

A Clinical Review of Physical Rehabilitation Protocol and Early Mobilization Patterns for Post-COVID-19 Patients: Tertiary Healthcare Facility Experience

Takroni Mohammed^{1*}, Al-Thumayri Abdulaziz¹, Poulouse Shiji², Al-Eissa, Sarah¹, Mohammed Ahmed³ and Al-Zahrani Mohammed¹

¹ Physical. Rehabilitation Dept. King Faisal Specialist Hospital and Research Center, Riyadh, KSA

² Critical Care Nursing Dept. King Faisal Specialist Hospital and Research Center, Riyadh, KSA

³ Respiratory Services Dept. King Faisal Specialist Hospital and Research Center, Riyadh, KSA

ABSTRACT

Several studies have emphasized the urgent need for Physical Rehabilitation guidelines for COVID-19 patients and the effect of Early Mobilization in these patients. Previous reports revealed that dealing with COVID-19 patients was based on expert opinion, evidence from patients with other lung diseases, and not on the recent literature concerning COVID-19. International guidelines have also reported that early mobilization is safe and feasible, starting in the ICU setting. Therefore, this clinical literature review aimed to designate the indications for physical rehabilitation programs and early mobilization benefits to add to the existing literature the necessary up-to-date recommendations and to share the experience of a tertiary healthcare facility in the Kingdom of Saudi Arabia (KSA) in dealing with different stages of post-COVID-19 patients.

Conclusion: The multidisciplinary approach of KFSH&RC for rehabilitating COVID-19 patients was integrated through early mobilization and remarkable follow-up of different clinical service divisions, including physical and occupational rehabilitation, respiratory therapy, and nutrition, with the collaboration of the medical and psychological teams aiming to regain optimal physical function, psychological well-being, and better quality of life for those populations.

*Corresponding author

Mohammed Takroni, Cardiopulmonary Rehabilitation Specialist, Physical Rehabilitation Department, King Faisal Specialist Hospital & Research Center, Riyadh, Saudi Arabia.

Received: July 05, 2023; **Accepted:** July 13, 2023; **Published:** July 20, 2023

Keywords: ICU, Early Mobilization, COVID-19, Rehabilitation, Respiratory-Care, KSA.

Introduction

Patients with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), Known as a novel severe acute respiratory syndrome coronavirus (COVID-19) may have different symptoms [1]. Some individuals may present with no or mild symptoms that do not require hospitalization, whereas others may present with severe symptoms that require hospital or intensive care unit (ICU) admission. Studies have stated that approximately 14% of individuals present with severe forms of COVID-19 symptoms requiring hospitalization and oxygen therapy; however, only 5% present with severe symptoms that necessitate admission to the ICU [2, 3]. COVID-19 symptoms may include numerous comorbidities such as respiratory failure, physical deconditioning, muscle weakness, acute cerebrovascular diseases, and or acute cardiac injury [4-6]. Studies have reported that in the ICU, COVID-19 patients may be exposed to infections, including ventilator-associated pneumonia, catheter-associated bloodstream infections, urinary tract infections, venous thromboembolism (VTE), delirium, myopathies, and neuropathies related to critical

illness and stress ulcers, and some patients develop neurological complications, psychological disorders, and cognitive impairments [7-11]. Other studies also showed that the incidence of ICU-acquired weakness (ICU-AW) ranges from 25 to 31% with approximately 3.25 – 6.2 million new patients annually [12, 13]. ICU-AW varies depending on age, sex, primary disease, and treatment. Up to 70% of the elderly patients in the ICU experience complications due to muscle atrophy. According to current studies, ICU-AW incidence is estimated to be 40% in patients on mechanical ventilation for > 7 days. It has been proven that skeletal muscle mass is correlated with immune function and glucose and protein metabolism, and such patients have significantly higher mortality [14]. It has been recognized that reviewed data on Musculoskeletal dysfunction after acute critical illness is very common in the ICU setting, and about 25% of patients have muscle weakness [13,14]. A study of 116 patients reported that a reduction in limb strength was associated with respiratory muscle weakness and delayed weaning from mechanical ventilation. This study concluded that if these symptoms were not enclosed by early exercise and mobilization programs, they may lead to prolonged ICU and hospital length of stay (LOS) [15]. Most previous studies and reports indicate an urgent need to develop

rehabilitation recommendations for COVID-19 patients that aim to guide the rehabilitation field and healthcare professionals to ensure safe and effective practice [15, 16]. These recommendations can guide clinicians to the essential early rehabilitation programs for COVID-19 patients, which have been poorly utilized during and after the pandemic. Existing guidelines in the Kingdom of Saudi Arabia (KSA) are primarily oriented toward respiratory problems, showing a clear limitation on the importance of early mobilization and the role of physical and occupational rehabilitation in these populations. The term “early mobilization (EM)” refers to an implementation of physiotherapy programs (passive or active mobilization, breathing exercise, respiratory muscle training, etc.) in addition to new mobilization techniques using equipment such as an ergometer cycle, or neuromuscular electrical stimulation at early stages of patient hospital stay [17]. EM for post-COVID-19 and ICU patients require interdisciplinary team cooperation and can be performed by different health professionals, particularly physiotherapists, respiratory therapists occupational therapists and nursing teams [9, 16,18-20]. Therefore, this review aimed to highlight the indications for physical rehabilitation programs and early mobilization benefits, add to the existing guidelines the

necessary up-to-date recommendations, and share the experience of a tertiary healthcare facility in dealing with different stages of post-COVID-19 conditions.

Stages and definitions of COVID-19

The Infection Control and Hospital Epidemiology (ICHE) Department at King Faisal Specialist Hospital and Research Center (KFSH&RC) developed adult guidelines for the management of COVID-19 and categorize COVID-19 patients into stages according to their symptoms [21]. These symptoms were divided into four categories according to the severity of the disease, severity of the symptoms, requirement for hospital ICU admission, and necessity for mechanical ventilation. Since there are minor variations in the severity of COVID-19, the ICHE department followed the Saudi Ministry of Health (MOH) classifications which adopted from the World Health Organization (WHO)’s classification and definition of COVID-19 severity for adults [1,22]. The stages and definitions of the COVID-19 patients are shown in Table 1.

Table 1: Stages & Definition of COVID-19 [22]

STAGES	DEFINITIONS
Stage A: ASYMPTOMATIC	Patients with no signs or symptoms of infection
Stage B: MILD INFECTION	Patients with upper respiratory tract infection symptoms and other mild symptoms (including fever and gastrointestinal symptoms) without evidence of pneumonia
Stage C: MODERATE INFECTION	Patients with hypoxia with oxygen saturation less than 93% at rest or the presence of pneumonia not requiring ICU admission
Stage D: SEVERE INFECTION	Patients with pneumonia requiring ICU admission or any of the following: <ol style="list-style-type: none"> 1. Respiratory rate of 30 breaths/min 2. Arterial oxygen partial pressure to fractional inspiratory oxygen ratio (PaO2/FiO2) less than 300 3. More than 50% lung involvement on imaging within 24-48 hours 4. Critical respiratory failure requiring mechanical ventilation, septic shock, or multi-organ dysfunction
HIGH-RISK PATIENTS	Any patient with COVID-19 with any of the following: <ol style="list-style-type: none"> 1. Age more than 60 years old 2. History of pulmonary disease 3. Chronic kidney disease 4. History of atherosclerotic cardiovascular disease 5. Diabetes mellitus 6. Hypertension 7. History of solid organ or stem cell transplantation 8. Human immunodeficiency virus (HIV) positive 9. On chemotherapy or other immunosuppressive medications 10. Second or third-trimester pregnancy

Impact of Early Mobilization on Post COVID-19

Limitations in movement, prolonged bed rest, and immobilization of COVID-19 patients in the ICU are standard practices, especially for sick patients requiring sedation and mechanical and high-alert drug therapy [23]. Although these restrictions are essential parts of the delivered care for COVID-19 patients in the ICU, they may cause serious physical and psychological damage. It has been observed that during their hospitalization period and even after their discharge from the hospital, patients often exhibit neuromuscular weakness, reduced cognitive function, and various psychological side effects. In addition, patients with COVID-19 admitted to the ICU may have multiple organ failures, including ARDS, acute kidney injury, cardiac injury,

and liver dysfunction [24]. In association with these factors, mechanical ventilation duration in the ICU is another factor associated with acquired weakness, which is widely accepted to describe the difficult situations experienced by ICU patients. Studies have reported that approximately 75-80% of patients hospitalized with COVID-19 have prolonged hospital stays of approximately 21 days [25, 26]. Muscle weakness and nerve damage started on the first day of hospitalization. Some of these patients have associated comorbidities, such as advanced age, renal dysfunction, hypertension, diabetes, and heart disease, which may contribute to the incidence of ICU-AW [12, 13, 15]. All these factors contribute to immobility, which, in turn, has deleterious effects on the cardiorespiratory, nervous, musculoskeletal systems,

and metabolism, leading to major changes in the patient's daily life and reduced quality of life [26]. Therefore, the immediate action of early mobilization intervention must be taken for these special populations to prevent their complications, improve muscle power, decrease ICU and hospital length of stay, and improve their quality of life through evidence-based practice guidelines and the experience of healthcare providers. Several international guidelines support early mobilization and have reported that it is safe and feasible in the ICU setting [27- 29].

Evidence on EM, and Exercise Program

Earlier reports specified that dealing with COVID-19 patients was not dependent on recent literature, but was mostly based on expert opinion and evidence from patients with other lung diseases [30]. Numerous clinical trials have emphasized the need for urgent up-to-date guidelines on the rehabilitation of COVID-19 patients [2, 30, 31]. A study by Schweickert et al. also stated that EM and Rehabilitation have significant benefits for ICU patients in terms of functional capacity upon discharge from the hospital and should be initiated as early as possible. Several randomized control trials (RCT) and meta-analyses have specified that EM intervention for COVID-19 patients helps reduce the deleterious effects of the disease on cardiopulmonary function, mobility, muscle weakness, and functionality [32-34]. In addition, recent reviews by Goodwin et al. and Bernal-Utrera et al. reported that physical therapy exercise, early mobilization, and multi-component programs are necessary strategies to improve recovery after ICU admission for severe respiratory illness and contribute to patient stability during critical periods for patients with COVID-19 [35,36].

Referring COVID-19 patients to Physical Rehabilitation

In the KFSHRC, the patients' referral system follows the Saudi Ministry of Health (MOH) guidelines referral system [22]. If a COVID-19 patient is admitted to the ICU will be assessed by the ICU multidisciplinary COVID-19 team. If the patient is hemodynamically stable, the team will refer the patient to Physical Rehabilitation Services or other clinical service facilities. Patients can also be referred to Physical Rehabilitation services by other services involved in patient care, such as pulmonologists, internal medicine physicians, or other medical services. The Physiotherapist (PT) will review the eligibility of the patient's condition and will evaluate the patient from all aspects. Including physical and psychological aspects, Previous history of any current illness, level of consciousness, respiratory condition, muscle strength, range of motion (ROM), functional status, and bed and out of bed mobility will be assessed too. The Physical Therapist then selects a suitable intervention and discusses it with the COVID-19 team.

PT Program for COVID-19 Patients & When to Start!

The assessment of COVID-19 patients should be completed before starting EM, and the goals of the physical rehabilitation program should be initially decided. It is also essential to know

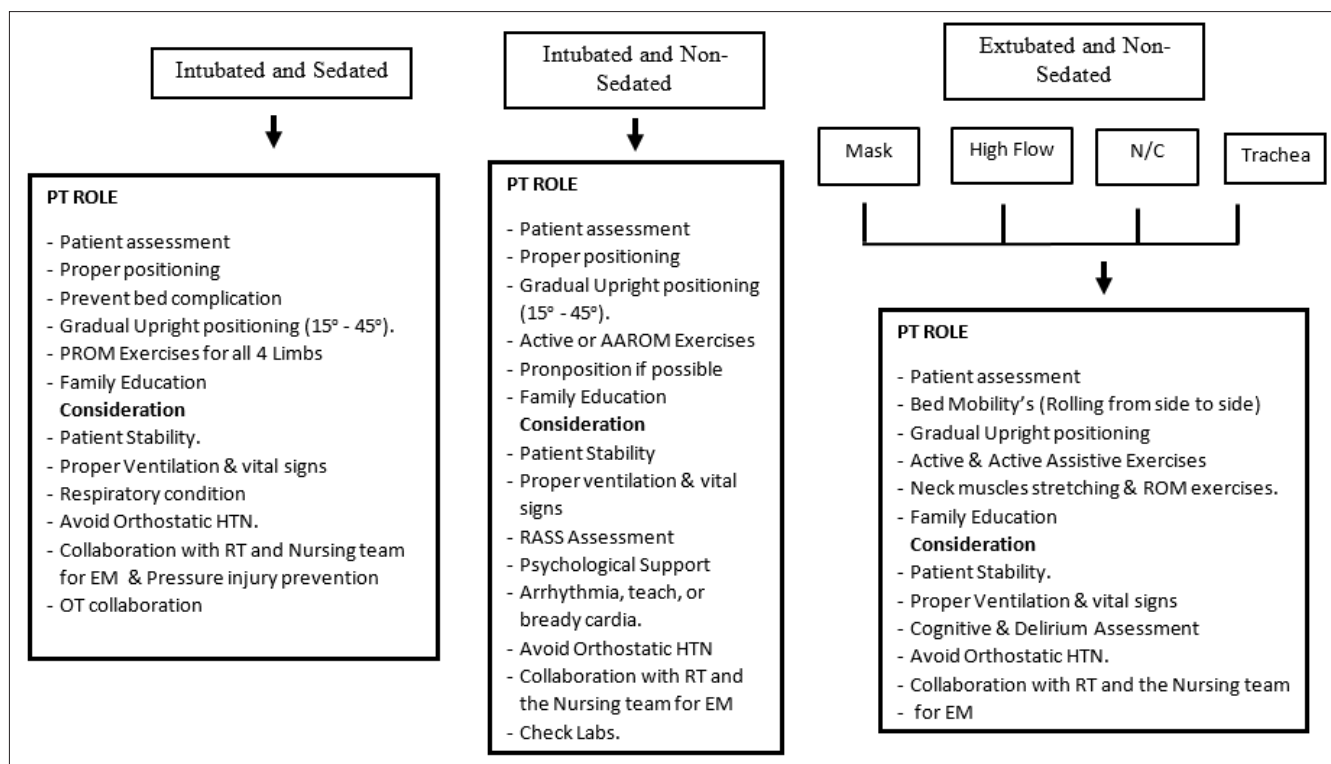
the respiratory status and physical condition of the patient and ensure that the ventilation frequency, inspiration pressure (positive end-expiration pressure; mmH₂O), arterial blood gas values, PH, PaO₂, PaCO₂, PaO₂/FiO₂, and all vital signs (temperature, blood pressure, pulse, respiration rate, and oxygen saturation) are within normal limits. A quick check on the patient's laboratory test results; C-reactive protein, white blood cells (WBC), Platelets counts, and hemoglobin level is also essential [37]. The first rehabilitation step for these patients is usually initiated by having a fully present and past patient history before assessing the patient's stability and level of consciousness using the Glasgow Coma Scale (GSC) and Richmond Agitation Sedation Scale (RASS). This information should be available in the patient file and confirmed by existing ICU Physicians and Nursing teams. Assessing the patients' attachments, joint range of motion (ROM), muscle power, and functional ability is very important in determining the functional ability of patients [38]. The collaboration between physiotherapists and respiratory therapists (RT) is important in the ICU setting. However, the Saudi MOH, presented respiratory guidelines before starting a physical rehabilitation program for COVID-19 patients [22] (Table 2).

Table 2: Standard Respiratory Parameters before PT session. [17]

Parameters	Accepted range
Fraction of Inspired Oxygen (FiO ₂)	≤ 60%. (0.6)
Saturation (SpO ₂)	≥ 90%
Respiratory rate	≤ 40 BREATH/MIN
Positive End-Expiratory Pressure (PEEP)	≤ 10 cmH ₂ O
Systolic Blood Pressure (BP) ≥	≥ 90 mmHg and ≤ 180 MMHG
Mean Arterial Pressure (MAP)	≥ 65 mmHg and ≤ 110 MMHG
Heart rate (HR)	≥ 40 BPM and 120 ≤ BPM
Body temperature	≤ 38.5°C

In KFSH&RC, the Critical Care Medicine Department, Critical Care Nursing Department, and all clinical services divisions collaborated to implement EM attainment for COVID-19 patients from the initial phase of ICU admission, especially for severe COVID-19 conditions associated with hypoxia or pneumonia at different stages. The EM program for physical rehabilitation includes various exercise programs starting with passive movement, active and active-assisted exercises, bed mobility, and out-of-bed mobility up to walking. This program usually begins immediately after the clinical stabilization of the patient's condition. At the King Faisal Specialist Hospital and Research Center, the harshness of the rehabilitation program for post-COVID-19 usually depends on the patient's condition, consciousness level, respiratory involvement, and COVID stages (See Figure 1).

Figure 1: Strategies for implementing early mobilization in Acute & sub-acute COVID-19 patients



EM for Ventilated and Sedated Patients

Studies on early rehabilitation interventions for patients with COVID-19 have not reported any adverse events of early mobilization for mechanically ventilated patients (other than COVID-19) during deep sedation. Early mobilization and exercise prescription for COVID-19 patients, especially, sedated and intubated patients, should be carefully considered, and prescription parameters should depend on the patient’s current clinical situation [39,40]. In this stage, the patient was admitted to the ICU. The EM program for sedated and ventilated patients should be started immediately after clinical stability has been achieved, as confirmed by the COVID-19 team [41]. If the patient is under deep sedation or mechanical ventilation, the EM program might be limited to passive range of motion (PROM) exercises for both upper and lower limbs after appropriately assessing the ventilation mechanism. Proper postural exchange and gradual upright posture must be initiated as early as possible because patients are in the supine position most of the time [34, 41, 42]. This position may be changed increasingly to achieve an early sitting position to maintain good respiratory function based on lung protection, which is consistent with the treatment of acute respiratory distress syndrome, involving low tidal volume, low driving pressure, positive end-expiratory pressure, and long-term ventilator management [43]. Maintaining good ROM in all joints and preventing bed complications, such as bed sores, are very important, and the nursing team plays a significant role by turning the patient from side to side hourly. This early intervention for ventilated patients has been supported by several previous studies [34,41,43,44]. Some unconscious or sedated critical COVID-19 patients’ studies recommended neuromuscular electrical stimulation (NES) whereas other studies are not supporting applying “NES” to avoid any further muscle fibrosis injury [45-47]. It is known that exercise programs are prescribed and supervised by physiotherapists therefore, bed positioning and ROM exercises could be initiated by PTs and then could be frequently done by the nursing team who are changing

the patients’ positions regularly based on the patient’s clinical condition [9,38,48,49]. Occupational Therapy (OT) services for COVID-19 patients are critical and recommended in this stage to confirm proximal and distal limb safety, especially during the sedation period when patients’ extremities are in the wrong position or compressed against the patient’s body that could lead to nerve dysfunction [37]. OT Therapists could also assess the need for splinting and may provide nursing staff or family members with the necessary education. One of the challenges in this stage is that the patients are not oriented due to sedation, mechanical ventilation consequences, or other comorbidities such as heart and kidney problems, which may delay early mobilization intervention [32, 49].

EM for Ventilated and Off-Sedated Patients

In this phase, the patients will usually be in the ICU and can be either intubated/ventilated and/or with a tracheostomy, but without sedation. The initial step in this stage is to assess the patient’s situation physically and cognitively; the therapist must also assess the patient’s respiratory condition before starting the session. Certainly, Physiotherapists (PTs) in the ICU always work alongside Respiratory Therapists (RTs), nursing teams, and intensivists (ICU Physicians) to ensure proper ventilation and to avoid unexpected deterioration, respiratory complications, or any adverse reactions from early mobilization. The rehabilitation team should discuss the possibility of starting an active mobilization program as soon as patient sedation is reduced, to avoid critical myopathy and physical disability. Assessing the patient’s awareness or delirium is important as it is one of the most common symptoms among COVID-19 patients in the ICU, especially among mechanically ventilated patients with an incidence ranging from 45% to 87% [50-52]. Delirium is an acute change in attention and awareness that develops over a relatively short time interval and is associated with additional cognitive deficits such as memory deficits, disorientation, or perceptual disturbances [50]. The EM program

for COVID-19 in the ICU depends on the awareness, delirium, and ability of the patient to follow verbal commands. Therefore, if the patient is off sedation but completely disoriented, with a high level of delirium, or does not respond to verbal commands, the program will be almost similar to the previous stage. This means that the exercise program will be more oriented to proper bed positioning, maintaining good ROM, preventing bed complications, and maintaining good ventilation and breathing patterns (Figure 1). However, if the patient is attentive, oriented, and responds to verbal commands, the EM program will be more oriented toward active or active-assisted ROM exercises, bed mobility, frequent postural changes, and functional and balance training [18, 53]. However, the therapeutic approaches must be based on the patient's clinical condition and can be stopped at any time if the therapist finds any serious deterioration in the patient's condition [54].

EM for Extubated and Non-sedated Patients

This stage is important because most patients will be off sedation, but they might still be dependent on oxygen (O₂) therapy, which could be through an O₂ Mask, high flow, Nasal Cannula, or Tracheostomy. At this stage, patients are expected to be more responsive to the cardiac rehabilitation team, and the therapist may have the opportunity to push for activities and out-of-bed mobility. Thus, patient assessment is essential in this stage, with the aim of determining the level of stability, consciousness, and O₂ demands, and the ability of patients to perform advanced activities. In this stage, the CR program should include delirium assessment, breathing exercises, and the Active Cycle Breathing Technique (ACBT), which helps clear sputum from the airway. This technique involves a set of breathing exercises that loosen and move sputum from the airway and consists of breathing control, deep breathing, and huffing. As the patient improves, we can progress from the small-long huff technique that moves sputum from the low down of the chest to the big-short huff technique that moves sputum from the higher up of the chest, taking into consideration the percentage of O₂ saturation, which should be > 90% during the exercise session [55]. Muscle power of the upper and lower limbs, hand grip, ROM, and functional mobility must also be assessed to determine the patient's ability to initiate the exercise program properly. In addition to bed mobility encouragement, such as circulatory exercises, ROM exercises, sitting at the edge of the bed, or sitting out on a chair should be initiated at this stage because patients will be more attentive and responsive to the clinician [9]. Physiotherapists at this stage may also need to collaborate with other clinical service members and the nursing team to achieve optimum goals.

When to interrupt the COVID patients' PT program?

The Saudi MOH guidelines, specify that Physical Rehabilitation sessions must be stopped during acute or subacute stages when the following situations occur: a high intensity of fatigue and intolerance of physical activity of the patient, or when the patient is anxious or starts to develop arrhythmia or myocardial ischemia [22]. When the resting heart rate (RHR) was >120 BPM or systolic blood pressure was <90 mmHg or > 180 mmHg. Sometimes, unsealing of the closed respiratory system may occur during a session, and the clinician should immediately stop the session. The exercise session should also be interrupted when the blood oxygen saturation is < 90% or drops to > 4% from the baseline, or when there is no synchronization between the patient and the ventilator machine. Exercise sessions should be stopped in cases with coexisting diseases that are unsuitable for exercise [56].

EM Post-Acute Stage of COVID-19

At this stage, most patients overcome the serious situation and are ready to be transferred to post-acute units. However, patients

may still have some COVID-19 symptoms such as respiratory problems, O₂ therapy dependence, and ICU-AW, which may depend on functional motilities. Therefore, rehabilitation programs should be continued, and clinicians should resume working on deep breathing exercises, especially Active Cycle of Breathing Techniques (ACBT), strengthening exercises, encouraging independent bed and out-of-bed mobility, AROM, strengthening exercises, and functional mobility. Considerations, including patient stability, proper ventilation, good vital signs, and delirium assessment, should be considered at this stage. Avoiding orthostatic HTN and collaborating with RT is important. At this stage, patient, and family education about the clinical course of the disease and estimated comorbidities are essential. The EM exercise program should be progressively increased, depending on the patient's ability and stability. In addition, the main objective of this stage was to encourage patients to gradually move out of bed and take a few steps with a multidisciplinary team using a walking aid. At this stage, family members' involvement in the treatment plan is advisable, and they can participate in a simple exercise program to prepare them to deal with the patient after discharge home [57]. At this stage, appropriate ventilation, delirium assessment, and fall prevention should be considered.

Discharge Planning and Rehabilitation Requirements

The discharge plan can help limit any impact that may arise from any unprecedented situation for COVID-19 facilities to either home or long-term care facilities. Early discharge planning is very important after patients overcome acute stages and become clinically stable. This decision is usually made in collaboration with the COVID-19 and multidisciplinary teams. However, before discharge starts, COVID-19 patients need to regain most of their cardiorespiratory capacity by maintaining good oxygen saturation and performing good muscle-strengthening exercises. Though, some patients might be D/C with O₂ support (home oxygen) thus, all the needed equipment must be prepared by the rehabilitation team including home assessments [58]. It has been reported that COVID-19 symptoms may persist for up to four weeks from the onset of symptoms to three months. The symptoms include myalgia, muscular dysfunction, sleep abnormalities, psychosocial alterations, pulmonary fibrosis, and reduced lung capacity. Therefore, before discharge, it is recommended to use a test-based strategy that includes resolution of fever without the use of fever-reducing medications, improvement in respiratory symptoms (cough, shortness of breath), and negative results of COVID-19 from at least two consecutive nasopharyngeal swabs specimens collected ≥ 24 h apart (a total of two negative specimens) [59]. All equipment, including home assessments, must be assessed and prepared by the COVID-19 Rehabilitation team. All COVID-19 patients must be provided with a home exercise program that includes breathing exercises (the ACBT technique), strengthening, and aerobic exercise programs, such as bridging exercises, sideways leg lifts, and straight leg raises. In the sitting position, patients can perform seated knee extension, seated hip flexion, Sit-to-stand, Shoulder press using slight weight, and shoulder strengthening. From a standing position, the patient can perform standing leg exercises using a chair, and then the patient can swing their legs back word and forward, and to the side alternatively. Patients may also add hip flexion and extension while exercising from the standing position. Patients are usually advised to start these exercises gradually with 10 repetitions on each side, with rest between sessions, and then progressively increase the repetition according to individual tolerance [60]. All of these exercises must be reviewed by patients before D/C, and outpatient follow-up assessments are mandatory.

Out-Patient Rehabilitation Follow-up post-COVID-19

Studies have reported that the disabling effects of COVID-19 are typically complex and long-lasting [61, 62]. It is expected that outpatient multidisciplinary rehabilitation follow-up will need to be continued for an extended period after discharge from inpatient rehabilitation. The alteration in quality-of-life post-COVID not only concerns hospitalized patients but also ambulatory patients who should not be neglected. Critically unhealthy patients with COVID-19 are likely to have rehabilitation needs during and after an acute illness. Herridge et al. reported that many individuals recovering from COVID-19 might have health problems that extend beyond the acute infection stage [25]. This study also revealed that functional limitations resulting from these problems may affect the physical, cognitive, and mental aspects of health and may have an important impact on work and social life. Consequently, COVID-19 patients must undergo physical, respiratory, and functional independence assessments before starting the outpatient follow-up rehabilitation program. At this stage, attention must be paid to residual COVID-19 symptoms such as residual muscle weakness, body fatigue, dyspnea and/or shortness of breath, and cognitive impairment, in addition to neurological sequelae [63].

Assessment required during outpatient follow-up

The rehabilitation assessment of COVID-19 patients should include all aspects that remain post-discharge, such as cognitive impairments that range from problems with memory or attention deficits to difficulties with expression. Mental health impairments include anxiety, mood disorders such as depression, and Post-Traumatic Stress Disorder. In addition to all other physical, occupational and respiratory problems that need assessment should be taken in consideration [64]. Rehabilitation for people experiencing severe problems or a protracted course of Post COVID-19 Condition most likely requires a person-centered, comprehensive, and multidisciplinary approach to interventions that are provided in close collaboration with primary health care and several medical specialties.

Outpatient Rehabilitation Team and Treatment

During outpatient rehabilitation, patients will be seen by Physiotherapists, Occupational therapists, speech and language therapists, dietitians, and psychiatrists depending on their needs. Studies have reported that recovery from COVID-19 is time-consuming and varies from person to person. This can range from weeks to months [63]. It has been recognized that for some individuals, there may be an unacceptably high acute risk associated with starting a physical activity program or substantially increasing their level of activity; thus, pre-exercise screening and assessment tools are illustrated in Table 3. It is important to accept that it takes time to recover physically and psychologically. Several studies specified that the resources for the rehabilitation of COVID-19 recommended interventions for rehabilitation that include advice on the resumption of activities; breathing techniques; exercise therapy; psychological interventions; cognitive training; rehabilitation for communication and swallowing difficulties; and occupational rehabilitation [65-67]. The recommended rehabilitation program will be tailored to the patients' needs and will depend on the pre-exercise screening outcomes. The rehabilitation program is shown in Table-4.

Table 3 Screening and Assessment tools before outpatient Follow-up [64]

Table 3: Screening and Assessment tools before outpatient Follow-up [64]

Required Screening and Assessment Tools	Justification
Family history of heart and other diseases	A risk is given if a 1st-degree family member has had a heart attack and was a male aged < 55 years or a female < 65 years.
Smoking history	A risk factor is assigned to smokers irrespective of how many cigarettes are smoked per day or if they have stopped smoking in the last 6 months
Increased BMI	A risk factor is assigned in either Stage 2 (self-report) or Stage 3 (measured) if the person has a BMI of 30 or greater
Vital signs (HR, BP, RR, SPO2)	Should be assessed before after and in between exercise sessions
Hypertension	A risk factor is given if the person has a resting systolic BP reading of >140 mmHg or resting diastolic BP reading of >90 mmHg (If both are greater they have a maximum of one risk factor for BP)
Blood Glucose	R if they are taking medication to lower blood glucose. In Stage 3 a risk factor is given if the person has a fasting glucose level of 5.5 mmol/L or greater
High cholesterol	A risk factor is given if the person has a total cholesterol level of 5.2 mmol/L or greater. Or taking medication.
The current medications	Has to be reviewed and be sure that the patients are aware of their medications, and monitoring their adherence to taking them
Perge scale	Should be measured before the exercise prescription and before the end of the exercise program as an assessment tool to know the rate of preserved exertion.
Six min walk test	One of the important tests to be done before the exercise prescription is to know the pre-exercise functional capacity
Ejection Fraction	One of the tools that the clinician should be aware of is to build up the exercise intensity of the patients (mild, moderate, or maximum).
Muscle, bone, or joint pain or soreness	Must be measured to find out patients' limitations and strengths. If the patient has pain in the muscles, bones, or joints, then the response is related to an acute problem, further medical guidance may be required.
Functional Ability	A risk factor is given if the person fails to meet 150 min/wk of weighted physical activity
Cognitive Function & Psychosocial Well-being	Delirium monitoring is important to be assessed and managed before EM, exercise; and Family engagement too. Mental health such as anxiety and depression must be assessed also and the patient may need to follow up with Psychiatry or Psychosocial Services.

Table 4: The outpatient Rehabilitation program for Post-COVID-19 patients. [68]

Intervention Parameters	Rehabilitation & Exercise Program
Frequency	3 – 4 times/week for 6 – 8 weeks
Intensity	Low – Moderate Intensity depending on pre-exercise screening results. Building up to 3 sets of 10 for each exercise). RPE, 12–14, 60%–75% HRmax, Borg scale <15
Types	Breathing Exercise; Active Cycle of Breathing Technique (ACBT) exercise consists of breathing control, deep breaths to be repeated 3 or 4 times, and Forced expiration techniques (Huff) to be repeated 1-2 times Range of motion Exercises: Head Turns, Shoulders Circles, Trunk Rotation, and Side bends Aerobic and endurance exercises: Marching on the spot, step-up on stairs, half jumping Jacks, Upper body ergometer, bike, and treadmill (the length of time or speed and resistance can be gradually increased). Strengthening Exercises: Sit to stand, Squatting, Knee Extensions, Arm raise to the side, Wall shoulder press and Arm raises to the front (hold for 3 seconds & Weight could be gradually increased).
Time	45 min (15 min warm-up, 20 min breathing, aerobic, strengthening, balance exercises, and 10 min cooldown).
Sitting	Patients can be seen in the gymnasium or a physical rehabilitation facility.

RPE: Rate of preserve exertion. HRmax: Maximum Heart Rate

Tele-rehabilitation for post-COVID-19 patients in the KSA

Early Physical Rehabilitation protocols improve functional outcomes and reduce mortality rates. Virtual Rehabilitation (VR) has enabled practitioners to provide safe treatment without the risk of viral contamination. Telerehabilitation was suggested as a clinical restoration administration with a focal point of assessment, finding, and treatment. This could significantly promote innovation in scientific discovery and learning opportunities. Telehealth is an expansive umbrella of modalities that incorporates both clinical and non-clinical services [69]. For several reasons, virtual care sessions may be preferable to face-to-face contact post-COVID-19. However, it is a great option for patients with difficulties coming to a rehabilitation facility or for those who still have remaining symptoms. King Faisal Specialist Hospital and Research Center is one of the pioneers of telemedicine, mobile health, and virtual clinics. In addition, physical rehabilitation is one of the active departments in the clinical services section that utilizes this technology and gains the optimum advantage in serving COVID-19 and non-COVID-19 patients.

Conclusion

Although COVID-19 is a novel disease, rehabilitation providers routinely treat patients who experience disabilities due to critical illness and ARDS. All follow-up studies found significant deficits, poor quality of life, limitations in physical functioning, and poor cognitive and mental health in post-acute COVID-19 patients. Studies have revealed that high-quality rehabilitation intervention is a key strategy to reduce the health impact of COVID-19, which plays a crucial role in bringing patients back to normal life, especially critically ill patients. This review deliberates and prove that the multidisciplinary team approach, and the proper

follow-up of Physical Rehabilitation, Occupational Therapy, Respiratory Therapy, and Nutrition, with the collaboration of the medical, nursing, and different clinical services divisions, is an integral part of the intervention designed to regain optimal physical function, psychological well-being, and a better quality of life for post-COVID-19 and all other critical ill patients.

Author Contributions

All others contributed equally to the writing and reviewing of the manuscript. Mohammed Takroni, Abdulaziz Al-Thumayri: original draft and writing, Ms. Shiji Poulouse, Ms. Sara Al-Eisa, Mohammed Al-Zahrani, Mohammed Ahmed, and Mohammed Takroni: review & editing.

Conflicts of Interest and Funding

The authors have no potential conflicts of interest to disclose for any of the authors listed in the article. This study did not require any funding.

Acknowledgments

The authors would like to thank the COVID-19 team, all clinical services departments, respiratory therapists, and occupational therapists who worked alongside the physical rehabilitation staff. Grateful thank the physical rehabilitation management for prodigious support, and special thanks to Ms. Shiji Poulouse from the Critical Care Nursing Department for the tremendous guidance and support, Professor Collins Ogbeivor for the great guidance, and Digital Library Team for the remarkable help.

References

1. World Health Organization WHO May (2020). Clinical Management of COVID-19: Interim Guidance. <https://apps.who.int/iris/handle/10665/332196> (Accessed 01 Aug 2022)
2. D. Blumenthal, E.J. Fowler, M. Abrams, S.R. Collins (2020) Covid-19. implications for the health care system, *N. Engl. J. Med* 383: 1483-1488,
3. Pan American Health Organization (PAHO) (2020) Rehabilitation considerations during the COVID-19 outbreak, 2020. Available at: <https://iris.paho.org/handle/10665.2/52035>.
4. F.A. Klok, M.J.H.A. Kruip, N.J.M. van der Meer, M.S. Arbous, D.A.M.P.J. Gommers, K.M. Kant, et al., (2020) Incidence of thrombotic complications in critically ill ICU patients with COVID-19, *Thromb. Res* 191: 145-147.
5. C. Huang, Y. Wang, X. Li, L. Ren, J. Zhao, et al. (2020) Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China, *Lancet* 395: 497-506.
6. K.J. Clerkin, J.A. Fried, J. Raikhelkar, G. Sayer, J.M. Griffin, et al. (2020) COVID-19 and cardiovascular disease, *Circulation* 141: 1648-1655.
7. Y.Y. Zheng, Y.T. Ma, J.Y. Zhang, X. Xie (2020) COVID-19 and the cardiovascular system, *Nat. Rev. Cardiol* 17: 259-260.
8. F.J. Carod-Artal (2020) Neurological complications of coronavirus and COVID-19. *Complicaciones neurologicas por coronavirus y COVID-19, Rev. Neurol* 70: 311-322.
9. P. Thomas, C. Baldwin, B. Bissett, I. Boden, R. Gosselink, et al. (2020) Physiotherapy management for COVID-19 in the acute hospital setting: clinical practice recommendations, *J. Physiother* 66: 73-82.
10. Paddon-Jones D, Sheffield-Moore M, Cree MG, et al. (2006) Atrophy and impaired muscle protein synthesis during prolonged inactivity and stress. *J Clin Endocrinol Metab* 91: 4836-4841.
11. Puthuchery Z.A., Rawal, J., McPhail, M., Connolly B.,

- Ratnayake. G., et al. (2013) Acute skeletal muscle wasting in critical illness. *JAMA* 310: 1591-600.
12. Appleton R, Kinsella J, Quasim T (2015) The incidence of intensive care unit-acquired weakness syndromes: A systematic review. *JICS* 16: 126- 136.
13. Griffiths, R., Hall, J (2015). Intensive care unit-acquired weakness. *Critical Care Medicine* 38: 779-787.
14. De Jonghe, B., Sharshar, T., Lefaucheur, J.P., Authier, F. J., (2002) Paresis acquired in the intensive care unit: a prospective multicenter study. *JAMA* 288: 2859-2867.
15. De Jonghe, B., Bastuji-Garin, S., Durand, M.C, Malissin I, Rodrigues P, et al. (2007) Respiratory weakness is associated with limb weakness and delayed weaning in critical illness. *Crit Care Med* 39: 2007-2015.
16. R. Momosaki, H. Yasunaga, H. Matsui, H. Horiguchi, K. Fushimi, et al. (2015) Effect of early rehabilitation by physical therapists on in-hospital mortality after aspiration pneumonia in the elderly. *Arch. Phys. Med. Rehabil* 96: 205- 209.
17. C.L. Hodgson, K. Stiller, D.M. Needham, C.J. Tipping, M. Harrold, et al. (2014) Expert consensus and recommendations on safety criteria for active mobilization of mechanically ventilated critically ill adults, *Crit. Care* 18: 1-9.
18. P. Arias-Fernandez, M. Romero-Martin, J. Gomez-Salgado, D. Fernandez-García (2018) Rehabilitation and early mobilization in the critical patient: systematic review, *J. Phys. Ther. Sci* 30: 1193-1201.
19. M.D. Hashem, A. Nelliott, D.M. Needham (2016) Early mobilization and rehabilitation in the ICU: moving back to the future, *Respir. Care* 61: 971-979.
20. J. Garzon-Serrano, C. Ryan, K. Waak, R. Hirschberg, S. Tully, et al. (2011) Early mobilization in critically ill patients: patients' mobilization level depends on health care provider's profession, *Pharm. Manag. PM R* 3: 307-313.
21. Infection Control & Hospital Epidemiology (ICHE) department, King Faisal specialist hospital and Research Center, May, 2020; <https://www.kfshrc.edu.sa/en/home/search?q=ICHE>
22. The Saudi Ministry of Health (MOH), Physiotherapy Guidelines for Patients with COVID-19 in the Acute Hospital Setting, V2, 2020; <https://www.moh.gov.sa/Ministry/MediaCenter/Publications/Documents/Physiotherapy-Recommendations.pdf>
23. Gupta A, Madhavan MV, Sehgal K Nair, N, Mahajan S, Sehrawat TS, et al. (2020) Extrapulmonary manifestations of COVID-19. *Nat Med* 26:1017-1032.
24. Wang, L, He, W, Yu X, Hu D, Bao M, Liu H, et al. (2020) Coronavirus disease 2019 in elderly patients: characteristics and prognostic factors based on 4-week follow-up. *J Infect* 80: 639-645.
25. Herridge MS, Tansey, CM, Matte A, Tomlinson, G. Diaz-Granados, et al. (2011) Functional disability 5 years after acute respiratory distress syndrome. *N Engl J Med* 364: 1293- 1304.
26. Kayambu G, Boots R, Paratz J (2013) Physical therapy for the critically ill in the ICU: a systematic review and meta-analysis. *Crit Care Med* 41: 1543-1554.
27. Righetti RF, Onoue MA, Politi FVA, Teixeira DT, Souza PN, et al. (2020) Physiotherapy Care of Patients with Coronavirus Disease 2019 (COVID-19) - A Brazilian Experience. *Clinics (Sao Paulo)* 75: e2017.
28. Felten-Barentsz KM, van Oorsouw R, Klooster E, Koenders N, Driehuis F, Hulzebos EHJ, et al. (2020) Recommendations for Hospital-Based Physical Therapists Managing Patients With COVID-19. *Phys Ther* 100: 1444-1457.
29. Connolly B, O'Neill B, Salisbury L, Blackwood B (2016) Enhanced Recovery after Critical Illness Program Group. Physical rehabilitation interventions for adult patients during critical illness: an overview of systematic reviews. *Thorax* 71: 881-890.
30. Baricich A, Borg MB, Cuneo D, Cadario E, Azzolina D, et al. (2021) Midterm functional sequelae and implications in rehabilitation after COVID-19: a cross-sectional study. *Eur J Phys Rehabil Med* 57: 199-207.
31. Smondack P, Gravier FE, Prieur G, Repel A, Muir JF, et al. (2020) [Physiotherapy and COVID-19. From intensive care unit to home care-An overview of international guidelines.] *Rev Mal Respir* 37: 811-822
32. Schweickert WD, Pohlman MC, Pohlman AS, Nigos C, Pawlik AJ, et al. (2009) Early physical and occupational therapy in mechanically ventilated, critically ill patients: a randomized controlled trial. *Lancet (London, England)* 373: 1874-1882.
33. Jennings G, Monaghan A, Xue F, Mockler D, Romero-Ortuño R. (2021) A systematic review of persistent symptoms and residual abnormal functioning following acute COVID-19: ongoing symptomatic phase vs. post-COVID-19 syndrome. *J Clin Med* 10: 5913.
34. De Sire A, Giray E, Ozyemisci Taskiran O (2021) Chelsea physical assessment tool for evaluating functioning in post-intensive care unit COVID-19 patients. *J Med Virol* 93: 2620-2622.
35. Goodwin VA, Allan L, Bethel A, Cowley A, Cross JL, et al. (2021) Rehabilitation to enable recovery from COVID-19: a rapid systematic review. *Physiotherapy* 111: 4-22.
36. Bernal-Utrera C, Anarte-Lazo E, Gonzalez-Gerez JJ, De-La-BarreraAranda E, Saavedra-Hernandez M, et al. (2021) Could physical therapy interventions be adopted in the management of critically ill patients with COVID-19? A scoping review. *Int J Environ Res Public Health* 18: 1627.
37. Yang X, Yu Y, Xu J, Shu H, Xia J, et al. (2020) 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* 8: 475-481.
38. A Jos'e, S Dal Corso (2016) Inpatient rehabilitation improves functional capacity, peripheral muscle strength and quality of life in patients with community-acquired pneumonia: a randomised trial, *J. Physiotherapy* 62: 96-102.
39. Nakamura K, Nakano H, Naraba H, Mochizuki M, Hashimoto H (2020) Early rehabilitation with dedicated use of belt-type electrical muscle stimulation for severe COVID-19 patients. *Crit Care* 24: 342.
40. Eggmann S, Kindler A, Perren A, Ott N, Johannes F, et al. (2021) Early physical therapist interventions for patients with COVID-19 in the acute care hospital: a case report series. *Physical Therapy* 01: 1-9.
41. Wittmer VL, Paro FM, Duarte H, Capellini VK, Barbalho-Moulim MC (2021) Early mobilization and physical exercise in patients with COVID-19: a narrative literature review. *Complement Ther Clin Pract* 43: 101364.
42. Cameron, S, Ball, I, Cepinskas, G, Choong, K, Doherty, TJ, Ellis, CG, et al. Early mobilization in the critical care unit: A review of adult and pediatric literature. *J Crit Care* 30: 664-672.
43. Vlaker JH, van Bommel J, Hellemons ME, Wils EJ, Gommers D, et al. (2021) Intensive care unit-specific virtual reality for psychological recovery after ICU treatment for COVID-19; a brief case report. *Front Med (Lausanne)* 7: 629086.
44. Saeki T, Ogawa F, Chiba R, Nonogaki M, Uesugi J, et al.

- (2020) Rehabilitation therapy for a COVID-19 patient who received mechanical ventilation in Japan. *Am J Phys Med Rehabil* 99: 873-875.
45. Nakamura K, Nakano H, Naraba H, Mochizuki M, Hashimoto H (2020) Early rehabilitation with dedicated use of belt-type electrical muscle stimulation for severe COVID-19 patients. *Crit Care* 24: 342.
46. Saeki T, Ogawa F, Chiba R, Nonogaki M, Uesugi J, et al. (2020) Rehabilitation therapy for a COVID-19 patient who received mechanical ventilation in Japan. *Am J Phys Med Rehabil* 99: 873-875.
47. Nosaka K, Aldayel A, Jubeau M, Chen TC (2011) Muscle damage induced by electrical stimulation. *European Journal of Applied Physiology* 11: 2427-2437.
48. T Larsen, A Lee, D Brooks, S Michieli, M Robson, et al. (2019) Effect of early mobility as a physiotherapy treatment for pneumonia: a systematic review and meta-analysis. *Physiother Can* 71: 82-89.
49. A Jaffri, UA Jaffri (2020) Post-Intensive care syndrome and COVID-19: crisis after a crisis? *Heart Lung* 49: 883-884.
50. Kotfis K, Marra A, Ely EW (2018) ICU delirium - a diagnostic and therapeutic challenge in the intensive care unit. *Anaesthesiol Intensive Ther* 50: 160-167.
51. Liptzin B, Levkoff SE (1992) An empirical study of delirium subtypes. *Br J Psychiatry* 161: 843-845.
52. Goldberg TE, Chen C, Wang Y, Jung E, Swanson A, et al. (2020) Association of Delirium with Long-term Cognitive Decline: A Meta-analysis. *JAMA Neurol* 77: 1373-1381.
53. M Lazzeri, A Lanza, R Bellini, A Bellofiore, S Cecchetto, et al. (2020) Respiratory physiotherapy in patients with COVID-19 infection in acute setting: a position paper of the Italian association of respiratory physiotherapists (ARIR). *Monaldi Arch. Chest Dis.* 90: 164-168.
54. Eggmann S, Kindler A, Perren A, Ott N, Johannes F, et al. (2021) Early physical therapist interventions for patients with COVID-19 in the acute care hospital: a case report series. *Physical Therapy* 101: 1-9.
55. T Larsen, A Lee, D Brooks, S Michieli, M Robson, et al. (2019) Effect of early mobility as a physiotherapy treatment for pneumonia: a systematic review and meta-analysis. *Physiother. Can* 71: 82-89.
56. Enrico C, Michele V, Mauro C, Paneroni M, Lazzeri M, et al. (2020) Joint statement on the role of respiratory rehabilitation in the COVID-19 crisis: the Italian position paper 99: 493-499.
57. RM Barker-Davies, OO'Sullivan, KPP Senaratne, P Baker, M Cranley, et al. (2020) The Stanford Hall consensus statement for post-COVID-19 rehabilitation, *Br. J. Sports Med* 54: 949-959.
58. S Schujmann, T Teixeira Gomes, AC Lunardi, M Zoccoler Lamano, A Fragoso, et al. (2020) Impact of a progressive mobility program on the functional status, respiratory, and muscular systems of ICU patients: a randomized and controlled trial. *Crit. Care Med* 48: 491-497.
59. R Momosaki, H Yasunaga, H Matsui, H Horiguchi, K Fushimi, et al. (2015) Effect of early rehabilitation by physical therapists on in-hospital mortality after aspiration pneumonia in the elderly. *Arch. Phys. Med. Rehabil* 96: 205-209.
60. S Chindhy, PR Taub, CJ Lavie, J Shen (2020) Current challenges in cardiac rehabilitation: strategies to overcome social factors and attendance barriers, *Expert Rev. Cardiovasc Ther* 18: 777-789.
61. Arab-Zozani M, Hashemi F, Safari H, Yousefi M, Ameri H (2020) Health-Related Quality of Life and its Associated Factors in COVID-19 Patients. *Osong Public Health Res. Perspect* 11: 296-302.
62. Garrigues E, Janvier P, Kherabi Y, Le Bot A, Hamon A, et al. (2020) Post-discharge persistent symptoms and health-related quality of life after hospitalization for COVID-19. *J. Infect* 81: e4-e6.
63. Fan E, Dowdy DW, Colantuoni E, Mendez-Tellez PA, Sevransky JE, et al. (2014) Physical complications in acute lung injury survivors: a two-year longitudinal prospective study. *Crit Care Med* 42: 849-859.
64. Daynes E, Gerlis C, Chaplin E, Gardiner N, Singh SJ (2021) Early experiences of rehabilitation for individual's post-COVID to improve fatigue, breathlessness exercise capacity and cognition – a cohort study. *Chron Respir Dis* 18: 1-4.
65. Halpin SJ, McIvor C, Whyatt G, Adams A, Harvey O, et al. (2021) Postdischarge symptoms and rehabilitation needs in survivors of COVID-19 infection: a cross-sectional evaluation. *J Med Virol* 93: 1013-1022.
66. Sivan M, Taylor S (2020) NICE guideline on long covid. Research must be done urgently to fill the many gaps in this new “living guideline”. *BMJ* 371: m4938.
67. Royal College of Speech and Language Therapists (2021) New RCSLT report on long COVID and speech and language therapy <https://www.rcslt.org/news/new-rcslt-report-on-long-covid-and-speech-and-language-therapy/>.
68. Bernal-Utrera C, Anarte-Lazo E, Gonzalez-Gerez JJ, De-La-BarreraAranda E, Saavedra-Hernandez M, et al. (2021) Could physical therapy interventions be adopted in the management of critically ill patients with COVID-19? A scoping review. *Int J Environ Res Public Health* 18: 1627.
69. Rawstorn JC, Gant N, Direito A, Beckmann C, Maddison R (2016) Telehealth exercise-based cardiac rehabilitation: a systematic review and meta-analysis. *Heart* 102: 1183-1192.

Copyright: ©2023 Mohammed Takroni. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.