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ΕΡΕΥΝΗΤΙΚΗ ΕΡΓΑΣΙΑ

Does acute respiratory rehabilitation impact hospitalization duration in mild to moderate COVID-19 pneumonia patients?

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ΑΡΧΕΙΑ ΕΛΛΗΝΙΚΗΣ ΙΑΤΡΙΚΗΣ 2026, 43(Συμπλ 1):31–37

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Επηρεάζει η οξεία αναπνευστική αποκατάσταση τη διάρκεια νοσηλείας σε ασθενείς με ήπια έως μέτρια πνευμονία λόγω COVID-19;

Περίληψη στο τέλος του άρθρου

OBJECTIVE **To assess whether acute respiratory rehabilitation in patients with pneumonia caused by SARS-CoV-2 reduces the length of hospitalization.** METHOD **A total of 57 patients (34 men, 23 women) participated in a respiratory rehabilitation program. The monitored parameters included symptom duration before hospitalization, the date of the SARS-CoV-2 test, hospitalization date, rehabilitation initiation date, length of hospitalization, rehabilitation duration, oxygen therapy or use of continuous positive airway pressure (CPAP), heart rate, blood pressure, oxygen saturation, respiratory rate, modified Borg dyspnea scale, and fatigue levels before and after rehabilitation.** RESULTS **Symptoms before hospitalization lasted from 2 to 21 days (mean: 6.1±3.4 days). Rehabilitation was initiated, on average, 7.74±4.76 days after hospitalization. Rehabilitation duration ranged from 1 to 10 days (mean: 4.16±2.1 days, median: 4 days). Total hospitalization length varied from 4 to 20 days. Statistical analysis revealed that longer symptom duration before hospitalization was significantly associated with a longer hospital stay and delayed rehabilitation initiation but did not correlate with the total rehabilitation duration. Half of the patients, 28 (49.12%), experienced symptoms for up to one week prior to hospitalization and initiated rehabilitation within the first week of their hospital stay.** CONCLUSIONS **The study did not provide clear evidence that acute respiratory rehabilitation directly reduces the length of hospitalization in patients with SARS-CoV-2 pneumonia. Although delayed rehabilitation initiation was linked to longer hospitalization, no direct impact on the total length of hospitalization was found. Further studies are needed to definitively determine the relationship between respiratory rehabilitation and hospitalization outcomes in COVID-19 patients. This study underscores the complexity of recovery from COVID-19 pneumonia and the need for more focused research in the field of respiratory rehabilitation for these patients.**

Key words

COVID-19
Hospitalization length
Pneumonia
Respiratory rehabilitation

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At the end of 2019, pneumonia caused by the novel coronavirus began to spread rapidly worldwide, significantly impacting global public health, healthcare systems, and economic development.[1] On February 7th, 2020, the World Health Organization (WHO) officially defined corona viral disease 2019 as COVID-19. In March 2020, the first case of infection was registered in Montenegro. Acute respiratory syndrome caused by SARS-CoV-2 is an infectious disease that can lead to physical, respiratory, and psychological disorders. The clinical features of COVID-19 can range from fever, cough, and weakness to more severe consequences such as bilateral pneumonia, hypoxia, respiratory failure, septic shock, acute respiratory distress syndrome, and, in the worst cases, patient death.[2,3]

Pneumonia often affects both lungs and primarily involves the lower lobes.[4] Radiological findings of COVID-19 include the presence of "ground glass" opacities, thickening of the interlobular septa, and unbalanced consolidation.[5,6] Data from Chinese studies showed that older patients and those with comorbidities had poorer clinical outcomes.[7] Multimorbidity has also been correlated with worse clinical outcomes.[8] Comorbidities related to cardiopulmonary diseases, such as diabetes, hypertension, asthma, and chronic obstructive pulmonary disease (COPD), were of particular concern. Patients with mild symptoms were defined as individuals who had any of the various signs and symptoms of COVID-19, such as fever, cough, sore throat, malaise, headache, muscle pain, nausea, vomiting, diarrhea, and loss

of taste and smell, but who did not experience shortness of breath, dyspnea, or abnormal chest imaging (no computed tomography [CT] evidence of pneumonia on admission). These individuals were categorized as mild cases following a positive polymerase chain reaction (PCR) test.

Specialists in physical medicine and rehabilitation, as well as physiotherapists, were quickly involved in the treatment of COVID-19 patients. Their role was focused on acute respiratory rehabilitation, prevention of deep vein thrombosis and pulmonary embolism, early mobilization, and support for postural changes. The purpose of respiratory rehabilitation in patients with COVID-19 is to alleviate symptoms of dyspnea, reduce anxiety, prevent complications, minimize disability, preserve function, and improve quality of life. Respiratory rehabilitation should be tailored to each patient individually.[9]

With a deeper understanding of COVID-19 and the accumulation of clinical experience, as well as the review of literature and evidence, it is still not possible to definitively confirm the effectiveness of acute respiratory rehabilitation in these patients, especially due to the lack of evidence of its effect in the early stages of the disease.[10,11] A review of the literature has shown that early application of respiratory rehabilitation improves gas exchange, reverses pathological progression, and reduces or avoids the need for artificial ventilation.[12,13] Additionally, respiratory rehabilitation can effectively increase the expiratory capacity of the lungs and improve lung function. Kinesitherapy, which involves exercises to preserve and increase the range of motion of the upper and lower extremities (passive, active-assisted, and active), along with respiratory rehabilitation, can reduce dyspnea, improve lung ventilation, and alleviate cough, leading to a better prognosis for patients with COVID-19.[14] The purpose of this study was to determine whether acute respiratory rehabilitation in patients with pneumonia caused by SARS-CoV-2 reduces the length of hospitalization.

MATERIAL AND METHOD

Study design

The present study was a descriptive observational study.

Participants

The study included patients who underwent respiratory rehabilitation following a consultative examination by a specialist in physical medicine and rehabilitation, upon the invitation of an infectious disease specialist. Out of a total of 640 hospitalized patients, 57 patients were evaluated.

Recruitment and data collection

The study was conducted on patients hospitalized at the Infectious Diseases Clinic, Clinical Center of Montenegro in Podgorica, from November 2020 to April 2021, who had a confirmed diagnosis of COVID-19 with unilateral or bilateral pneumonia. All patients signed a written informed consent in this researcher study. The study was approved by the Ethics Committee of the Clinical Center (number 03/01–13101/2). The research was in keeping with the Declaration of Helsinki (1975).

Inclusion criteria: All adult patients over 18 years of age with a confirmed diagnosis of COVID-19, using all types of diagnostic tests; patients with or without comorbidity and or disability; both sex.

Exclusion criteria: Severe form of the disease; cardiac patients with heart rhythm disorders, myocardial ischemia, moderate or severe heart disease (grade III or IV, New York Heart Association); patients with severe ischemic or hemorrhagic stroke or neurodegenerative diseases; psychiatric patients. Baseline descriptive data collection included age, sex, comorbidities, duration of symptoms before hospitalization, date of testing for new SARS-CoV-2 virus, date of hospitalization, on which day of hospitalization did the respiratory rehabilitation protocol included, total time of hospitalization, duration of rehabilitation in days, oxygen therapy or non-invasive ventilation-continuous positive airway pressure (CPAP) were obtained by interview and from medical documentation.

The rehabilitation protocol included: Posture changes (prone, sitting or semi-orthopneic position); pulmonary rehabilitation: (a) Respiratory muscle training, (b) diaphragmatic training, (c) stretching exercise, (d) caught exercise, active secretion removal techniques including chest percussion or assisted cough; motor rehabilitation: (a) mobilization in bed, changing lateral positions, (b) exercises to preserve and increase the range of motion of the upper and lower extremities in bed, passive, active-assisted and active exercises, (c) mobilization program included sitting unsupported, sit to stand, (d) walking with the assistance of a physiotherapist to independent walking. Rehabilitation treatment was always administered under strict monitoring and adjustment of oxygen therapy. The criteria for termination of rehabilitation were: Body temperature above 38 °C; progression of radiological signs, subcutaneous emphysema, pneumomediastinum, etc.; arterial oxygen saturation (SpO_2) <80% or large drop in saturation during mobilization; blood pressure (TA) <90/60 mmHg or >180/90 mmHg, as well as an increase in blood pressure by 20 mmHg during rehabilitation; respiratory rate (RR) >40/min; heart rate <40/min or >120/min, as well as increase in heart rate by 20 beats/min during rehabilitation; occurrence of arrhythmia or myocardial ischemia; altered level of consciousness. During rehabilitation, the following parameters were monitored: (a) Heart rate (HR), (b) blood pressure (BP), (c) oxygen saturation (SpO_2), monitored by pulse oximetry, (d) respiratory rate (RR), (e) modified Borg dyspnea scale, and (f) fatigue level (measured using the visual analog scale [VAS]), both before and after rehabilitation. After ensuring that the patients met the safety criteria, the rehabilitation protocol was initiated, individualized to each patient based on their clinical status.

Rehabilitation sessions were conducted seven days a week, twice per day, for each participant. During all activities, the intensity of the exercises was progressively increased, depending on the individual's tolerance and stability. Descriptive statistical analysis included the following statistical parameters: Arithmetic mean, standard deviation (SD), minimum (min), maximum (max), absolute frequency (N), and percentage (%) structure index. Analytical statistical methods were used to assess the statistical significance of the differences in average values for certain characteristics across all subjects, and within specific groups. Both parametric and non-parametric tests were applied, depending on whether the coefficient of variation (CV) was greater than 30%. The Pearson Chi-square test was used to determine significant improvements in scores from admission to discharge.

Statistical analysis

Descriptive statistical analysis shows the following statistical parameters: arithmetic mean, SD, minimum range (min) and maximal value (max), absolute frequency (N) and structure index (%).

Analytical statistical methodology measured the statistical significance of the mutual differences of the average values of certain characteristics in all subjects and divided into groups. We used parametric tests and nonparametric if CV >30%. Pearson Chi-square test was applied to determine significant improvements in scores from admission to discharge.

Statistical analysis was done using the Excel program from the Microsoft Office software package and the PASW program in version 18.0. As the statistical significance threshold, the estimation error was less than 5% ($p<0.05$).

RESULTS

Fifty-seven patients completed respiratory rehabilitation: 34 men (59.65%) with an average age of 63±8.28 years, and 23 women (40.35%) with an average age of 66.26±11.54 years. The difference in average age was not statistically significant (tab. 1). The duration of symptoms before hospitalization ranged from 2 to 21 days, with a mean of 6.1±3.4 days and a median of five days. Rehabilitation began on average of 7.74±4.76 days after hospitalization (one patient on the first day, three on the second day, and two patients only on day 22). The median value was the seventh day of hospitalization. The length of rehabilitation ranged from 1 to 10 days, with an average of 4.16±2.1 days and a median of 4 days (tab. 2). Half of the patients (28, or 49.12%) had symptoms for up to seven days before hospitalization and started rehabilitation during the first week of hospitalization. The total hospitalization duration ranged from 4 to 20 days, with an average of 11.2±4.34 days and a median of ten days. The duration of rehabilitation (in days) was similar (just over four days) regardless of when rehabilitation started (tab. 3). No statistically significant difference was found in the distribution of rehabilitation duration in relation to the time rehabilitation was initiated ($x^2=10.780$; $p=0.291$). One-fifth of the patients had no comorbidities. Additionally, the number and type of comorbidities in the examined patients were not significantly related to the start of rehabilitation ($x^2=0.04$; $p=0.8495$). Out of the total patient cohort, 13 individuals presented without any comorbid conditions. Arterial hypertension was observed in 18 patients, while 5 patients had a diagnosis of diabetes mellitus. A combination of arterial hypertension and diabetes mellitus was present in 10 patients. Other comorbidities, including various chronic or systemic conditions, were identified in 11 patients (tab. 4). The parameters we monitored (HR, BP, SpO_2, RR, modified Borg dyspnea scale,

Table 1. Average age of examined patients.

	Sex	n	Mean	SD	t test
Age	Male	34	63.00	8.283	t=1.167
	Female	23	66.26	11.537	p=0.251

SD: Standard deviation

Table 2. Rehabilitation and hospitalization parameters.

Descriptive statistics	n	Min Statistic	Max Statistic	Mean Statistic	SD Statistic	Skewness		Kurtosis	
						Statistic	Std error	Statistic	Std error
Start of rehabilitation	57	1	22	7.74	4.757	1.053	0.316	1.072	0.623
Day of rehabilitation	57	1	10	4.16	2.077	1.145	0.316	0.909	0.623
Total hospitalization	57	4	20	11.19	4.336	0.443	0.316	-0.843	0.623
Duration of symptoms before hospitalization	57	2	21	6.09	3.398	2.045	0.316	5.630	0.623
Valid N	57								

SD: Standard deviation

Table 3. Total duration of rehabilitation (in days).

Early rehabilitation		n	Mean	SD	t-test
Day of rehabilitation	1–7 day	32	4.25	1.867	t=0.376
	8+ day	25	4.04	2.354	p>0.05
Start of rehabilitation	1–7 day	32	4.34	1.677	t=10.401
	8+ day	25	12.08	3.763	p<0.0001
Duration of symptoms before hospitalization	1–7 days	32	5.25	2.627	t=2.175
	8+ days	25	7.16	3.986	p<0.05
Total hospitalization	1–7 days	32	8.47	2.449	t=7.631
	8+ days	25	14.68	3.682	p<0.0001

SD: Standard deviation

Table 4. Comorbidities in the examined patients.

Acute respiratory rehabilitation		Early rehabilitation				Total	
		1–7 day		8+ day			
		n	%	n	%	n	%
Comorbidities	NO	7	21.90	6	24.00	13	22.80
	Arterial hypertension	12	37.50	6	24.00	18	31.60
	Arterial hypertension, diabetes mellitus	5	15.60	5	20.00	10	17.50
	Diabetes mellitus	3	9.40	2	8.00	5	8.80
	Other	5	15.60	6	24.00	11	19.30
Total		32	100.00	25	100.00	57	100.00
Chi-squared tests	**Value**			**Sig**			
Pearson Chi-squared	0.04			0.8495			

and fatigue rate) were lower compared to values before the start of rehabilitation, but no statistically significant difference was found.

Longer symptom duration before hospitalization was significantly associated with longer hospitalization (r=0.365, p=0.005) and delayed rehabilitation initiation (r=0.270, p=0.042), but it was not significantly associated with the length of rehabilitation (r=0.122, p=0.366) (tab. 5).

DISCUSSION

The total number of hospitalized patients at the Infectious Disease Clinic from November 2020 to April 2021 was 640, with the average length of hospitalization being about 18 days. This situation represents a significant burden on the national health system and raises public health concerns.

Over the past few decades, various rehabilitation therapies have been employed to facilitate the recovery process of patients with respiratory diseases. In our study, the rehabilitation program was primarily initiated after the viremic period, when the risk of transmission of infection is low. None of the members of our rehabilitation team contracted COVID-19. Our rehabilitation program posed no risk to the team, as appropriate precautions were taken, and it did not worsen the condition of the patients.

In the acute phase, inpatient rehabilitation, including pulmonary rehabilitation, is feasible and can be beneficial for COVID-19 patients, although it is not always possible.[15] Physical exercise, when properly structured and guided or supervised, intervenes in this inflammatory state by promoting the recovery of antioxidant defenses.[16] Respiratory rehabilitation during the acute management of COVID-19 should be considered when feasible. Pulmonary rehabilitation results in moderate to large improvements in health-related quality of life and exercise capacity,[17] using volume strategies such as chest expansion exercises (thoracic expansion exercises, TEE). These exercises focus on inspiration and are characterized by deep and slow breaths, reaching the inspiratory reserve volume, followed by a

Table 5. Correlation between duration of symptoms, duration of hospitalization and duration of rehabilitation.

Correlations		Before hospitalization	Total hospitalization	Day of rehabilitation	Start of rehabilitation
Before hospitalization	Pearson correlation	1	0.365**	0.122	0.270*
	Sig (2-tailed)		0.005	0.366	0.042
	N	57	57	57	57
Total hospitalization	Pearson correlation	0.365**	1	0.294*	0.764**
	Sig (2-tailed)	0.005		0.026	0.000
	N	57	57	57	57
Day of hospitalization	Pearson correlation	0.122	0.294*	1	0.013
	Sig (2-tailed)	0.366	0.026		0.922
	N	57	57	57	57
Start of hospitalization	Pearson correlation	0.270*	0.764**	0.013	1
	Sig (2-tailed)	0.042	0.000	0.922	
	N	57	57	57	57

*Correlation is significant at the 0.05 level (2-tailed)

**Correlation is significant at the 0.01 level (2-tailed)

pause at the end of inspiration and an unforced expiration up to the residual functional capacity.[18] Early mobilization and rehabilitation may help prevent or mitigate sequelae related to bed rest, thus improving physical function and outcomes and reducing the length of stay.[19]

Our study showed that half of the patients (28 or 49.12%) had symptoms for up to one week before hospitalization and began rehabilitation within the first week of hospitalization. The length of rehabilitation ranged from 1 to 10 days, with an average of 4.16±2.1 days and a median of 4 days. Wölfel and colleagues showed that for patients with mild COVID-19 infectious virus could not be detected more than eight days after the onset of symptoms.[20] Bullard et al obtained similar results, but the severity of the disease was not reported.[21] Shedding of infectious virus up to 18 days after the onset of symptoms has been reported for a single case of mild COVID-19.[22] In our study, the median duration of hospitalization was 10 days. In the study by Guan et al the median duration of hospitalization was 12 days,[8] while in the study by Wu et al the median hospital stay was 13 days.[23] The median duration of hospitalization in the study by Thai et al was 21 days.[24] In the United States and several European countries the average hospital stay is shorter, ranging from 7 to 8 days.[25–27] Our study showed that a longer duration of symptoms before hospitalization is significantly associated with a longer hospitalization and delayed onset of rehabilitation, but not with the length of rehabilitation. The percentage of individuals hospitalized increased with age, from 2% to 3% among individuals aged <19 years to ≥31% among adults aged ≥85 years.[24] In a study by Ozden et al it was reported that the available published papers on the rehabilitation of COVID-19 patients are based mainly on expert opinions.

Although the authors emphasize the role of rehabilitation as a critical intervention during the COVID-19 outbreak and suggest models for rehabilitation services in the acute and post-acute stages, data on its effectiveness are lacking.[28] Our study had several limitations. Some cases had incomplete documentation of the exposure history. A major limitation of our study was the small sample size, which makes it difficult to draw definitive conclusions about the influence of acute respiratory rehabilitation on the length of hospitalization in patients with mild to moderate COVID-19 pneumonia. Another limitation is that the study was not a randomized controlled trial. There are no conflicts of interest related to this research.

In conclusion, the results of our study did not clearly demonstrate whether respiratory rehabilitation affects the reduction of hospitalization length. However, the consequences of moderate and severe COVID-19 infection on dependency appear to be primarily related to motor limitations.

ΠΕΡΙΛΗΨΗ

Επηρεάζει η οξεία αναπνευστική αποκατάσταση τη διάρκεια νοσηλείας σε ασθενείς με ήπια έως μέτρια πνευμονία λόγω COVID-19;

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Αρχεία Ελληνικής Ιατρικής 2026, 43(Συμπλ 1):31–37

ΣΚΟΠΟΣ Η εκτίμηση του κατά πόσο η οξεία αναπνευστική αποκατάσταση σε ασθενείς με πνευμονία που προκαλείται από τον SARS-CoV-2 μειώνει τη διάρκεια της νοσηλείας. **ΥΛΙΚΟ-ΜΕΘΟΔΟΣ** Συμμετείχαν 57 ασθενείς (34 άνδρες, 23 γυναίκες) σε πρόγραμμα αναπνευστικής αποκατάστασης. Οι παράμετροι που παρακολουθήθηκαν περιλάμβαναν τη διάρκεια των συμπτωμάτων πριν από τη νοσηλεία, την ημερομηνία της δοκιμασίας SARS-CoV-2, την ημερομηνία νοσηλείας, την ημερομηνία έναρξης της αποκατάστασης, τη διάρκεια νοσηλείας, τη διάρκεια της αποκατάστασης, τη χρήση οξυγονοθεραπείας ή τη συνεχή θετική πίεση αεραγωγών (CPAP), τον καρδιακό ρυθμό, την αρτηριακή πίεση, τον κορεσμό οξυγόνου, τη συχνότητα αναπνοής, την κλίμακα δύσπνοιας Borg και τα επίπεδα κόπωσης πριν και μετά την αποκατάσταση. **ΑΠΟΤΕΛΕΣΜΑΤΑ** Τα συμπτώματα πριν από τη νοσηλεία διήρκεσαν 2–21 ημέρες (μέσος όρος: 6,1±3,4 ημέρες). Η αποκατάσταση άρχισε κατά μέσον όρο 7,74±4,76 ημέρες μετά τη νοσηλεία. Η διάρκεια της αποκατάστασης κυμάνθηκε από 1–10 ημέρες (μέσος όρος: 4,16±2,1 ημέρες, διάμεσος: 4 ημέρες). Η συνολική διάρκεια νοσηλείας κυμάνθηκε από 4–20 ημέρες. Η στατιστική ανάλυση έδειξε ότι η μεγαλύτερη διάρκεια των συμπτωμάτων πριν από τη νοσηλεία σχετιζόταν σημαντικά με μεγαλύτερη διάρκεια νοσηλείας και καθυστέρηση στην έναρξη της αποκατάστασης, αλλά δεν συσχετίστηκε με τη συνολική διάρκεια της αποκατάστασης. Οι μισοί ασθενείς, 28 (49,12%), παρουσίασαν συμπτώματα έως και μία εβδομάδα πριν από τη νοσηλεία και άρχισαν την αποκατάσταση εντός της πρώτης εβδομάδας παραμονής τους στο νοσοκομείο. **ΣΥΜΠΕΡΑΣΜΑΤΑ** Η μελέτη δεν παρείχε σαφή αποδεικτικά στοιχεία ότι η οξεία αναπνευστική αποκατάσταση μειώνει άμεσα τη διάρκεια της νοσηλείας σε ασθενείς με πνευμονία λόγω SARS-CoV-2. Αν και η καθυστερημένη έναρξη της αποκατάστασης συνδέθηκε με μεγαλύτερη διάρκεια νοσηλείας, δεν βρέθηκε άμεση επίδραση στη συνολική διάρκεια της νοσηλείας. Απαιτούνται περαιτέρω μελέτες για να προσδιοριστεί οριστικά η σχέση μεταξύ αναπνευστικής αποκατάστασης και αποτελεσμάτων νοσηλείας σε ασθενείς με COVID-19. Η εν λόγω μελέτη υπογραμμίζει την πολυπλοκότητα της ανάρρωσης από την πνευμονία λόγω COVID-19 και την ανάγκη για πιο στοχευμένη έρευνα στον τομέα της αναπνευστικής αποκατάστασης για τους συγκεκριμένους ασθενείς.

Λέξεις ευρετηρίου: Αναπνευστική αποκατάσταση, Διάρκεια νοσηλείας, COVID-19, Πνευμονία

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