Correlation of tests used in Comprehensive Geriatric Assessment. Systematic Review

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Abstract

Comprehensive Geriatric Assessment (CGA) has been used in clinics for almost 100 years. It includes holistic approach to patients examination. In this systematic review we analyzed results of tests used in CGA and correlation of results. Moreover, we underlined some issues concerning homogeneity of tests used in CGA as well as scientific validity of some of its tools.

Results of prospective studies show that some of results of examination used in CGA are good predictors of functioning in another health domain in next years.

Systolic blood pressure as well as BMI could be good predictors for neuropsychological functioning, however results are equivocal.

Low scores in dual task (walking and cognitive engaging task simultaneously) are good predictor for falls occurrence. Education measured by socioeconomic status is very often mentioned as one of the best predictors of cognitive functioning.

Undergoing Mini Nutritional Assessment by patients could be an effective tool to improve their nutrition status, possibly by indirectly influencing on their diet habits. Moreover, genotype examination could be worth to include into CGA due to, inter alia, examination of possible causes of dietary deficits.

Aerobic examination could be done by cost-free tests, which sensitivity and specify are on tolerable level. It could help lowering CGA costs, which will help make it widely available for patients.

Keywords: Comprehensive Geriatric Assessment, cognitive functioning, older people.

I Introduction

"Comprehensive Geriatric Assessment" (CGA) was first introduced in the United Kingdom in the late 1930s. It turned out that this model, its foundations, method for evaluating patients

was very fruitful, what has been approved by many of reports of scientific studies using this approach [1]. Methods used in CGA were constantly changed during the time, however few main sections could be established, i.e.:
1. Some of the ordinary clinical examinations
2. Socioeconomic status examinations
3. Nutrition state of patients
4. Functional assessment done by physiotherapist
5. Neuropsychological assessment.
CGA is considered to be diagnostic as well as therapeutic process [2]. Its goal is an identification, quantification and management of the patients problems properly. CGA was discovered to be useful in defining patients prognosis and their outcomes [1, 3, 4]. Moreover, meta analysis [3] of random controlled trials of interventions which described results of CGA, showed that providing to patients a coordinated specialist services significantly increased chances of survivability and living in own home than standard care in a hospital setting.

Geriatric patients are characterized by high probability of occurrence of multiple concomitant problems. Moreover, these problems could interact with each other, therefore holistic approach in creating intervention for patients is needed. In this systematic review we would describe results of interventions which showed interdependency between patients performance in tools used in CGA.

II. Correlation of tests used in CGA

1. Clinical examinations in CGA
Clinical examinations in CGA differs from research to research and from hospital to hospital. However, few of most common used methods could be named; blood pressure (BP) measurement, and body mass index (BMI) adjustment.

1.1. Correlation of blood pressure and pulse pressure with results of neuropsychological tests
In study with almost 34 thousands of participants 60 years and older people engaged, correlation between blood pressure and pulse pressure and cognitive functioning were examined [5]. Optimal blood pressure (SBP <120 mmHg and DBP <80 mmHg) was associated with the best cognitive performance. Higher blood pressure was inversely related to cognitive functions after controlling for blood pressure treatment and other confounding factors in participants who were 70 and over. The overall negative correlation between high pulse pressure and cognitive performance has been established, however participants aged 60 to 69 with higher pulse pressure showed better results of cognitive functions tests [5].
In another studies, cognitive functioning of almost 5 hundred patients from 70 to 85 year old were examined using screening test (mini-mental state examination), tests that measured memory, concentration, visual retention, verbal fluency [6]. Normotensive patients performed worse patients with mild hypertension in last 4 of above listed tests [6].
Another studies conducted on almost 1200 patients from Japan revealed U-shaped correlation of the average level of systolic blood pressure measured at home with mortality in older men. Independent risk factor for mortality in older men were not only high home systolic blood pressure, but also low home systolic blood pressure [7].

1.2. Correlation of body mass index with results of neuropsychological tests
BMI is another common used value based on the mass (weight) and height of an individual. In an interesting study [8] researchers included 2,684 patients 65 to 94 years old. They were

assigned into one of three groups based on their BMI: normal-weight, overweight, or obese [8]. Results showed that overweight participants obtained better results in cognitive tests, which measured reasoning and visuospatial speed of processing than normal weight participants [8]. Moreover, obese persons noticed better scores in visuospatial speed of processing test than normal weight. However, it was not a prospective study, moreover, BMI gives no opportunity to distinct between fat-free mass, which is correlated with better cognitive functioning, fat mass.

In another prospective studies, 2,223 participants aged 32-62 were examined in 1996 and 2001 [9]. Four tests were used to assess their cognitive functioning: word-list learning in three trials, each followed by immediate free recall, the Wechsler Adult Intelligence Survey (WAIS) Digit–Symbol Substitution Subtest and delayed free recall test of selected data which were used in above mentioned tests [9]. Greater BMIs were correlated with diminished results of cognitive tests in a linear way in above mentioned tests, after adjustment for the main confounding factors. Higher BMIs at baseline were associated with a greater cognitive decline 5 years later [9].

In interesting studies, [10] participants were categorized into younger (20-50) and older (aged 50-82 years) groups. Participants were undergoing several neuropsychological tests which measured different cognitive domains: IQ: Spot-the-word, attention: Digit span forward, Choice reaction time, Switching of attention—number, Span of visual memory, executive functions: Verbal interference, Switching of attention—letter/number, Maze errors [10]. Results showed that participants with higher BMI showed worse cognitive performance, which was estimated as an inverse correlation between BMI and cognitive functioning. The strongest relationships were estimated in verbal interference tests ($r = 0.23$) and switching of attention—letter/number ($r = 0.20$) [10].

Very interesting topic is an underlying neurobiology in correlation between BMI and cognitive functioning. Walther et al. [11] examined 95 women (52 to 92 years old) who underwent magnetic resonance imaging (MRI) examination. It allowed on distinguishing precisely the brain structure differences between obese and non-obese women and their brain structures. Higher BMI was correlated with diminished volume of gray matter in the left orbitofrontal, right inferior frontal, and right precentral gyri, a right posterior region including the parahippocampal, fusiform, and lingual gyri, right cerebellar regions. Greater volumes of white matter in the frontal, temporal, and parietal lobes, after adjustment for the hypertension, was correlated with greater BMI in examined participants [11].

2. Neuropsychological assessment

Declining of cognitive functioning is one of the so called Geriatric Giants [12]. Minor neurocognitive disorders could have several underlying biological mechanisms. However, neuroimaging techniques are still expensive, which restricts its common use. Therefore, conventional CGA examination is solely based on cognitive functioning is examined, without complete central nervous system examination. Higher age is significantly correlated with higher risk of stroke incidents, hyperbaric oxygen therapy seems to be an interesting tool in restricting negative after-effects of stroke, what in consequence could potentially contribute to better cognitive functioning of patients who underwent such therapy [13].

2.1 Correlation of results in neuropsychological tests with functional assessment

Holistic approach in studying performance of geriatric patients resulted in many interesting conclusions in the field of neuroscience. For example, it was discovered that two evaluations traditionally done separately, i.e. gait assessment and neuropsychological assessment have shown to be highly inter-dependent. Studies from 1997 [14] have shown that older patients have problems with performing task consisting of walking and maintaining conversation in

same time. Occurrence of problems with performing this dual-task was discovered to be good predictor of falls in elderly [14]. In most younger patients, walking is rather automatic and do not derive resources of patients attention, however, it could change due to aging and lower capacity of attention.

Moreover, physical exercise seems to be promising tool in improving cognitive functioning of older people [15].

Interestingly, results of neuropsychological test are highly correlated with activities of daily live (ADL) results. Some studies showed that visuo-spatial performance is best correlated with ADL [16], while another showed that performance in executive functions is correlated with ADL [17], underlining its effectiveness as predictor of patients functional status [18]. Moreover, longitudinal studies based on 256 community-living older adults [19] showed the risk of falls occurrence could be predicted by performance on executive functions and attention tests conducted at the baseline, 5 years earlier. Executive functions were examined by computerized battery tests which contained the Go-No-Go and the Stroop interference tests (response inhibition), and another test which was measuring eye-hand coordination capabilities (reaction time and errors in judgment) [19].

Additionally, another studies used Modified Mini-Mental State (3MS) Examination as well as gait speed, chair stands (measured in amount of stands in 15 seconds), and grip strength [20] to detect changes between baseline and at 6-years follow-up in 1,793, 65- to 80-year-old women. Baseline examination showed that results of 3MS results were modestly but significantly correlated with all of above mentioned physical functioning tests. Moreover, initial results of 3MS were significantly correlated with changes in all of above mentioned functional tests conducted at the follow-up [20].

In another interesting studies, 555 participants which were 85 years old at the baseline, were examined in terms of functional, cognitive and social health. Handgrip strength measured by dynamometer was used as a functional tests, Cognitive functioning was measured with the Mini-Mental State Examination and 15-item Geriatric Depression Scale. Social health was as seed by Time Spending Pattern questionnaire and Loneliness Scale. It was revealed that diminished baseline handgrip strength statistically significantly predicted an higher decline in activities of daily living (ADL) and cognition, however, it was not related with social health at the follow-up.

Muriel Lezak [21] noted in 1983 that performance in executive function tests are highly similar to daily living tasks, however, Author underlined that not every tests measuring performance in this domain requires performance in conditions when patients are free to do what they want (as in daily life tasks), without imposing strict rules [21]. Therefore, establishing of best neuropsychological battery test, which would be not time-consuming, however would have an ecological value, is needed.

3. Socioeconomic status examinations

Examination of socioeconomic status of patients has lot of benefits for patients, nevertheless this examination is skipped very often [22]. First of all, it is impossible to establish any validated tool, which would be widely available in multi-language versions, which could be globally used in researches on older people across the world. It would be extremely hard to create one, regarding social and economic differences even between so-called "developed countries", not mentioning about "third-world countries". Additionally, it is often very hard to assess patients economic status by hospital personnel because of patients mistrust in relations with others. Moreover, in case of United States, it was proposed that financial income at the moment of examination may be not the best way to reveal real financial state of the older, retired patients [22]. Real estate and other goods, which were acquired throughout lifespan should be also included into economic status [22].

3.1 Correlation of socioeconomic status examinations with overall health
Correlation between low funds income and low overall health scores is well known [23-26]. Moreover, educations seems to affect life-long health state [27]. More educated participants responded to have greater sense of control and social support. These two factors were in turn, correlated with better overall health [27].

3.2 Correlation of socioeconomic status examinations with results of cognitive test
Education level is so important in cognitive functioning assessment of older people, that in the Montreal Cognitive Assessment (MoCA), one of the most popular cognitive screening tests, an extra point is added for participants which have 12 years or fewer of formal education [28]. Studies from 1997 showed that prolonged incidents of financial troubles in older patients were statistically correlated with, inter alia, worse cognitive functioning assessed by a subjective scale which measured incidences of forgetting where common items were put, difficulties in remembering things, paying attention and finding the right word [29].
Another studies showed, that age-related decline in cognitive functions is slower in women and in participants which had apriority college education [30].

3.3. Problems that stand against frequent use of socio-economic state in CGA and possible solution
It is often difficult to assess patients economic status by hospital personnel because of patients mistrust in relations with others. The Camberwell Assessment of Need for the Elderly questionnaire (CANE) was developed as an attempt to solved the problem of estimating the socioeconomic status [31]. Studies have confirmed the usefulness of CANE questionnaire in clinical practice [31-33]. This research tool assess the needs of elderly patients in 24 areas of life. These areas have been divided into four categories: social, physiological, physical and environmental needs. The questionnaire provides an answer: how many needs has an individual and which of these needs are being satisfied (met needs) or not (unmet needs). Knowledge of the needs of individuals, especially unmet, allows the implementation of an optimal care strategy. Implemented care should in particular focus on satisfying unmet needs. Under the premise this questionnaire should be filled to 30 minutes and should be useful for medical staff without training [31]. Individual assessment of needs could be assess by the career, member of the medical staff or by the patient himself. Hancock et al. show that user-based assessment should be given a high priority for older people with mental health problems. Also, the researchers noted that the careers and the researchers, in particular, do not adequately assessed the needs of individuals [32]. This indicates differences in perception of the needs between the patient and the medical staff. Furthermore CANE questionnaire can be useful for the assessment individuals in long-term care facilities [33, 34] and to individuals of their home environment [35]. This tool has been translated into a considerable number of languages, including Polish. It has been shown that the translation did not affect the quality of the tools [36-38]. In addition, research indicate a relationship between the result of the questionnaire CANE and depression. Stein et al. noted that unmet needs are significantly associated with depression [39]. Thus, based on the result of the CANE it can be implemented appropriate treatment. This may improves the psychosomatic condition of the patient. Research confirms that care based on the needs assessment of people with dementia in residential care homes resulting in improved of quality of life [40]. Therefore, socioeconomic status examinations of the patient and thereby assess their needs is so important in order to therapeutic strategy was carried out correctly. For this purpose it may be useful the Camberwell Assessment of Need for the Elderly questionnaire- CANE.

4. Nutrition state of patients

Malnutrition is very common among the elderly. It is an imbalance of nutrients caused by deficit in intake of nutrients or a nutritional deficit. The problems related with nutrition disorders contribute to an increase in incidence of elderly people. About 60-65% of hospitalized elderly people are experiencing malnutrition. There are many risk factors for malnutrition. Some of them have been identified, for example social, physical, or medical factors.

Interestingly, some studies [41] showed, that using the dietary counseling only, nutritional state of older patients could be improved. 173 people over 75 years old were divided into intervention (n=84) and control group (n=89) and examined in the population-bases studies [41]. Several variables were considered, i.e.: body weight, body mass index, nutritional status examination by Mini Nutritional Assessment Test (MNA) as well as level of serum albumin. At the two-year follow-up, statistically significant increased score in MNA and serum albumin was noted [41].

4.1 Correlation of nutrition state of patients with cognitive functioning

Nutritional status is also associated with cognitive functioning. There are several studies showing that nutritional status, specifically the presence of or the risk for malnutrition is associated with impaired cognition in aging adults in a variety of settings ranging from hospital to living in the community.

The article which was published in 2013 in Brazil showed that cognitive (impairment was associated with lower BMI, waist circumference, triceps skinfold thickness among the younger participants (60-69 years), while lower arm muscle circumference and corrected arm muscle area were associated with cognitive impairment among the older participants (70 years and over) [42].

The relationship was the strongest between cognitive ability and nutritional status among those living in special housing [42].

Also adequate intake of vitamin B12 and folate is essential for cognitive function in elderly age. Patients with low blood levels of folate or B12 scored worse on cognition tests [43]. These differences remained significant after controlling for age, gender, level of income, and amount of education. "Subclinical" malnutrition may play a small role in the depression of cognitive function detectable in some elderly individuals.

In contrary, another double-blind, controlled studies including 195 participants showed no improvement in cognitive functions after oral supplementation of B12 alone or in combination with folic acid [44].

On the other hand, randomized, double blind, controlled trial studies which lasted for 3 years and included 818 participants showed improvement of several cognitive domains in intervention group which underwent treatment based on folic acid supplementation [45]. Word learning test, Concept shifting test, Stroop color-word test, Verbal fluency test and Letter digit substitution test were used. Interestingly, results were not influenced by preliminary folate level or MTHFR C677T genotype [45]. MTHFR converts 5,10-methylenetetrahydrofolate into the activated form, 5-MTHF or 5-methyltetrahydrofolate, whereas C667T genotype is characterized by diminished activity [46]. L-methylfolate seems to be crucial trimonoamine modulator, however, it is unknown if folic acid supplementation would be effective in patients without folate deficiency [46].

Nonetheless, monitoring the status of elderly can help in preventing malnutrition and possibly their cognitive impairment. Dietary modifications, such as including foods high in, vitamins B12, folate, may improve cognition and modify vascular risk factors in elderly patients.

5. Functional assessment done by physiotherapist

Systematic review [47] underlined importance of gait assessment, as well revealed problems in drawing conclusions from researches which used different methodologies. Indeed, some of the low-cost functional tests seems to be low-objectively. However, ergospirometry, which is gold standard aerobic capacity assessment is not available in every clinic which conduct CGA. Moreover, while conducting researches on huge populations it is sometimes necessary to use low-cost methods, such a Six-Minute Walk Test. Therefore, it is worth to bring results of correlation of results of gold standard results with another, low-cost methods.

5.1 Correlation of gait assessment with aerobic capacity

Article published in 2009 [48] reported an results of intervention on 45 patients after stroke at the age 64.7 ± 3.6 in exercise group and 64.7 ± 3.6; 65.7 ± 2.3 in matched pairs. Participants were individuals living less than 3 months after stroke. The goal was to organize a rehabilitation program based on aerobic training using cycloergometer to demonstrate relationship between aerobic and walking capacity [38]. Participants were recruited to the survey after testing their ability to understand and evaluate procedures, providing deliberative agreement when they achieved the goal of at least 3 but less than 7 according to Chedoke McMaster Stroke Assessment leg impairment scale and if they could walk the distance of at least 5 meters on their own. Before study all contestants had to take part in Six-Minute Walk Test and Stroke Impact Scale. The therapy continued from 4 to 5 weeks 5 days a week. All examined patients received a conventional inpatient rehabilitation consisted of physical, occupational and/or language therapy. The exercise group was provided with an additional program appropriately matched with every person aerobic training on a semirecumbent cycloergometer [48]. Training took place 3 times a week for 30 minutes. All exercise contestants completed the training without adverse effects. Significant grow in aerobic capacity was observed in both groups. Improvements over time with a greater aerobic capacity in the exercise group with 13% and 26% increases in peak VO2, compared to 8% and 16% in the control group. Similar results achieved in 6-Minute Walk Test distance improvement. In the exercise group 53% comparing with 23% among control one [48].

Results

Correlation of blood pressure and pulse pressure with results of neuropsychological tests show equivocal, sometimes age-dependent results.

Moreover, correlation of body mass index with results of neuropsychological tests showed unequivocal results. On the one hand, results showed that participants with higher BMI showed worse cognitive performance, which was estimated as an inverse correlation between BMI and cognitive functioning. The strongest relationships were estimated in verbal interference tests ($r = 0.23$) and switching of attention—letter/number ($r = 0.20$). On the other hand, prospective studies, which included 2,223 participants aged 32-62, showed that greater BMIs were correlated with diminished results of cognitive tests in a linear way in above mentioned tests, after adjustment for the main confounding factors. Interestingly, researches which used neuroimaging technique which allowed to obtained high-resolution images of brain structures of women 52 years old and over. Higher BMI was correlated with diminished volume of several structures of gray matter. In contrary, greater volumes of white matter in some regions was correlated with greater BMI.

Some studies have evaluated link between cognitive functioning and physical performance. Effective predictors of future falls occurrence were executive functioning index. Patients with diminished results of executive functioning tests had higher chance to fall more frequently and sooner during the 66 months of follow-up ($p<0.02$).

Studies which correlated socio-economic status examination with several other factors showed many interesting results. For example, years of education were an effective predictor of patients physical performance at the one-year follow-up (b = .006, s.e. = .002, Beta = .049, p = .004). Education significantly slows the decline in physical functioning over time.

Results of researches which used Mini Nutritional Assessment, showed that using questionnaire only had significant impact on nutrition state of patients at the follow-up. Serum albumin increased 0.9 g/l from baseline to follow-up in the intervention group, compared to no changes in control group.

In research which examined correlation of aerobic capacity examination using higher-precision techniques and screening functional tests, 23 participants underwent a graded maximal exercise test on a ergometer, spatiotemporal gait assessments, 6-Minute Walk Test, and Stroke Impact Scale Training, and control group received conventional rehabilitation only. Both groups noted aerobic benefit in the exercise group with 13% and 23% increases in peak VO2 and work rate respectively, compared to 8% and 16% in the control group (group-time interaction p=.71 and .62). A similar trend toward improved 6-Minute Walk Test distance (exercise 53% vs controls 23%, p=.23) was observed.

Conclusions

Blood pressure and body mass index is correlated with cognitive functioning, however exact direction of influence should be estimated. It seems that blood pressure correlation is highly dependent on several factors, including age of participants; having positive influence in oldest participants and worse as a predictor of cognitive functioning in younger ones.

Neuropsychological functioning is highly inter-related with motor system functioning. Diminished performance in dual task which consisted of gait and cognitive task was good predictor for future falls in elderly. Not surprisingly, results of cognitive tests were correlated with results of Activities of Daily Living and Instrumental Activities of Daily Living scales.

Moreover, data extracted from socioeconomic questionnaires could be correlated with several factors. Economic status is highly correlated with overall health, education is correlated with better cognitive functioning in older people.

 Malnutrition is a very serious problem not only in Poland but in the whole world, because it impacts morbidity hospital length of stay, functional and physical disabilities, and even mortality. It is a great challenge for geriatrics to focus on it and to join pharmacotherapy and proper nutrition in everyday work. Results of nutrition states questionnaires seems to be correlated with biochemical indices, however, further researchers are needed. Additionally, estimation of effects on cognitive functioning of supplementation with B12 and folate acid should be further investigated due to conflicting results. Nutrition states questionnaires results seems to be correlated with body mass index.

Interestingly, results clinical gait assessment methods, which are cost-free and widely available could be correlated with more sophisticated methods such as ergospirometry.

Keeping above mentioned correlations in mind, it is indispensable to design an intervention for older patients which would increase their performance in few dimensions simultaneously. Such method would lower costs and time spent for patients and health care. Above mentioned inter-dependency of older patients problems could give possibility that overcoming one of them, by using successful intervention, another problems would be also fixed.

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