

## EXAMINATION OF EXECUTIVE DYSFUNCTIONS AMONG STROKE SURVIVORS VIA 64 - WISCONSIN CARD SORTING TEST.

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### SUMMARY:

**Objective:** The objective of our study was to examine executive dysfunctions in stroke survivors (three months after stroke) via Wisconsin Card Scoring Test (WCST) and to assess the influence of stroke severity and lesion location.

**Contingent and methods:** We examined 20 stroke survivors with the following neuropsychological battery: MMSE, 21 – Hamilton test and WCST.

**Results:** We found executive dysfunctions in 90% of our patients. Stroke severity measured by NIHSS influenced MMSE scoring and some of the WCST results (percent conceptual level, trials to complete first category, failure to maintain set and learning abilities). Patients with left hemispheric lesions had statistically significant higher level of total errors than patients with right hemispheric and brainstem lesions.

**Conclusion:** Sub-acute stroke stage is strongly associated with executive dysfunctions.

**Key words:** WCST, executive dysfunctions, stroke

### INTRODUCTION:

Stroke is a disease of social significance not only because it is one of the leading causes of death and physical disability, but also due to its strong influence on the quality of life<sup>1, 2</sup>. It impairs emotional intelligence<sup>3</sup> and most of the cognitive domains<sup>4, 5</sup>, such as memory, language, attention, executive functions, etc. Severity of executive dysfunctions is strongly and independently associated with health related quality of life<sup>6</sup> and social prognosis of the disease, which is very important for the clinical practice and all aspects of life of the stroke survivor. 64 – Wisconsin Card Sorting Test (WCST) is one of the most useful tests<sup>3, 7, 8, 9</sup> for the assessment of executive dysfunctions and is applied on a global scale. It measures hypothesis testing, categorization, inference, cognitive flexibility, cognitive inhibition and feedback response.

The objective of our study was to examine executive dysfunctions in stroke survivors (three months after a stroke) using 64 – WCST and to assess the influence of

stroke severity and the location of the lesion on them.

Our hypothesis was that patients still have executive dysfunctions three months after stroke.

### CONTINGENT AND METHOD:

Contingent: 20 stroke patients from 47 to 83 years old (median age - 65.15) were recruited from the Neurology Clinic, Medical University Pleven. Out of them, 60% were men and 40% were women. Patients were considered eligible for the study if they met the following criteria: 1. Diagnosis of stroke according to the ICD 10 criteria; 2. NIHSS score ranging from 1 to 14; 3. No aphasia, severe apraxia or agnosia; 4. 21 Hamilton score bellow 20. The exclusion criteria applied: other severe neurological disease (past record of epilepsy, multiple sclerosis, encephalitis, meningitis or degenerative brain diseases), record of psychiatric disease and lack of interest or refusal.

Informed consent was obtained from all the participants.

Procedure: All the patient underwent assessment that included clinical evaluation by neurologist, CT scan, blood testing at the time of admission to the clinic and neuropsychological examination three months after the stroke onset. We used the following neuropsychological battery: Mini Mental State Examination (MMSE), 21 Hamilton Questionnaire, WCST, Luria Aphasia test, Simple apraxia battery. The level of stroke disability was assessed by the NIHSS. The Location of the lesion was verified by CT scan (left hemispheric lesions in 30%; right hemispheric lesions in 45%, and brainstem lesions in 25%). MMSE was used for assessment of global cognitive functioning. 21-Hamilton Depression Scale was used as a screening test for depression. WCST was used as a test for assessment of the executive functions. Standard score and T – score of the number of total errors, perseverations, perseverative errors, nonperseverative errors, conceptual levels were used as independent measures, as well as number of completed categories, trials to complete first category, failure to maintain set, learning to learn assessed with percentiles.

Statistical analysis: STATGRAPHICS 5.0 Plus free version was used for statistical analysis. For our purposes we used One – Way and Multifactor ANOVA and simple and multiple regression analyses. All statistical tests were interpreted at the 5% significance level.

**RESULTS:**

The MMSE scores were within 17-30 (average 23.45; SD 3.25), the distribution of the patients according to MMSE is shown on figure 1. Hamilton scoring s within the 4 to 18 range (average 12.6, SD 3.66, figure 2).

Assessments of patients’ attitude, cooperation and effort are shown on Figures 3, 4 and 5. As it is shown on Table 1a & 1b we failure to find influence of attitude, cooperation and effort on test scoring.

No statistically significant association was found between MMSE and Hamilton score and WCST results (table 2a, 2b)

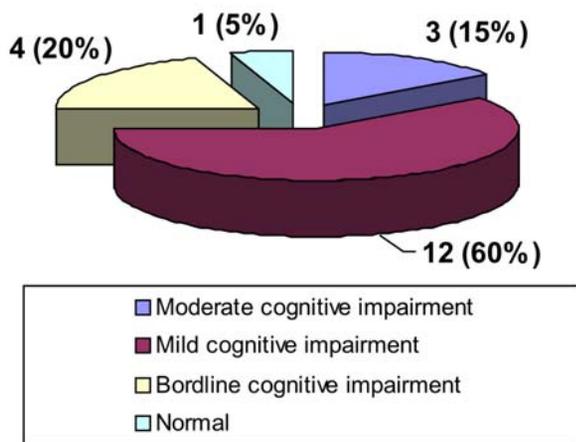
Statistically significant difference of number of total errors was found between the left hemispheric lesion group and the other two groups (Kruskall – Wallis Test p=0.0268). The influence of lesion location on WCST results is shown on Table 3.

Main WCST results are summarized on Table 4.

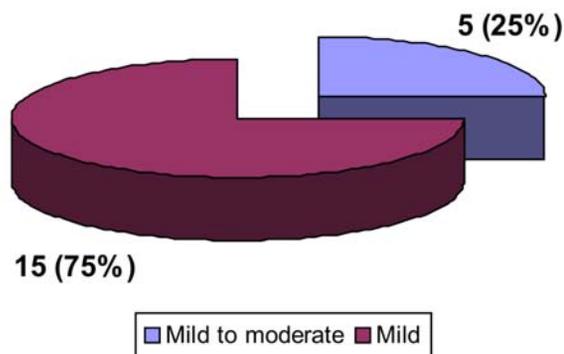
As it is shown on Table 5a, no severe or moderate to severe impairment was found. 20% of our patients had abnormal results on number of total errors, 15 % - on number of perseverative errors, 60% - on number nonperseverative errors and 40 % on conceptual level scoring. Borderline results (below average compared with normal population) had about 25% of them.

The influence of stroke severity on examined cognitive parameters is shown on Table 6. Relationships between NIHSS and respectively MMSE – scoring, standard score of percent conceptual level, trials to complete first category, failure to maintain set and learning to learn abilities were been found.

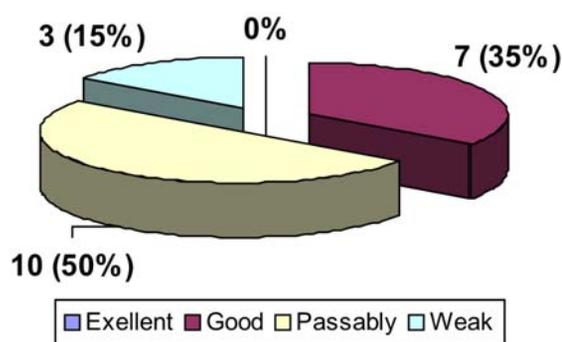
**Fig. 1: MMSE groups.**



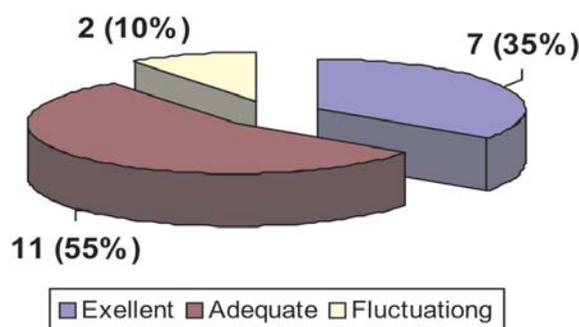
**Fig. 2: Hamilton scoring.**



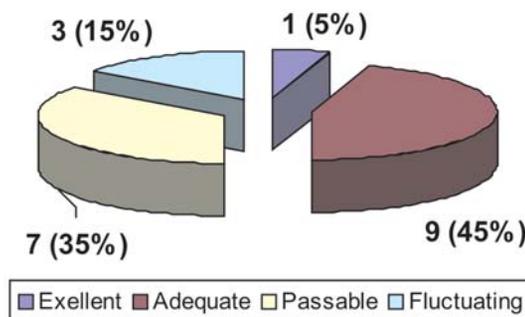
**Fig. 3: Patients attitude.**



**Fig. 4: Cooperation.**



**Fig. 5: Effort.**



**Table 1a:** Influence of attitude, cooperation and effort on WCST results.

	Number total errors	Perseverations	Perseverative errors	Nonperseverative errors	Percent conceptual level
Attitude	No ( $p \geq 0.05$ )	No ( $p \geq 0.05$ )			
Cooperation	No ( $p \geq 0.05$ )	No ( $p \geq 0.05$ )			
Effort	No ( $p \geq 0.05$ )	No ( $p \geq 0.05$ )			

**Table 1b:** Influence of attitude, cooperation and effort on WCST results.

	Number Completed Categories	Trials to complete first category	Failure to maintain set	Learning to learn
Attitude	No ( $p \geq 0.05$ )	No ( $p \geq 0.05$ )	No ( $p \geq 0.05$ )	No ( $p \geq 0.05$ )
Cooperation	No ( $p \geq 0.05$ )	No ( $p \geq 0.05$ )	No ( $p \geq 0.05$ )	No ( $p \geq 0.05$ )
Effort	No ( $p \geq 0.05$ )	No ( $p \geq 0.05$ )	No ( $p \geq 0.05$ )	No ( $p \geq 0.05$ )

**Table 2a:** Association between MMSE/Hamilton and WCST results.

	Number total errors	Perseverations	Perseverative errors	Nonperseverative errors	Percent conceptual level
MMSE	No ( $p \geq 0.05$ )	No ( $p \geq 0.05$ )			
Hamilton score	No ( $p \geq 0.05$ )	No ( $p \geq 0.05$ )			

**Table 2b:** Association between MMSE/Hamilton and WCST results

	Number Completed Categories	Trials to complete first category	Failure to maintain set	Learning to learn
MMSE	No ( $p \geq 0.05$ )	No ( $p \geq 0.05$ )	No ( $p \geq 0.05$ )	No ( $p \geq 0.05$ )
Hamilton score	No ( $p \geq 0.05$ )	No ( $p \geq 0.05$ )	No ( $p \geq 0.05$ )	No ( $p \geq 0.05$ )

**Table 3:** Association between lesion location and WCST results.

	Numb total errors	Perse- veration	Perse- verative errors	Non- persevera- tive errors	Percent concept. Level	Number Compl. categories	Trials to compl. first category	Failure to maintain set	Learning to learn
Lesion location	Yes	No $p \geq 0.05$	No $p \geq 0.05$	No $p \geq 0.05$	No $p \geq 0.05$	No $p \geq 0.05$	No $p \geq 0.05$	No $p \geq 0.05$	No $p \geq 0.05$

**Table 4:** Main results on WCST

		Number total errors	Perseverations	Perseverative errors	Nonperse- verative errors	%Conceptual level
Standard score	Interval	75-122	73-145	77-145	67-126	77-128
	Average / Median	91.9	98.4	102.9	82.0	90.5
	SD	13.5	17.39	18.92	12.93	
T-score	Interval	33-65	32-80	35-80	28-67	35-69
	Average / Median	44.65	48.95	51.95	38.0	41.5
	SD	8.83	11.65	12.54	8.62	

**Table 5a. Rating**

	Number Total Errors (%)	Number Persev. Errors (%)	Number Nonpers. Errors (%)	Percent Conceptual Level (%)
Severe impairment	0	0	0	0
Moderate to severe	0	0	0	0
Moderate	0	0	15	0
Mild to mod	5	0	15	0
Mild	15	15	30	40
Below average	20	25	25	10
Average	35	20	10	40
Above	30	40	5	10

**Table 5b. Rating**

	Number Completed Categories (%)	Trials to complete first category (%)	Failure to maintain set (%)	Learning to learn (%)
Normal	10	45	50	15
Mild impairment	15	15	10	5
Moderate impairment	20	20	0	15
Severe impairment	10	10	25	0
Totally impaired or no answer	45	10	15	65

**Table 6. Influence of NIHSS on**

	P=	Correlation coefficient	Notes
MMSE	0.0002	-0,734377	Opposite proportional /Moderately strong relationship at the 99% confidential level
Hamilton score	0.4033		No correlation
Wisconsin/Number of total errors	0.3183		No correlation
Number of perseverations	0.2010		No correlation
Number of perseverative errors	0.3183		No correlation
Number of nonperseverative errors	0.1786		No correlation
Percent conceptual level	0.0536	-0.437704	Opposite proportional/Weak relationship at 90% confidential level
Trials to complete first category	0.0218	-0.509292	Opposite proportional/Moderately strong relationship at 95% confidential level
Failure to maintain set	0.0072	-0,580799	Opposite proportional/Moderately strong relationship at 99% confidential level
Learning to learn	0.0360	-0.471266	Opposite proportional/Weak relationship at 95% confidential level

## CONCLUSIONS:

The results of our study are similar with the results of previous studies regarding the cognitive dysfunctions (75% of our patients) and tendency to depressive mood (75%) three months after the stroke onset. Moderately strong relationship between stroke severity (measured with NIHSS) and global cognitive functioning (assessed with MMSE) was found. No association between stroke severity and Hamilton scoring was observed and this gave us the basis for presuming that the mechanism of developing executive dysfunction after stroke differed from depression developing mechanism.

We did not find statistically significant association between MMSE - & Hamilton scoring and Wisconsin test results at the 5% significance level ( $p \geq 0.05$ ) so we strongly recommend the test for assessment of executive functions in stroke patients with mild depression.

Patients' attitude, cooperation and effort had no impact on the results on Wisconsin test scoring, despite the poor attitude and relative homogeneity of the group on these parameters.

90% of our patients had scores below the normal limit (for normal population) on number of categories completed, mostly due to nonperseverative errors (60% below normal scores for age, sex and education) and attention deficit (measured as failure to maintain set – 50% below normal scores). We found decline in learning to learn ability in 85%,

which was higher than results from the previous studies. Only 15% had more perseverative errors than in normal population. 55% had difficulties in initiation measured by trials to complete first category. 40% of our patients had below normal standard score and T - score on percent conceptual level. Severe and total impairment was found in 55% for number of completed categories, 20% - trials to complete first category, 35% - failure to maintain set. These facts support the hypothesis of executive dysfunctions among stroke survivors.

Unlike the results from previous studies<sup>3, 7, 10</sup> statistically significant differences were established between the left hemispheric lesion group and the other two groups (right hemispheric lesion group and brainstem lesion group) on the number of total errors; they were significantly more than in other two groups. Such a relationship was not found for the other examined parameters.

Stroke severity, measured by NIHSS, influenced MMSE scoring and some of the Wisconsin test results (percent conceptual level (at 90% confidential level), trials to complete first category, failure to maintain set and learning to learn abilities). We presume that this is due to a disconnection between the brain cognitive zones because of a stroke lesion or possibly executive dysfunctions preceded or were the first manifestations of brain ischemia before stroke, which is a question that should be the subject of future studies.

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