportions were tested with chi-square test. Spearman rank correlations were tested to a significance level of <0.05. In order to assess the influence of mood disorders, malnutrition, functional impairment, falls and severity of heart failure on the prevalence of cognitive impairment suspected according to the CDT scored with the modified Sunderland et al. and Shulman et al. methods, and the Mini-Mental State Examination results, logistic regression analyses with adjustment for age and sex were used. Additionally, we fitted the multiple logistic regression with explanatory variables such as age, sex, mood disorders, malnutrition, falls, classes of heart failure, number of drugs, number of diseases, functional impairment and functional disability. Statistical significance was set at $p < 0.05$ and the stability of the estimates was reflected by 95% confidence intervals (95% CIs). All statistics were done with Statistica, version 10.

3. Results

3.1. General characteristics

The mean (SD) age of 92 patients with chronic heart failure was 73.8 (8.7) years, min.-max.: 60–96 years. The 37 (40.2%) included patients were at least 75 years of age. General, 52 (56.5%) men were younger than women [72.3 (8.3) vs 75.8 (8.8) years, p = 0.07]. The mean (±SD) score of the Mini-Mental State Examination test was 26.9 ± 2.6, median (Q1;Q3): 27 (25;29); min-max: 20–30 points; the Geriatric Depression Scale: 10.2 ± 5.7, median (Q1;Q3): 9 (6;14); min-max: 1–26 points; the Activities of Daily Living Scale: 5.9 ± 0.5, median (Q1;Q3): 6 (6;6), min-max:2–6; the Instrumental Activities of Daily Living Scale: 23.9 ± 3.2, median (Q1;Q3): 25 (22;26), min-max:10–27; the Mini-Nutritional Assessment: 25.1 ± 2.8, median (Q1;Q3): 25.5 (23.5;27), min-max:15–30, respectively. Sample characteristics were included in Table 1.

3.2. The Clock Drawing Test results

Most of the patients presented some abnormalities on the CDT examination. Results considered abnormal were observed in 60.8% and 72.9%, 58.7% and 72.9%, 43.5% and 85.9%, and 52.2%, respectively for modified Sunderland et al. (3:00 and 11:10), Shulman et al. (3:00 and 11:10), Goodglass and Kaplan (3:00 and 11:10), and Watson et al. scoring systems (Figure A.1 -A.4-Supplementary materials). The most common reported errors included the clock face abnormalities. More errors were noted for the 11:10 o'clock-task, when comparing the CDT results for 3:00 o'clock and 11:10 o'clock. Almost perfect positive correlations were observed between the results of the modified Sunderland and Shulman scoring systems; high correlations were shown for the Watson and the other scoring methods. All the employed CDT scoring systems correlated significantly with the Mini-Mental State results. There was no correlation observed between CDT and MMSE, and IADL results (Table 2).In the comparisons of those who

Table 1
The comparisons of those with [CI (+)] and without cognitive impairment [CI (−)] according to the different Clock Drawing Test protocols. Statistical significance (*) was set at the level of <0.05.

	Nb	All	Sunderland 3:00 CI (+)	CI (−)	Sunderland 11:10 CI (+)	CI (−)	Shulman 3:00 CI (+)	CI (−)	Shulman 11:10 CI (+)	CI (−)
Age (years)	92	73.8 ± 8.7	74.3 ± 8.2	73.1 ± 9.4	73.9 ± 8.1	73.4 ± 10.3	74.3 ± 8.2	73.1 ± 9.5	73.9 ± 8.1	73.4 ± 10.3
Male (%)	92	56.5	50.0	66.7	55.2	60.0	48.2	68.4*	55.2	60.0
Geriatric assessment:										
MMSE	92	27	26	29	27	29	26	28.5	27	29
(median,Q1;Q3 pts.)		(25;29)	(24.5;28)	(27.5;30)*	(25;28)	(27;30)*	(25;28)	(27;30)*	(25;28)	(27;30)*
Executive functions impairment (%)	92	25.0	25.0	25.0	23.9	28.0	24.1	26.3	23.9	28.0
Cognitive impairment (%)	92	39.1	53.6	16.7*	47.8	16.0*	53.7	18.4*	47.8	16.0*
Depression (%)	90	40.7	41.4	40.0	37.3	50.0	40.7	40.5	37.3	50.0
Malnutrition (%)	90	27.8	35.2	16.7*	30.8	20.0	35.9	16.2*	30.8	20.0
ADL (median,Q1;Q3 pts.)	92	6 (6;6)	6 (6;6)	6 (6;6)	6 (6;6)	6 (6;6)	6 (6;6)	6 (6;6)	6 (6;6)	6 (6;6)
IADL	92	25	24.5	25	25	25	25	25	25	25
(median,Q1;Q3 pts.)		(22;26)	(22;26)	(22.5;27)	(22;27)	22;26)	(22;26)	(22;27)	(22;27)	(22;26)
Functional impairment (%)	92	45.7	50.0	38.9	46.3	44.0	48.2	42.1	46.3	44.0
Falls (%)	92	23.9	28.6	16.7	25.4	20.0	27.8	18.4	25.4	20.0
Nb of diseases	89	5(4;6)	5 (4;6)	5 (4;7)	5 (4;6)	5.5(4;6.5)	5 (4;6)	5 (4;6.5)	5 (4;6)	5.5(4;6.5)
Nb of drugs	88	7(5;8.5)	7 (5;8)	7 (6;9)	7 (6;8)	6 (5;9)	7 (5;8)	7 (6;9)	7 (6;8)	6 (5;9)
NYHA class (%)										
I class	92	34.8	33.9	36.1	31.3	44.0	33.3	36.8	31.3	44.0
II class		27.2	25.0	30.6	26.9	28.0	25.9	29.0	26.9	28.0
III class		38.0	41.1	33.3	41.8	28.0	40.7	34.2	41.8	28.0

NA: not applicable, CI: cognitive impairment, MMSE: the Mini-Mental State Examination, ADL: the Activities of Daily Living, IADL: the Instrumental Activities of Daily Living, NYHA class: the New York Heart Association class.

Table 2
The correlation coefficients for the analyzed Clock Drawing Test scoring protocols, the Mini-Mental State Examination (MMSE) and the Instrumental Activities of Daily Living (IADL) tests. Statistical significance (*) was set at the level of <0.05. NA: not applicable.

	Sunderland 3:00	Sunderland 11:10	Shulman 3:00	Shulman 11:10	Goodglass & Kaplan 3:00	Goodglass & Kaplan 11:10	Watson	IADL	MMSE
Sunderland 3:00	NA	NA	0.959*	0.900*	0.498*	0.550*	−0.824*	0.097	0.446*
Sunderland 11:10	NA	NA	0.878*	0.965*	0.388*	0.695*	−0.833*	−0.010	0.426*
Shulman 3:00	0.959*	0.878*	NA	NA	0.576*	0.556*	−0.840*	0.124	0.469*
Shulman 11:10	0.900*	0.965*	NA	NA	0.472*	0.674*	−0.830*	0.027	0.453*
Goodglass & Kaplan 3:00	0.498*	0.388*	0.576*	0.472*	NA	0.433*	−0.361*	0.085	0.310*
Goodglass & Kaplan 11:10	0.550*	0.695*	0.556*	0.674*	0.433*	NA	−0.515*	0.018	0.330*
Watson	−0.824*	−0.833*	−0.840*	−0.830*	−0.361*	−0.515*	NA	−0.013	−0.361*
MMSE	0.446*	0.426*	0.469*	0.453*	0.310*	0.330*	−0.361*	0.166	NA

did and did not present cognitive impairment in the CDT examination, scored with the modified Sunderland et al. and Shulman et al. methods, differences in raw MMSE results, rates of cognitive impairment according to the MMSE, and rates of malnutrition (but only for the task with 3:00 o'clock denoting) were note. Similar rates of those who presented executive function impairment, mood disorders, functional impairment and falls were showed in the analyses in both those with and without cognitive impairment according to the CDT scored with the modified Sunderland et al. and Shulman et al. methods. No significant difference was also found with regard to heart failure severity and its class in the NYHA scale, the median number of drugs taken and chronic diseases diagnosed. The subgroups did not differ according to age (Table 1).

3.3. Logistic regression analysis

Mood disorders, malnutrition, functional impairment, falls and severity of heart failure were shown in logistic regression analyses not to be associated with cognitive impairment suspected according to the CDT scored with the modified Sunderland et al. and Shulman et al. methods, and MMSE results. All the employed models were statistically insignificant (p for all models >0.05), and the specific odds ratios (95% CI) were presented in Table 3. In the multiple logistic regression none of the analyzed variables was significantly associated with cognitive impairment suspicion based on the CDT nor MMSE results.

4. Discussion

As heart failure is one of the most deteriorating chronic diseases, we launched the study on the cognitive and functional performance of the aged patients with HF in the prospective observation. The scope of the presented analysis was to assess the usefulness of the Clock Drawing Test in the geriatric screening assessment of older patients with chronic heart failure.

We showed a high prevalence of five analyzed geriatric problems in the aged patients with stable chronic heart failure, who had no previous diagnosis of dementia and achieved at least 20 points in the Mini-Mental State Examination. In majority, the examined patients presented signs of cognitive impairment of different patterns and severity on the Clock Drawing Test. The most commonly observed errors were related to the drawing of the clock faces, and when denoting the hour, more errors were noted for the 11:10 o'clock-task.There was a non-significant trend to a higher prevalence of geriatric problems such as functional impairment and falls, and malnutrition among those with cognitive deterioration, as assessed by the employed in the analysis the Clock Drawing Test scoring methods. Significant correlations were observed between the results of all the employed CDT scoring methods and the Mini-Mental State Examination.

The problem of a high prevalence of geriatric deficits and disabilities among aged people with chronic conditions has been well-described [2]. In the nationwide cross-sectional project on epidemiological, medical, psychological, and socioeconomic aspects of ageing in Poland, it was shown that subjects who reported hospital admission due to HF had a higher number of geriatric conditions. It was noticed, at the community level, that those with HF had mood disorders, hearing impairment, and functional limitation more often. Heart failure-related hospitalization increased the risk of functional dependence by 40%, both in ADL and IADL scale [25]. In a prospective cohort study of 282 older adults with a diagnosis of heart failure it was also shown that cognitive impairment is common, but not frequently documented in patients' medical data [26]. Dodson et al. found in the *COPing with Heart Failure* study *(Comorbidity in Older Patients with Heart Failure)* that 46.8% of patients at the mean age of 80 hospitalized for heart failure presented symptoms of cognitive impairment on the screening examination with the Folstein Mini-Mental State Examination. It is worth mentioning that, despite the fact that 21.6% of them met criteria for moderate to severe and 25.2% for mild cognitive impairment, only 22.7% of them did have cognitive impairment documented in their discharge medical records. Notably, patients who did not have their cognitive impairment documented, had a higher 6-month mortality and re-hospitalization rate [26]. Our results are in line with Dodson findings, as 39.1% of our study population was diagnosed with cognitive impairment, but none of them had this diagnosis before. The frequency of cognitive impairment diagnosis in our heart failure sample might be compared to the results of the cross-sectional, nationally representative study of 6189 respondents aged 67 years and more living in the US [27]. Gure et al showed that 24% of community dwelling subjects with heart failure were diagnosed with mild cognitive impairment and the next 15% with dementia. The authors subsequently concluded that a routine cognitive assessment should be included into the focused model of care for heart failure aged patients [27]. What is more, it was shown that the prevalence rate and the severity of cognitive impairment depended significantly on the progress of heart failure and its stage [7,28,29]. Trojano et al. found, in their multicenter observational case-control study of hospitalized elderly patients, that cognitive impairment was diagnosed more frequently in the subjects with HF in the III–IV NYHA stage (57.9%) when compared to those with the NYHA II stage (43%) and to those without diagnosis of chronic heart failure (34.3%) [28]. Likewise, Huijts et al. showed in 611 patients from *the Trial of Intensified versus standard Medical therapy in Elderly patients with Congestive Heart Failure (TIME-CHF),* using the Hodkinson Abbreviated Mental Test, that patients classified as NYHA IV stage

Table 3
Age and sex adjusted odds ratios for cognitive impairment suspected according to the different Clock Drawing Test protocols and the Mini-Mental State Examination, and the analyzed geriatric impairments.

	Sunderland 3:00 OR (95% CI)	Sunderland 11:10 OR (95% CI)	Shulman 3:00 OR (95% CI)	Shulman 11:10 OR (95% CI)	MMSE OR (95% CI)
Depression[a]	1.04 (0.43–2.54)	1.73 (0.66–4.53)	0.91 (0.37–2.21)	1.73 (0.66–4.53)	0.62 (0.25–1.50)
Malnutrition[a]	0.39 (0.13–1.14)	0.57 (0.18–1.79)	2.69 (0.92–7.86)	0.57 (0.18–1.79)	0.73 (0.28–1.95)
Functional impairment[a]	0.65 (0.27–1.57)	0.92 (0.36–2.37)	1.25 (0.52–2.97)	0.92 (0.36–2.37)	1.16 (0.48–2.78)
Falls[a]	0.59 (0.20–1.76)	0.77 (0.24–2.49)	0.72 (0.25–2.11)	0.77 (0.24–2.49)	0.96 (0.34–2.73)
NYHA class II[a]	1.14 (0.42–3.06)	1.02 (0.34–3.00)	0.94 (0.35–2.55)	1.02 (0.34–3.00)	1.87 (0.66–5.30)
NYHA class III[a]	0.51 (0.19–1.35)	0.46 (0.15–1.35)	0.51 (0.19–1.34)	0.46 (0.15–1.35)	0.56 (0.21–1.45)

NYHA class: the New York Heart Association class; OR: odds ratio; CI: confidence interval; MMSE: Mini-Mental State Examination.
[a] age and sex adjusted.

had a 2.94 higher risk of severe cognitive impairment than those staged as NYHA II class [29].There are various CDT application and interpretation methods [10–12]. Different skills are tested when performing the task of drawing, setting or reading the clock. Additionally, distinct brain regions (mainly frontal and temporo-parietal areas) are involved and aroused when applying its different psychometric properties [30]. There has been no standardized CDT application and assessment method, with the comprehensive scoring protocol, approved so far [11]. The numerous CDT operation methods require a pre-drawn circle to be used for the clock drawing task, whereas some of them prefer the subject to draw a figure of a clock face on his/her own [11]. Several different hours of the clock are also exploited [31]. There are studies comparing different CDT examination methods available [10,11,32,33]. Good correlations between CDT results, scored with five different protocols, were shown in Korner et al. survey of 72 aged out-patients and 29 healthy controls [32]. Whereas, Richardson and Glass showed that deterioration in the Clock Drawing Test, scored with five protocols (incl. Sunderland and modified Shulman methods), correlated in the group of 63 demented patients with both total MMSE and memory MMSE results [33]. The levels of correlation coefficients showed in our group of HF patients, for CDT assessed with Sunderland and Shulman protocols, and MMSE results, are comparable to the Richardson and Glass results. In our study we demonstrated an almost perfect agreement between the results of the Sunderland and Shulman assessment methods, that is also in line with the above-mentioned results [33]. However, we did not test the efficiency and feasibility of different CDT variants for the dementia screening assessment. It also seems important to comment in reference to the Mainland et al. who concluded that ‘ *no system emerged as consistently superior in terms of predictive validity* [for cognitive impairment]’ in their review of the available literature on the multiple clock drawing scoring systems [11]. It was shown that the CDT is highly dependent on age and level of education [13,34]. The normative results for CDT performance, within a community-based cohort, were identified for the Portuguese population and in the Framingham Heart Study [35,13]. Not only were the mistakes in the CDT shown to be more frequent among those of older age and those less educated, but also some patterns of errors were established. Both the higher age and lower educational background were related to the greater number of errors for the time-setting and numerals [13]. In our study we noted more errors for the 11:10 o’clock-task, when comparing CDT results for 3:00 o’clock and 11:10 o’clock. It might be related to the different psychometric properties of the tasks. In the latter task it is necessary for a patient to inhibit his “frontal pull” (stimulus bond) towards the number 10 instead of 2, and to mark an offset when the hour hand is placed on the correct number with an offset depending on the minute data [13,31]. In order to capture all the errors that might be indicative for cognitive deterioration with executive function and functional impairment, we decided to place the threshold for cognitive deterioration at the level of 8/9 for the Sunderland and 2/3 for the Shulman scale. This might have resulted in the false positive outcomes, with errors clinically not relevant, being accounted. However, there has been no normative data for CDT performance in the Polish population, and what is more, we had no data on the educational level of the respondents which is a serious limitation of the analysis. Of note, there has been a growing need for a formal validation of the Clock Drawing Test in a general population of older Polish adults which would thereupon contribute to a more efficient use of this handy tool in the future.In our study most of the patients presented some cognitive deterioration in the Clock Drawing Test, however, it did not correlate with the results of functional assessment in the IADL scale, nor did it discriminate between the patients with and without geriatric conditions. We can only speculate if the findings might have been influenced by procedure of CDT administration. As described in the details above, we used the pre-drawn clock faces in the process of cognitive assessment. It is of further interest whether the application of a clean sheet of paper, on which the subject draws a clock face by oneself, would change the results and reveal executive dysfunction in heart failure patients.

5. Conclusions

To conclude, in our group of the aged patients with chronic stable heart failure and no previous diagnosis of dementia, we showed a high prevalence of geriatric problems, as assessed with simple screening measures. The majority of the patients presented signs of cognitive deterioration of different patterns and severity on the Clock Drawing Test. The Clock Drawing Test correlated with the results of the MMSE but failed to discriminate between those with and without executive function impairments or functional deficits, or other analyzed geriatric problems. However, even though the CDT is an easy-to-use and time-efficient cognitive screening measure that can be easily performed by both trained nurses and doctors, we consider our results relevant and applicable for ambulatory and hospital settings. As our results are in line with the above-mentioned study, it seems reasonable to perform the routine CGA with the CDT examination in all aged heart failure patients.

Conflict of interest

The authors declare no conflict of interest.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.advms.2017.11.005.

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