



REHABILITATION SETTINGS DURING AND AFTER COVID-19: AN OVERVIEW OF RECOMMENDATIONS

Francesco AGOSTINI, MD¹, Massimiliano MANGONE, PhD¹, Pierangela RUIU, MD¹, Teresa PAOLUCCI, MD², Valter SANTILLI, MD¹ and Andrea BERNETTI, MD¹

From the ¹Department of Anatomical and Histological Sciences, Legal Medicine and Orthopedics, Sapienza University, Rome and ²Department of Medical, Oral and Biotechnological Sciences, G. D'Annunzio University of Chieti-Pescara, Chieti, Italy

Objective: The aim of this review is to identify the best evidence to define rehabilitative approaches to acute and post-acute phases of coronavirus 2019 (COVID-19) disease.

Methods: A literature search (of PubMed, Google Scholar, PEDro and Cochrane databases) was performed for relevant publications from January to April 2020.

Results: A total of 2,835 articles were retrieved, and the search resulted in a final total 31 published articles. A narrative synthesis of the selected articles was then performed. Some studies examine the effect of the pandemic on rehabilitation services and provide suggestions for a new reorganization of these services. Other studies focus on COVID-19 sequelae, formulating recommendations for rehabilitative interventions.

Conclusion: For COVID-19 patients, an integrated rehabilitative process is recommended, involving a multidisciplinary and multi-professional team providing neuromuscular, cardiac, respiratory, and swallowing interventions, and psychological support, in order to improve patients' quality of life. The intervention of a physician expert in rehabilitation should assess the patient, and a dedicated intervention set up after thorough assessment of the patient's clinical condition, in collaboration with all rehabilitation team professionals.

Key words: rehabilitation; COVID-19; recommendation.

Accepted Nov 24, 2020; Epub ahead of print Dec 7, 2020

J Rehabil Med 2021; 53: jrm00141

Correspondence address: Francesco Agostini, Department of Anatomical and Histological Sciences, Legal Medicine and Orthopedics, Physical Medicine and Rehabilitation, Sapienza University, Piazzale Aldo Moro 5, 00185, Rome, Italy. E-mail: francescoagostini.ff@gmail.com

In late December 2019, coronavirus 2019 (COVID-19) emerged in Wuhan, the capital city of Hubei province, China, and spread rapidly throughout the world, causing a large global outbreak and becoming a major health concern (1). In March 2020, the World Health Organization (WHO) declared COVID-19 a global pandemic and public health emergency (2).

The causative agent is the newly identified severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), initially named 2019 novel coronavirus (2019-nCoV) (3). It is a non-segmented, enveloped, positive-sense single-strand

LAY ABSTRACT

Rehabilitation, in a multidisciplinary and multi-professional setting, plays a pivotal role in the management of Covid-19 patients, focusing on respiratory and motor functions and it is therefore crucial to establish treatment strategies to guarantee an optimal recovery of these patients. We performed a review of the scientific literature. All the studies concerning respiratory rehabilitation treatments for Covid-19 patients were included. Respiratory rehabilitation has the goal of improve respiratory symptoms, preserve function and reduce complications and disability; it also has positive effects on the psychological sphere, reducing anxiety and depression that can frequently develop in this context.

RNA β -coronavirus (4), which may have been transmitted to humans from a potential reservoir in bats, through as-yet unknown intermediate hosts (5). Human-to-human transmission of COVID-19 occurs mainly through the respiratory tract, by inhalation of infected droplets (from symptomatic, but also asymptomatic people) and through direct contact (6, 7). The estimated incubation period is 1–14 days, mainly in the range 3–7 days (8).

COVID-19 infection displays a prevalence of respiratory involvement, being responsible for interstitial pneumonia, the major manifestation of the disease, which first led to identification of the pathogen (3, 9). It causes various degrees of illness, with a clinical picture ranging from asymptomatic cases to acute respiratory distress syndrome (ARDS) and multi-organ failure (10).

Symptoms include fever and dry cough (dominant manifestations), anosmia, sore throat, upper airway congestion, fatigue, headache, muscle ache, shortness of breath, and other signs of upper respiratory tract infection. Progression to pneumonia (mainly occurring in the second or third week of a symptomatic infection) (10, 11) is associated with a reduction in oxygen saturation, reduction in arterial blood gas exchange, extreme increase in inflammatory markers, and lymphopaenia (10). The clinical picture also correlates with bilateral ground glass opacities and patchy consolidations, seen on chest computed tomography (CT) (12, 13).

Diagnosis of COVID-19 infection can be made only through nucleic acid detection by real-time polymerase chain reaction (RT-PCR) in respiratory tract samples.

Since there is currently no approved treatment for COVID-19, management of the disease is based on

symptomatic and supportive treatments, mainly targeted at preserving hydration and nutrition and controlling fever and respiratory symptoms. Oxygen or non-invasive ventilation are necessary for hypoxic patients. In most severe cases mechanical ventilation is required, and even extra-corporeal membrane oxygen (ECMO), which is recommended by the WHO for patients with refractory hypoxaemia (14). Elderly people and patients with underlying comorbidities are more susceptible to developing complications, including ARDS, acute kidney injury, arrhythmias, cardiac injury, and liver dysfunction (15, 16).

Patients may undergo prolonged bed rest, leading to immobilization syndrome (17) associated with respiratory dysfunction, both of which might require rehabilitation interventions. Prolonged immobilization leads to muscle weakness, motor deconditioning, balance and postural impairment, and joint stiffness, pain and limitation, which have a strong impact on patients' general condition (17, 18).

Post-intensive care syndrome (PICS) refers to a new or worsening impairment of patient's physical, cognitive, or mental health status arising during stay in the intensive care unit (ICU) and persisting beyond ICU discharge or hospital discharge. These patients undergo various degrees of respiratory, physical and psychological distress (19, 20). It is essential that any rehabilitative intervention is customized to the specific condition of each patient, and that this should take into account, as already observed in SARS-CoV and MERS-CoV, that SARS-CoV-2 may also have a neurotropic effect, leading to neurological involvement, which may be partially responsible for acute respiratory failure in COVID-19 patients (21).

Indeed, it has recently been observed that SARS-CoV-2 is involved in neurological manifestations (22) in COVID-19 patients, including in the central nervous system (CNS) (e.g. dizziness, headache, impaired consciousness, acute cerebrovascular disease, ataxia, and seizure), peripheral nervous system (PNS) (e.g. impairments of taste, smell and vision, and nerve pain), and skeletal muscle injury (23). Cases of viral encephalitis and infectious toxic encephalopathy have been reported (24). Patients who had cerebrovascular disease were older, developed severe COVID-19 and underlying disorders, an increased inflammatory response, and a hypercoagulable state (25, 26). Neurological manifestations, apart from cerebrovascular disease and impairment of consciousness, have been reported early in the illness prior to the onset of COVID-19-related symptoms (23). Hence it is important to evaluate patients who present with neurological symptoms, to assess risk factors (25) and underlying disorders that indicate an early diagnosis of COVID-19 (23), enabling the recognition and management of complications and improving the prognosis (24).

The ongoing COVID-19 pandemic is placing great stress on healthcare systems, especially acute care departments, and is already having an impact on the rehabilitation community (17, 18, 27). In a multidisciplinary and multi-professional setting, rehabilitation plays a pivotal role in the management of patients with COVID-19, focusing on respiratory and motor functions. It is therefore crucial to establish rehabilitation treatment strategies that enable optimal recovery of these patients.

The aim of this study was to review the literature on COVID-19, in order to identify best evidence to define rehabilitative approaches to acute and post-acute phases of the disease.

MATERIAL AND METHODS

A systematic review was performed according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (28). A literature search (of PubMed, Google Scholar, PEDro and Cochrane databases) was performed from January to April 2020, using the following Medical Subject Headings (MeSH) terms and free-text terms: "COVID-19", "severe acute respiratory syndrome coronavirus 2", "2019-nCoV" OR "SARS-CoV-2" AND "rehabilitation", "respiratory rehabilitation" OR "pulmonary rehabilitation".

Three authors independently performed all searches and removed duplicate records. All studies regarding rehabilitation interventions and rehabilitation services for patients with COVID-19 were included. Given the recent and exponential spread of COVID-19, no date limits were applied to the search.

Studies for which the complete text could not be found or which did not address the rehabilitation treatments or services of COVID-19 patients were excluded.

All studies, in both English and Chinese languages, were included. Studies not published in English were translated by certified translators or by native speakers. Data extraction was performed independently by 3 researchers in Physical and Rehabilitation Medicine, and any inconsistencies were resolved through discussion and comparison of the data.

A narrative synthesis of the selected articles was performed.

RESULTS

Out of 2,835 retrieved articles, the search resulted in a final total of 31 relevant published articles. Fig. 1 shows the study selection process.

A range of different issues are addressed by the analysed articles. Some studies examine the effect of the pandemic on rehabilitation services and provide suggestions for a new reorganization of these services. Other studies focus on COVID-19 sequelae, formulating recommendations for rehabilitative interventions.

Rehabilitation services and reorganization

In a study published in March 2020, Koh et al. (29), describe several viable rehabilitative interventions for use in this global emergency. They suggest using tele-

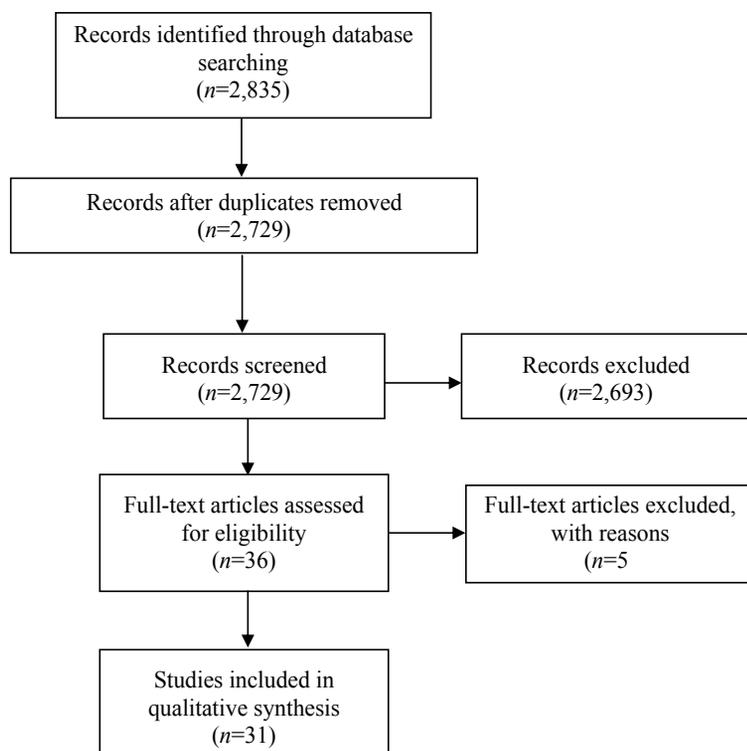


Fig. 1. Study flow-chart.

rehabilitation as a first option, where feasible, to enable supervision of rehabilitation without risk of exposure to the virus. An alternative is for patients to continue to perform previously prescribed exercises at home. Patients who need to attend rehabilitation centres must undergo checks prior to entrance. For inpatient rehabilitation, clinical conditions and symptoms must be monitored continuously, and protective measures employed, predisposing to isolation of positive patients in dedicated treatments rooms equipped with adequate staff and personal protective equipment (PPE). High levels of PPE, along with attention to infection control, are indicated, especially for rehabilitative team members, such as speech, swallowing and chest therapists. Koh et al. also suggest that healthcare teams working in direct contact with patients should be split into sub-teams, each sub-team being sufficiently skilled to resume the work of the others if one is unable to work. All contact between different sub-team members should be avoided in order to minimize the risk of infection.

Boldrini et al. (17) report the recommendations of the Italian Physical Medicine and Rehabilitation Society (SIMFER) to the rehabilitation community. For acute care patients they recommend providing rehabilitative treatments (aiming for clinical stability and prevention of complications) and further planning the subsequent clinical pathway. For inpatient settings

the recommendation is to provide rehabilitative treatments for patients arriving from acute care departments (including COVID-19 patients with sequelae), and to promote early discharge home to outpatient and community rehabilitation centres, depending on the patient's condition. For outpatient and home-based rehabilitation services SIMFER recommend providing care for patients with acute or chronic conditions whose treatments cannot be postponed. They also focus on protective measures, recommending social distancing measures, preventative identification of symptomatic cases, and use of PPE. In addition, they initiated a free-of-charge remote support "telerehabilitation" service in Italy, which aims to support patients, family members and caregivers in a safe way. These measures are also reported by Pedersini et al. (30), illustrating the situation in Italy during the pandemic.

Negrini et al. (31) describe factors implicated in stressing the rehabilitation sector, including differences in disease spread among regions, and regional variations in healthcare, social and rehabilitation services in Italy. In support of rehabilitation professionals, SIMFER produced an official document (17) and scheduled weekly webinars ("Covinars") to enable sharing of information about the experiences of rehabilitation teams and services from different areas.

Boldrini et al. (32) report the reorganization and adaption required of rehabilitation services, including conversion of beds, wards, hospitals, and closure of outpatient services, and observe the overall inadequate preparation of rehabilitation services to face a sudden epidemic (as acute services).

Similarly, Treger et al. (33) further report that, in Israel, most rehabilitation services closed, mainly due to cancellation of patient appointments due to infection risk. They proposed and applied a scheme to protect medical staff from exposure to infection as much as possible, in order to be able to provide the highest achievable level of rehabilitation care.

For people quarantined at home or with restricted mobility due to the lockdown Ceravolo et al. (34) suggest providing a multicomponent rehabilitation intervention for 5–7 days/week at moderate intensity, in order to avoid or reduce the risk of psycho-physical complications, preferring telerehabilitation for patients who are able to undergo this modality. They further contemplate work reorganization in outpatient and

inpatient facilities during the pandemic, recommending the adoption of safety measures for patients and staff.

Balkaya et al. (35), by virtue of their transition from rehabilitation to the medical unit, describe their positive experience in managing COVID-19 patients, based on close interaction with internal medicine and other units and a detailed transfer protocol, and suggest that patients with higher medical acuity are referred to medical service care. They further noticed that understanding the patient's psychiatric background (including a detailed psychiatric history, physical examination, assessment and plan) is an extremely effective tool and resource, even when applied to non-rehabilitation medical patient care.

These aspects are also addressed by Gitkind et al. (36), who focus on finding a safe way to deliver services to both COVID and non-COVID patients, and on the value of teamwork with other acute care units to make provision of rehabilitation an important role in the pandemic.

Stam et al. (37) emphasize the urgency of preparing for aftershock of the pandemic, through employment of a multi-professional team providing a global rehabilitation intervention. Wainwright et al. (38), further propose adoption of customized self-management strategies for long-term rehabilitation, in which patients are encouraged and educated (using technology) "to actively manage medical, lifestyle or emotional elements of their condition".

Vigorito et al. (39) describe the strong impact of the pandemic on cardiology settings, including cardiac rehabilitation, whose services in the COVID-19 era should be remodelled according to European Association of Preventive Cardiology (EAPC) recommendations. They observe that the challenge in this field will be to re-educate and encourage patients to refer to cardiology services when needed (since reduced access has been noted due to restrictive measures and patient refusal). Moreover, cardiac rehabilitation units should develop strategies to deal with cardiac patients who have developed COVID-19, and might be required to make changes in rehabilitation strategies due to COVID-related cardiovascular complications, although the medium-to long-term consequences of the disease are unknown.

Dalal et al. (40) state the need to implement innovative delivery models in cardiac rehabilitation, pointing out that "the urgency of maintaining access to evidence-based cardiac rehabilitation services from the safety of home, particularly during the current global pandemic, could not be greater".

Babu et al. (41), after the withdrawal of centred-based cardiac rehabilitation (CBCR) services due to

the pandemic, propose technology-driven cardiac rehabilitation (TDCR) as a potential alternative delivery model to provide cardiac rehabilitation to patients with cardiovascular disease. This new approach is similarly supported by Thomas et al. (42) and Yeo et al. (43), who state that embedding technology in the delivery of cardiac rehabilitation could provide a much-needed boost to such programmes, not only during, but also beyond, the COVID-19 outbreak.

Negrini et al. (44) provide feedback on the telerehabilitation experience, which was appreciated overall, and is likely to be embedded in rehabilitative services in the future.

Prada et al. (45) report strong positive feedback regarding telerehabilitation, which provided the possibility to evaluate and continue postsurgical rehabilitation on a Charcot-Marie-Tooth patient with suspected COVID-19.

Shanthanna et al. (46) focus on the repercussions for care of patients with chronic pain. They give recommendations for their management, emphasizing that is crucial to cancel elective surgical procedures, continue to provide medical and psychosocial assistance, using telehealth and classifying and prioritizing essential procedural visits (which should always take place with all protective measures) to avoid morbidity.

Solé et al. (47) report the consequences of the pandemic for management of neuromuscular patients in France. The French Rare Health Care for Neuromuscular Diseases Network (FILNEMUS) developed guidance to standardize management of these patients, and set up new website features to provide remote support (e.g. frequently asked questions (FAQ), provision of support systems for self-rehabilitation, and guided exercises).

Rehabilitative interventions for COVID-19 patients

For post-COVID-19 patients, McNeary (48) endorse rehabilitation involvement (in a safe environment, ensuring protection of staff and patients) for sequelae resulting from ARDS, ECMO, and prolonged prone position (posterior reversible encephalopathy syndrome, neuromuscular illness, plantar flexion contractures, and wounds), always taking account of respiratory distress, which might not allow the patient to tolerate intense therapies.

Yang et al. (49) set out respiratory rehabilitation guidelines based on the principle of 4S (simple, safe, satisfy, save), identifying measures for prevention or avoidance of symptom worsening and including a multidisciplinary and multi-professional intervention providing for total body, respiratory, swallowing exer-

cises and psychological support. This intervention can be carried out by patients at home, up to those under mechanical ventilation, with, for the latter, mandatory monitoring of vital parameters (especially oxygen saturation (SpO₂)) during exercises. The guidelines include adequate ventilation, cleaning and disinfection of treatment rooms. Total-body exercises should be performed according to patient abilities and needs, taking into account the low tolerance of critical patients. Two daily sessions are recommended, repeating each exercise 15–20 times. Yang et al. describe Zheng exercise, which includes air leg cycling, sit-ups and bridge exercises (which can be performed in ambient air, under oxygen, with non-invasive or invasive ventilation). For air cycling exercises the patient, in the supine position, flexes the knee joints to lift the lower limbs and simulates a cycling motion. For bridge exercise, the patient, from a supine position and feet on the bed, flexes the knee joints and lifts the hips approximately 10–15 cm off the bed. In the sit-up exercise, starting from a supine position and holding onto bed bars, the patient moves to a seated position, holds it for 5 min and returns to the start position. Respiratory rehabilitation for patients with dyspnoea, cough or expectorate production includes respiratory muscles and expectorate training, twice a day, 50 breaths each time. For digestive rehabilitation Yang et al. suggest frequent mobilization in bed and abdominal muscle contraction to improve abdominal circulation and digestion.

Chinese guidelines (50) describe rehabilitation interventions in COVID-19 patients in more detail, as described in the following paragraphs. After an essential initial assessment, it is advised that rehabilitation requires continuous monitoring of the patient's clinical condition, rehabilitation should be withdrawn in case of adverse effects, and should be performed with maximum safety for staff and patients. For patients in isolation, the use of videos and remote consultations is recommended, in order to save PPE resources and avoid cross-infection. After isolation, rehabilitation can continue, depending on the patient's condition. Chinese guidelines provide differentiated recommendations for different categories of COVID-19 patients.

For hospitalized patients with mild symptoms, an exercise (respiratory rehabilitation, tai chi or square dance) of ≤ 3 intensity on the Modified Borg Dyspnoea Scale is recommended, twice a day for 15–45 min, from 1 h after meals. Chinese guidelines also suggest psychological intervention and patient education to understand and deal with the disease.

Due to prolonged immobilization during ordinary hospitalization, patients could develop asthenia and

insufficient drainage of sputum. These guidelines (50) recommend airway cleaning, breathing control training and physical exercise. For breathing control, the patient is in a sitting position (or semi-sitting in case of shortness of breath), they relax the auxiliary inspiratory muscles of the shoulders and neck, slowly inhale through the nose, exhale slowly and observe the expansion of their lower chest. Physical exercise (respiratory rehabilitation, stepping, tai chi, and exercises to prevent deep venous thrombosis) is recommended, within the tolerance limits of these patients, for 15–45 min twice a day, starting from 1 h after meals. Patients who are prone to fatigue or frailty can undergo intermittent exercise.

In severe and critically ill patients, treatment should begin early (if inclusion criteria are met), carried out on the patient's bed, encompassing early physical activity, posture and breathing management. Early physical activity includes regular rollovers and bed activities, and transferring from bed to chair, sitting in the chair, standing and taking a step forward, in this order; it also comprises passive and active training of the joints. Patients with limited physical strength can reduce the intensity and range of activities, not exceeding 30 min of training, in order to avoid increased fatigue. Patients who are sedated, or who have cognitive or physical impairment, should undergo passive mobilization using dedicated devices, passive mobilization techniques, and neuromuscular electrical stimulation. Posture management, if allowed by the patient's physiological condition, gradually increases the simulated antigravity position until the patient cannot maintain a vertical position, such as a bed elevation of 60°. Breathing management mainly involves lung expansion and sputum control, paying attention not to induce a severe irritating cough, or increased respiratory work. High-frequency chest wall oscillation (HFCWO) or oscillatory positive expiratory pressure (OPEP) treatments are recommended by Chinese guidelines. These therapeutic intervention techniques should be chosen according to patient's consciousness and functional status. Respiratory rehabilitation is not recommended for unstable critical patients or those with progressive exacerbation.

The rehabilitation of mild and non-COVID patients after discharge has the primary goal of restoring physical performance and psychological adaptation. This could be performed through aerobic exercise to gradually recover patient's motor skills and promote social reintegration.

For critical patients, after discharge, respiratory rehabilitation comprises aerobic exercise, balance, resistance

and respiratory training. Aerobic exercise (e.g. walking, jogging, swimming) is recommended for patients with underlying conditions and residual disease, starting from low intensity, and increased gradually from 3 up to 5 times a week, 20–30 min each time. Intermittent exercise is suggested for patients who are prone to fatigue. Balance training (under the supervision of a rehabilitation therapist), if required, and progressive resistance training for strength training, are recommended in the Chinese guidelines (50). Respiratory training focuses on respiratory and sputum training, and includes body management, respiratory rhythm regulation, chest activity and respiratory muscle training.

Chinese guidelines (50) also focus on the importance of application of the evaluation scales, Basic Activities of Daily Living (BADL) and Instrumental Activities of Daily Living (IADL), with the aim of also setting up rehabilitative programmes for these aspects.

Regarding rehabilitation for primary, secondary and tertiary prevention of COVID-19, Li et al. (51) emphasize the need for rehabilitation in both acute and recovery phases of the disease, aiming to improve respiratory and motor function and the recovery of self-care in activities of daily living. They emphasize the great impact of early rehabilitation in this context, in reducing hospitalization, preventing and managing complications, reducing dysfunction and improving function and clinical efficacy. They further suggest the use of remote rehabilitation, leading to a new era of smart medicine.

In the above-mentioned rapid systematic review by Ceravolo et al. (34), it is also suggested to provide early adequate rehabilitative intervention for COVID-19 patients (appropriately monitored), performed by a multidisciplinary team with all protective measures.

Bajwah et al. (52) focus on the importance of intervening on symptoms and the psychological sphere, through pharmacological and non-pharmacological approaches (including breathing techniques to manage breathlessness) in patients with severe COVID-19 at the end of life.

Borg & Stam (53) also focus on the need for interventions in non-COVID patients requiring rehabilitation and, moreover, claim that COVID-19 consequences, including PICS, cardiovascular and neurological sequelae will require the intervention of PRM specialists in the long term. Mobilization of these patients will be a slow process, due to respiratory distress, lung fibrosis, cardiovascular deconditioning, and prolonged immobilization. The roles of psychological support and cognitive training are both crucial in this setting. These aspects are also reported by Chaler et al. (54), who furthermore suggest reinforcing research, physician and rehabilitation team formation in internal medicine and especially PICS assessment and management; and to allocate resources

to strengthen rehabilitation. Simpson et al. (20) focus on the same issues, emphasizing that rehabilitation should gain a role in acute services, early in pandemic response plans, and not only after the development of disability. Acute care rehabilitation should start early, via a global intervention provided by a multi-professional team, with passive and active mobilization performed in the ICU. They report on care in inpatient facilities and the relevance of pre-habilitation in the context of COVID-19, to educate patients and reinforce general health and public health measures.

Similarly, Kiekens et al. (55) stress the need to prepare for the post-acute phase and to tailor rehabilitative intervention, especially in severe cases. Acute phase rehabilitation starts after the decurarization phase, as early rehabilitation seems to not be tolerated with rapid desaturation. The weaning phase and transfer should be gradual. Communication between physician, patients and family is considered a focal point.

Thomas et al. (56), provide recommendations for the delivery of physiotherapy and management of COVID-19 in the acute care setting. Recommendations for physical therapists caring for patients with PICS in home- and community-based settings are provided by Smith et al. (57).

DISCUSSION

Reorganization of rehabilitation departments and services

The recommendations compiled in this review highlight the importance of reshaping rehabilitation departments and services to properly manage patients during the COVID-19 pandemic. New service settings should be designed in order to cope with COVID-19 patients, without neglecting care and therapeutic continuity for non-COVID patients.

Based on this review, we suggest the following recommendations for provision of rehabilitation services in the current pandemic:

- *Acute care:* treatment of patients to prevent major disabling complications, facilitating discharge and planning rehabilitative strategies for the subsequent rehabilitative pathway (17).
- *Inpatient rehabilitation settings:* provide rehabilitative treatment to patients coming from acute care departments (including COVID-19 patients), facilitate early safe discharge home, to outpatient and community rehabilitation centres, depending on the patient's condition (17).
- *Outpatient and home-based rehabilitation services:* provide care for patients with acute or chronic conditions whose treatments cannot be postponed,

- preferring, when possible, use of telerehabilitation (17, 34).
- *Telerehabilitation.* Consider telerehabilitation as a first choice for all patients who can undertake this type of intervention; this service allows the delivery of rehabilitation under supervision and provides psychological support with the risk of virus exposure (17, 29, 34, 40, 42, 43, 47, 51).
- *Safety.* Ensure adequate protective measures and equipment for healthcare workers (especially rehabilitative team members, e.g. speech, swallowing and chest therapists) and patients, and ensure safe environmental conditions (Table I) (17, 29, 34).

Recommendations for patients with COVID-19

Limited data on rehabilitative interventions are currently available, due to the early stage of the pandemic, the short window of time examined, and the unknown long-term consequences of the disease. Nonetheless, we conclude that rehabilitative intervention should be implemented in this context, for the disability that the disease entails, in the acute, post-acute and long-term periods. Indeed, for COVID-19 patients we recommend provision of an integrated rehabilitative process, involving a multidisciplinary and multi-professional team performing neuromuscular, cardiological, respiratory, swallowing interventions, psychological support and improving quality of life. Rehabilitation interventions should be preceded by a global clinical assessment from a physician expert in rehabilitation, including the use of evaluation scales, in order to clearly define the clinical picture.

In more detail, we propose the following suggestions to cope with different phases and severity of the disease.

Acute rehabilitation

- *Hospitalized patients with mild COVID-19:* neuromuscular and respiratory rehabilitation is suggested, along with provision of psychological support (50).

- *Hospitalized severe stable patients with COVID-19:* early global rehabilitation (when inclusion criteria are met) delivered by a multi-professional team, providing swallowing exercises, psychological support, neuromuscular and respiratory interventions including passive and active mobilization, posture and breathing management. Patients sedated, or with cognitive or physical impairment, should undergo passive mobilization through dedicated devices, passive mobilization techniques and neuromuscular electrical stimulation (20, 50, 52).
- *Hospitalized severe unstable COVID-19 patients or those with progressive exacerbation:* respiratory rehabilitation is not recommended (50).

Post-acute rehabilitation

- *Mild COVID-19 patients after discharge:* aerobic exercise and psychological intervention to gradually restore the patient’s motor skills and promote social reintegration (50, 58).
- *Severe COVID-19 patients after discharge:* Integrated and customized programme encompassing neuromuscular, cardiac, swallowing, and respiratory rehabilitation. Aerobic exercise is suggested, starting at low intensity and gradually increasing. Intermittent exercise can be used for patients who are prone to fatigue. Strength and balance along with respiratory training are suggested (40, 50).

Long-term rehabilitation.

Little information regarding long-term rehabilitation emerged from this review, as it is based on a narrow period of time referring to the early phase of the pandemic. Nevertheless, we expect that rehabilitative interventions will be required for long-term treatment to provide therapeutic continuity to COVID-19 patients. Individualized self-management strategies and telerehabilitation could be also valuable for long-term rehabilitation (38) (Table II).

Monitoring and communication.

All these intervention techniques must be delivered under continuous monitoring of clinical conditions

Table I. Rehabilitation department and service reorganization in the context of COVID-19

Setting	Scope
Acute care	Prevent major disabling complications, facilitating discharge and planning rehabilitative strategies (17).
Inpatient rehabilitation (Patients from acute care departments)	Ensure rehabilitative treatment to patients coming from acute care departments (including COVID-19 patients) and facilitate early discharge (17).
Outpatient and home-based rehabilitation	Guarantee care of patients with acute or chronic conditions whose treatments cannot be postponed, with a preference for telerehabilitation employment, when possible (17, 34).
Telerehabilitation	For all patients who can undergo this kind of intervention (17, 29, 34, 40, 42, 43, 47, 51).
Protective measures and equipment	For both healthcare workers (especially rehabilitative team members, e.g. speech, swallowing and chest therapists) and patients (17, 29, 34).

Table II. Global clinical assessment. All these intervention techniques must be delivered under continuous monitoring of clinical conditions and withdrawn in case of adverse effects. Moreover, it is crucial to maintain communication among physician, patients and family and to provide psychological support during the entire course of rehabilitation

Patients	Recommendations
<i>Acute phase</i>	
Hospitalized patients with mild COVID-19	Neuromuscular and respiratory rehabilitation is suggested (50). Integrated rehabilitation programme must start early (when inclusion criteria are met) and includes swallowing exercises, neuromuscular and respiratory interventions. Patients sedated, or with cognitive of physical impairment, should undergo passive mobilization through dedicated devices, passive mobilization techniques and neuromuscular electrical stimulation (20, 50, 52).
Hospitalized severe stable patients with COVID-19	
Hospitalized severe unstable COVID-19 patients or those with progressive exacerbation	Respiratory rehabilitation is not recommended (50).
<i>Post-acute phase</i>	
Mild COVID-19 patients after discharge	Aerobic exercise and psychological intervention to gradually restore the patient’s motor skills and promote social reintegration (50). Integrated and customized programme encompassing neuromuscular, cardiac, swallowing, and respiratory rehabilitation. Aerobic exercise is suggested, starting from low intensity, and gradually increased. Intermittent exercise can be used for patients who are prone to fatigue. Strength and balance along with respiratory training are suggested. Individualized self-management strategies and telerehabilitation could be valuable for long-term rehabilitation (40, 50).
Severe COVID-19 patients after discharge	

and withdrawn in case of adverse effects. Moreover, it is crucial to maintain communication between physician, patients and family and to provide psychological support during the course of all rehabilitation interventions.

Study limitations

A limitation of this review is that there were few available objective data on rehabilitation needs. In addition, the analysed articles were based mainly on previous research. Nevertheless, in the same way that previous research provides evidence that wearing masks prevents the spread of COVID-19, it could also provide evidence of the rehabilitation that will be required as consequence of COVID-19-related disability. Formulation of recommendations is necessary to provide guidance to rehabilitation professionals dealing with this new, precarious, and still not completely defined, situation.

This review highlights the need to provide a complete and integrated rehabilitation programme, involving a multidisciplinary and multi-professional team, with the aim of fully recovering the patient’s clinical condition and improving their quality of life. Based on the evidence, we conclude that a physician expert in rehabilitation should assess the patients’ clinical condition, in collaboration with all rehabilitation team professionals, before setting up tailored interventions.

In this context, implementation of a tailored gradual respiratory rehabilitation plan is crucial, based on the patient’s abilities, needs and comorbidities. Respiratory rehabilitation aims to improve respiratory symptoms, preserve function and reduce complications and disability; it also has positive psychological effects, reducing anxiety and depression, which develop frequently in this context.

Considering that we are dealing with a completely new and precarious situation, which is con-

stantly evolving, further studies are needed in order to assess and define the best rehabilitative approach to the COVID-19 pandemic.

The authors have no conflicts of interest to declare.

REFERENCES

1. Wang C, Horby PW, Hayden FG, Gao GF. A novel coronavirus outbreak of global health concern. *Lancet* 2020; 395: 470–473.
2. World Health Organization (WHO). WHO statement on cases of COVID-19 surpassing 100.000. Geneva: WHO. [accessed 2020 Mar 12]. Available from: <https://www.who.int/news-room/detail/07-03-2020-who-statement-on-cases-of-covid-19-surpassing-100-000> [updated 2020 Mar 7].
3. Guo YR, Cao QD, Hong ZS, Tan YY, Chen SD, Jin HJ, et al. The origin, transmission and clinical therapies on coronavirus disease 2019 (COVID-19) outbreak – an update on the status. *Mil Med Res* 2020; 7: 11.
4. Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al. China Novel Coronavirus Investigating and Research Team. A novel coronavirus from patients with pneumonia in China, 2019. *N Engl J Med* 2020; 382: 727–733.
5. Giovanetti M, Benvenuto D, Angeletti S, Ciccozzi M. The first two cases of 2019-nCoV in Italy: where they come from? *J Med Virol* 2020; 92: 518–521.
6. Li Q, Guan X, Wu P, Wang X, Zhou L, Tong Y, et al. Early transmission dynamics in Wuhan, China, of novel coronavirus-infected pneumonia. *N Engl J Med* 2020; 382: 1199–1207.
7. Rothe C, Schunk M, Sothmann P, Bretzel G, Froeschl G, Wallrauch C, et al. Transmission of 2019-nCoV infection from an asymptomatic contact in Germany. *N Engl J Med* 2020; 382: 970–971.
8. Jin YH, Cai L, Cheng ZS, Cheng H, Deng T, Fan YP, et al. For the Zhongnan Hospital of Wuhan University Novel Coronavirus Management and Research Team, Evidence-based medicine chapter of China International Exchange and Promotive Association for Medical and Health Care (CPAM). A rapid advice guideline for the diagnosis and treatment of 2019 novel coronavirus (2019-nCoV) infected pneumonia (standard version). *Mil Med Res* 2020; 7: 4.
9. Chan JF, Yuan S, Kok KH, To KK, Chu H, Yang J, et al. A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: a study of a family cluster. *Lancet* 2020; 395: 514–523.
10. Chen N, Zhou M, Dong X, Qu J, Gong F, Han Y, et al. Epidemiological and clinical characteristics of 99 cases of

- 2019 novel coronavirus pneumonia in Wuhan, China: a descriptive study. *Lancet* 2020; 395: 507–513.
11. Velavan TP, Meyer CG. The COVID-19 epidemic. *Trop Med Int Health* 2020; 25: 278–280.
 12. Chung M, Bernheim A, Mei X, Zhang N, Huang M, Zeng X, et al. CT imaging features of 2019 novel coronavirus (2019-nCoV). *Radiology* 2020; 295: 202–207.
 13. Guan WJ, Ni ZY, Hu Y, Liang WH, Ou CQ, He JX, et al. Clinical characteristics of coronavirus disease 2019 in China. *N Engl J Med* 2020; 382: 1708–1720.
 14. World Health Organization (WHO). Clinical management of severe acute respiratory infection when novel coronavirus (nCoV) infection is suspected. Geneva: WHO. [accessed 2020 Jan 28]. Available from: [https://www.who.int/publicationsdetail/clinical-management-of-severe-acute-respiratory-infection-when-novelcoronavirus-\(ncov\)-infection-is-suspected](https://www.who.int/publicationsdetail/clinical-management-of-severe-acute-respiratory-infection-when-novelcoronavirus-(ncov)-infection-is-suspected)
 15. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, et al. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. *JAMA* 2020; 323: 1061–1069.
 16. Yang X, Yu Y, Xu J, Shu H, Xia J, Liu H, et al. Clinical course and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: a single-centered, retrospective, observational study. *Lancet Respir Med* 2020; 8: 475–481.
 17. Boldrini P, Bernetti A, Fiore P. SIMFER Executive Committee and SIMFER Committee for international affairs. Impact of COVID-19 outbreak on rehabilitation services and Physical and Rehabilitation Medicine (PRM) physicians' activities in Italy. An official document of the Italian PRM Society (SIMFER). *Eur J Phys Rehabil Med* 2020; 56: 316–318.
 18. Brugliera L, Spina A, Castellazzi P, Cimino P, Tettamanti A, Houdayer E, et al. Rehabilitation of COVID-19 patients. *J Rehabil Med* 2020; 52: 1–3.
 19. Inoue S, Hatakeyama J, Kondo Y, Hifumi T, Sakuramoto H, Kawasaki T, et al. Post-intensive care syndrome: its pathophysiology, prevention, and future directions. *Acute Med Surg* 2019; 6: 233–246.
 20. Simpson R, Robinson L. Rehabilitation following critical illness in people with COVID-19 infection. *Am J Phys Med Rehabil* 2020; 99: 470–474.
 21. Li YC, Bai WZ, Hashikawa T. The neuroinvasive potential of SARS-CoV2 may play a role in the respiratory failure of COVID-19 patients. *J Med Virol* 2020; 92: 552–555.
 22. Coraci D, Fusco A, Frizziero A, Giovannini S, Biscotti L, Padua L. Global approaches for global challenges: The possible support of rehabilitation in the management of COVID-19. *J Med Virol* 2020; 92: 1739–1740.
 23. Mao L, Jin H, Wang M, Hu Y, Chen S, He Q, et al. Neurologic manifestations of hospitalized patients with coronavirus disease 2019 in Wuhan, China. *JAMA Neurol* 2020; 77: 683–690.
 24. Wu Y, Xu X, Chen Z, Duan J, Hashimoto K, Yang L, et al. Nervous system involvement after infection with COVID-19 and other coronaviruses. *Brain Behav Immun* 2020; 87: 18–22.
 25. Madjid M, Safavi-Naeini P, Solomon SD, Vardeny O. Potential effects of coronaviruses on the cardiovascular system: a review. *JAMA Cardiol* 2020; 5: 831–840.
 26. Beyrouiti R, Adams ME, Benjamin L, Cohen H, Farmer SF, Goh YY, et al. Characteristics of ischaemic stroke associated with COVID-19. *J Neurol Neurosurg Psychiatry* 2020; 91: 889–891.
 27. Carda S, Invernizzi M, Bavikatte G, Bensmaïl D, Bianchi F, Deltombe T, Draulans N, Esquenazi A, Francisco GE, Gross R, Jacinto LJ, Moraleda Pérez S, O'Dell MW, Reebye R, Verdusco-Gutierrez M, Wissel J, Molteni F. The role of physical and rehabilitation medicine in the COVID-19 pandemic: The clinician's view. *Ann Phys Rehabil Med* 2020; 63: 554–556.
 28. Moher D, Liberati A, Tetzlaff J, Altman DG; PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *BMJ* 2009; 339: b2535.
 29. Choon-Huat Koh G, Hoening H. How should the rehabilitation community prepare for 2019-nCoV? *Arch Phys Med Rehabil* 2020; 101: 1068–1071.
 30. Pedersini P, Corbellini C, Villafañe JH. Italian Physical therapists' response to the novel COVID-19 emergency. *Phys Ther* 2020; 100: 1049–1051.
 31. 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; 56: 313–315 .
 32. Boldrini P, Kiekens C, Bargellesi S, Brianti R, Galeri S, Lucca L, et al. First impact on services and their preparation. "Instant paper from the field" on rehabilitation answers to the Covid-19 emergency. *Eur J Phys Rehabil Med* 2020; 56: 319–322.
 33. Treger I, Lutsky Treger L, Friedman A. Organization of acute patients' transfer to rehabilitation services during COVID-19 crisis. *Eur J Phys Rehabil Med* 2020; 56: 366.
 34. Ceravolo MG, 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; 56: 347–353.
 35. Balkaya IY, Fernandez JA, Gerguis W, Kaner MT, Lamagna M, Lekshminarayanan A, et al. When Physical medicine and rehabilitation became medicine – life in the time of COVID-19. *Am J Phys Med Rehabil* 2020; 99: 480–481.
 36. Gitkind AI, Levin S, Dohle C, Herbold J, Thomas M, Oh-Park M, et al. Redefining pathways into acute rehabilitation during the COVID-19 crisis. *PM R* 2020; 12: 837–841.
 37. Stam HJ, Stucki G, Bickenbach J. Covid-19 and post intensive care syndrome: a call for action. *J Rehabil Med* 2020; 52: jrm00044.
 38. Wainwright TW, Low M. Beyond acute care: Why collaborative self-management should be an essential part of rehabilitation pathways for COVID-19 patients. *J Rehabil Med* 2020; 52: jrm00055.
 39. Vigorito C, Faggiano P, Mureddu GF. COVID-19 pandemic: what consequences for cardiac rehabilitation? *Monaldi Arch Chest Dis* 2020; 90.
 40. Dalal H, Taylor RS, Greaves C, Doherty PJ, McDonagh ST, van Beurden SB, Purcell C; REACH-HF Study Group. Correspondence to the EJPC in response to position paper by Ambrosetti M et al. 2020: Cardiovascular rehabilitation and COVID-19: The need to maintain access to evidence-based services from the safety of home. *Eur J Prev Cardiol* 2020 Apr 28: 2047487320923053.
 41. Babu AS, Arena R, Ozemek C, Lavie CJ. COVID-19: a time for alternate models in cardiac rehabilitation to take center stage. *Can J Cardiol* 2020; 36: 792–794.
 42. Thomas E, Gallagher R, Grace SL. Future-proofing cardiac rehabilitation: Transitioning services to telehealth during COVID-19. *Eur J Prev Cardiol* 2020 Apr 23: 2047487320922926.
 43. Yeo TJ, Wang YL, Low TT. Have a heart during the COVID-19 crisis: Making the case for cardiac rehabilitation in the face of an ongoing pandemic. *Eur J Prev Cardiol* 2020; 27: 903–905.
 44. Negrini S, Kiekens C, Bernetti A, Capecci M, Ceravolo MG, Lavezzi S, et al. 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; 56: 327–330
 45. Prada V, Bellone E, Schenone A, Grandis M. The suspected SARS-Cov-2 infection in a Charcot-Marie-Tooth patient undergoing postsurgical rehabilitation: the value of tele-rehabilitation for evaluation and continuing treatment. *Int J Rehabil Res* 2020; 43: 285–286.
 46. Shanthanna H, Strand NH, Provenzano DA, Lobo CA, Eldabe S, Bhatia A, et al. Caring for patients with pain during the COVID-19 pandemic: consensus recommendations from an international expert panel. *Anaesthesia* 2020; 75: 935–944.
 47. Solé G, Salort-Campana E, Pereon Y, Stojkovic T, Wahbi

- K, Cintas P, et al. Guidance for the care of neuromuscular patients during the COVID-19 pandemic outbreak from the French Rare Health Care for Neuromuscular Diseases Network. *Rev Neurol (Paris)*. 2020; 176: 507–515.
48. McNeary L, Maltser S, Verduzco-Gutierrez M. Navigating coronavirus disease 2019 (Covid-19) in physiatry: a CAN Report for inpatient rehabilitation facilities. *PM R* 2020; 12: 512–515.
49. Yang F, Liu N, Hu JY, Wu LL, Su GS, Zhong NS, et al. 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* 2020; 43: 180–182.
50. Zhao HM, Xie YX, Wang C. Recommendations for respiratory rehabilitation in adults with COVID-19. *Chin Med J (Engl)* 2020; 133: 1595–1602.
51. Li J. Effect and enlightenment of rehabilitation medicine in COVID-19 management. *Eur J Phys Rehabil Med* 2020; 56: 335–338.
52. Bajwah S, Wilcock A, Towers R, Costantini M, Bausewein C, Simon ST, et al. Managing the supportive care needs of those affected by COVID-19. *Eur Respir J* 2020; 55: 2000815.
53. Borg K, Stam H. Editorial: Covid-19 and physical and rehabilitation medicine. *J Rehabil Med* 2020; 52: jrm00045.
54. Chaler J, Gil-Fraguas L, Gómez-García A, Laxe S, Luna-Cabrera F, Llavona R, et al. Impact of coronavirus disease 2019 (covid-19) outbreak on rehabilitation services and physical medicine and rehabilitation (PM&R) physicians' activities: perspectives from the Spanish experience. *Eur J Phys Rehabil Med* 2020; 56: 369–371.
55. Kiekens C, Boldrini P, Andreoli A, Avesani R, Gamna F, Grandi M, et al. 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. *Eur J Phys Rehabil Med* 2020; 56: 323–326.
56. Thomas P, Baldwin C, Bissett B, Boden I, Gosselink R, Granger CL, et al. Physiotherapy management for COVID-19 in the acute hospital setting: clinical practice recommendations. *J Physiother* 2020; 66: 73–82.
57. Smith JM, Lee AC, Zeleznik H, Coffey Scott JP, Fatima A, Needham DM, et al. Home and community-based physical therapist management of adults with post-intensive care syndrome. *Phys Ther* 2020; 100: 1062–1073.
58. Masiero S, Maccarone MC, 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. *Int J Biometeorol* 2020; 64:1807–1809.