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# Features of cognitive dysfunction in patients with depressive disorder and cerebrovascular pathology

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## Abstract

**Background.** In recent years, there has been an increase in the number of elderly people, and at the same time the accumulation of mental and somatic diseases inherent in these age categories. Depression, dementia and cardiovascular disease continue to occupy leading positions. Executive dysfunction syndrome in patients with organic depressive disorder and cerebrovascular pathology is one of the pathognomonic features of violation of higher brain functions in subcortical ischemic depression, which is important for the prognosis of the disease, provision of timely medical care, development of preventive measures and improvement of patients' quality of life.

**Methods.** Using TMT and Strup tests, 138 patients with depressive disorder were screened for the purpose of detecting cognitive dysfunction.

**Results.** More pronounced cognitive dysfunction in the form of violation of the executive function, cognitive control, volume and distribution of attention was observed in patients with organic depressive disorder and signs of subcortical ischemia of the GM. Differences in the structure of violations of cognition are caused by zones of morphological defeat of the GM and the rupture of cortico-strial paths.

**Conclusion.** Thus, in patients with subcortical ischemic depression, there is a syndrome of executive dysfunction, which is the leading cause of subcortical ischemic dementia. Ability to develop and implement a comprehensive program for the recovery of cognitive dysfunction will improve the quality of life of patients.

**Keywords:** `depression`, `organic depressive disorder`, `congitive dysfunction`, `attention`, `executive function`

## 1 Background

People who suffer from mental disorders demonstrate a significant decrease in viability and disproportionate increase in mortality. Depression is one of the most common mental disorders among Ukrainian and many other populations in recent years. It's closely associated with an increased risk of suicide, reduced functioning and quality of life. From recent epidemiological studies in depressive disorders in the elderly can be seen a demographic shift toward later ages alongside with accumulation of mental, physical illnesses and their combination in this age group. Mental disorders are able to affect the physical condition and, conversely, they are influenced by other chronic somatic health prob-

lems such as cardiovascular diseases. The prevalence of mental disorders among older age groups is 3-7 times higher than in the general population cohort [1]. About one third of mental and behavioral disorders are referred to affective pathology, and the first place belongs to organic, including symptomatic, mental disorders (F00-F09) - 69%. Among them leading positions are occupied by dementia and depressive disorders [2]. The most common risk factor of depression in elderly are cardiovascular diseases. Forecasts of incidence cardiovascular disease suggest saving tendency to growth in the world and in Ukraine [1]. At the same time, the results of several studies had shown that the risk of vascular dementia significantly increases in presence of depressive disorders in a premorbid period [3]. Also, it was concluded that late depression can be a precursor and a risk factor for dementia [4]. In addition, the risk of vascular dementia in elderly patients with depression may be much higher than for Alzheimer's disease [5]. Among the major mechanisms of later life depression are immune and vascular components [6]. Within many studies was found that increased indicators of inflammation in the peripheral blood contributes to the development of depression in the elderly. But, in turn, prolonged emotional distress is the basis for occurrence of inflammation and subsequent development of depression [7].

Cerebrovascular diseases are mostly the result of common diseases such as hypertension and atherosclerosis. Depending on the etiological factors can be distinguished micro- or macroangiopathy. The hypertension is characterized by microangiopathy of the brain and the initial vascular lesions of the basal ganglia and subcortical white matter. For atherosclerotic lesions is common macroangiopathy, which often develops as a result of acute cerebrovascular accident (CVA) [8].

The concept of vascular (microangiopathic) depression has been first proposed in 1997 by G.Alexopoulos, who noted that it occurs in people over 60 with chronic cerebral dyscirculation and have such pathopsychological phenomena as psychomotor retardation, presence of cognitive dysfunction and reduced response to antidepressant treatment [9]. MRI brain images of vascular depression demonstrate the increasing signal intensity in the deeper parts of white matter in frontal region and putamen. The result of microangiopathy is a development of ischemia regions in the gray and white matter of the brain, which leads to separation of neural networks.

This is a potentially irreversible structural change rather than functional, which explains the relative resistance to antidepressant therapy and sustained violations of executive function [10]. Executive dysfunction is the violation of higher brain functions and includes impairment in planning, organization, implementation of multistage operations, regulation and control individual actions and behavior in general. Sometimes these cognitive disorders referred to as regulatory. The morphological structure of executive function is fronto-strial system, which ensures the purposeful selection of the most adequate action program at the moment, monitors its implementation and effectiveness, inhibits inadequate actions, corrects, and if necessary, replaces one program to another [11].

It is known that the incidence of depressive disorders is influenced by various factors such as gender, age, education, availability of unhealthy habits, socio-economic conditions and others. Considering the difficult socio-economic circumstances in Ukraine in recent years, increasing in the number of elderly and female population, we can assume that the incidence of depression on the background of cerebrovascular disease will tend to increase. So, a high risk of dementia processes in organic depressive disorders causes a pathognomonic relevance of examining the mechanisms of depression and dementia.

Thus, it may be important for the prognosis of the disease and the provision of timely medical care to identify the features and differences of organic affective disorder in elderly patients with cerebrovascular diseases, depending on the etiopathogenetic mechanisms, as well as allocation of pathophysiological phenomena inherent in depression in subcortical ischemic brain damage.

## 2 Materials and methods

During the 2013-2016 patients were examined with obtaining the informed consent at the neurological department of CMU "City Hospital № 3" in Kramatorsk (Donetsk region) and at the psychoneurological department of Kiev Railway Clinical Hospital № 1. In this study were included 138 patients aged 50 to 78 years (average age 63.6 years) who were divided into basic (BG) and the comparison group (CG), representative by age. According to a survey, BG patients were divided into two groups: BG1 (F06.3 + presence of subcortical hyperintense lesions in the brain, according to MRI, n=38) and BG2 (F06.3 + CVA restorative period, n=32). A total of 68

participants with clinical depression and normal brain MRI image were included in the comparison group (CG). We used MOCA test for dementia excluding and TMT test and Stroop test for cognitive dysfunction subsequent identification.

The TMT test allows to make a differential diagnosis between the lack of attention concentration associated with a decrease in the activation of the cortex from the stem-subcortical structures side (the test run time increase in part A and part B in proportion to the normal ratio) and bradyphrenia related to violations of regulatory functions (increase in time of part B more than part A time) [12].

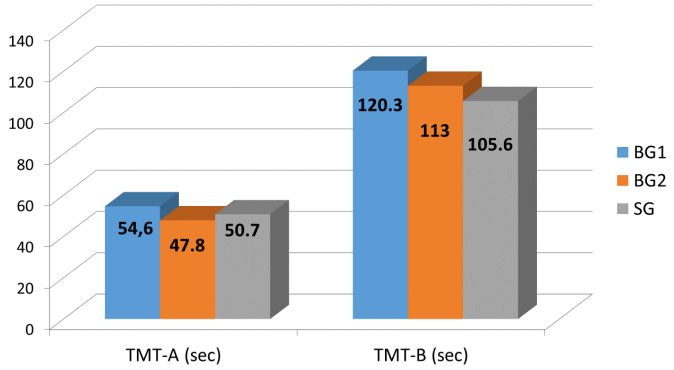
Additionally, speed of the visual search, mental mobility, strategy of passing, visual planning skills, and distributed attention were measured. It should be emphasized, that part A allowed to estimate dynamic parameters of attention and level of its arbitrary regulation, spatial orientation and proper visual-motor coordination; part B - distributed attention, working memory and executive function. The estimated parameter was the time in seconds spent on the task. The more time was spent on the test, the greater was the deterioration in cognitive functioning.

Stroop Color Word Interference Test consists of tasks of varying difficulty and is used to assess the distribution of attention and executive functions. In particular, for this study the main measures were time spent doing the test and the number of errors that were observed during the execution of this test. The main measured neuropsychological parameter was cognitive control, that is, the regulatory function. This test can be considered as the most sensitive to the pathology of the cortex, which is closely linked with the function of cognitive control. At the same time, this test is also sensitive to impairment of intellectual flexibility, which is to a large extent a function of dorsolateral frontal cortex [12].

## 3 Results

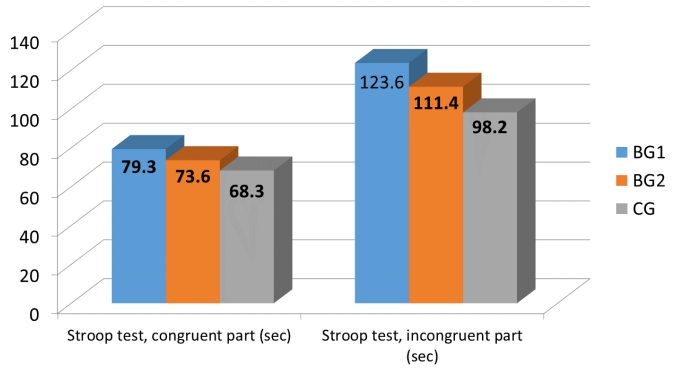
In Table 1 are presented the indicators of attention and executive function in the studied groups. Indicators of attention measured by TMT-A had a statistically significant intergroup difference among patients with organic depressive disorder with signs of subcortical brain ischemia (BG1 group) compared with patients with post-stroke depression (BG2 group) ($p<0.05$). Also, the group of patients with signs of subcortical brain ischemia (BG1) demonstrated a statistically significant tendency to increase the time of TMT-B (assessment of allocation of attention, working memory and executive function) compared with the group of patients with depressive disorders without organic CNS lesion (CG group; $p<0.01$), and a group of patients with post-stroke depression (group BG2; $p<0.05$). The findings revealed more pronounced cognitive impairment in the volume and distribution of attention, working memory and executive function in patients suffering from organic depressive disorder and have signs of subcortical brain ischemia. Patients with poststroke depression (group BG2) had fastest time completion for the TMT-A task (attention span), but demonstrated a fairly significant slowdown in TMT-B task compared with a group of patients with depressive disorders without organic CNS lesion (group CG; $p<0.05$). However, compared with referent normal values all three groups revealed a decrease in task completion time of TMT test, that probably reflects a lack of functional regulation of cognitive processes in patients with depressive disorders, regardless of the disease origin (Table 1).

Figure 1: Indicators of attention and executive function in patients with depressive disorders




Patients with organic depressive disorder, regardless of lesion characteristics, had more pronounced impairment of executive function. According to the results of TMT-B testing, group BG1 had $120,3 \pm 3,8$ sec., BG2 group had $113.0 \pm 3.4$ sec., compared with $105.6 \pm 3.9$ sec. for group CG. The differences between experimental groups and control group was significant ($p<0.01$ and $p<0.05$, respectively). Attention impairment was more pronounced in the OG1 group ($54.4 \pm 3.6$ seconds) compared with the OG2 group ($47.8 \pm 3.1$ seconds), the difference was significant ($p<0.05$).

Figure 2: Indicators of reading speed and selectivity of attention in patients with depressive disorders




The number of errors during the test in both of its parts reliably prevailed in OG1 group, indicating a significant disturbance of attention function in patients with signs of chronic cerebrovascular disorder.

The assessment of executive function in groups with the presence of organic CNS lesions (BG1 and BG2) revealed even more deficits relative to the conditional norms. TMT-B time in these groups was also significantly higher in comparison with the CG group (respectively, BG1 vs CG, $p<0.01$; BG2 vs CG, $p<0.05$). Consequently, the presence of depression in cognitive impairment patients, regardless of the origin of the disease, caused slower task completion (TMT-B). At the same time, the amount of attention, its distribution and executive function, were most impaired in patients with an organic depressive disorder and coexisted signs of subcortical brain ischemia, i.e. with chronic cerebrovascular abnormalities.

Indicators of reading speed and selectivity of attention from the Stroop test are presented in Table 2.

In assessing of the Stroup test congruent part indicators, there were no significant intergroup differences between groups BG1 and BG2, as well as between BG2 and CG groups ($p> 0.05$).

At the same time, the reading speed rates determined by this test in the BG1 group were significantly lower than in the CG group (the difference was significant, $p <0.001$). Also in all groups speed reading rates were lower than the norm. So, can be said that patients with depressive symptoms, regardless of the genesis of depression, had a deficit in a mental activity speed.

Regarding the performance of patients in incongruent second Stroop test (that evaluates cognitive mobility), the difference between groups was also significant. Patients in BG1 group coped with the task more slowly compared with other 2 groups (BG1 vs BG2: $p<0.01$; BG1 vs CG: $p<0.001$).

Such results reflect reasoning slowing and a certain rigidity of mental processes, that are inherent in depressive disorders, similar to those given with the same type of stimuli in the first part of the test. It is noteworthy that the results, obtained from the second part of the Stroop test, had a more pronounced tendency for deterioration in all groups compared to the referent norms. This reflects an increase in the test load on the attention switching, i.e. on the mobility of mental processes. The number of errors during the Stroop test in both of its parts was significantly more prevalent among patients from the BG1 group compared with GG group, what can be explained by a significant disturbance of attention function (especially, attention selectivity) in patients with subcortical brain ischemia. Stimuli contrast in the second part of Stroop test led to a decrease in the results compared to referent norms in all studied groups.

Indicator of control rigidity/flexibility, assessed as the difference in the execution time of incongruent and congruent part of Stroop test, was estimated at 44.3 sec. in the BG1

Table 1: Indicators of attention and executive function in patients with depressive disorders

| Indicator | Study group/time (sec.) | | | The significance of differences between groups | | |
|---|---|---|---|---|---|---|
| | BG1, M $\pm \sigma$ | BG2, M $\pm \sigma$ | CG, M $\pm \sigma$ | BG1 vs BG2 | BG1 vs CG | BG2 vs CG |
| TMT-A | 54,6± 3,6 | 47,8±3,1 | 50,7± 3,7 | p<0,05 | p>0,05 | p>0,05 |
| TMT-B | 120,3±3,8 | 113,0±3,4 | 105,6± 3,9 | p<0,05 | p<0,01 | p<0,05 |

*M - arithmetic mean, $\sigma$ - standard deviation

group, 37.8 sec. in the BG2 group and 29.9 sec. in the CG group. Consequently, the most pronounced effect of interference and, correspondingly, more severe rigidity (narrowness, stiffness) of cognitive control was observed in patients with organic depressive disorder with chronic cerebrovascular disorders. The number of errors was the highest also in BG1 group ($p<0.01$ compared to others groups).

Patients from BG1 group had a deficit of mental activity ($123.6 \pm 5.5$ sec.) relative to CG group ($98.2 \pm 3.6$ sec.) and BG2 group ($111.4 \pm 4.6$ sec.) the difference was significant ($p<0.001$ and $p<0.01$ respectively). But the difference between BG2 and CG group was not significant ($p>0.05$). The obtained results demonstrate the presence of disturbances in attention selectivity, cognitive mobility and speed of mental activity in depressive disorders, regardless of their genesis.

# 4 Conclusion

Thus, based on the conducted pathopsychological examination of patients with organic depressive disorder with cerebrovascular pathology and depressive disorder without signs of brain damage using TMT and Stroop tests for the detection of cognitive dysfunction, the following conclusions can be drawn:

1. More severe cognitive impairment of volume and distribution of attention, working memory, cognitive control and executive function are defined in patients suffering from organic depressive disorder and having signs of subcortical brain ischemia.

2. In comparison with the referent norms, patients from all three groups showed a significant slowing in performance on tasks for cognitive mobility and selective attention, what reflects a certain functional deficiency of cognitive processes regulation in patients with depressive disorders, regardless of their genesis.

# Competing interests

The author declares that no competing interests exist.

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Table 2: Indicators of reading speed and attention selectivity in patients with depressive disorders

| Indicator | Survey groups | | | The significance of differences between groups | | |
|---|---|---|---|---|---|---|
| | BG1, M $\pm \sigma$ | BG2, M $\pm \sigma$ | CG, M $\pm \sigma$ | BG1 vs BG2 | BG1 vs CG | BG2 vs CG |
| Stroop Test, congruent, part 1 (time, sec.) | 79.3±4.8 | 73.6±4.2 | 68.3± 3.4 | p>0.05 | p<0.01 | p>0.05 |
| Stroop Test, incongruent, part 2 (time, sec.) | 123.6 ±5.5 | 111.4±4.6 | 98.2± 3.6 | p<0.01 | p<0.001 | p<0.05 |
| Errors, part 1 | 2.7±0.6 | 2.1±0.5 | 1.5±0.3 | p>0.05 | p<0.01 | p>0.05 |
| Errors, part 2 | 5.9±1.6 | 3.2±0.9 | 2.6±0.6 | p<0.01 | p<0.001 | p>0.05 |

*M - arithmetic mean, $\sigma$ - standard deviation

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