

Received: 25 May 2024 / Accepted: 14 August 2024 / Published online: 30 August 2024

DOI 10.34689/SH.2024.26.4.019

UDC 616.98:578.834.1:364.048.6(1-87)



## REHABILITATION AFTER COVID-19: THE EXPERIENCE OF FOREIGN COUNTRIES. REVIEW.

**Aiyam B. Bekezhanova**<sup>1</sup>, <http://orcid.org/0000-0002-0140-4897>

**Gulnara M. Shalgumbayeva**<sup>1</sup>, <http://orcid.org/0000-0003-3310-4490>

**Gaukhar K. Amantayeva**<sup>1</sup>, <https://orcid.org/0000-0002-8422-7936>

**Arailym Baurzhan**<sup>1</sup>, <http://orcid.org/0000-0003-0279-6607>

**Bagym S. Jobalayeva**<sup>1</sup>, <https://orcid.org/0000-0002-2145-2263>

**Zhanar M. Zhumanbayeva**<sup>1</sup>, <http://orcid.org/0000-0001-8941-862X>

**Altynay M. Dosbayeva**<sup>1</sup>, <https://orcid.org/0000-0002-0554-2680>

**Alua M. Sharapiyeva**<sup>1</sup>, <http://orcid.org/0000-0001-7325-398X>

<sup>1</sup> NCJSC «Semey medical university», Semey, Republic of Kazakhstan.

### Summary

**Background:** Rehabilitation involves collaboration across various disciplines and is pivotal in reintegrating patients with COVID-19, particularly focusing on their respiratory and motor systems. It plays a critical role in the care of COVID-19 patients, underscoring the necessity of devising treatment strategies to facilitate their optimal recovery. In the face of this socio-medical problem, rehabilitation teams are of particular importance. A month after discharge from the intensive care unit, patients with COVID-19 had severely limited functionality. Even 6-12 months after discharge, a significant proportion of infected patients have symptoms such as fatigue, muscle weakness, sleep disorders, anxiety and depression. Symptoms of COVID-19 can persist for several months and cause a syndrome called persistent COVID (or prolonged COVID), which have adverse effects on the health of patients - from cardiac, neurological and respiratory problems to skin and gastrointestinal symptoms.

**Objective.** To analyze the literature data on rehabilitation measures after a coronavirus infection.

**Search strategy.** A literature review was conducted on PubMed, Google Scholar and Cochrane databases. The study employed "Rehabilitation", "respiratory rehabilitation" or "lung rehabilitation" in combination with mesh terms and free-text terms such as "COVID-19", "Severe Acute Respiratory syndrome Coronavirus 2", "2019-n CoV" or "SARS-CoV-2". A total of 240 publications were identified on this subject. Out of these, 60 publications aligned with the objectives of our study.

**Results and conclusions.** Various studies have investigated the impact of the pandemic on rehabilitation services and made recommendations for the reconstruction of these services. In addition, other studies have focused on the aftermath of COVID-19 and made recommendations for rehabilitation interventions. A comprehensive rehabilitation process is recommended for COVID-19 patients. Multidisciplinary groups need to provide patient support in various disciplines such as neuromuscular, cardiac, respiratory and psychological fields. Rehabilitation specialists should apply targeted therapy after evaluating the patient's condition and thoroughly evaluating the clinical situation.

**Keywords:** *rehabilitation, COVID-19, recommendations.*

### Резюме

## РЕАБИЛИТАЦИЯ ПОСЛЕ COVID-19: ОПЫТ ЗАРУБЕЖНЫХ СТРАН. ОБЗОР ЛИТЕРАТУРЫ.

**Айым Б. Бекежанова**<sup>1</sup>, <http://orcid.org/0000-0002-0140-4897>

**Гульнара М. Шалгумбаева**<sup>1</sup>, <http://orcid.org/0000-0003-3310-4490>

**Гаухар К. Амантаева**<sup>1</sup>, <https://orcid.org/0000-0002-8422-7936>

**Арайлым Бауржан**<sup>1</sup>, <http://orcid.org/0000-0003-0279-6607>

**Багым С. Джобалаева**<sup>1</sup>, <https://orcid.org/0000-0002-2145-2263>

**Жанар М. Жуманбаева**<sup>1</sup>, <http://orcid.org/0000-0001-8941-862X>

**Алтынай М. Досбаева**<sup>1</sup>, <https://orcid.org/0000-0002-0554-2680>

**Алуа М. Шарapieва**<sup>1</sup>, <http://orcid.org/0000-0001-7325-398X>

<sup>1</sup> НАО «Медицинский университет Семей», г. Семей, Республика Казахстан.

**Введение:** Реабилитация предполагает сотрудничество представителей различных дисциплин и играет ключевую роль в реинтеграции пациентов с COVID-19, уделяя особое внимание их дыхательной и двигательной системам. Это играет решающую роль в уходе за пациентами с COVID-19, подчеркивая необходимость разработки

стратегий лечения, способствующих их оптимальному выздоровлению. Перед лицом этой социально-медицинской проблемы реабилитационные бригады имеют особое значение. Через месяц после выписки из отделения интенсивной терапии у пациентов с COVID-19 были сильно ограничены функциональные возможности. Даже через 6-12 месяцев после выписки у значительной части инфицированных пациентов наблюдаются такие симптомы, как усталость, мышечная слабость, нарушения сна, тревога и депрессия. Симптомы COVID-19 могут сохраняться в течение нескольких месяцев и вызывать синдром, называемый персистирующим COVID (или пролонгированным COVID), который оказывает неблагоприятное воздействие на здоровье пациентов - от сердечных, неврологических и респираторных проблем до кожных и желудочно-кишечных симптомов.

**Цель.** Проанализировать данные литературы о реабилитационных мероприятиях после коронавирусной инфекции.

**Стратегия поиска.** Был проведен обзор литературы в базах данных PubMed, Google Scholar и Cochrane. В исследовании использовались слова "реабилитация", "респираторная реабилитация" или "реабилитация легких" в сочетании с сетчатыми терминами и терминами свободного текста, такими как "COVID-19", "Severe Acute Respiratory syndrome Coronavirus 2", "2019-nCoV" или "SARS-CoV-2". Всего было выявлено 240 публикаций по данной теме. Из них 60 публикация соответствовала целям нашего исследования.

**Результаты и выводы.** В нескольких исследованиях изучались последствия пандемии для реабилитационных служб и содержались предложения по реструктуризации этих служб. Кроме того, другие исследования были сосредоточены на последствиях COVID-19 и предлагали рекомендации по реабилитационным мероприятиям. Рекомендуется комплексный процесс реабилитации пациентов с COVID-19. Мультидисциплинарные группы должны предлагать пациентам помощь в различных областях, таких как нервно-мышечная, сердечная, респираторная и психологическая. Специалисты по реабилитации должны оценить состояние пациента и назначить целенаправленное лечение после тщательной оценки его клинического статуса.

**Ключевые слова:** реабилитация, COVID-19, рекомендации.

Түйіндеме

## COVID-19-ДАН КЕЙІНГІ ОҢАЛТУ: ШЕТ ЕЛДЕРДІҢ ТӘЖІРИБЕСІ. ӘДЕБИЕТТІК ШОЛУ.

**Айым Б. Бекежанова**<sup>1</sup>, <http://orcid.org/0000-0002-0140-4897>

**Гульнара М. Шалгумбаева**<sup>1</sup>, <http://orcid.org/0000-0003-3310-4490>

**Гаухар К. Амантаева**<sup>1</sup>, <https://orcid.org/0000-0002-8422-7936>

**Арайлым Бауржан**<sup>1</sup>, <http://orcid.org/0000-0003-0279-6607>

**Бағым С. Джобалаева**<sup>1</sup>, <https://orcid.org/0000-0002-2145-2263>

**Жанар М. Жуманбаева**<sup>1</sup>, <http://orcid.org/0000-0001-8941-862X>

**Алтынай М. Досбаева**<sup>1</sup>, <https://orcid.org/0000-0002-0554-2680>

**Алуа М. Шарapieва**<sup>1</sup>, <http://orcid.org/0000-0001-7325-398X>

<sup>1</sup> КеАҚ «Семей Медицина Университеті», Семей қ., Қазақстан Республикасы.

**Кіріспе:** Оңалту әртүрлі пәндер бойынша ынтымақтастықты қамтиды және COVID-19 пациенттерін реинтеграциялауда, әсіресе олардың тыныс алу және қозғалыс жүйелеріне ерекше назар аударуда шешуші рөл атқарады. Бұл COVID-19 пациенттеріне күтім жасауда шешуші рөл атқарады, бұл олардың оңтайлы қалпына келуін жеңілдету үшін емдеу стратегияларын әзірлеу қажеттілігін көрсетеді. Осы әлеуметтік-медициналық проблема жағдайында оңалту топтарының маңызы ерекше. Реанимация бөлімінен шыққаннан кейін бір айдан кейін COVID-19 пациенттерінің функционалдығы айтарлықтай шектеулі болды. Шығарылғаннан кейін 6-12 айдан кейін де жұқтырған науқастардың едәуір бөлігінде шаршау, бұлшықет әлсіздігі, ұйқының бұзылуы, мазасыздық және депрессия сияқты белгілер байқалады. COVID-19 белгілері бірнеше айға созылуы мүмкін және пациенттердің денсаулығына теріс әсер ететін тұрақты COVID (немесе ұзаққа созылған COVID) деп аталатын синдромды тудыруы мүмкін - жүрек, неврологиялық және тыныс алу проблемаларынан тері мен асқазан-ішек жолдарының белгілеріне дейін.

**Мақсаты.** Коронавирустық инфекциядан кейінгі оңалту шаралары туралы әдебиеттерге талдау жасау.

**Іздеу стратегиясы.** PubMed, Google Scholar және Cochrane дерекқорларында әдебиеттерге шолу жасалды. Зерттеуге "covid-19", "ауыр жедел респираторлық синдром коронавирусы 2", "2019-nCoV" немесе "SARS-CoV-2" сияқты Торлы терминдер мен тегін мәтіндік терминдер, сондай-ақ "оңалту", "тыныс алуды қалпына келтіру" немесе "өкпені қалпына келтіру" қолданылды. Осы тақырып бойынша барлығы 240 жарияланым анықталды. Оның ішінде 60 басылым біздің зерттеуіміздің мақсаттарына сәйкес келді.

**Нәтижелер мен қорытындылар.** Бірнеше зерттеулер пандемияның оңалту қызметтеріне әсерін зерттеді және осы қызметтерді қайта құрылымдау бойынша ұсыныстар берді. Сонымен қатар, басқа зерттеулер COVID-19 әсеріне назар аударды және оңалту шаралары бойынша ұсыныстар берді. COVID-19 пациенттерін оңалтудың кешенді процесі ұсынылады. Пәнаралық топтар пациенттерге жүйке-бұлшықет, жүрек, тыныс алу және психологиялық салалар сияқты әртүрлі салаларда көмек көрсетуі керек. Оңалту мамандары пациенттің жағдайын бағалап, олардың клиникалық жағдайын мұқият бағалағаннан кейін мақсатты емдеуді жүзеге асыруы керек.

**Түйінді сөздер:** оңалту, COVID-19, ұсыныстар.

**For citation / Для цитирования / Дәйексөз үшін:**

Bekezhanova A.B., Shalgumbayeva G.M., Amanbayeva G.K., Baurzhan A., Jobalayeva B.S., Zhumanbayeva Zh.M., Dosbayeva A.M., Sharapiyeva A.M. Rehabilitation after Covid-19: the experience of foreign countries. Review // *Nauka i Zdravookhranenie* [Science & Healthcare]. 2024. Vol.26 (4), pp. 152-161. doi 10.34689/SH.2024.26.4.019

Бекежанова А.Б., Шалгумбаева Г.М., Аманбаева Г.К., Бауржан А., Джобалаева Б.С., Жуманбаева Ж.М., Досбаева А.М., Шарapieва А.М. Реабилитация после Covid-19: опыт зарубежных стран. Обзор литературы // *Наука и Здравоохранение*. 2024. Т.26 (4). С. 152-161. doi 10.34689/SH.2024.26.4.019

Бекежанова А.Б., Шалгумбаева Г.М., Аманбаева Г.К., Бауржан А., Джобалаева Б.С., Жуманбаева Ж.М., Досбаева А.М., Шарapieва А.М. Covid-19-дан кейінгі оңалту: шет елдердің тәжірибесі. Әдебиеттік шолу // *Ғылым және Денсаулық сақтау*. 2024. Т.26 (4). Б. 152-161. doi 10.34689/SH.2024.26.4.019

**Introduction**

The end of December 2019 marked a new coronavirus infection in global health history, which was first identified in the Chinese city of Wuhan. And three months later, the World Health Organization officially declared the infection a pandemic and an emergency [46].

This highly contagious infection is caused by a virus called sars-CoV-2, which is mainly in direct contact with airborne droplets from both symptomatic and asymptomatic individuals. The incubation period of this infection usually occurs within 3 to 7 days, with symptoms ranging from 1 to 14 days [23], [35], [19]. COVID-19 infections commonly result in respiratory tract damage and can progress to interstitial pneumonia, with symptoms varying from mild to severe, including fever, dry cough, and loss of smell, sore throat, fatigue, headache, muscle pain, and shortness of breath. Diagnosis relies on detecting viral nucleic acids through real-time polymerase chain reaction testing of respiratory samples [9], [43], [16].

A patient's ability to return to work or exercise should be evaluated individually and will vary depending on the initial functional status before covid-19, the severity of the disease and acute COVID complications, and the intensity of planned activity. Appropriate job adjustment may be required to help the employee return. In people without significant fatigue or post-exercise discomfort, it is typical to gradually resume this type of physical activity as acceptable, starting at a low intensity level and gradually increasing the activity over the coming weeks. In general, patients who plan to return to intense activity or physically demanding professions after myocarditis should first be evaluated by a cardiologist. More details about the return to sports or intensive activity after COVID-19 can be found separately. COVID-19 infection can only be diagnosed by detecting nucleic acids using real-time polymerase chain reaction in samples from the respiratory tract [26].

In treating this infection, doctors focus on eliminating symptoms such as fever and respiratory problems. Patients who need to enrich their lungs with oxygen are ventilated. Elderly and comorbid patients are at higher risk of complications such as acute renal failure, arrhythmia, and organ dysfunction. Prolonged bed rest can lead to immobilization syndromes, characterized by muscle weakness, reduced mobility, balance issues, joint dysfunction, and pain. The post-intensive care syndrome significantly impacts patients' overall health, encompassing physical, cognitive, and mental health challenges that persist beyond their intensive care unit stay [47], [49]. The rest of the extended bed can cause the onset of stationary syndrome, which impairs respiratory function. Prolonged immobilization can significantly affect the patient's overall condition, including November muscle weakness, decreased mobility, balance problems, impaired posture and joint function, pain and mobility restriction [3].

The effect of intensive care has a significant impact on the patient's overall health. Intensive Care outcome syndrome occurs during a patient's stay in the intensive care unit and is a newly developed or aggravated condition that persists on or after discharge [5].

**Objective.** To analyze the literature data on rehabilitation measures after coronavirus infection.

**Search strategy.** A literature review was conducted on PubMed, Google Scholar and Cochrane databases. The study employed "Rehabilitation", "respiratory rehabilitation" or "lung rehabilitation" in combination with mesh terms and free-text terms such as "COVID-19", "Severe Acute Respiratory syndrome Coronavirus 2", "2019-n CoV" or "SARS-CoV-2". A total of 240 publications were identified on this subject. Out of these, 60 publications aligned with the objectives of our study. The algorithm for selecting a publication for analysis is shown in Figure 1.

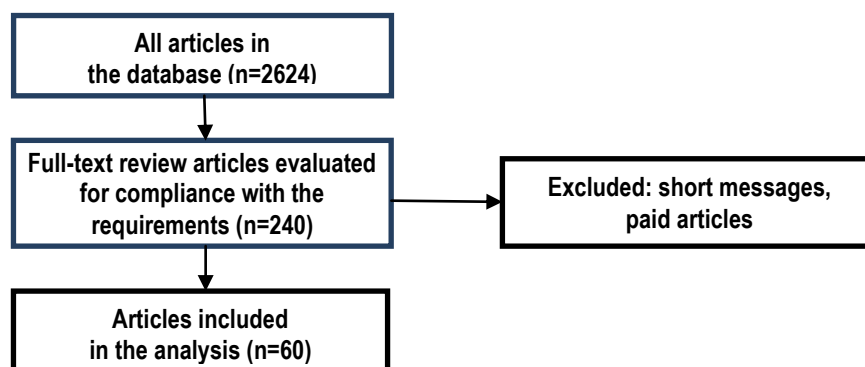


Fig.1. The algorithm for selecting a publication for analysis.

**Search results and their discussion.**

Coronavirus infection is a respiratory disease caused by a coronavirus. In January 2020, a new type of coronavirus was identified in China, officially named SARS-CoV-2, which causes COVID-19 disease. It spreads through the airborne droplet pathway, and can also be transmitted by contact with contaminated surfaces. Coronavirus symptoms encompass fever (88.7%), cough (57.6%), breathing difficulties (45.6%), fatigue, and more. However, in a notable proportion of individuals aged 65 and above with underlying conditions like hypertension and diabetes, the infection can lead to severe outcomes. Among hospitalized patients, a significant portion (20.3%) require intensive care, where they frequently encounter multiple organ failure stemming [5].

Isolation proves effective in curbing the spread of the highly contagious SARS-CoV-2. Many patients suffer from fever, fatigue, and muscle aches, often necessitating prolonged bed rest. This prolonged immobility results in reduced muscle strength, hindering effective sputum clearance and substantially elevating the risk of deep vein thrombosis. Patients in intensive care units may experience a range of complications due to prolonged immobility and extended periods of lying down [21], [11], [22]. These problems include neuromuscular problems, marked muscle weakness and fatigue, restricted movement, swallowing difficulties, psychological distress, decreased mobility, significantly reduced quality of life, frequent falls, and possibly impaired motor function of both limbs [39], [4]. Also, mental health problems in patients, particularly depression, affect about 29% of patients and often persist after ICU discharge; prolonged ICU stay increases the risks of physical, cognitive and emotional impairment. The closure of day care facilities and enforced home isolation further exacerbate the well-being of vulnerable patients, leading to feelings of physical discomfort, fear, loneliness, and depression, which can result in treatment refusal or the onset of additional psychological issues [8]. The necessary interventions for patients diagnosed with coronavirus infection are to remove the barriers leading to respiratory problems, reduce the risks that can lead to disability, maximize patient relief, and prevent further complications. Currently, there is insufficient conclusive evidence regarding the effectiveness of customized rehabilitation programs for COVID-19 patients. Clinical Evaluation - Persistent shortness of breath (at rest and exertion), cough, chest discomfort, pleuritic pain and wheezing, orthopedic breathing, chest pain (exercise, position), peripheral edema, palpitations, dizziness, orthostasis and fainting or fainting for patients with persistent cardiopulmonary symptoms or complications during the disease. We usually use the modified Borg dyspnea scale to assess the symptoms of general dyspnea [14]. Face-to-face, check vital signs, pay special attention to blood pressure to look for new-onset hypertension [1] and pay attention to Spo<sub>2</sub> to look for hypoxemia. Apply postural blood pressure in orthostatic, pre-fainting or fainting patients (up to 10 minutes after standing up) and check the pulse rate [13].

Cardiopulmonary examination - Patients with cardiopulmonary symptoms or signs who have passed more than 4 weeks since acute illness are usually examined according to medical history and physical examination.

Such tests may include chest imaging, electrocardiography (ECG), and evaluation of motor skills and oxygenation. Additional tests such as echocardiography, weightlifting monitoring and lung function test (P Oct) may also be required for selected patients [36,49].

Especially if cardiopulmonary symptoms cannot be explained after regular examination (e.g. Pulmonary hypertension, deconstruction) early referral to a pulmonologist and / or cardiologist is recommended. [24]. Cured patients with negative PCR results are encouraged to undergo respiratory rehabilitation tailored to their specific clinical condition. The importance of personalized respiratory rehabilitation measures is underscored, particularly for individuals with concurrent conditions, advanced age, obesity, and multiple complications. Rehabilitation teams are urged to address the unique challenges faced by patients to formulate customized programs [20]. The entirety of the respiratory rehabilitation process should employ diverse techniques [28]. Amidst a pandemic exerting substantial strain on global healthcare systems, encompassing emergency departments, intensive care units, laboratories, and imaging facilities, a balance between stringent standards and professional pragmatism becomes imperative. Early discharge of patients might become necessary to alleviate hospital bed shortages, thereby prompting the adjustment of traditional rehabilitation protocols [27].

In this context, it appears prudent to tailor rehabilitation programs for discharged patients, with particular consideration for those with comorbidities, individuals living alone, or residing in rural areas. Patients discharged following COVID-19 infection may encounter physical and respiratory discomfort, along with muscle fatigue affecting both respiratory and core muscles, as well as psychological conditions like post-traumatic stress disorder [60]. According to the results of the study, it is recommended to refer patients to rehabilitation to restore physical fitness and reduce anxiety and depression in patients with mild lung dysfunction. Respiratory rehabilitation is recommended for patients who have undergone a severe phase, but have signs of pulmonary dysfunction [39]. Data from the first RCT evaluating coronavirus infection have been published. A cohort of elderly participants engaged in a respiratory rehabilitation program, including respiratory muscle training, cough exercises, diaphragmatic exercises, stretching and home exercises, which patients did for six weeks for ten minutes each, showed significant improvements in respiratory function, quality of life and decreased anxiety levels [25]. Given the multifaceted nature of coronavirus-associated pneumonia, it is imperative that physicians and paramedical staff adhere to the highest standards of clinical care. Post-acute care facilities face significant challenges with the increasing flow of patients with varying degrees of disability. Facilitating information sharing requires transparent communication between rehabilitation centers, allowing centers without home-based programs to quickly adopt successful practices implemented in other countries [33]. According to *Huang S. et al.* telemedicine plays a key role in sharing experiences between doctors in different countries. It provides an opportunity to connect patients and physicians while limiting physical contact. There is little data available, but the initial results are encouraging [18].

Today, attention is being paid to the management of seriously ill patients in emergency medical institutions. Less attention has been paid to the ability of the postoperative healthcare system to treat many patients, that is, when patients are transferred from hospitals to nursing homes or return home. Therefore, rehabilitation that gradually returns to a normal life should focus on screening programs [29]. It is necessary to create the necessary conditions for screening activities. A general practitioner or a specialist within a multidisciplinary team. The choice of screening methods (including telemedicine and other e-health applications) depends on available resources, the local health infrastructure and the availability of further rehabilitation interventions. Many COVID-19 patients require restorative care on an outpatient basis and at home, and the restorative healthcare sector may make it difficult for patients to be hospitalized. The reconstruction of the hospital with a reduction in the number of rehabilitation services may lead to an increase in waiting lists and the need to go to a private clinic. The reuse of clinics, sports facilities and gyms to create temporary postoperative facilities, when necessary, will create free space for individual physical activity [39],[59].

Patients seeking admission to rehabilitation centers must undergo testing for coronavirus infection prior to admission. Inpatient treatment and rehabilitation necessitate continuous monitoring of clinical status and symptoms, along with isolating infected patients in designated treatment areas staffed with appropriate personnel equipped with personal protective equipment (PPE). Adherence to strict protocols regarding PPE usage and infection control is paramount. Furthermore, medical teams directly interacting with patients are segmented into subgroups, ensuring that if one member of a subgroup is unable to work, another qualified individual can fulfill their duties. Interactions between members of different subgroups should be minimized to mitigate the risk of infection [10].

*P. Boldrini and colleagues* discuss the guidelines provided by the Italian Society for Rehabilitation (SINFER) regarding the rehabilitation sector. It recommends that patients receiving emergency care should have a rehabilitation plan and subsequent clinical strategy to ensure clinical stability and prevent complications. When inpatient treatment is necessary, rehabilitation activities should be started from the emergency room according to the needs of each patient in order to facilitate the patient's early recovery. Resistance/strength training has the potential to improve November muscle mass and strength more than endurance training. During resistance / strength training, individual November muscle groups are trained by repeatedly lifting weights selected according to the individual's capacity. The optimal approach to resistance training in pulmonary rehabilitation has not been determined, but preliminary evidence suggests that endurance training provides additional benefits A potential advantage is that resistance training results in lower oxygen consumption and fine ventilation, and induces less shortness of breath, which may be advantageous for patients with October lower tolerance to endurance training. Italy has also launched a free telerehabilitation support service to provide safe assistance to patients, their families

and caregivers. Researcher *P. Pedersini et al.* They emphasize the importance of rehabilitation efforts, showing the example of Italy during the coronavirus pandemic [32], while *S. Negrini et al.* they highlight a large burden on rehabilitation measures due to the high incidence in Italy, and also points to differences and inequalities in this area in its different regions [29]. In order to support rehabilitologists, this organization publishes the latest documents and organizes webinars called Covinars. With this project, in order to support rehabilitation specialists, Light training can provide additional benefits for endurance training. Oct. For example, one report evaluated 14 COPD patients enrolled in a home program [23]. Patients were randomly assigned to daily walks while carrying a light backpack (control) or additional dumbbells (wrist and arm bends, partial leg squats, calf Octobers, supine dumbbell press). [23] After training, the weightlifters had reduced their minute ventilation and increased their ergonomic endurance by 16 percent compared to the controls. Lung rehabilitation can improve symptoms, quality of life, lung function, healthcare utilization, and improve the survival of patients with chronic respiratory diseases. Most of the evidence supporting the benefits of lung rehabilitation comes from studies of patients with chronic obstructive pulmonary disease (COPD). However, the results obtained in patients with respiratory diseases other than COPD provide evidence that benefits from lung rehabilitation are also observed in symptomatic patients with other respiratory diseases. The indications, goals, components of pulmonary rehabilitation and potential benefits for patients with chronic lung disease are reviewed here [1]. Smoking cessation, oxygen therapy, bronchodilators, antibiotics, nutritional supplements, respiratory November muscle training and other treatments such as rest and cardiac rehabilitation were discussed separately [30], [58].

A group of researchers, *I. Tregger et al.*, note that in Israel, a significant number of rehabilitation services have been suspended due to the need for beds for patients with coronavirus infection, primarily driven by infection concerns. For individuals in home quarantine, they suggest adopting a strategy that focuses on safeguarding healthcare workers from infection to ensure they can deliver optimal rehabilitation care to those with limited mobility due to quarantine. To reduce the likelihood of psychophysical complications, they propose implementing moderate-intensity multicomponent rehabilitation interventions for 5-7 days per week, preferably utilizing remote methods for patients for whom this approach is suitable. *F. Agostini et al.* suggested implementing safety protocols for both patients and staff. *I. Balkaya et al.*, recounting their transition of patients from the rehabilitation department to the medical department, share a positive experience facilitated by close collaboration with internal medicine physicians and other departments, as well as adherence to a comprehensive transfer protocol [42]. *A. Gitkind et al.* concentrate on identifying secure methods to attend, along with emphasizing the significance of collaborating with other emergency departments to uphold the pivotal role of rehabilitation during a pandemic. They also highlight the effectiveness of comprehending a patient's physiotherapy regimen, which it includes a if it is used to help patients who do not require rehabilitation [15]. *H. Stam et al.* underscore

the importance of promptly preparing for the repercussions of the pandemic by engaging a diverse team to deliver comprehensive rehabilitation worldwide. Wainwright et al. additionally advocate for patients have the authority to autonomously manage various medical, lifestyle or emotional aspects of their condition and are directed (using technology) to develop long-term rehabilitation programs [45], [55].

Most lung rehabilitation programs receive pre- and post-bronchodilator preparation spirometry, carbon monoxide diffusion capacity and motor skill tests. These tests are used to allow for the appropriate exercise formulation of the program and to provide a basis for post-program comparisons. In order for physical education to be successful, the exercise program must be adapted to the individual, since the patient must overcome the physical load that is already encountered in daily life [44]. Furthermore, cardiac rehabilitation centers need to develop plans to manage cardiovascular complications in and can adjust rehabilitation modalities due to virus-related cardiovascular issues, even in the face of uncertainty regarding medium- and long-term outcomes. They recommend the adoption of new maintain a model of cardiac rehabilitation support and continuous remote locations, especially in a wide variety of contexts pandemic [12]. After the suspension of centralized cardiac rehabilitation amid the pandemic, Babu and co-authors suggested technological cardiac rehabilitation as a feasible alternative model for providing such services to individuals with cardiovascular ailments [1]. Thomas et al. and Yeo et al. similarly support this innovative approach, contending that the integration of technology into cardiac rehabilitation programs could substantially improve them, not just but also in its aftermath [40], [50].

S. Negrini et al. reported on their experience with telerehabilitation, which received and highlighted the positive outcomes achieved with telerehabilitation; H. Shanthanna et al. reviewed the management of patients with chronic pain and highlighted the importance of elective surgical procedures through telemedicine and emphasize the importance of maintaining and providing continuous medical and psychosocial support. After the initial assessment, patients with cardiopulmonary symptoms, patients with a complicated course due to venous thromboembolism and heart disease, and patients hospitalized with acute COVID-19 are usually subjected to a 6-minute walk test. Although it is not designed as an oxygen titration test, it is a good indicator of physical and respiratory function and can identify any oxygenation problems that help explain the patient's shortness of breath. Measurements of oxygen concentration at night are typically performed unless the patient is symptomatic during sleep (e.g. It is performed if recurrent wakefulness, chest pain, shortness of breath) or if no underlying serious heart or lung disease is suspected [31].

McNeary suggests should engage in rehabilitation, conducted in a secure setting that safeguards both staff and patients, to address resulting complications such as prolonged immobilization-associated issues (e.g., posterior reversible encephalopathy syndrome, neuromuscular disorders, plantar flexor contractures, and wounds). For most patients, arterial blood gas (ABG) is not normally

guaranteed. However, in patients with acute hypercapnia requiring non-invasive ventilation (NIV) during acute illness, ABG will take into account low Spo2 to detect abg and potential hypoxemia in patients with unexplained symptoms, as well as further management, especially in patients requiring continuous NIV [24].

Many COVID-19 need rehabilitation services, including physical and occupational therapy, pulmonary or cardiac rehabilitation, speech therapy and swallowing therapy. If rehabilitation services are indicated, it makes sense to refer the patient within 30 days of recovery from the initial infection. Cardiopulmonary exercise test (CPET) is usually not required unless dyspnea is explained; CPET is used to determine the etiology of symptoms and also to determine the pathogenesis of pulmonary or physical rehabilitation [48],[54].

They outline C. Zheng's exercise regime, which incorporates "aerial cycling," squats, and bridge exercises. "Aerial cycling" involves lying on the back and bending the knees to simulate cycling movements, while the "bridge" exercise involves raising the hips off the bed. Squats are executed by transitioning from a lying position to sitting upright. Respiratory rehabilitation for patients experiencing breathing difficulties comprises respiratory muscle training and expectoration sessions twice a week [38].

It is advised to continuously monitor the patient's clinical status throughout the rehabilitation process and promptly discontinue it if any Side effects happen to ensure the safety of both staff and patients. Isolated individuals are encouraged to use video recording and remote consultations to conserve personal protective equipment (PPE) and reduce the risk of cross-infection. Depending on the patient's condition, rehabilitation can continue after the isolation period [36].

Chinese guidelines recommend different individual programs depending on the type of disease. Patients with mild symptoms are advised to exercise with low intensity. Prolonged immobilization may lead to weakness and inadequate sputum clearance, for which airway clearance techniques and physical exercises are recommended. Severe cases should receive prompt treatment, including early mobilization, posture correction, and breathing exercises, with activities adjusted based on the patient's strength and cognitive status [17]. Respiratory management primarily focuses on lung expansion and controlling sputum production, while being mindful to avoid triggering severe coughing or heightened respiratory effort. The selection of therapeutic interventions should align with the patient's level of consciousness and functional status. Breathing exercises are not recommended for patients in critical or serious condition. Following discharge, rehabilitation for patients with a mild illness or without COVID aims primarily to restore physical function and aid psychological adjustment. This typically involves incorporating gradual aerobic exercises to regain motor abilities and facilitate social reintegration [51].

After discharge, respiratory encompasses a range of exercises, including aerobic, balance, resistance, and respiratory training. Although fatigue and Decadent functional conditions improve in most patients, they can be profound and last for 1, 3 months or longer, especially among hospitalized people and intensive care unit survivors

with common and uncomfortable symptoms. Fatigue and decreased endurance can be directly related to physical weakness caused by the virus, but this problem is usually multifactorial with other factors, such as lack of nutrient intake, musculoskeletal pain and myalgia, insomnia November and many psychological symptoms of COVID-19. Patients prone to fatigue should engage in intermittent physical activity. Breathing exercises aim to enhance respiratory function and address sputum production, incorporating methods such as breath control, regulation of respiratory rhythm, chest mobility exercises and respiratory November training. The Chinese guidelines emphasize the importance of using the assessment scale and evaluating daily life activities to tailor rehabilitation programs accordingly [34], [56].

Q. Li *et al.* stress the crucial role of rehabilitation in enhancing reinstating independence in daily activities throughout the COVID-19. They underscore the significant advantages of initiating rehabilitation early, including reduced hospital stays, complication prevention, and enhanced functional capacity and clinical outcomes. Telerehabilitation is hailed as a pioneering approach in modern healthcare. Similarly, M. Ceravolo *et al.* advocate for early rehabilitation patients under the supervision of a multidisciplinary team, adhering to basic preventive measures [6].

S. Bajwah and colleagues highlight the importance of addressing symptoms and psychological aspects in severe COVID-19 cases through a combination of pharmacological and non-pharmacological methods, such as respiratory techniques aimed at alleviating breathlessness. Borg and Stam emphasize the necessity of rehabilitation for non-COVID infected patients and the long-term involvement of rehabilitation specialists due to potential complications like cardiovascular, and neurological issues [2], [57].

J. Chaler *et al.* highlight the significance of rehabilitation response plan, we advocate emergency rehabilitation with multidisciplinary teams in intensive care units. C. Kiekens *et al.* stress the need for individual rehabilitation interventions in the post-acute phase, particularly for severe cases [7,21].

The results are usually good, and most symptoms improve over time. However, there is a wide variability in the time it takes for symptoms to resolve, and a small proportion of patients have persistent symptoms for more than 1 year. Inpatients are at long-term symptoms, such as elderly patients, patients with existing comorbidities, and complications [37], [40], [41].

#### Conclusion.

The growing number of COVID-19 infections worldwide and the respiratory and neuromuscular effects it can cause justify the need for a comprehensive rehabilitation process. It should be begin early in the inpatient setting, focusing on those patients who have completed two intensive care units, and continue and progress in those patients who have persistent COVID. A comprehensive initial assessment is essential for rehabilitation in the community at this stage.

This assessment should cover various aspects including respiratory and musculoskeletal functions, overall physical fitness, endurance, and strength training, with a particular focus on respiratory muscle training. Additionally, it's vital to consider the psychological and social aspects of

patients undergoing rehabilitation and ensure the availability of resources to implement the recommended measures.

**Contribution of the authors:** Each of the authors made an equal contribution.

**Conflict of Interest:** The authors declare that they have no conflict of interest.

**Funding:** There is no financial support and sponsorship.

**Publication Information:** The results of this study have not been previously published in other journals and are not pending review by other publishers.

#### References:

1. Babu A.S., Arena R., Ozemek C., Lavie C.J. COVID-19: A Time for Alternate Models in Cardiac Rehabilitation to Take Centre Stage. *Can J Cardiol.* 2020 Jun;36(6):792-794. doi: 10.1016/j.cjca.2020.04.023. Epub 2020 Apr 25. PMID: 32344000; PMCID: PMC7195273.
2. Bajwah S., Wilcock A., Towers R., Costantini M., Bausewein C., Simon S.T., Bendstrup E., Prentice W., Johnson M.J., Currow D.C., Kreuter M., Wells A.U., Birring S.S., Edmonds P., Higginson I.J. Managing the supportive care needs of those affected by COVID-19. *Eur Respir J.* 2020 Apr 23;55(4):2000815. doi: 10.1183/13993003.00815-2020. PMID: 32269090; PMCID: PMC7144268.
3. Boldrini P., Bernetti A., Fiore P.; SIMFER Executive Committee, SIMFER Committee for International Affairs. Impact of COVID-19 outbreak on rehabilitation services and Physical and Rehabilitation Medicine physicians' activities in Italy. An official document of the Italian PRM Society (SIMFER). *Eur J Phys Rehabil Med.* 2020 Jun;56(3):316-318. doi: 10.23736/S1973-9087.20.06256-5. Epub 2020 Mar 16. PMID: 32175719.
4. Boldrini P., Kiekens C., Bargellesi S., Brianti R., Galeri S., Lucca L., Montis A., Posteraro F., Scarponi F., Straudi S., Negrini S. First impact of COVID-19 on services and their preparation. "Instant paper from the field" on rehabilitation answers to the COVID-19 emergency. *Eur J Phys Rehabil Med.* 2020 Jun;56(3):319-322. doi: 10.23736/S1973-9087.20.06303-0. Epub 2020 Apr 8. PMID: 32264667.
5. Bouteleux B., Henrot P., Ernst R., *et al.* Respiratory rehabilitation for Covid-19 related persistent dyspnoea: A one-year experience. *Respir Med* 2021; 189:106648.
6. Ceravolo M.G., de Sire A., Andrenelli E., Negrini F., Negrini S. Systematic rapid "living" review on rehabilitation needs due to COVID-19: update to March 31st, 2020. *Eur J Phys Rehabil Med.* 2020 Jun;56(3):347-353. doi: 10.23736/S1973-9087.20.06329-7. Epub 2020 Apr 22. Update in: *Eur J Phys Rehabil Med.* 2020 Jun;56(3):354-360. Update in: *Eur J Phys Rehabil Med.* 2020 Aug;56(4):508-514. PMID: 32316718.
7. Chaler J., Gil Fraguas L., Gómez García A., Laxe S., Luna Cabrera F., Llavona R., Miangolarra Page J.C., Del Pino Algarrada R., Salaverria Izaguirre N., Sánchez Tarifa P., Santandr Eu M.E., Garreta Figuera R. Impact of Coronavirus disease 2019 outbreak on rehabilitation services and physical rehabilitation medicine and rehabilitation physicians' activities: perspectives from the Spanish experience. *Eur J Phys Rehabil Med.* 2020 Jun;56(3):369-371. doi: 10.23736/S1973-9087.20.06304-2. Epub 2020 Apr 24. PMID: 32329590.
8. Carfi A., Bernabei R., Landi F. Gemelli Against COVID-19 Post-Acute Care Study Group. Persistent



Symptoms in Patients After Acute COVID-19. *JAMA* 2020; 324:603.

9. Chopra V., Flanders S.A., O'Malley M., et al. Sixty-Day Outcomes Among Patients Hospitalized With COVID-19. *Ann Intern Med* 2021; 174:576.

10. Cho R.H.W., To Z.W.H., Yeung Z.W.C., et al. COVID-19 Viral Load in the Severity of and Recovery From Olfactory and Gustatory Dysfunction. *Laryngoscope* 2020; 130:2680.

11. Cherobin G.B., Guimarães R.E.S., de Paula Gomes M.C., et al. Intranasal Insulin for the Treatment of Persistent Post-COVID-19 Olfactory Dysfunction. *Otolaryngol Head Neck Surg* 2023; 169:719.

12. Dhooria S., Chaudhary S., Sehgal I.S., et al. High-dose versus low-dose prednisolone in symptomatic patients with post-COVID-19 diffuse parenchymal lung abnormalities: an open-label, randomised trial (the COLDSTER trial). *Eur Respir J* 2022; 59.

13. Dolinay T., Jun D., Chen L., Gornbein J. Mechanical Ventilator Liberation of Patients With COVID-19 in Long-term Acute Care Hospital. *Chest* 2022; 161:1517.

14. Falvey J.R., Murphy T.E., Gill T.M., Stevens-Lapsley J.E., Ferrante L.E. Home Health Rehabilitation Utilization Among Medicare Beneficiaries Following Critical Illness. *J Am Geriatr Soc.* 2020 Jul;68(7):1512-1519. doi: 10.1111/jgs.16412. Epub 2020 Mar 18. PMID: 32187664; PMCID: PMC7712590.

15. Gitkind A.I., Levin S., Dohle C., Herbold J., Thomas M., Oh-Park M., Bartels M.N. Redefining Pathways into Acute Rehabilitation during the COVID-19 Crisis. *PM R.* 2020 Aug;12(8):837-841. doi: 10.1002/pmjr.12392. Epub 2020 May 22. PMID: 32347661; PMCID: PMC7267405.

16. Guler S.A., Ebner L., Aubry-Beigelman C., et al. Pulmonary function and radiological features 4 months after COVID-19: first results from the national prospective observational Swiss COVID-19 lung study. *Eur Respir J* 2021; 57.

17. Goëtz Y.M.J., Van Herck M., Delbressine J.M., et al. Persistent symptoms 3 months after a SARS-CoV-2 infection: the post-COVID-19 syndrome? *ERJ Open Res* 2020; 6.

18. Huang S. [u dp.]. Implications for Online Management: Two Cases with COVID-19 // *Telemedicine journal and e-health: the official journal of the American Telemedicine Association.* 2020. № 4 (26). P. 487–494.

19. Jenkins AR, Burtin C, Camp PG, et al. Do pulmonary rehabilitation programmes improve outcomes in patients with COPD posthospital discharge for exacerbation: a systematic review and meta-analysis. *Thorax* 2024; 79:438.

20. Borg K., Stam H.. Editorial: Covid-19 and Physical and Rehabilitation Medicine. *J Rehabil Med.* 2020 Apr 15;52(4):jrm00045. doi: 10.2340/16501977-2679. PMID: 32286673.

21. Kiekens C. [u dp.]. Rehabilitation and respiratory management in the acute and early post-acute phase. «Instant paper from the field» on rehabilitation answers to the COVID-19 emergency // *European journal of physical and rehabilitation medicine.* 2020. № 3 (56). P. 323–326.

22. Lerum T.V., Aaløkken T.M., Brønstad E. et al. Dyspnoea, lung function and CT findings 3 months after hospital admission for COVID-19. *Eur Respir J* 2021; 57.

23. Li Q. [u dp.]. Early Transmission Dynamics in Wuhan, China, of Novel Coronavirus-Infected Pneumonia // *The New England journal of medicine.* 2020. № 13 (382). P. 1199–1207.

24. Li Z. [u dp.]. Rehabilitation needs of the first cohort of post-acute COVID-19 patients in Hubei, China // *European journal of physical and rehabilitation medicine.* 2020. № 3 (56). P. 339–344.

25. Liu K. [u dp.]. Respiratory rehabilitation in elderly patients with COVID-19: A randomized controlled study // *Complementary therapies in clinical practice.* 2020. (39), P.84–89.

26. Masiero S., Maccarone M. C., Agostini F. Health resort medicine can be a suitable setting to recover disabilities in patients tested negative for COVID-19 discharged from hospital? A challenge for the future // *International journal of biometeorology.* 2020. № 10 (64). P. 1807–1809.

27. McNeary L., Maltser S., Verduzco-Gutierrez M. Navigating Coronavirus Disease 2019 (Covid-19) in Psychiatry: A CAN Report for Inpatient Rehabilitation Facilities // *PM & R: the journal of injury, function, and rehabilitation.* 2020. № 5 (12). P. 512–515.

28. Mukaino M. [u dp.]. Staying Active in Isolation: Telerehabilitation for Individuals With the Severe Acute Respiratory Syndrome Coronavirus 2 Infection // *American journal of physical medicine & rehabilitation.* 2020. № 6 (99). P. 478–479.

29. Negrini S., Ferriero G., Kiekens C., Boldrini P. Facing in real time the challenges of the COVID-19 epidemic for rehabilitation. *Eur J Phys Rehabil Med.* 2020 Jun;56(3):313-315. doi: 10.23736/S1973-9087.20.06286-3. Epub 2020 Mar 30. PMID: 32225137.

30. Negrini S., Kiekens C., Bernetti A., Capecci M., Ceravolo M.G., Lavezzi S., Zampolini M., Boldrini P. Telemedicine from research to practice during the pandemic. "Instant paper from the field" on rehabilitation answers to the COVID-19 emergency. *Eur J Phys Rehabil Med.* 2020 Jun;56(3):327-330. doi: 10.23736/S1973-9087.20.06331-5. Epub 2020 Apr 24. PMID: 32329593.

31. Palacios Cruz M., Santos E., Velázquez Cervantes M.A., León Juárez M. COVID-19, a worldwide public health emergency. *Rev Clin Esp (Barc).* 2021 Jan;221(1):55-61. doi: 10.1016/j.rceng.2020.03.001. Epub 2020 Apr 21. PMID: 33998479; PMCID: PMC7173827.

32. Pedersini P., Corbellini C., Villafañe J.H. Italian Physical Therapists' Response to the Novel COVID-19 Emergency // *Physical therapy.* 2020. № 7 (100). P. 1049–1051.

33. Percy E., Luc J.G.Y., Vervoort D., Hirji S., Ruel M., Coutinho T.. Post-Discharge Cardiac Care in the Era of Coronavirus 2019: How Should We Prepare? *Can J Cardiol.* 2020 Jun;36(6):956-960. doi: 10.1016/j.cjca.2020.04.006. Epub 2020 Apr 9. PMID: 32299750; PMCID: PMC7194869.

34. Prada V. [u dp.]. The suspected SARS-Cov-2 infection in a Charcot-Marie-Tooth patient undergoing postsurgical rehabilitation: the value of telerehabilitation for evaluation and continuing treatment // *International journal of rehabilitation research. Internationale Zeitschrift fur Rehabilitationsforschung. Revue internationale de recherches de readaptation.* 2020. № 3 (43). P. 285–286.



35. Roach A., Chikwe J., Catarino P., et al. Lung Transplantation for Covid-19-Related Respiratory Failure in the United States. *N Engl J Med* 2022; 386:1187.
36. Singh S.J., Baldwin M.M., Daynes E., Evans R.A., Greening N.J., Jenkins R.G., Lone N.I., McAuley H., Mehta P., Newman J., Novotny P., Smith D.J.F., Stanel S., Toshner M., Brightling C.E. Respiratory sequelae of COVID-19: pulmonary and extrapulmonary origins, and approaches to clinical care and rehabilitation. *Lancet Respir Med*. 2023 Aug;11(8):709-725. doi: 10.1016/S2213-2600(23)00159-5. Epub 2023 May 19. PMID: 37216955; PMCID: PMC10198676.
37. Shanthanna H. [u dp.]. Caring for patients with pain during the COVID-19 pandemic: consensus recommendations from an international expert panel // *Anaesthesia*. 2020. № 7 (75). P. 935–944.
38. Smith J.M. [u dp.]. Home and Community-Based Physical Therapist Management of Adults With Post-Intensive Care Syndrome // *Physical therapy*. 2020. № 7 (100). P. 1062–1073.
39. Solé G. [u dp.]. Guidance for the care of neuromuscular patients during the COVID-19 pandemic outbreak from the French Rare Health Care for Neuromuscular Diseases Network // *Revue neurologique*. 2020. № 6 (176). P. 507–515.
40. Stam H.J., Stucki G., Bickenbach J. Covid-19 and Post Intensive Care Syndrome: A Call for Action // *Journal of rehabilitation medicine*. 2020. № 4 (52), P.23-29.
41. Thomas E., Gallagher R., Grace S.L. Future-proofing cardiac rehabilitation: Transitioning services to telehealth during COVID-19 // *European journal of preventive cardiology*. 2021. № 7 (28). P. E35–E36.
42. Thomas P., Baldwin C., Beach L., Bissett B., Boden I., Cruz S.M., Gosselink R., Granger C.L., Hodgson C., Holland A.E., Jones A.Y., Kho M.E., van der Lee L., Moses R., Ntoumenopoulos G., Parry S.M., Patman S. Physiotherapy management for COVID-19 in the acute hospital setting and beyond: an update to clinical practice recommendations. *J Physiother*. 2022 Jan;68(1):8-25. doi: 10.1016/j.jphys.2021.12.012. Epub 2021 Dec 23. PMID: 34953756; PMCID: PMC8695547.
43. Treger I., Lutsky Treger L., Friedman A. Organization of acute patients' transfer to rehabilitation services during COVID-19 crisis // *European journal of physical and rehabilitation medicine*. 2020. № 3 (56). P. 366.
44. Velavan T.P., Meyer C.G. The COVID-19 epidemic // *Tropical medicine & international health: TM & IH*. 2020. № 3 (25). P. 278–280.
45. Vigorito C., Faggiano P., Mureddu G. F. COVID-19 pandemic: what consequences for cardiac rehabilitation? // *Monaldi archives for chest disease = Archivio Monaldi per le malattie del torace*. 2020. № 1 (90). P. 205–206.
46. Wainwright T.W., Low M. Beyond acute care: Why collaborative self-management should be an essential part of rehabilitation pathways for COVID-19 patients // *Journal of rehabilitation medicine*. 2020. № 5 (52), P.101-105.
47. Wang C. [u dp.]. A novel coronavirus outbreak of global health concern // *Lancet* (London, England). 2020. № 10223 (395). P. 470–473.
48. Wang D. [u dp.]. Clinical Characteristics of 138 Hospitalized Patients With 2019 Novel Coronavirus-Infected Pneumonia in Wuhan, China // *JAMA*. 2020. № 11 (323). P. 1061–1069.
49. White C., Connolly B., Rowland M.J. Rehabilitation after critical illness. *BMJ*. 2021 Apr 15;373:n910. doi: 10.1136/bmj.n910. PMID: 33858835.
50. Yang F. [u dp.]. [Pulmonary rehabilitation guidelines in the principle of 4S for patients infected with 2019 novel coronavirus (2019-nCoV)] // *Zhonghua jie he he hu xi za zhi = Zhonghua jiehe he huxi zazhi = Chinese journal of tuberculosis and respiratory diseases*. 2020. № 3 (43). P. 180–182.
51. Yang X. [u dp.]. Clinical course and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: a single-centered, retrospective, observational study // *The Lancet. Respiratory medicine*. 2020. № 5 (8). P. 475–481.
52. Yeo T.J., Wang Y.T.L., Low T.T. Have a heart during the COVID-19 crisis: Making the case for cardiac rehabilitation in the face of an ongoing pandemic // *European journal of preventive cardiology*. 2020. № 9 (27). P. 903–905.
53. Zhao H.M., Xie Y.X., Wang C. Recommendations for respiratory rehabilitation in adults with coronavirus disease 2019 // *Chinese medical journal*. 2020. № 13 (133). P. 1595–1602.
54. Zhu S., Zhang L., Xie S., He H., Wei Q., Du C., Yang Y., Liu Z., He C., Gao Q., Yang L. Reconfigure rehabilitation services during the Covid-19 pandemic: best practices from Southwest China. *Disabil Rehabil*. 2021 Jan;43(1):126-132. doi: 10.1080/09638288.2020.1853828. Epub 2020 Dec 5. PMID: 33280457.
55. Zha L., Xu X., Wang D., Qiao G., Zhuang W., Huang S. Modified rehabilitation exercises for mild cases of COVID-19. *Ann Palliat Med*. 2020 Sep;9(5):3100-3106. doi: 10.21037/apm-20-753. Epub 2020 Aug 10. PMID: 32787373.
56. Zhao J., Cai Q., Jiang D., Wang L., He H., Chen S., Jia W., Zhang C. The Impact of COVID-19 on SARS-CoV-2-Negative Elderly Patients with Hip Fractures: A Single-Center Retrospective Study from Shanghai, China. *Clin Interv Aging*. 2022 Jul 1;17:991-999. doi: 10.2147/CIA.S374083. PMID: 35799949; PMCID: PMC9255716.
57. Zhou S., Zhang A., Liao H., Liu Z., Yang F. Pathological Interplay and Clinical Complications between COVID-19 and Cardiovascular Diseases: An Overview in 2023. *Cardiology*. 2024;149(1):60-70. doi: 10.1159/000533359. Epub 2023 Aug 16. PMID: 37586358; PMCID: PMC11251668.
58. Zavaroni S., Tristano I., Casamenti V., Colonna V., Cereti M., Mamone M., Prencipe U., Sanzone F., Murgia M., Masala S., Beccacece A., Vetrano M., Vulpiani M.C., Bemporad J. Ultrasound-based Neuropathy Diagnosis in COVID-19 Patients in Post-intensive Care Rehabilitation Settings: A Retrospective Observational Study. *Arch Phys Med Rehabil*. 2023 Aug;104(8):1236-1242. doi: 10.1016/j.apmr.2023.02.002. Epub 2023 Feb 26. PMID: 36854349; PMCID: PMC9968491.
59. Zolfaghari M.A., Ghadiri Moghaddam F., Rajput S., Karimi A., Naghi Vishteh M., Mahmoodpoor A., Dolati S., Yousefi M. SARS-CoV-2 vaccines: A double-edged sword throughout rapid evolution of COVID-19. *Cell Biol Int*. 2022

Dec;46(12):2009-2017. doi: 10.1002/cbin.11903. Epub 2022 Sep 1. PMID: 36047303; PMCID: PMC9539123.

60. Zangrillo A., Belletti A., Palumbo D., Calvi M.R., Guzzo F., Fominskiy E.V., Ortalda A., Nardelli P., Ripa M., Baiardo Redaelli M., Borghi G., Landoni G., D'Amico F., Marmiere M., Righetti B., Rocchi M., Saracino M., Tresoldi

M., Dagna L., De Cobelli F. COVID-BioB Study Group. One-Year Multidisciplinary Follow-Up of Patients With COVID-19 Requiring Invasive Mechanical Ventilation. *J Cardiothorac Vasc Anesth.* 2022 May;36(5):1354-1363. doi: 10.1053/j.jvca.2021.11.032. Epub 2021 Nov 27. PMID: 34973891; PMCID: PMC8626145.

#### Information about authors:

**Aiym Bekezhan** - PhD student on Public Health specialty, num.: 87024197428, e-mail: bekezhanovna95@mail.ru, <http://orcid.org/0000-0002-0140-4897>, NCJSC «Semey Medical University», Semey, Republic of Kazakhstan;

**Gulnara Shalgumbayeva** - PhD, Associate Professor, Department of General Medical Practice of Semey city, num:+7 (705) 530-25-61, [gulnar.shalgumbayeva@smu.edu.kz](mailto:gulnar.shalgumbayeva@smu.edu.kz), <http://orcid.org/0000-0003-3310-4490>, Semey, NCJSC «Semey Medical University», Semey, Republic of Kazakhstan;

**Gaukhar Amantayeva**<sup>1</sup>, PhD, Lecturer at the Department of Public Health, num: +77007493193, e-mail: [gauhar2101@mail.ru](mailto:gauhar2101@mail.ru), <https://orcid.org/0000-0002-8422-7936>, NCJSC «Semey Medical University», Semey, Republic of Kazakhstan;

**Arailym Baurzhan**<sup>1</sup>, - PhD, Doctor on Center for Nuclear Medicine and Oncology, Semey, num:+77755378239, e-mail: [Aiko\\_-87@mail.ru](mailto:Aiko_-87@mail.ru), <https://orcid.org/0000-0003-0279-6607>, NCJSC «Semey Medical University», Semey, Republic of Kazakhstan;

**Bagym Jobalayeva** - PhD candidate, Lecturer at the Department of Public Health, num.:87025255628, e-mail: [bagym.jobalayeva@smu.edu.kz](mailto:bagym.jobalayeva@smu.edu.kz), <https://orcid.org/0000-0002-2145-2263>, NCJSC «Semey Medical University», Semey, Republic of Kazakhstan;

**Zhanar Zhumanbayeva** - PhD, Associate Professor, Nursing department, num: 87759803208, [zhanar.zh\\_79@mail.ru](mailto:zhanar.zh_79@mail.ru), <http://orcid.org/0000-0001-8941-862X>, Semey, NCJSC «Semey Medical University», Semey, Republic of Kazakhstan;

**Altynay Dosbayeva** - Nursing department, num: 87784123612, [altin\\_vko@mail.ru](mailto:altin_vko@mail.ru), <https://orcid.org/0000-0002-0554-2680>, NCJSC «Semey Medical University», Semey, Republic of Kazakhstan;

**Alua Sharapiyeva** - PhD, Nursing department, num: 87784549954, [alulya\\_2790@mail.ru](mailto:alulya_2790@mail.ru), <http://orcid.org/0000-0001-7325-398X>, NCJSC «Semey Medical University», Semey, Republic of Kazakhstan;

#### Corresponding author:

**Aiym Bekezhanova** - PhD student on Public Health specialty, NCJSC «Semey Medical University», Semey, Republic of Kazakhstan. <http://orcid.org/0000-0002-0140-4897>,

**Address:** Republic of Kazakhstan, 010000, Astana, Mukhamedkhanova street, 12

**Email:** [bekezhanovna95@mail.ru](mailto:bekezhanovna95@mail.ru)

**Phone:** +7(702) 419 74 28