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A current challenge of rehabilitation medicine: the management of disabilities induced by acute SARS-CoV-2 infection

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Abstract

Coronavirus 2 (SARS-CoV-2) was a new type of coronavirus that appeared in 2019 and caused a disease with a predominantly severe manifestation of the respiratory tract (COVID-19). Patients who have survived this condition could develop as a complication a syndrome characterized by physical, mental and cognitive disorders. "Intensive care post-syndrome" may also develop which, in addition to the respiratory system may require complex musculoskeletal rehabilitation. SARS-CoV-2 infection can affect various organs and systems (respiratory, neurological, cardiac, ocular, gastrointestinal and others), with a strong impact on the functionality of affected patients; in the long term this could cause various disabilities.

The extent of the problem in terms of severity and incidence of dysfunction and disability is still unknown, but early research suggests that the patients concerned will need rehabilitation at all stages of the disease - acute, post-acute and long-term, presenting concomitant respiratory neurological, musculoskeletal, psychiatric conditions.

Current research suggests that the integrated medical rehabilitation service with the care of patients with SARS CoV-2 offers benefits for both the patient and the medical system in general. Studies on post-COVID-19 medical rehabilitation services are preliminary, the pandemic generated by COVID-19 being a complex situation, little known by health systems. At the same time, numerous clinical trials offer recommendations on interventions and principles for organizing rehabilitation care for this category of patients.

Keywords: SARS-CoV-2 infection, respiratory rehabilitation, musculoskeletal rehabilitation, organization of post-COVID rehabilitation services.

Introduction

Coronavirus 2 (SARS-CoV-2) was a new type of coronavirus that appeared in 2019 and caused a disease with a predominantly severe manifestation of the respiratory tract (COVID-19). Patients who have survived this condition could develop as a complication a syndrome characterized by physical, mental and cognitive disorders. "Intensive care post-syndrome" may also develop, which in addition to the respiratory system may require complex musculoskeletal rehabilitation (Guan et al., 2020).

COVID-19 most often manifests as a flu-like respiratory infection with fever (89%), cough (68%), fatigue (38%), respiratory secretion (34%) and/or breathing difficulty (19%). Symptoms can range from an asymptomatic infection to a mild upper respiratory illness, to severe viral pneumonia, but respiratory failure can also develop which can eventually be fatal. Current data suggest that 80% of cases are asymptomatic or mild; 15% of cases are severe (the disease requires oxygen administration) and 5% are critical, requiring mechanical ventilation and interventions that support vital functions (***, 2020; Guan et al., 2020); (1); (2).

SARS-CoV-2 infection can affect various organs and systems (respiratory, neurological, cardiac, ocular, gastrointestinal, etc.), having a strong impact on the functionality of affected patients, and in the long term it can cause various disabilities (***, 2020; Guan et al., 2020); (1); (2).

Recent research suggests that the integrated medical rehabilitation service with the care of patients with SARS-CoV-2 offers benefits for both the patient and the medical system in general. Studies on post-COVID-19 medical rehabilitation services are preliminary, the pandemic

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generated by COVID-19 being a complex situation, little known by health systems. At the same time, numerous clinical trials offer recommendations on interventions and principles for organizing rehabilitation care for this category of patients (Wade, 2020).

Complications associated with SARS-CoV-2 infection

Multiple complications occur after COVID-19 infection, with a frequency that is still being studied. Although known to have tropism on the respiratory system, the virus can affect the heart and cardiovascular system, the brain directly (encephalitis) and indirectly (secondary to hypoxia or vascular thrombosis), the renal function with altered blood clotting mechanisms, the gastrointestinal tract or liver function. There is also a psychosocial impairment which has a significant importance: at the time of diagnosis, patients become anxious and due to isolation there are social problems (feeling abandoned) (Wade, 2020).

The extent of the problem in terms of severity and incidence of dysfunction and disability is still unknown, but early research suggests that these patients will need rehabilitation at all stages of the disease - acute, post-acute and in the long term (Wade, 2020). Recent research suggests that over 50% of patients with COVID 19 who required hospitalization show marked fatigue 60 days after the onset of symptoms. A current study shows that 3 months after the onset of the disease, one third of the patients who were not hospitalized had the same degree of dependence on their relatives/caregivers as in the acute phase of the disease. It has also been shown that regardless of the severity of the disease, patients may experience persistent symptoms and a progressive functional decline that is not evident at a routine consultation, such as cognitive impairment that did not exist prior to SARS-CoV-2 infection. Manifestations with late onset may continue to occur in the rehabilitation phase of the disease; distant effects of COVID-19 disease have been reported consisting of inflammatory, thromboembolic or autonomic complications - stroke, pulmonary thromboembolism and acute myocardial infarction (Stam et al., 2020); (3).

Rehabilitation can be a key strategy to reduce the impact of COVID-19 on health and functionality. The consequences of COVID-19 will be specific to each individual, and their rehabilitation needs will be individualized according to these complications (Wade, 2020).

The existence of specific syndromes that appear after COVID-19 infection and are due to prolonged hospitalization in the intensive care unit has already emerged. Changes that occur after prolonged hospitalizations in intensive care can be summarized as follows:

- *Critical Illness Polyneuropathy*, characterized by - dependence on mechanical ventilation, generalized and symmetrical weakness (includes diaphragmatic weakness), distal sensory disorder, atrophy, possibly associated with pain, sphincter incontinence, decreased joint amplitude of movement, dysphagia, anxiety, depression.

- *Critical Illness Myopathy* is a non-necrotic myopathy, diffuse, with fatty degeneration, atrophy and fibrosis of muscle fibres.

- *Post-Intensive Care Syndrome,* characterized by cognitive impairments - memory, attention, psychomotor disorder, anxiety, depression, dyspnoea with impaired lung function by reducing inspiratory muscle strength, pain, sexual dysfunction; low tolerance to exercise, neuropathy, muscle weakness/paresis, severe fatigue, reduced functional capacity (Stam et al., 2020; Lazzeri et al., 2020); (3); (4);

The most important and common complications that occur in COVID-19 infection can be classified as follows:

- *heart damage*: arrhythmias, heart failure, decreased ejection fraction, increased troponin I, severe myocarditis with reduced systolic dysfunction; the presence of cardiac lesions should always be considered in a patient after COVID-19 infection if suggestive symptoms occur;

- *musculoskeletal impairment*: physical deconditioning, severe muscle weakness, reduced joint mobility, pain in the neck and shoulders (due to prolonged position in a prone position), difficulty standing, lack of balance and gait (Lazzeri et al., 2020; Vitacca et al., 2020);

- *pulmonary damage*: pulmonary fibrosis; abundant bronchial secretions (Lazzeri et al., 2020; Vitacca et al., 2020);

- *neurological impairment*: headache, impaired consciousness, epileptic seizures, anosmia, ageusia, paresthesias, encephalopathies, encephalitis, stroke, Guillain Barre syndrome, swallowing disorders;

- *psychiatric impairment*: cognitive impairment, delirium, confusion.

- *other disorders*: voice disorders - diphonia, xerostomia, knot in the throat, vocal fatigue, burning sensation in the pharyngo-larynx (4); (Stam et al., 2020; Lazzeri et al., 2020).

General principles and organization of the post-COVID-19 medical rehabilitation service

Organizing a multidisciplinary medical team is essential to ensure the most complex recovery of patients, as COVID-19 is a multisystemic disease. The rehabilitation team must have skills in the diagnosis, management and prognosis of complex disabilities associated with SARS-VOC-2 infection, and must take into account international guidelines for the rehabilitation of various conditions that SARS-VOC-2 infection has caused (thrombotic events with their consequences - stroke, acute myocardial infarction, acute ischemia of the limbs, phenomena of direct invasion - meningitis, myocarditis, myositis; or immune-mediated reactions - for example Guillain-Barre syndrome) (Stam et al., 2020; Righetti et al., 2020); (3).

The decision regarding the optimal time to start the post-COVID-19 medical rehabilitation program belongs to the multidisciplinary team that will coordinate the rehabilitation program and must be according to patient's health. The working conditions and logistics dedicated to the rehabilitation process must also be individualized on a case-by-case basis, so that even patients who still remain contagious can benefit from such a recovery program (4); (Stam et al., 2020); (3).

The rehabilitation program must be customized according to the patient's needs, functional deficits and

comorbidities. Rehabilitation of patients after COVID-19 will focus on improving the symptoms of dyspnoea, psychological stress, limiting physical capacity, with the gradual increase in the intensity of the rehabilitation program, the ultimate goal being to improve physical condition and quality of life. The initial assessment and functional re-assessment must be performed throughout the rehabilitation period. Patients should receive information about their health and must be educated on self-management strategies, symptom control and rehabilitation interventions (Lazzeri et al., 2020); (6).

In the case of patients who have been hospitalized, rehabilitation after discharge must be a continuity of interventions during the acute period, and is a condition for ensuring the safety of the act of discharge from the hospital. Upon discharge, the patient's medical condition corroborated with SARS-COV-2 secondary disabilities should be evaluated and a rehabilitation plan designed to take into account all these medical data, including the need for oxygen therapy at home, the need for assistive devices, and also the possibility of adapting the environment to which the patient returns to his new dysfunctions should be implemented. In post-COVID-19 recovery, there may be a frequent decrease in the oxygen saturation of the arterial blood when exercising or during light/moderate exertion, without correlation with SaO2 at rest or with the subjective sensation of dyspnoea; this situation can be predicted by applying a 1-minute sit-to-stand test (Stam et al., 2020); (3).

After discharge from the hospital, rehabilitation specialists will develop the rehabilitation program with a gradual increase of physical effort, will educate patients on how to conserve energy and on changing behaviour, will provide solutions to adapt the environment at home and at work, will recommend the use of assistive walking devices, as well as rehabilitation interventions for any individual functional deficiencies. Patients will be trained to save energy and avoid physical exhaustion, adapting daily activities to individual physical tolerance and symptoms; exercise will also be adapted according to the severity of symptoms (Stam et al., 2020; (3); (6).

The need for rehabilitation must be met through long-term rehabilitation services accessed by patients in a timely manner. In case of difficult access to such medical services, patients and their relatives should be guided to information sources (printed materials, video recordings, etc.) to ensure the acquisition of self-management techniques of post-COVID-19 symptoms. In the case of transfer from a COVID hospital to a recovery centre, it is essential to share patient's medical data between the two medical teams, in order to ensure the qualitative continuity of the medical act (Stam et al., 2020); (3); (4).

In specialized rehabilitation centres, patients with complex needs must have access to medical methods, facilities and equipment, and the medical and paramedical staff trained in rehabilitation care must follow preventive measures, use appropriate personal protective equipment in accordance with local standards, policies and international measures (Righetti et al., 2020).

At present, there is no consensus on strict limits regarding the chronological staging of medical rehabilitation for people who have contracted SARS CoV-2 infection. Rehabilitation interventions can be conventionally divided into acute phase (the patient is hospitalized in the intensive care unit), subacute (stabilization of the patient's vital functions after the critical condition) and long-term (after discharge from the hospital) (Wade, 2020).

During long-term recovery after severe COVID-19, patients can benefit from pulmonary rehabilitation interventions which aim to alleviate respiratory and physical deficiencies by indicating physical activity programs, education, involvement in daily activities and psychoeducation interventions, screening depression and suicidal ideation, psycho-emotional support (Wade, 2020; Keyse, 2015).

Post COVID-19 rehabilitation can be performed at all levels: hospital, outpatient and home, including the use of telemedicine (Lazzeri et al., 2020; Righetti et al., 2020); (4); (6).

Objectives of post-COVID-19 medical rehabilitation

The rehabilitation team of the service dedicated to patients who went through SARS-CoV-2 infection must focus on establishing the clinical-functional diagnosis, correlating clinical, biological, imaging data with discussions with the patient and his family to determine the real functional needs (Stam et al., 2020; Wade, 2020).

The objectives of short-term rehabilitation are to improve joint mobility, to increase endurance and muscle strength, to improve breathing, adaptation to effort, to re-educate ADLs.

The objectives of long-term rehabilitation are to obtain functional independence, return to social, professional and recreational activities.

In order to achieve these targets, it is essential to select rehabilitation interventions and to develop individualized programs, to estimate risks, complications, and functional and psychosocial limitations (Stam et. al., 2020; Lazzeri et al., 2020).

Functional impairments and post COVID-19 sequelae

COVID-19 infection can cause respiratory deficiencies of varying degrees of severity, as well as many other manifestations and extrapulmonary functional deficiencies. The rehabilitation plan must be individualized and patient-centered.

Rehabilitation objectives are established in relation to the functional impact of COVID-19 infection on the respiratory system and other systems/organs taking into account personal, environmental and pre-existing comorbidities.

The most common sequelae and dysfunctions after SARS-CoV-2 infection are as follows:

- *respiratory sequelae*: dyspnoea, pulmonary fibrosis, expectoration deficiencies, pathological breathing patterns, hyperventilation (Lazzeri et al., 2020; Vitacca et al., 2020);
- *musculoskeletal sequelae*: physical deconditioning and fatigue, severe muscle weakness, joint hypomobility,

myalgia, balance and gait disorders, decreased exercise tolerance;

- *neurological sequelae*: headache, disturbances of consciousness, convulsive syndrome, altered sense of taste and smell, paraesthesia, reversible encephalopathy syndrome, viral encephalitis, increased risk of stroke, polyneuropathy;

- *cardiac sequelae*: arrhythmias, heart failure, reduced ejection fraction, myocarditis

- thromboembolism, coagulopathies;

- *psychiatric sequelae*: distortion of body image, loss of dignity and control, anxiety, panic attacks, emotional lability, depression, self-pity, confusion, post-traumatic stress, suicidal ideation;

- *other types of sequelae*: limitation of daily activities (ADL), dysphagia, speech disorders, dysphonia with vocal fatigue, decreased tone of voice, xerostomia, impaired swallowing, gastrointestinal disorders, visual disturbances (Stam et. al., 2020; Lazzeri et al., 2020); (4).

Initial functional evaluation and evaluation of the results of the rehabilitation program

Functional evaluation of the patient who has undergone COVID-19 infection is performed during the specialized clinical rehabilitation medical examination. It is recommended to use accessible, easily applicable tests without overburdening the patient and without additional costs. The multidisciplinary team must use the same means of evaluation for effective communication and for monitoring functional progress. The following functional tests may be applied to assess cardiorespiratory function and overall exercise tolerance:

- Patient Specific Functional Scale - assessment of the perception of limits in performing daily activities.

- International Physical Activity Questionnaire - assessment of functionality and disability.

- Monitoring oxygen saturation and vital signs (HR, BP, RF) before, during and at the end of the rehabilitation session.

- Borg scale and Borg CR10 - assessment of the degree of dyspnoea and fatigue.

- Berg scale - balance assessment.

- Medical Research Council dyspnoea scale.

- 6-minute walking test - functional capacity.

- Dysphagia severity scale.

- Barthel score - assessment of daily functional abilities (ADL).

- Mini Mental State Examination Scale.

- Visual analogue scale of pain.

- 30-second sit-up test - limited functional capacity.

- Goniometry - assessment of joint balance.

- Manual muscle testing - evaluation of muscle strength.

- Other tests and examinations as needed (3); (4); (Lazzeri et al., 2020; Keyse et al., 2015).

Rehabilitation of pulmonary sequelae after COVID-19

Pulmonary rehabilitation includes physical therapy programs and interventions aimed at increasing strain tolerance. Rehabilitation programs for post COVID-19 patients should be developed in conjunction with respiratory complications and other conditions/sequelae that impose general functioning restrictions (Vitacca et al., 2020; Sbenghe, 2020).

The initial assessment is recommended in a timely and safe manner depending on the degree of normocapnic respiratory failure, as well as on coexisting conditions. Low-intensity exercise (≤3 METs or equivalent) should be considered especially for patients in need of oxygen therapy with simultaneous monitoring of vital parameters (HR, RF, BP, pulse oximetry). Exercise intensity should be gradually increased in relation to the evolution of symptoms and the general condition of the patient (Vitacca et al., 2020; Simonelli et al., 2020).

The objectives of post-acute rehabilitation of SARS-CoV-2 infection are: reduction of dyspnoea, respiratory re-education, facilitation of expiration, maintenance/ increase of joint mobility, increase of muscular strength, cardiorespiratory adaptation to physical effort, rehabilitation of speech and swallowing, improvement of the behavioural component (hygiene and diet plan, avoidance of sedentary lifestyle, avoidance of toxic consumption), ADL training, social reintegration (5); (Vitacca et al., 2020; Sbenghe, 1987; Winck & Ambrosino, 2020).

The means to achieve these goals are: early mobilization, re-education of transfers, training of respiratory muscles, re-education of diaphragmatic breathing, facilitation of expectoration, learning breathing and expectoration facilitation positions, re-education of cough, positive expiratory pressure therapy (PEP), stimulating spirometry, static and dynamic breathing exercises, joint mobilization, endurance exercises, aerobic training, tolerance training to exercise, phonation and swallowing re-education techniques, electrical stimulation of hypotrophic muscles, oxygen therapy, occupational therapy, psychological counselling, psychological intervention of short duration and psychotherapy, psychosocial support of the patient and/or caregivers (family members) and balneotherapy (5); (Keyse et al., 2015; Sbenghe, 1987; Matcovschi et al., 2011).

The basic components of pulmonary rehabilitation are: *kinesiotherapy*, *electrotherapy*, *balneotherapy*

a) Kinesiotherapy consists of: aerobic exercises - walking, brisk walking, jogging, swimming, etc., starting from low intensity with gradual increase of intensity and duration of effort, repeated 3-5 times a week, 20-30 min for each session; strength training - progressive resistance training is recommended, the training load for each target muscle group is 8-12 repetitions, 1-3 muscle groups/ time unit, the training interval of each group is 2 minutes, 2-3 times/week with increasing training load by 5% -10% per week; re-education of coordination and balance - patients with balance and coordination disorders require involvement in activities aimed at restoring balance, including the use of assistive devices (crutches, sticks, walking frame); respiratory re-education (Righetti et al., 2020; Sbenghe, 1987; Matcovschi et al., 2011).

If after discharge from the hospital patients have symptoms such as dyspnoea, changes in the respiratory pattern, productive cough, respiratory rehabilitation is

recommended. This includes postures, postural drainage, percussion and vibration manoeuvres of the chest (chest physiotherapy), adjustment of respiratory rate, breathing exercises with training of the respiratory muscles and training on cough and correct expectoration (Lazzeri et al., 2020; Abdullahi, 2020; Bhutani et al., 2020). Active segmental mobilization should be followed by progressive muscle toning in individual rehabilitation programs. Aerobic reconditioning can be done by walking, bicycle riding. Progressive aerobic exercise can be subsequently increased to 20-30 minutes daily. The physical therapy program will be specifically adapted for the disability that occurs as a result of SARS-CoV-2 infection; it is not limited to respiratory physiotherapy but will also include the rehabilitation of other conditions and disabilities (e.g. neuromuscular, cardiac, psychiatric) (Sbenghe, 1987; Matcovschi et al., 2011; Keyse et al., 2015).

b) Electrotherapy includes procedures such as super inductive system therapy and laser therapy. Super inductive system therapy (SIS) aims to myostimulate weak muscles - diaphragm, intercostal muscles, to improve blood circulation and breathing. The procedure is applied daily, and 10 treatment sessions are recommended. It begins with the protocol for improving circulation on the dorsal side of the trunk (the area between the ribs 1-6), treating both sides (anterior application is not possible due to the heart). Application is continuous with improved breathing, stimulating the diaphragm (on both sides: left-right) and intercostal muscles (lateral and posterior parts; the anterior part can be effectively treated only on the right side of the body). The intensity is adjusted individually with the control of the motor response; it increases gradually ensuring maximum patient comfort throughout the treatment (Miranda et al., 2015).

LASER therapy aims to improve respiratory symptoms and subjective complaints of patients: improvement of cough, dyspnoea, tachypnoea, fatigue, and increased exercise capacity, objective improvement of lung function: decrease in the need for O2 intake, increased environmental oxygen saturation in arterial blood, improvement of COVID-19 pneumonia severity scores (SMART-COP and BresciaCOVID), improvement of disease progression from a biochemical (reduction of inflammatory, immunological markers) and imaging point of view (decrease in lung damage on two-dimensional radiography and chest CT scan), improving the independence and performance of ADLs, shortening the recovery period after COVID-19 induced pneumonia, being an adjunct to classical methods of pulmonary rehabilitation (physiotherapy) (Sigman et al., 2020a; Sigman et al., 2020b; Mokmeli et al., 2020; Mehani, 2017).

The biological and clinical effects of laser therapy consist of the production of photochemical cellular reactions that activate the biomolecules responsible for restoring normal cell function, increasing the healing speed of lung parenchymal tissue through tissue regeneration in acute lung lesions, decreasing the number of proinflammatory cytokines by modulating the "cytokine storm" and the acute respiratory distress syndrome, reducing lung inflammation at molecular, cellular and tissue level, reducing pulmonary oedema, relieving lung pain, increasing lung volume and exercise capacity (Nejatifard et al., 2021; de Brito et al., 2020; Fekrazad, 2020; Cury et al., 2016; de Lima et al., 2011).

The advantages of laser therapy are the following: the procedure is non-invasive, painless, it involves low costs compared to benefits, has no known side effects (reported) if the therapeutic parameters established in the studies are applied, and the epidemiological risk is low – non-contact application method (Fekrazad, 2020, quoted by da Cunha et al., 2018).

Method of application - use of low power laser emitting in the range of 905-808 nm, at a frequency of 1500 Hz, at a dose of 7.2 J/cm^2, 20 cm above the skin, with scanning of each lung field, from the apex to the lung bases, 1 session/ day, for 4 consecutive days (Sigman et al., 2020a; Sigman et al., 2020b).

c) Balneotherapy can be indicated between the rehabilitation stages within the hospital, the patients following treatment courses in resorts dedicated to the treatment and recovery of respiratory diseases. It consists of aerotherapy, fumarole, saline therapy, aerosols and inhalations with sodium chloride waters or iodinated waters (if the patient does not have a lung disease with a spastic component at the time of examination).

This therapy can be performed in resorts such as Turda, Praid, Ocnele Mari, Mangalia, Techirghiol, Eforie Nord, Tg. Ocna, Amara, Ocna Șugatag, Slănic Moldova, Slănic Prahova, Govora, Praid, Buziaș, Tușnad (for external treatment); Calimănești, Olănești, Herculane, Sacelu, Govora, Buziaș (for internal treatment) (Munteanu, 2013; Munteanu & Cinteză, 2011).

Therapeutic massage applied to the chest combined with physical therapy and electrotherapy has positive effects on increasing chest compliance with relief of dyspnoea, sputum, joint and muscle pain and decreased chest muscle contractions and subjective sensation of stiff chest. Preliminary research suggests that therapeutic chest massage in patients recovering from COVID-19 improves the remaining symptoms and increases quality of life (Wu et al., 2021).

Rehabilitation of extrapulmonary sequelae after COVID-19

The rehabilitation management of the patient after COVID-19 is determined by the severity of clinical manifestations and functional deficiencies caused by the possible damage to several organs and systems. Their long-term impact on post-COVID-19 individuals is unknown. Recent studies and research show that survivors of COVID-19 infection can develop various neurological, musculoskeletal, psychological, physical and cognitive disorders, most of them with multiple comorbidities (Stam et al., 2020).

All patients requiring rehabilitation after COVID-19 should receive a specialized functional assessment for neurological, musculoskeletal and cardiac symptoms, as well as psychological and cognitive screening to determine the causes of residual phenomena and to carry out appropriate rehabilitation interventions (Lazzeri et al., 2020).

Rehabilitation of patients who have been admitted to intensive care units and those with multiple comorbidities prior to COVID-19 disease requires a multidisciplinary therapeutic approach involving the multiprofessional rehabilitation team. Patients with post-intensive care syndrome or after intubation should follow a rehabilitation program focused on physical and cognitive impairments. For these patients, in addition to the classic physiotherapy and electrotherapy program, special treatment methods such as occupational therapy and speech therapy must be approached to ensure complexity and efficiency of long-term rehabilitation (Stam et al., 2020; Copotoiu, 2007; Vitacca et al., 2020).

Occupational therapy uses physical exercises from ordinary human activities - life, work, entertainment, and is oriented towards the functional and psychological level of the patient. The main objectives of occupational therapy in post-COVID recovery are to restore the ability to move in all its aspects (amplitude, strength, muscular endurance, ability and coordination), motor and psychomotor education or re-education, sensory re-education, family reintegration, re-adaptation and integration in social and professional fields, restoring gestures, retraining and adapting to the daily life of the patient, adapting to temporary or permanent disability secondary to the disease, achieving maximum possible independence, stimulating positive free thinking, independence in ADL, during transfers and gait. It is mainly addressed to patients who have been hospitalized in an intensive care unit and who have been sedated, mechanically ventilated and immobilized on the bed for a long time (Irsay et al., 2016; Scott, 2020).

In the post-COVID-19 recovery process it is important to adapt the environment to the patient's functional abilities under the guidance of an occupational therapist who evaluates the environment in which the patient lives and works after discharge from the hospital; useful adaptations to the patient's home may be the installation of handles in the bathroom, in the shower and on the stairwell, the adaptation of the toilet bowl, the use of orthoses to facilitate walking and the degree of independence, learning to use assistive devices (3); (Scott, 2020).

Speech therapy along with occupational therapy is indicated in patients with vocal impairment, speech and swallowing disorders secondary to prolonged intubation or in the context of neurological impairment during the disease. These patients are at risk for food aspiration and may have deficits in expression and communication. It is recommended to apply breathing re-education exercises, re-education of swallowing solids and liquids, vocal exercises, pronunciation correction, correction of voice disorders, rhythm and fluency, learning gestural communication techniques, stimulating expressive communication (3); (Stam et al., 2020).

Rehabilitation of neurological and cognitive complications is extremely important and screening is required in all patients who have presented with COVID-19 for neurological manifestations as they may be immediate (at the time of active infection) or delayed (in the weeks following COVID-19). Cognitive evaluation of patients who have been hospitalized in ICU or have a residual cognitive impairment is also recommended. We need to make sure that mild neurological symptoms such as headache, dizziness, loss of smell and/or taste and other sensory disorders will go away soon. Physical, cognitive and functional assessments must be taken into account to support socio-professional reintegration (4); (Lazzeri et al., 2020). For patients with cognitive, memory, attention impairment, memory exercises, reading or various games such as puzzle are indicated. It is also recommended to learn strategies and methods to reduce stress and anxiety associated with cognitive impairment, for emotional support of these patients, and also to learn compensatory techniques - dividing complex activities into simple activities (3); Stam et al., 2020; Wade, 2020).

Rehabilitation of cardiac complications is done through specific individually adapted cardiac rehabilitation programs based on the evaluation of cardiac dysfunctions. Patients after ultrasound-confirmed myocarditis who return to performance sports require a period of 3-6 months of complete rest. The rest period depends on the clinical severity and duration of the disease, on the function of the left ventricle (4); (Lazzeri et al., 2020).

The rehabilitation of chronic post-COVID-19 pain is done by a multidisciplinary medical team, in order to ensure complex pain management according to the principle of the bio-psycho-social model (Stam et al., 2020).

In case of emergence of a new medical condition during the rehabilitation program, the patient should be referred to a specialist for its management (Lazzeri et al., 2020).

Situations that require the interruption/timing of the rehabilitation program

Safety is an extremely important element for the rehabilitation of patients with COVID-19. The occurrence of the following red flags requires the cessation/timing and individualized adaptation of the rehabilitation programs:

- Low SaO2 (<95%)
- Changes in blood pressure (<90/60 mmHg or >140/90 mmHg)
- Tachycardia/Bradycardia (>100 beats per minute, or <50 beats per minute)
- Abnormal increase in body temperature (>37.2ºC)
- Dyspnoea
- Marked fatigue
- High intensity headache
- Balance disorders
- Retrosternal pain
- Severe cough
- Blurred vision
- Vertigo
- Feeling of palpitations
- Deep sweating (***, 2020; Matcovschi et al., 2011); (4)

Conclusions

1. SARS-CoV-2 infection can affect various organs and systems - respiratory, neurological, cardiac, ocular, gastrointestinal and other systems, having a strong impact on the functionality of affected patients, and in the long term it could cause various disabilities.

2. The severity and incidence of dysfunctionality and disability secondary to SARS-CoV-2 infection are still unknown, but early research suggests that these patients

will need rehabilitation at all stages of the disease - acute, post-acute and long-term.

3. The integrated medical rehabilitation service with the care of patients with SARS-CoV-2 offers advantages both for the patient and for the medical system in general.

4. Numerous clinical trials provide recommendations on interventions and principles for the organization of rehabilitation care for this category of patients.

5. The objectives of post-COVID-19 medical rehabilitation are to improve joint mobility, increase endurance and muscle strength, improve breathing, re-educate balance, correct swallowing disorders, adapt to exertion, re-educate ADLs, achieve functional independence, return to social, professional and recreational activities.

6. Functional evaluation of the patient who has undergone COVID-19 infection is performed by specialized medical rehabilitation clinical examination using accessible, easily applicable tests without overloading the patient and without additional costs.

7. Rehabilitation of pulmonary and extrapulmonary sequelae after COVID-19 includes kinesiotherapy, electrotherapy and balneotherapy programs, individualized for each patient.

8. Post-COVID-19 rehabilitation can be carried out at all levels: hospital, outpatient and home, including the use of telemedicine.

Conflicts of interests

The authors have no conflicts of interests.

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