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## ***Rehabilitation and physiotherapy protocols in patients affected by COVID-19***

*Protocolos de rehabilitación y fisioterapia en pacientes afectados por COVID-19*

*Protocolos de reabilitação e fisioterapia em pacientes acometidos pela COVID-19*

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## ABSTRACT

The COVID-19 represents an international emergency due to the increasing numbers of infected and deceased people worldwide. Recovered patients may suffer respiratory, cardiac and neurological effects and sequelae, which affects their quality of life. The objective of this article was to reconstruct the respiratory, cardiovascular, neurological and neuromuscular rehabilitation and physiotherapy protocols for patients affected by COVID-19, based on reported scientific evidence. For it, a bibliographic review was carried out in the main international databases (PubMed, sciELO, Google Scholar, among others). The key words were used for the search: COVID-19, acute respiratory distress syndrome, physiotherapy, respiratory rehabilitation, cardiovascular rehabilitation, neuromuscular and neurological rehabilitation, in English and Spanish. These protocols attribute significant improvements in sequelae and in the quality of life of patients. Respiratory physiotherapy exercises in the prone position, inspiratory muscle training, aerobic exercises and moderate muscle strength training are recommended. The results of the application of these protocols are satisfactory in the recovery of patients.

**Keywords:** COVID-19, physiotherapy, respiratory rehabilitation, cardiovascular rehabilitation, neurological rehabilitation, neuromuscular rehabilitation.

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## RESUMEN

La COVID-19 representa una emergencia internacional por los crecientes números de contagiados y fallecidos a nivel mundial. Los pacientes recuperados pueden sufrir afectaciones y secuelas respiratorias, cardíacas y neurológicas, lo que afecta su calidad de vida. El objetivo de este artículo consistió en reconstruir los protocolos de rehabilitación y fisioterapia respiratoria, cardiovascular, neurológica y neuromuscular para pacientes afectados por COVID-19, a partir de evidencias científicas reportadas. Para ello, se realizó una revisión bibliográfica en las principales bases de datos internacionales (PubMed, SciELO, Google Académico, ente otras). Para la búsqueda se utilizaron las palabras claves: COVID-19, síndrome de distrés respiratorio agudo, fisioterapia, rehabilitación respiratoria, Rehabilitación cardiovascular, rehabilitación neuromuscular y neurológica, en inglés y en



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español. Estos protocolos atribuyen mejoras significativas de las secuelas y en la calidad de vida de los pacientes. Se recomiendan ejercicios de fisioterapia respiratoria en posición decúbito-prono, entrenamiento de músculos inspiratorios, ejercicios aeróbicos y entrenamiento moderado de fuerza muscular. Los resultados de la aplicación de estos protocolos son satisfactorios en la recuperación de los pacientes.

**Palabras clave:** COVID-19, fisioterapia, rehabilitación respiratoria, rehabilitación cardiovascular, rehabilitación neurológica, rehabilitación neuromuscular.

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## RESUMO

A COVID-19 representa uma emergência internacional devido ao número crescente de pessoas infectadas e falecidas em todo o mundo. Os pacientes recuperados podem sofrer efeitos e sequelas respiratórias, cardíacas e neurológicas, o que afeta sua qualidade de vida. O objetivo deste artigo foi reconstruir os protocolos de reabilitação respiratória, cardiovascular, neurológica e neuromuscular e de fisioterapia para pacientes afetados pela COVID-19, com base em evidências científicas relatadas. Para tanto, foi realizada uma revisão bibliográfica nas principais bases de dados internacionais (PubMed, SciELO, Google Scholar, entre outras). As palavras-chave foram utilizadas para a busca: COVID-19, síndrome do desconforto respiratório agudo, fisioterapia, reabilitação respiratória, reabilitação cardiovascular, reabilitação neuromuscular e neurológica, nos idiomas inglês e espanhol. Esses protocolos atribuem melhorias significativas nas sequelas e na qualidade de vida dos pacientes. São recomendados exercícios de fisioterapia respiratória em posição prona, treinamento muscular inspiratório, exercícios aeróbicos e treinamento moderado de força muscular. Os resultados da aplicação desses protocolos são satisfatórios na recuperação dos pacientes.

**Palavras-chave:** COVID-19, fisioterapia, reabilitação respiratória, reabilitação cardiovascular, reabilitação neurológica, reabilitação neuromuscular.

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## INTRODUCTION

At the end of 2019, an outbreak of acute respiratory syndrome caused by a new coronavirus called SARS-CoV2 was reported in China. The disease, called COVID-19 from its English acronym, spread rapidly throughout the world to such an extent that the World Health Organization (WHO) declared it a pandemic (Zhu et. al, 2020; Rodríguez - Labrada et., al, 2020). At the beginning of 2022, more than 400 million infections and nearly six million deaths from this disease were already reported worldwide, due to the appearance of more contagious and lethal viral strains (Olivo et. al, 2022). As a result of this international emergency, doctors, scientists, researchers, psychologists and other professionals have joined forces to minimize the damage caused by this pandemic. For their part, the teams of rehabilitators and physiotherapists have not been left behind in the fight against COVID-19, since they play an important role in improving the quality of life of patients who suffered from this disease, even those who manifested more severe symptoms.

COVID-19 presents a characteristic set of symptoms and signs (Castellón et. al, 2020), and patients may also have complications and even respiratory, cardiac, and neurological sequelae (Grácio & Koçer, 2020; Ahmad, & Rathore, 2020). Given the intensive medical treatment for some COVID-19 patients, including prolonged protective lung ventilation, sedation, and the use of neuromuscular blocking agents, those admitted to the intensive care unit may be at high risk of developing acquired weakness. Therefore, it is essential to initiate early rehabilitation after the acute phase to limit the severity of the weakness suffered and promote rapid functional recovery. Physiotherapy and rehabilitation have an important role in providing exercise, mobilization and rehabilitation interventions to survivors of critical manifestations associated with COVID-19 in order to allow an improvement in their quality of life (Condezo, 2020).

The above confirms that rehabilitation is an important factor for improving the quality of life of patients who suffered severe manifestations and sequelae of this disease. For their treatment, physiotherapy and rehabilitation protocols reported in the literature were generated (Table 1). Taking this into account, the objective of this article is to reconstruct the main respiratory, cardiovascular, neurological and neuromuscular rehabilitation and



physiotherapy protocols for the care of patients who suffered from COVID-19, based on their effective results.

*Table 1. - Synthesis of the protocols for respiratory, cardiovascular, neurological and neuromuscular rehabilitation of the sequelae caused by COVID-19*

<b>Damage caused by COVID-19</b>	<b>Recommended physiotherapy and rehabilitation protocols</b>
<b>Respiratory damage</b>	Secretion drainage techniques Strengthening respiratory muscles Breathing training in the prone position Tai Chi, Qigong, and other traditional Chinese medicine Conventional oxygen therapy and high-flow nasal oxygen
<b>Cardiovascular damage</b>	Aerobic walking and cycling exercises Moderate muscle strength exercises Fitness Exercises in biohealthy gyms Sport games
<b>Neurological and neuromuscular damage</b>	Muscle strength exercises Endurance Coordination Balance Tai Chi and Qigong Telerehabilitation

## **DEVELOPMENT**

Bibliographic review of articles published in the main bibliographic databases (Web of Sciences, SCOPUS, SciELO, Google Scholar, PubMed) was carried out. A total of 32 articles from the last 5 years were reviewed, related to rehabilitation and physiotherapy in pathologies similar to respiratory, cardiovascular, neurological and neuromuscular damage caused by infection with the SARS-CoV2 virus, as well as protocols applied in patients with COVID-19. The key words were used for the search: COVID-19, Acute respiratory distress syndrome, Physiotherapy, Respiratory rehabilitation, Cardiovascular rehabilitation, Neuromuscular and neurological rehabilitation, in English and Spanish.



### *Respiratory rehabilitation*

The objective of respiratory rehabilitation in patients hospitalized with COVID-19 is improve symptoms of dyspnea, relieve anxiety and depression, reduce complications, prevent and improve dysfunction, reduce disability, preserve maximum function and improve quality of life. Given the high percentage of hospitalized patients requiring intensive care, it is likely that in the weeks and months following an increase in the number of patients admitted to hospitals and intensive care units, there will likely be a considerable number of COVID-19 survivors, which requires rehabilitation services. For this reason, a rehabilitation program must be developed that adapts to the specific needs of each patient (Demeco *et. al*, 2020).

Physiotherapy may be beneficial in the respiratory treatment and physical rehabilitation of patients with COVID-19. Although productive cough is a less common symptom (34%), physical therapy may be indicated if COVID-19 patients have copious airway secretions that they cannot clear independently. This must be evaluated on a case-by-case basis and the interventions applied must be established based on clinical indicators.

Physical therapists practicing in the intensive care unit setting may also perform secretion drainage techniques for ventilated patients who show signs of inadequate airway drainage, and may assist in the postural management of patients with severe respiratory failure associated with COVID-19, including the use of prone positioning to optimize oxygenation (Thomas *et. al*, 2020).

It is important to carry out early respiratory rehabilitation in the acute phase, to improve the chances of recovery. Early active mobilization is essential to improve muscle strength, ensuring better mobility when the patient is discharged from the hospital and improving quality of life (Simpson & Robinson, 2020). Despite this, other studies ensure that it is not advisable to carry out early rehabilitation, mainly in severe and critical states, because it is not well tolerated by patients (Kiekens *et. al*, 2020; Martínez-Pizarro, 2020). The time to start respiratory rehabilitation should be determined after ruling out contraindications, and it is necessary to pay attention to all precautions to prevent the spread of infection (Demeco *et. al.*, 2020). In the acute phase, diaphragmatic breathing, pursed-lip breathing, bronchial



hygiene, lung expansion techniques, incentive spirometry, manual mobilization of the rib cage, respiratory muscle training, and exercise are not recommended. aerobic, because they cause an additional load on the work of breathing, exposing the patient to a greater risk of respiratory distress (Lazzeri *et. al*, 2020).

During the acute phase, it is proposed that the prone position for two minutes can help with lung ventilation. This position considerably increases transpulmonary pressure at the end of expiration and expiratory reserve volume, promotes more homogeneous lung inflation from dorsal to ventral and improves oxygenation. The prone position has also been used in intensive care units to improve gas exchange and reduce cardiovascular comorbidities. The patient may also engage in modified segmental breathing, whereby pressure is applied to his or her own rib cage, to resist respiratory excursion in one area of the thoracic cavity and facilitate expansion of adjacent regions of the thoracic cavity that may have decreased ventilation and mobility (Wang *et. al*, 2020).

In the post-acute phase, training of the inspiratory muscles should be included if they are weakened. Slow deep breathing, chest expansion (with shoulder elevation), diaphragmatic breathing, respiratory muscle mobilization, airway clearance techniques if necessary, and positive expiratory pressure devices may be added as assessed needs. Care should be taken to avoid overloading the respiratory system and causing discomfort (Zhao *et. al.*, 2020).

Respiratory rehabilitation improves the lung function of patients with COVID-19 due to the strengthening of respiratory muscles, such as the intercostals, abdominal wall muscles, diaphragmatic muscles, among others (Gu *et al.*, 2020). These muscles play an important role in maintaining respiratory function. A respiratory muscle strengthening protocol is reported in elderly patients, a group at higher risk of suffering from severe forms of the disease. This protocol includes two sessions per week for six weeks, once a day with a duration of ten minutes of respiratory muscle training; cough exercises; diaphragmatic and stretching exercises. This series of exercises significantly improved lung function after six weeks of respiratory rehabilitation training, reducing chest wall movement, slowing respiratory rate to reduce energy consumption, increasing lung ventilation and oxygen





content in blood. In addition, these exercises improved the performance of activities of daily living (Liu *et. al.*, 2020).

The practice of leisurely activities based on traditional Chinese medicine, such as Tai Chi, Baduanjin and Qigong, is also recommended. It is proposed that Qigong can improve immune function, reduce the risk of infection, improve prognosis, improve sports endurance, quality of life and rationality in carrying out activities of daily living. On the other hand, the practice of Qigong can strengthen the muscles of the chest and abdomen, increase the depth of breathing, relieve dyspnea, and improve lung function in patients who suffered from COVID-19. It can also relieve psychological stress, depression and anxiety, and improve sleep quality (Peng *et. al.*, 2020).

Other specialists recommend respiratory physiotherapy, conventional oxygen therapy, high-flow nasal oxygen, continuous positive airway pressure, and postural changes for the treatment of patients who did not undergo invasive ventilation. On the other hand, airway clearance techniques, lung recruitment maneuvers and endotracheal suction are recommended for those who did undergo invasive ventilation (Lazzeri *et. al.*, 2020). Relevant aspects of physiotherapy are multidisciplinary management of non-invasive ventilation, frequent changes in posture, passive mobilization, positional therapy and recovery of motor function once the acute phase has resolved.

Regarding postural management, it is important to gradually increase the antigravity position depending on the patient's clinical condition, until the patient can maintain an upright position. It can also be useful to keep patients in a semi-sitting position, with the back of the bed at 45 or 60 degrees (Brugliera *et. al.*, 2020).

#### *Cardiovascular rehabilitation*

In addition to the respiratory conditions caused by COVID-19, there is evidence of cardiovascular system damage caused by SARS-CoV2. It is proposed that 20% of patients hospitalized in China with COVID-19 had an associated cardiac injury. These patients were more likely to have comorbidities, require mechanical ventilation, and suffer other complications (Sheehy, 2020). Presentations may include arrhythmia, heart failure,



decreased ejection fraction, elevated troponin I, and severe myocarditis with reduced systolic function. One brief report described a woman with acute myopericarditis/heart failure post-COVID-19. Persistent tachycardia is common after respiratory syndrome (Sheehy, 2020). Acute coagulopathies, malignant ventricular arrhythmias such as tachycardia and ventricular fibrillation, among other cardiovascular effects, are also reported (García *et. al*, 2020).

Related to cardiovascular rehabilitation, individualized exercise training is proposed that includes aerobic exercises and muscle strength training. The aerobic exercise program focuses on six-minute walks and stationary bike exercises. Strength training is performed in three sets of 20 repetitions with the maximum tolerated load. The authors report that functional capacity and subjective health status improved significantly upon completion of this protocol. Interestingly, patients with prior mechanical ventilation showed identical improvements as patients without ventilation and without significant differences in baseline patient characteristics, including risk factors, respiratory parameters, and functional measures (Hermann *et al.*, 2020).

Currently, there are few reported cardiovascular rehabilitation protocols for patients recovered from COVID-19 with cardiac sequelae. Some exercise protocols for respiratory rehabilitation described above can be used, mainly those based on aerobic exercises, fitness, and moderate intensity muscle strength training. The authors of this article propose the following protocol for the rehabilitation of patients recovered from COVID-19 with cardiovascular sequelae, taking into account the damage caused by the SARS-CoV2 virus, taking into account the care of patients with high risks of suffering from diseases. cardiovascular (Khera *et. al*, 2020).

The physical exercise program has an appropriate progression rate, depending on the patient's functional capacity, age, state of health, and needs. The exercise program is divided into three phases for its development:

- An initial phase: It covers the first to the sixth week. Starting with sessions of 12 to 20 minutes twice a week, excluding warm-up, with an equivalent number of days of rest between each session and with an intensity depending on the initial fitness level,



one could set 10% below the minimum intensity level that would correspond to the prescription in more advanced phases. The end of this phase must be achieved by carrying out three weekly sessions, equidistant in time, at the minimum level of intensity prescription and lasting 20 minutes.

- Improvement phase: It is considered from the seventh to the 27th week. It will increase progressively; the duration above 20 minutes, the frequency of 4 to 5 times a week and the intensity of 60 to 70 %.
- Maintenance phase: Reached approximately after 6 months. At this time the patient will exercise with an intensity within the limits of the prescription, for 60 to 90 minutes and four or five times a week. And it should stay that way.

Warm-up exercises include stretching exercises and replacing joint mobility exercises. Patients must perform between 10 and 20 repetitions of each of the joint mobility and respiratory exercises, and must maintain the position for between 10 and 15 seconds during the stretching exercises. Subsequently, strengthening exercises without implements such as semi-squats and abdominal exercises will be incorporated, as well as with weights tolerable to the patients' capacity, between 8 and 10 repetitions. In this case, exercises are performed to strengthen the biceps, triceps, pectorals, shoulders and legs, mainly. Aerobic walking and jogging exercises are also recommended, as well as treadmill exercises. Sports games with balls, and finally, muscle relaxation are complementary exercises for complete cardiovascular rehabilitation (Núñez-Hernández & Sentmanat-Belisón, 2020). In the maintenance phase, it is possible to perform exercises in biohealthy gyms with appropriate technical advice (Núñez-Hernández & Sentmanat-Belisón, 2018).

In addition to the basic components of cardiac rehabilitation, nutritional behaviors and habits, smoking cessation, and stress control must be taken into account. It has been shown that these behaviors complement cardiac rehabilitation and improve physiological reserve to face SARS-CoV2 infection. Additionally, the intensity, type, and duration of exercise generally recommended in cardiac rehabilitation improve immune system regulation. This may have positive repercussions on the immunosenescence of elderly patients with



cardiovascular disease, who in theory may have increased protection against the consequences of COVID-19 (Ribeiro & Santos, 2020).

### *Neurological and neuromuscular rehabilitation*

Isolation is effective in reducing the spread of SARS-CoV-2, but it also represents a severe limitation of the patient's movement and its corresponding disuse, which increases the possibility of immobilization syndrome, especially in case of fever, fatigue and muscle pain. All of these problems can lead to decreased muscle strength, increased risk of deep vein thrombosis, as well as neuropsychological problems, such as anxiety, depression, and demotivation (Brugliera *et. al.*, 2020). Additionally, weakness and neuromuscular disturbances occur in up to 50% of all people who have prolonged intensive care unit stays due to critical illness polyneuropathy, which can result in dysfunction for more than five years in 85% of the individuals. Considering the clinical conditions caused by prolonged immobilization and musculoskeletal deterioration, these patients also need rehabilitation treatments. On the other hand, neurological manifestations are reported in patients who have been infected with the SARS-CoV2 virus, such as encephalitis, transverse myelitis, ataxia, Guillain-Barré syndrome, among others, many of these with neurological sequelae, so the Neuromuscular rehabilitation plays an important role in the recovery of these patients (Ahmad, & Rathore, 2020; Fiani *et. al.*, 2020).

Strengthening exercises will help improve muscles that have become weak such as result of the disease. It is recommended to do three sessions of muscle strengthening exercises each week. It is recommended to try to complete up to three sets of ten repetitions of each exercise, taking a short rest between each set. It is advised to do the exercises and exhale as the effort is made. For this, biceps curl exercises with moderate weights, wall pushes from the bipedal position, lateral arm raises to strengthen the shoulders, heel raises, squats, among others, are recommended. Aerobic, endurance, balance, coordination and mobility training exercises are also recommended for the rehabilitation of patients recovered from COVID-19. Furthermore, it has been suggested to integrate the concept of cognitive training during the physical training session. Frequencies of five days a week are recommended, with sessions of at least 150 to 300 minutes per week of aerobic exercise and two endurance



training sessions per week. Mobility training exercises should be performed every training day and balance and coordination should be distributed between different training days at least twice (Jiménez-Pavón *et. al*, 2020).

Physical therapy should begin in the acute hospital setting and continue after transfer to inpatient rehabilitation. Early mobilization should include frequent postural changes, mobility in bed, sitting or standing, simple exercises in bed and activities of daily living, respecting the patient's respiratory and hemodynamic states. Active limb exercises should be accompanied by progressive muscle strengthening.

Neuromuscular electrical stimulation can be used to help with strengthening. Studies on the effectiveness of exercise interventions after severe acute respiratory syndrome showed benefits for endurance, maximal oxygen consumption, and strength. Speech and language specialists should evaluate and treat dysphagia and voice disturbances resulting from prolonged intubation and may also address respiratory strength and coordination. Other authors also report the benefits of traditional Chinese medicine for the treatment of neuromuscular ailments caused by COVID-19, such as Tai Chi and Qigong, with favorable results for patients (Sheehy, 2020).

In the context of the COVID-19 pandemic, telerehabilitation may be more preferable than physical interactions. A tele-rehabilitation system, with a physiotherapist following patients performing rehabilitation exercises for 20 minutes, can be easily developed using a combination of technologies. Tele-rehabilitation could prove to be a very useful tool, regardless of whether it is used in hospitals or in the community, to address the social difficulties associated with the ongoing pandemic (Mukaino *et. al*, 2020).

Through social platforms such as Skype and WhatsApp, several online exercise sessions are carried out for these patients, thus contributing to social isolation to prevent COVID-19 infection. This modality can bring beneficial effects for the recovery of muscle strength in patients who survive COVID-19 (Turolla *et. al*, 2020; López *et. al*, 2020).



In relation to the different neurological diseases that could be associated with COVID-19, this group of authors is of the opinion that the different neurological rehabilitation protocols and programs traditionally established at the international level can be used, as long as special attention is paid to respiratory rehabilitation as a basic starting element, to gradually introduce protocolized or programmed activities for each type of neurological disease and the treatment of the sequelae that occur (Bergado & Rodríguez, 2017).

### *CONCLUSIONS*

Rehabilitation and physiotherapy are important pillars for the complete recovery of people infected by the new coronavirus. Although there are currently few protocols reported in the literature, these demonstrate their effectiveness in improving the quality of life of patients. This article updates effective protocols based on demonstrated results for their application in these individuals, improving their respiratory, cardiovascular and neuromuscular capacities, damaged by COVID-19. It is evident that from the recovery of respiratory capacity, decreased by COVID-19, the quantity and complexity of the exercises can be increased, and the exercise loads can be progressively increased, depending on the type of rehabilitation that is being carried out. is going to be applied.

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The authors declare no conflicts of interest.

***Authors' contribution:***

**Julio César Rodríguez-Díaz, Yasmany González Garcés:** conceptualization.  
**Julio César Rodríguez Díaz, Yasmany González Garcés, Roberto Rodríguez Labrada:** methodology.



**Julio César Rodríguez-Díaz, Yasmany González Garcés, Roberto Rodríguez Labrada, Rigoberto González Piña, Armando Sentmanat-Belisón:** investigation.

**Yasmany González Garcés:** Display.

**Julio César Rodríguez Díaz, Roberto Rodríguez Labrada, Yasmany González Garcés:** writing original draft.

**Julio César Rodríguez Díaz, Roberto Rodríguez Labrada, Yasmany González Garcés, Rigoberto González Piña, Armando Sentmanat-Belisón:** writing review and editing



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