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# PSDRS, BDI, MoCA and MMSE as screening tools for the evaluation of mood and cognitive functions in patients at the early stage of cerebral stroke

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## Summary

**Aims.** To evaluate the suitability of the Post-Stroke Depression Scale (PSDRS) for detecting affective disorders, to examine the correlation of depressed mood states with cognitive disorders in patients at an early stage of cerebral stroke, and to attempt a comparison of the effectiveness of detecting depressive and cognitive disorders with the selected clinical scales.
**Material and methods.** The examination involved 43 patients within the first week after cerebral stroke. It was carried out with the application of two screening scales, the Mini-Mental State Examination (MMSE) and the Montreal Cognitive Assessment (MoCA), and two scales for the evaluation of the degree of depressiveness: PSDRS and Beck Depression Inventory (BDI).
**Results.** A significant negative correlation of the results of the PSDRS and MoCA scales was shown. Depressed mood in patients post-cerebral stroke was statistically significantly correlated with the disorders in selected cognitive skills: visual and spatial functions, memory, attention functions and abstracting ability.
**Conclusions.** The PSDRS and MoCA scales proved to be more effective tools for the evaluation of depressive and cognitive disorders in patients at an early stage after cerebral stroke than the conventionally applied MMSE and BDI scales. The examination results additionally show a significant dependence between mood and the cognitive impairment in this group of patients. With the weakening of cognitive functioning, the patients' mood also became depressed.

**stroke / post-stroke depression / cognitive functions**

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## INTRODUCTION

Cerebral stroke is one of the most frequent health problems affecting modern society. In about 60–70% of patients after cerebral stroke the reduction of both motor and cognitive ability is noted, while after a year approximately 50% of patients do not regain full ability [1]. The most frequent complications of mental nature that occur after a vascular incident include post-stroke depression (PSD). Depending on the criteria adopted and research tools applied, it is assumed that it occurs in about 16–72% persons after cerebral stroke. These differences can result, among others, from the selection of the

study group. In a randomly selected community sample, this proportion ranges between 23 and 44%, but it increases to 35–72% in hospitalised patients [2]. As research shows, post-stroke depression is a key factor in further convalescence of the patient after stroke. Its intensity is associated with worse results of motor rehabilitation and more difficult recovery [3]. What is more, post-stroke depression affects the reduction of the efficiency of patients' cognitive functioning [4,5]. However, the vast majority of studies include persons who experienced stroke at least a month before the examination. This limits the possibility of exploring the dynamics of the development of post-stroke depression, as well as its influence on patients' cognitive functioning.

## MATERIAL AND METHOD

The group under study consisted of patients of the Ludwik Rydygier Specialist Hospital in Krakow. The study included in-patients at the Department of Neurology and Cerebral Strokes, on the seventh day after the cerebralvascular accident. Patients in an acute state were not able to undergo tests and patients with considerable paresis and deep aphasia were also excluded from the study. The study did not include persons addicted to psychoactive substances or persons with coexisting neurological and mental disorders.

Overall, 43 persons aged 42 to 87 participated in the study (mean age 65.58 years (±10.63). Age distribution in the study group was close to the normal distribution and 58% of the group were men. The majority of patients in the study had secondary school education (51%), 9% had primary education, 30% vocational education and 7% higher education. No education data were available for one person.

The location of the stroke focus varied (Table 1). As the study focused on patients with left cerebral stroke, only those were included in whom aphasia was only vestigial and did not hinder the questionnaire test performance and the application of the cognitive functions scales. In about one quarter of the patients dysarthria was found, but the remainder did not have any speech defects. Paresis occurred in the majority of patients in the study (58%).

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**Table 1.** Location of stroke

| Location of stroke | Number of patients (n) | % |
|---|---|---|
| Right hemisphere<br>Left hemisphere<br>Both hemispheres | 15<br>21<br>7 | 34.88<br>48.84<br>16.28 |
| Posterior cortex | 11 | 25.58 |
| Subcortical structures | 13 | 30.23 |
| Frontal lobes | 19 | 44.19 |

## METHOD

The following scales were used in the study: Post-Stroke Depression Rating Scale (PSDRS, translated by Łucja Domańska [6, 7] ), Beck Depression Inventory (BDI), Mini-Mental State Examination (MMSE) and Montreal Cognitive Assessment (MoCA). Due to a lower prevalence and popularity of MoCA and PSDRS, they will be discussed in greater detail below.

### Post-Stroke Depression Rating Scale

The scale [6, 7] consists of 10 sections. The first 9 study various components of post-stroke depression, such as: depressed mood, sense of guilt, thoughts about death/suicidal thoughts, vegetative symptoms, apathy, loss of interests, level of anxiety, catastrophic reactions, emotional hyperactivity and anhedonia. The scale is completed by the researcher on the basis of what the patient says and how they behave, assigning to each group a value ranging from 0 to 5 points. The maximum test score is 45 points. Section 10 is not counted towards the sum of points. Its purpose is to distinguish whether depressive symptoms occurred only after cerebral stroke or have a different background [7]. PSDRS differs from the other, default measurement tools in its adjustment for the specific nature of mood disorders occurring in persons after cerebral stroke. An additional value of PSDRS is a possibility of analyzing the specific subscales separately, thus obtaining a qualitative profile of the patient's mood disorders. It is also possible to apply the total score in order to carry out a screening evaluation of depressed mood in post-stroke patients, as has been done in this study.

### Montreal Cognitive Assessment (MoCA)

This is a brief screening test of the paper-pencil type (it usually takes 10 min to complete). Unlike the MMSE, the MoCA scale includes a larger range of attempts evaluating the efficiency of cognitive processes functioning, as well as attempts evaluating to a larger degree the executive functions. The maximum obtainable score is 30 and the score ≥26 indicates normal cognitive functioning. The test evaluates cognitive functions and operational memory (2 points), visual and spatial functions (3 points), semantic memory (3 points) and attention (3 points). Additionally it evaluates calculia (3 points), the ability to repeat (2 points), verbal fluency (1 point), the ability to abstract (2 points), short-term memo-

ry (5 points) and orientation in time and space (6 points). Education level and age can influence test scores [8].

### Statistical methods

Results were analysed using the PQStat statistical package version 1.4.2.324. The normality of distributions was examined with the Szapiro-Wilk test. The relationship between age, MMSE and MoCA scales and BDI and PSDRS was analyzed estimating the Spearman rank correlation and Pearson linear ratios. The results of the BDI and PSDRS scales, gender dependent, were compared with the Mann–Whitney *U*-test and *t*-student test. For the examination of the distribution of the results in BDI and PSDRS scales, depending on education level and the location of brain damage, the Kruskal-Wallis and ANOVA tests were applied. On the other hand, the relationship between the individual components of the MoCA test with the results of BDI and PSDRS questionnaires was analyzed estimating the correlations of the Spearman rank order. Test probability at the level of $p<0.05$ was assumed as significant.

**Table 2.** Descriptive statistics and distribution of the results of MMSE, MoCA, BDI and PSDRS

| Scale | Descriptive statistics | | | | | | | Shapiro-Wilk |
|---|---|---|---|---|---|---|---|---|
| | Mean | S.D. | Min. | Q25% | Median | Q75% | Max | |
| MMSE | 24.86 | 4.80 | 13.00 | 22.00 | 26.00 | 29.00 | 30.00 | 0.0005 |
| MoCA | 20.86 | 6.24 | 4.00 | 16.00 | 22.00 | 26.00 | 30.00 | 0.0861 |
| BDI | 9.14 | 5.84 | 0.00 | 5.00 | 8.00 | 13.00 | 29.00 | 0.0318 |
| PSDRS | 14.46 | 7.46 | 3.00 | 8.00 | 14.00 | 20.00 | 35.00 | 0.0510 |

**Table 3.** The correlations of MMSE and MoCA with BDI and PSDRS scales

| | Spearman rank order correlations | | | | Pearson correlations | | | |
|---|---|---|---|---|---|---|---|---|
| | MMSE | | MoCA | | MMSE | | MoCA | |
| | R | p | R | p | r | p | r | p |
| BDI | -0.1449 | 0.3538 | -0.3551 | 0.0195 | -0.0690 | 0.6600 | -0.2660 | 0.0850 |
| PSDRS | -0.1998 | 0.1988 | -0.4233 | 0.0047 | -0.1385 | 0.3760 | -0.3094 | 0.0430 |

## RESULTS

Our study indicates a significant, directly proportional relationship between the level of cognitive impairment and the probability of the occurrence of depressive mood in patients who have experienced cerebral stroke. In patients in whom a significant deterioration of cognitive skills was found, also a clear deepening of mood disorders of the depressive type was observed. It is difficult, however, to make conclusions on

**Table 4.** Correlations of MoCA sub-scales with the BDI and PSDRS scores

| Sub-scale of MoCA | Descriptive statistics | | | Shapiro-Wilk | BDI | | PSDRS | |
|---|---|---|---|---|---|---|---|---|
| | X | SD | Me | | R | p | R | p |
| Visuospatial/ executive | 3.28 | 1.59 | 4.00 | 0.0001 | -0.3293 | 0.0311 | -0.4011 | 0.0077 |
| Memory | 2.28 | 1.68 | 2.00 | 0.0023 | -0.4359 | 0.0035 | -0.4209 | 0.0049 |
| Attention | 3.79 | 1.87 | 4.00 | 0.0010 | -0.2608 | 0.0911 | -0.3230 | 0.0346 |
| Language | 1.56 | 0.98 | 2.00 | 0.0001 | 0.1184 | 0.4495 | 0.0913 | 0.5602 |
| Abstraction | 1.40 | 0.62 | 1.00 | <0.0001 | -0.2569 | 0.0963 | -0.3292 | 0.0311 |
| Orientation | 5.42 | 1.28 | 6.00 | <0.0001 | 0.0375 | 0.8112 | -0.1069 | 0.4950 |
| Attention shiftability | 2.05 | 1.72 | 2.00 | 0.0006 | 0.2830 | 0.0659 | 0.3522 | 0.0205 |

## RESULTS

The distribution of the MMSE (p=0.0005) and BDI (p=0.0318) results differs significantly from the normal distribution, while the MoCA and PSDRS scales are consistent with it (Table 2). Due to the fact that some of the scales significantly diverge from the theoretical normal distribution and some are consistent with it, the analyses of the correlations were carried out applying both parametric ($p^{1}$) and non-parametric ($p^{2}$) approach.

In Table 3 the results of the correlation between the MMSE and MoCA scales and the BDI and PSDRS are presented. No significant (p>0.05) correlations were found between the cognitive impairment measured with the MMSE and mood measured with the BDI and PSDRS. On the other hand, in the case of the cognitive impairment measured with the MoCA scale, the dependence was significantly negatively correlated in rank (p=0.0195, R=-0.3551) with the mood level measured with the BDI test and significantly negatively correlated (p=0.0047, R=-0.4233) with the depressed mood measured with the PSDRS scale. This means that with the increase of the results of the MoCA scale (better cognitive functioning) the results of the BDI and PSDRS scales become lower (less depressed mood). Those correlations considered in a linear fashion are significant (p=0.0430) only in the case of the relations between the MoCA and PSDRS scales (R=-0.3094), and it is the only pair of variables to have a normal distribution and a justified linear correlation.

No significant correlations were found between mood disorders measured with the BDI and PSDRS scales and age ($p^{1}$=0.6980; $p^{2}$=0.9573); gender (for BDI $p^{1}$=0.5848, $p^{2}$=0.8923; for PSDRS $p^{1}$=0.7253, $p^{2}$=0.7489) and education (for BDI $p^{1}$=0.6973, $p^{2}$=0.7686; for PSDRS $p^{1}$=0.3801, $p^{2}$=0.6336). There were also no significant differences whether the right, left or both hemispheres were affected (for BDI $p^{1}$=0.2007, $p^{2}$=0.1198; for PSDRS $p^{1}$=0.2013, $p^{2}$=0.1235) and between brain damage location (for BDI $p^{1}$=0.3960, $p^{2}$=0.5192; for PSDRS $p^{1}$=0.3791, $p^{2}$=0.3251).

A significant negative correlation (Table 4) was found between the visual and spatial functions and mood disorders (BDI) (p=0.0311; R=-0.3293) and the depressed mood measured on the PSDRS (p=0.0077; R=-0.4011). Memory func-

the trend of the influence of the factors described on the basis of the examinations carried out. The depressed mood can deepen the already existing cognitive dysfunctions, whereas the awareness of those mental limitations certainly contributes to the worsening of the mood, sadness and depression. Cognitive functioning can also be affected by the person's IQ and education. It has also to be taken into account that depressed mood can occur before cerebral stroke.

The present study found a significant relationship concerning memory disorders, attention functions and visual and spatial functions and the occurrence of depressed mood in persons after cerebral stroke; the occurrence of executive dysfunctions can also be similarly significant. The association between post-stroke depression and cognitive functioning has been documented in the literature [4, 5, 10]. Some indicate a particularly strong correlation between the decrease in the efficiency of executive functions [11-13] and post-stroke depression. One of the papers suggests that persons after cerebral stroke who experience disorders of executive functions suffer from depression more frequently than persons without such disorders. Over half (53.3%) of people suffering from both depression and disorders of executive functions were still experiencing them 2 years after the stroke, and forecasts concerning their recovery were much worse than for patients with either disorders of executive functions or depression [14]. Considerably fewer studies focus on a more precise division of executive functions and their influence on the occurrence of depression. The study carried out on healthy persons indicate however that memory disorders [15, 16] co-occur with the emergence of depression. Similar conclusions were reached by Hommel et al., but in the case of persons who had cerebral stroke [11]. Disorders in attention functions can also affect the development of depression. Lockwood and colleagues [17] estimate that about a third of otherwise healthy elderly persons with depression have co-existing attention and executive functions disorders. Nys in turn [18] indicates an association between depression post-cerebral stroke and visual memory disorders, disorders of higher-order visual and spatial functions and hemispatial neglect. They are at the same time described as the best predictors of the retention of post-stroke depression at 6 months.

There are few studies involving patients in the first 3 weeks after the cerebral stroke that show the early interdependence of depressive symptoms and the worsening of cognitive functioning [13], and scant data indicating the influence of the latter upon the development of post-stroke depression within 6 months post-stroke [18]. However, a trend is emerging that tends to the earliest possible detection of depression, which was pointed out in the guidelines of European Stroke Organisation [19]. Fuentes et al. [20] examined patients before the 10th day after cerebral stroke and followed them up after 3 months. They noted that depression in 'the acute phase' of the stroke is maintained in the later period. They stress the importance of early detection of this disorder.

The present paper concerns persons in the first week after cerebral stroke, that is in the 'acute phase'. The results indicate co-occurrence of depressive symptoms and the worsening of cognitive functioning as early as in the first week after the vascular incident, whereby unlike other authors, it was decided not to use the term "post-stroke depression" in relation to the examination carried out due to the great dynamics of changes occurring in this period.

Post-stroke depression can be assessed using various scales, with the BDI being one of the most popular [12, 21]. However, scientific progress encourages one to search for new measures. That is why we have decided to introduce the Post-Stroke Depression Scale (PSDRS), aimed at the specific examination of patients who have experienced cerebral stroke. Although no studies were found that would compare both scales mentioned, the juxtaposition of the PSDRS with Hamilton Depression Scale which is also frequently applied post-cerebral stroke [20] indicates the diagnostic validity of the PSDRS [7]. Gainotti suggests, however, the possibility of the total comparison of the results of both scales (at the test author's consent). When cognitive functions need to be examined, the MMSE scale is normally used [13, 22].

However, due to numerous reports of better diagnostic properties, the MoCA scale was additionally introduced in this study [23-25]. The introduction of new scales produced interesting results, as the well-known MMSE scale did not yield any significant results in juxtaposition

with the scales for depression. Significant correlations were however noted in the case of comparing them with the MoCA. This can result from the fact that MoCA appears to be more effective, particularly in detecting disorders within executive functions and working memory, which, as mentioned before, indicate a stronger association with the occurrence of depressive symptoms. It is worth mentioning that the correlation was strongest in comparing the two less frequently applied scales, namely the MoCA and the PSDRS.

This study had certain limitations, such as a small and non-homogenous sample. Due to the changing dynamics of the course of cerebral stroke and great fatigability of the patients, only certain individuals were able to fully participate in the examination. However, despite the obstacles encountered, the results of the study can be an indication for diagnosticians. Owing to the early application of the scales suggested, a faster and more precise detection and counteraction against the worsening of cognitive functions as well as the co-occurring depressive symptoms will be possible.

### Findings

The results of this study indicate that with the worsening of cognitive functioning, measured with the MoCA screening scale, depressive symptoms as measured by the BDI and PSDRS tests are more severe. This is true when measuring visual and spatial functions, memory, attention (including attention shiftability) and the ability to abstract. It can be therefore assumed that in the group of persons in the study who did not suffer from severe aphasia or paresis, the depressed mood which manifests as early as in the first week post-cerebral stroke is related to the worsening of the quality of the patient's cognitive functioning.

The scales that appear particularly useful here are the MoCA screening scale and the PSDRS test which aim to distinguish the depressed mood occurring as a result of cerebral stroke from depressive states occurring before the stroke. Numerous authors indicated the diagnostic prevalence of the MoCA scale over the MMSE scale. However, any screening scales results have to be treated mainly as an initial diagnosis of the patient's functioning facilitating a selection of more precise tools for the examination of specific cognitive functions. The results of the examinations presented in this paper additionally suggest the clinical prevalence of the PSDRS scale over the commonly applied BDI scale, due to, among others, its greater relevance and diagnostic efficiency in this group of patients.

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