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THE IMPACT OF EARLY PHYSICAL REHABILITATION IN THE INTENSIVE CARE UNIT ON THE MENTAL STATE AND COGNITIVE FUNCTIONS OF PATIENTS WITH COVID-19

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As of 2021, according to the World Health Organization (WHO), over 700 million cases of COVID-19 have been recorded globally, of which approximately 20 % required hospitalisation and 5 % were transferred to Intensive Care Units (ICU). The primary cause for hospitalisation of patients in ICU is respiratory failure caused by acute respiratory distress syndrome (ARDS) associated with COVID-19. Breathing problems, prolonged ICU stays, and the need for mechanical ventilation significantly affect patients' overall health, reducing their ability to self-care, decreasing muscle strength, and negatively impacting cognitive functions. Early physical rehabilitation is considered a potentially effective method to improve treatment outcomes, particularly in reducing anxiety and depression and restoring cognitive functions.

The aim *of our study is to investigate the impact of early physical rehabilitation in the ICU on cognitive function and mental state in patients with COVID-19.*

Materials and methods: *We conducted a retrospective cohort study on patients with a confirmed diagnosis of COVID-19 who required hospitalisation in the ICU between October 2020 and March 2021. We compared the effects of one and two daily sessions of physical rehabilitation on anxiety and depression levels, as well as cognitive functions in these patients.*

Results: *We found that two daily sessions of physical rehabilitation significantly reduced anxiety and depression levels in patients with COVID-19, especially among males. Cognitive function dynamics did not show significant differences between the groups, which may indicate the limited impact of physical rehabilitation on cognitive functions in the short term.*

Conclusion: *Early physical rehabilitation is an important component of the treatment for patients with COVID-19 in the ICU. Increasing the frequency of physical rehabilitation sessions per day contributes to improving patients' mental state, reducing anxiety and depression, and also holds potential for preserving cognitive functions, which is critically important for the long-term recovery of patients after severe illness*

Keywords: *Early physical rehabilitation, physical rehabilitation, patient mobilisation, early patient activation, intensive care unit, post-COVID syndrome*

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1. Introduction

According to WHO data, as of 2021, over 700 million cases of COVID-19 were recorded globally [1]. Among these, approximately 20 % of patients required hospitalisation, and about 5 % needed admission to intensive care units (ICUs).

The primary reason for ICU admission is acute respiratory distress syndrome (ARDS) caused by the infection. A significant proportion of these patients require oxygen and respiratory therapy in the ICU. The high number of patients with respiratory failure leads to ICU overload, prompting the need for strategies to accelerate patients' recovery [2, 3].

Staying in an ICU contributes to a decline in a patient's ability to perform self-care, reduced muscle strength, and impaired basic mobility [4, 5]. Additionally, ICU stays have a well-documented negative impact on patients' cognitive functions and mental states [6–8]. According to the literature, around 50 % of patients who recovered from COVID-19 experience various changes in their mental status, 33 % suffer from cognitive impairments, and 28 % show changes in both domains [9–11]. Notably, the presence of one type of impairment increases the risk of developing others [12]. These changes often result in prolonged disruption of normal functioning and significantly diminish patients' quality of life [11, 13].

Early physical rehabilitation is one promising method of preventing these complications [14–16].

The aim: To study the impact of early physical rehabilitation in ICUs on the cognitive and mental health of patients with COVID-19.

2. Materials and methods

This retrospective cohort study included 102 patients with confirmed COVID-19 who were treated in the ICU of Dobrobut Medical Center between October 2020 and March 2021.

Inclusion criteria:

1) Age over 18 years;

2) PCR-confirmed COVID-19;

3) ICU admission due to respiratory failure caused by ARDS.

Exclusion criteria:

1) Pre-existing musculoskeletal conditions limiting mobility;

2) Neurological diseases limiting mobility;

3) Presence of oncological diseases;

4) Death of the patient or transfer to another healthcare facility; 5) Patient refusal to participate.

Patients were divided into two groups based on the number of physical rehabilitation sessions per day: Group 1 – 1 session/day; Group 2 – 2 sessions/day.

Each group included 51 patients. The average age in Group 1 was 57.55±14.34 years and in Group 2, 56.10±12.02 years. Approximately 70 % of patients in each group were male, and 30 % were female. The most common comorbidities were arterial hypertension and diabetes mellitus. The average BMI in both groups exceeded 30 kg/m², indicating that most participants were obese.

All clinical and laboratory studies were conducted in accordance with the Declaration of Helsinki of the World Medical Association "Ethical Principles of Medical Research Involving Human Subjects". In accordance with current legislation, before the start of the study, each of its subjects signed a detailed form of informed consent for conducting the study.

The study was approved by the Commission on Ethics based on the Bogomolets National Medical University, which is confirmed by an extract from the protocol of Commission No.161 dated October 17, 2022.

Clinical parameters such as respiratory rate (RR, breaths/min) and arterial oxygen saturation (SpO_2, measured by pulse oximetry) were used to assess the severity of patients' conditions. The percentage of lung parenchymal involvement was also evaluated using chest CT scans (% lung involvement). Detailed group characteristics are provided in Table 1.

All patients received treatment per a standard protocol, including physical rehabilitation sessions. These sessions comprised passive, active-passive, and active exercises, patient positioning in bed, verticalisation (sitting and standing), walking, and breathing exercises.

The physical rehabilitation sessions were conducted by a physical therapist under the supervision of a nurse and an anesthesiologist. Sessions started on the first day of ICU admission, lasting 15–20 minutes each. The therapist aimed to achieve the maximum possible intensity during each session. Sessions were discontinued if the patient's condition decompensated or if the patient refused to continue.

Table 1

Group Characteristics

Parameter	Group 1 n=51	Group 2 n=51
Age (mean±SD), years (t-test – p 0,58)	57.55±14.34	56.10±12.02
Sex		
Male	35 (69 %)	34 (67 %)
Female	16 (31 %)	17 (33 %)
BMI (mean±SD) U test – p 0,63	31.34±6.72	30.87±5.92
Comorbidities:		
Hypertension (HTN) (%)	31 (61 %)	33 (65 %)
Diabetes mellitus (DM) (%)	22 (43 %)	15 (29 %)
Chronic kidney disease (CKD) (%)	13 (25 %)	8 (16 %)
Smoking (%)	9 (18 %)	14 (27 %)
Severity of admission:		
CT lung involvement (%, mean±SD) U test - p 0,63	51.33±19.80	46.62±19.0
SpO_2 on ICU admission (mean ± SD) U test - p 0,56038	80.86±4.91	81.35±3.25
RR on ICU admission (mean ± SD) t test – p 0,092027	24.20±1.51	23.69±1.52

To assess the control parameters of the patients, the following tools were selected:

For cognitive status evaluation, the Mini-Mental State Examination (MMSE) was used [17, 18]. This is a standardised questionnaire consisting of 22 questions and tasks. It allows for the assessment of the patient's cognitive abilities across five domains: orientation in time and space, registration, attention and calculation, memory, language.

The interpretation of the results was carried out according to the following distribution (Table 2).

Table 2

MMSE Score Interpretation

Scores	Interpretation
28–30	Normal cognitive function
24–27	Mild cognitive impairment
20–23	Mild dementia
11–19	Moderate dementia
0–10	Severe dementia

The assessment of mental status was conducted using the Hospital Anxiety and Depression Scale (HADS) [19], which is a subjective method designed for the screening of anxiety and depression in hospitalised patients. The Hospital Anxiety and Depression Scale is characterised by its simplicity in application and processing (completing the questionnaire does not require a lot of time and does not pose complications for the patient). The questionnaire consists of 14 statements divided into two subgroups: subgroup A – "anxiety" and subgroup D – "depression." Each statement has 4 response options that reflect the degree of symptom severity from 0 to 3.

Table 3

HADS Score Interpretation

Scores	Interpretation
0–7	Normal
8–10	Subclinical anxiety/depression
11 and more	Clinical anxiety/depression

Both scales were assessed at the time of patient discharge from the hospital.

Statistical processing of the study results was performed using the licensed computer program Microsoft Excel 2010 using methods of parametric and nonparametric statistics. The normality of the distribution of quantitative traits was assessed using Shapiro-Wilk and Kolmogorov-Smirnov. The probability of differences in quantitative indicators in two unrelated groups was determined using the Mann–Whitney U-test and t-test. The difference between the values was considered significant by $p<0.05$

3. Results

Detailed results are provided in Table 4.

The mean score on the MMSE scale in Group 2 (2 sessions/day) was 28.32±2.52, which is considered normal. In Group 1, the score was slightly lower, specifically 26.45±4.37, which is interpreted as mild cognitive impairment. Further analysis of sex differences revealed that women in both groups had nearly identical mean scores on the MMSE: 25.0±5.11 in Group 1 and 25.41±4.58 in Group 2. In men, the difference was 1.22 points and approached statistical significance (p=0.12), favouring the group with 2 rehabilitation sessions per day.

To assess the psycho-emotional state, we used the HADS scale. Each group was evaluated for three indicators: the severity of depressive symptoms, the severity of anxiety symptoms, and the total score for both parameters. The data showed that the symptomatology among the studied patients was more characteristic of the anxiety spectrum, with the average HADS (A) scores for the groups being 7.04±2.84 and 6.31±3.57, respectively. The symptoms of depression were significantly less pronounced, with scores of 4.28±2.71 and 3.21±1.73, respectively. As we can see from the obtained values, the distribution of symptoms within the groups was similar. Regarding the total HADS score (A+D), the average values for the groups were 11.33±4.51 and 9.52±4.61, respectively, showing a statistically significant difference.

Further analysis of gender characteristics did not reveal significant differences between the groups among women; however, a significant difference (p=0.02) was found in the levels of depression (HADS (D)) among men, with scores of 4.41±2.64 and 3.06±1.84 in favour of the group with two sessions of physical rehabilitation per day.

Table 4

Cognitive and mental state evaluation (discharge)

Indicator	**p-value (instrument)**	**Group 1 n=51**	**Group 2 n=51**
MMSE	0.24 (U-test)	26.45±4.37	27.35±3.58
HADS (A+D)	0.02 (U-test)	11.33±4.51	9.52±4.61
HADS (A)	0.10 (U-test)	7.04±2.84	6.31±3.57
HADS (D)	0.06 (U-test)	4.28±2.71	3.21±1.73
Male			
Indicator	**p-value (instrument)**	**Group 1n=35**	**Group 2 n=34**
MMSE	0.12 (U-test)	27.11±3.89	28.32±2.52
HADS (A+D)	0.02 (U-test)	11.66±4.8	9.39±4.99
HADS (A)	0.09 (U-test)	7.25±3.02	6.33±3.91
HADS (D)	0.02 (U-test)	4.41±2.64	3.06±1.84
Female			
Indicator	**p-value (instrument)**	**Group 1 n=16**	**Group 2 n=17**
MMSE	0.80 (U-test)	25.0±5.11	25.41±4.58
HADS (A+D)	0.93 (t-test)	9.69±2.01	9.8±3.76
HADS (A)	0.91 (t-test)	6.38±2.4	6.27±2.81
HADS (D)	0.68 (t-test)	3.31±1.44	3.53±1.46

4. Discussion

The trend of declining cognitive function in both groups is a typical consequence of staying in the Intensive Care Unit (ICU), as confirmed by numerous studies [9, 11, 20]. The primary risk factors for cognitive impairments are considered to be respiratory failure and Acute Respiratory Distress Syndrome (ARDS), which are characteristic features of severe COVID-19 cases [20, 21]. In a recent systematic review conducted by Honarmand et al., 2020, which analysed over 300 articles, it was found that approximately 80 % of patients with the aforementioned symptoms will suffer from cognitive impairments at the time of discharge (ranging between 24–27 on the MMSE). These impairments may persist for up to 12 months [22]. According to the study by Patel et al., 2023, early physical rehabilitation in the ICU has proven effective in reducing long-term cognitive impairments in patients admitted to the ICU due to respiratory failure [23]. Other studies support our hypothesis that more intensive physical rehabilitation helps maintain cognitive functions in patients after prolonged illnesses, although changes are usually noticeable only after several months [22, 23]. However, our statistical analysis did not reveal a significant difference between the observation groups in the short term. However, even minimal differences could indicate the potential of early rehabilitation as a promising method to prevent cognitive impairments.

Regarding the mental state of patients, our results confirm a significantly lower level of total (HADS A+D) anxiety and depression symptoms in the group with 2 sessions of physical rehabilitation per day. Similar results were also found by other researchers who compared levels of depression and anxiety in patients after ICU treatment, revealing that in the group where early physical and psychological rehabilitation sessions were conducted, the levels of anxiety and depression symptoms were half that of the group without interventions [24]. Based on our findings, we can assert the effectiveness of such measures in improving the psychosocial state.

This is especially important for patients recovering from severe illness, during which anxiety and depression can significantly deteriorate the quality of life and the recovery process.

In the study conducted by Bienvenu et al. in 2018, which lasted about 5 years, interesting risk factors for mental disorders in the ICU were identified, namely female gender and an education duration of less than 12 years [11]. When analysing indicators in subgroups by gender, it was found that among women, none of the mental state parameters showed significant differences between groups, and their numerical values were almost identical. This may indicate that physical rehabilitation has a less significant positive impact on anxiety and depression manifestations in women. In contrast, significant differences were found in men not only in the total HADS score (A+D) but also in the category of depressive symptoms, indicating the importance of early physical rehabilitation in the male population.

These findings warrant additional attention in the development of rehabilitation programs in the ICU.

Study limitations: The study has a small sample size, a short observation period for patients, and lacks a control group without rehabilitation sessions (due to ethical considerations).

Prospects for future research: Future studies should focus on long-term monitoring of the effects of physical rehabilitation, as well as comparing the effectiveness of different types of exercises. It is also important to consider not only the physical component of rehabilitation but also the psychological and social aspects. The obtained results should be utilised to create an optimal rehabilitation algorithm for ICU patients.

5. Conclusions

The undergoing two rehabilitation sessions per day (Group 2) demonstrated a significantly lower level of anxiety and depression according to the HADS (A+D) scores compared to the group of patients who had one session per day (Group 1). The scores in Groups 1 and 2 were 11,33, and 9,52 points, respectively ($p<0,05$), indicating that early physical rehabilitation can be an effective method for maintaining mental health in COVID-19 patients in the ICU.

A similar trend was observed in cognitive function indicators, where the group with more intensive rehabilitation tended towards better cognitive function scores on the MMSE scale, with a score of 0,9 points higher than the group with one rehabilitation session per day. This suggests that increasing the frequency of rehabilitation sessions in the ICU could be a promising component of treatment for COVID-19 patients, especially in the context of maintaining cognitive functions.

The aforementioned positive effects were more pronounced among men, highlighting the need to consider gender distinctions for optimising rehabilitation programs in the ICU.

Early physical rehabilitation in the ICU is an important component of comprehensive treatment for patients diagnosed with COVID-19 and deserves further research.

Conflict of interest

The authors declare that they have no conflict of interest concerning this study, including financial, personal, authorship, or any other, that could affect the study and its results presented in this paper.

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Availability of data

Data will be provided upon reasonable request.

Use of artificial intelligence technology

The authors confirm that they did not use artificial intelligence technologies when creating the presented work.

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