PHYSIOTHERAPEUTIC REHABILITATION IN THE TREATMENT OF THE POST COVID-19 PATIENT

Santangelo Letizia[1], Ginestra Angelo[2]

[1]*Dott.ssa in Fisioterapia*
[2]*Dott. in Fisioterapia - Docente di riabilitazione fisioterapica in chirurgia e medicina specialistica, Università degli Stufi di Palermo - Dirigente delle professioni di area riabilitativa e Direttore di ricerca, A.R.N.A.S. Ospedale Civico Palermo - Componente Commissione d'Albo Fisioterapisti Palermo (ordine tsrm e pstrp)- Ex presidente regionale AIFI (Associazione Italiana Fisioterapisti)*

KEYWORDS: COVID-19, Long Covid, Post Covid, physiotherapy, respiratory rehabilitation, motor rehabilitation

ABSTRACT

On December 31, 2019, the WHO (World Health Organization) receives the report of a cluster of cases of pneumonia with unknown etiology in the city of Wuhan, capital of Hubei province and a month later, exactly on January 7, the Chinese authorities identify the etiological agent responsible for the onset of these mysterious pneumonias: it is the SARS-Cov-2, a virus belonging to the family of coronaviruses never identified before and responsible for a disease that shortly after will be named "COVID-19". In the last period more and more physicians and researchers are talking about "Long Covid" or "Post Covid", which occurs when a patient continues to manifest one or more symptoms had in the disease even months after the negativity. In the coronavirus emergency *physiotherapy* has had and continues to have a very important role in taking care of patients who, recovered from the disease, need an individualized path of recovery of respiratory and motor *rehabilitation, to prevent complications of all kinds and, in general, improve the quality of life*

INTRODUCTION

2019 is undoubtedly a year that will remain etched in each of us as it was inaugurated by the arrival of a new virus from China completely unknown by our immune system and responsible for an infectious disease known to all as COVID-19, which even today continues to affect our lives by spreading from one part of the world to another. Coronaviruses, so called because of the presence of crown-shaped spikes on their surface, are RNA viruses that, if contracted, can cause, among other symptoms, mild respiratory infections of the upper airways or severe respiratory infections involving the lower airways, which is why they are responsible for diseases ranging from the common cold to more serious respiratory syndromes such as MERS (Middle East Respiratory Syndrome), SARS (Severe Acute Respiratory Syndrome) and, more recently, COVID-19. The term COVID-19 derives from the acronym "COrona VIrus Disease 19" and refers to the current widespread infectious disease caused by SARS-CoV-2, a new viral strain belonging to the coronavirus family never previously identified in humans. Usually coronaviruses circulate more frequently among animals, but some of them, through the "pillover" or "species jump", have the ability to infect humans, leading to the onset of infectious diseases called "zoonoses". Although several hypotheses continue to circulate about the genesis of the virus, according to the WHO, the virus spread from the bat and then reached humans through an intermediate host, a scaly mammal that lives in China: the pangolin. This has been confirmed by the fact that the genetic sequence of the new viral strain isolated from the animal is 99% identical to that of the virus present in infected individuals. The incubation period of the disease lasts on average 5-6 days, but in some cases it can reach 14, while the symptoms vary according to the severity of the disease. In fact, if on the one hand there are the so-called "asymptomatic carriers" who, despite having contracted the virus, do not show any type of disorder, on the other hand there are individuals who present a multifaceted symptomatology characterized by the presence of fever, sore throat, dry cough, shortness of breath, fatigue, ageusia and/or anosmia, among the most common, and pneumonia or acute respiratory distress syndrome (ARDS), among the most serious. It is estimated that the majority (80%) of infected individuals have a mild-to-moderate disease, while the most severe disease affects 20% of people, especially those over 65 years of age with co-morbidities such as cardiovascular disease, diabetes and chronic respiratory disease. In addition, about 30% of sick people require hospitalization and of these 20% are admitted to the intensive care unit (ICU). The most frequent way of transmitting the disease is through the air, where both saliva droplets, also known as "droplets", and smaller microparticles in aerosols, which remain suspended in the air in high concentrations, are responsible for contagion through inhalation.

It should not be forgotten that it is also possible to become infected after touching contaminated objects and then bringing your hands to your mouth, nose or eyes. Finally, WHO (World Health Organization), ECDC (European Center for Disease Control and Prevention) and ISS (Italian National Institute of Health) recognize SARS-CoV-2 as a pathogen capable of infecting even through the fecal-oral cycle. In the SIAARTI (Italian Society of Anaesthesia Analgesia Resuscitation and Intensive Care) recommendations for the management of the critical patient COVID-19 six stages of the disease have been identified.

Tab. 2 | Sindromi cliniche associate all'infezione da SARS-CoV-2

I STADIO: Malattia Lieve - Mild COVID-19	Pazienti sintomatici che rispettano i criteri di definizione per COVID-19 SENZA evidenza di polmonite virale o ipossia. **I sintomi possibili sono:** febbre (83-99%), tosse (59-82%), fatica (44-70%), anoressia (40-84%), respiro corto (31-40%), mialgie (11-35%). Altri sintomi aspecifici: mal di gola, congestione nasale, cefalea, diarrea, nausea e vomito. Riportati anche anosmia e ageusia antecedenti l'onset dei sintomi. Gli anziani e gli immunocompromessi possono presentare sintomi atipici: fatica, riduzione della vigilanza, riduzione della mobilità, diarrea, anoressia, delirio e assenza di febbre. I sintomi dovuti al fisiologico adattamento in gravidanza o a eventi avversi durante la gravidanza (dispnea, febbre, sintomi gastrointestinali o fatica) o altre patologie come la malaria, possono sovrapporsi ai sintomi del COVID-19. I bambini potrebbero non presentare febbre o tosse così frequentemente come gli adulti, le manifestazioni gastrointestinali sono più frequenti.
II STADIO: Polmonite Lieve - Mild COVID-19	**Adulto:** Adolescente o adulto: paziente con polmonite NON grave, compresa nessuna necessità di ossigenoterapia (SpO_2≥90% in aria ambiente). **Bambino:** (<12 anni): paziente con polmonite NON grave: tachipnea in atti/min: <2 mesi, ≥60; 2–11 mesi, ≥50; 1–5 anni, ≥40. **La diagnosi è clinica; l'imaging del torace può assistere nella diagnosi ed escludere complicanze.**
III STADIO: Polmonite Grave - Severe COVID-19	**Adolescente o adulto:** segni clinici di polmonite (febbre, tosse, dispnea, tachipnea) ed ALMENO 1 dei seguenti: frequenza respiratoria >30 atti/min, grave difficoltà respiratoria o SpO_2<90% in aria ambiente. **Bambino:** segni clinici di polmonite (tosse o difficoltà respiratoria) ed ALMENO 1 dei seguenti: cianosi centrale o SpO_2<90%; grave difficoltà respiratoria (ad esempio tachipnea, grugnito, impegno toracico molto evidente); segni di polmonite con segni di gravità generale: incapacità di allattare o bere, letargia o perdita di coscienza o convulsioni; tachipnea (in atti/min: <2 mesi, ≥60; 2-11 mesi, ≥50; 1-5 anni, ≥40). **La diagnosi è clinica; l'imaging del torace può assistere nella diagnosi ed escludere complicanze.**
IV STADIO: Sindrome da Distress Respiratorio Acuto (ARDS) - Critical COVID-19	**Insorgenza o peggioramento** di sintomi respiratori entro una settimana dalla prima manifestazione clinica nota. **Imaging del torace** (radiografia, tomografia computerizzata o ecografia polmonare): opacità bilaterali NON correlabili a sovraccarico volemico, atelettasia polmonare o lobare o noduli. **Origine degli infiltrati polmonari:** insufficienza respiratoria non pienamente spiegabile da un'insufficienza cardiaca o da sovraccarico di liquidi. È necessaria una valutazione obiettiva (ad es. ecocardiografia) per escludere la causa idrostatica dell'edema/infiltrati, se non è presente alcun fattore di rischio. **Ossigenazione (adulti):** • ARDS lieve: 200 mmHg <PaO_2/FiO_2, ≤300 mmHg (con PEEP o CPAP ≥5 cmH_2O) • ARDS moderata: 100 mmHg <PaO_2/FiO_2 ≤200 mmHg (con PEEP ≥5 cmH_2O) • ARDS grave: PaO_2/FiO_2 ≤100 mmHg (con PEEP ≥5 cmH_2O) **Ossigenazione (bambini):** • Supporto non invasivo (NIV o CPAP) ≥5 cmH_2O tramite maschera full face: PaO_2/FiO_2 ≤300 mmHg o SpO_2/FiO_2 ≤264 • ARDS lieve (ventilati invasivamente): 4≤OI<8 o 5≤OSI<7.5 • ARDS moderata (ventilati invasivamente): 8≤OI<16 o 7.5≤OSI<12.3 • ARDS grave (ventilati invasivamente): OI≥16 o OSI≥12.3
V STADIO: SEPSI - Critical COVID-19	**Adulti:** disfunzione d'organo potenzialmente letale causata da una risposta disregolata dell'ospite a infezione sospetta o accertata, con delta SOFA>2*. I segni di disfunzione d'organo includono: stato mentale alterato, respirazione difficoltosa o rapida e superficiale, bassa saturazione in ossigeno, oligo-anuria, tachicardia, pulsazioni deboli, estremità fredde o ipotensione, alterazioni cutanee, riscontro laboratoristico di alterazioni della coagulazione, trombocitopenia, acidosi, lattati elevati o iperbilirubinemia. **Bambini:** sospetta o comprovata infezione e ≥2 criteri SIRS - età correlati, dei quali 1 deve essere alterazioni della temperatura o della conta leucocitaria.
VI STADIO: SHOCK SETTICO - Critical COVID-19	**Adulti:** ipotensione non responsiva ad espansione volemica, che richiede vasopressori per mantenere MAP ≥65 mmHg e livello sierico di lattati >2 mmol/lt. **Bambini:** qualsiasi ipotensione (SBP <5° percentile o >2 DS al di sotto del normale per età) o 2-3 dei seguenti: stato mentale alterato; bradicardia o tachicardia (HR <90 bpm o >160 bpm nei neonati e HR <70 bpm o >150 bpm nei bambini); refilling capillare prolungato (>2 sec) o pulsazione debole; tachipnea; marezzatura o rash petecchiale o purpurico; aumento dei lattati; oliguria; ipertermia o ipotermia.

Altre complicanze COVID-19 correlate sono state descritte con caratteristiche di emergenza clinica: tromboembolia polmonare acuta, stroke, sindromi coronariche acute.

Se l'altitudine è superiore a 1000 m, il fattore di correzione dovrebbe essere calcolato come segue: PaO_2/FiO_2 x Pressione barometrica/760.

* Il punteggio SOFA varia da 0 a 24 e comprende punti relativi a 6 sistemi di organi: respiratorio (ipossiemia definita da basso rapporto PaO_2/FiO_2), coagulazione (piastrinopenia), fegato (iperbilirubinemia), cardiovascolare (ipotensione), sistema nervoso centrale (basso livello di coscienza definito dalla Glasgow Coma Scale) e renale (oliguria o creatinina elevata). La sepsi è definita come cambiamento acuto nel punteggio totale del SOFA score ≥2 punti conseguente all'infezione. Si assume un punteggio pari a 0 se il dato non è disponibile.

Tab. 1 - *Sindromi cliniche associate all'infezione SARS-CoV-2*

In the last period, more and more physicians and researchers are talking about "Long Covid" or "Post Covid", a term first used in May 2020 as a hashtag on Twitter by Elisa Perego, honorary research associate at "University College" in London, to refer to a syndrome that occurs when a patient continues to manifest one or more symptoms had in the disease even months after the negativity. For this reason, such subjects are referred to as "long haulers". A systematic review and meta-analysis, following the PRISMA (Preferred Reporting Items for Systematic Reviewers and Meta-analysis) guidelines, was able to identify more than 50 long-term effects that the post-Covid syndrome can determine.

The SIMG journal shows that the main symptoms experienced by patients are: difficulty in walking (even for short distances), in transfers, turning over in bed, sitting for long periods and standing up, but also severe asthenia, muscle and joint pain, dizziness, dyspnoea on moderate exertion, decubitus, constipation, anxiety, depression, mental confusion/disorientation. The National Institute for Health Research in the United Kingdom claims that Multiple Organ Dysfunction Syndrome (MODS) has a bearing on Long Covid sufferers. To understand the extent of the problem it is enough to think that this syndrome affects about 1.5% of people three months after infection with SARS-Cov-2. In principle, the more severe the infection, the greater the risk of symptoms over time. In reality, it has been seen that this is not always the case, in fact, Long Covid can also affect people who, after contracting the virus, have only had a fever, cough and a bit of exhaustion. It is known that, following recovery and hospital discharge, 10-20% of subjects complain of persistent symptoms that last for more than a month, while one person out of forty-five is affected by outcomes that persist for more than twelve weeks. Between April and May 2020, the Fondazione Policlinico Universitario "Agostino Gemelli" IRCCS (institute of hospitalization and care with scientific character) of Rome has decided to follow the clinical course of 143 patients hospitalized in intensive care. The first results of this research showed that only 12.6% of patients reached a full recovery two months after the first illness, while 32% still showed one or two symptoms related to the disease and 55% complained of three or more symptoms characteristic of the virus. Moreover, in 53% of patients, symptoms such as fatigue (43%), dyspnoea (27%), joint pain and headache (22%) persisted. In this regard, a study by "King's College" in London showed that in the UK 10% of those infected did not fully recover within three weeks, while 250,000 people had symptoms for 30 days or more. In August 2020, universities and teaching hospitals NHS (National Health Service) Trust in Leicester also launched a study into the long-term effects of COVID-19, which is known as "Post-Hospitalization COVID-19" (PHOSP-COVID). This study was set up with the aim of analysing the clinical course of 10,000 patients for one year, paying attention to various clinical conditions by means of examinations and investigating a range of biomarkers. On January 29, 2020, in order to shed light on the condition that afflicts these people, Morena Colombi, founder of the Facebook group "We who the Covid we have overcome," addressing the Vice President of Health Pierpaolo Sileri, wrote and sent a PEC in which he requested, on behalf of all those who were or had been in the same situation as him, both the official recognition of the Long Covid as a real pathology, secondary to that caused by SARS-Cov-2, and the activation of the health system in order to assist all those who, as a result of this syndrome, were severely debilitated. In order to treat this group of patients, the healthcare systems of some countries have started the creation of specialized clinics, as happened in Great Britain, where the National Health Service (NHS), with a budget of ten thousand pounds, allowed the construction of specialized clinics and the activation of an online rehabilitation service known as "Your Covid Recovery" for

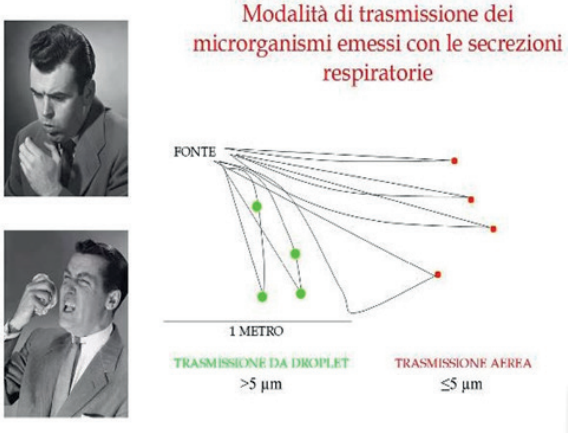

Fig. 1

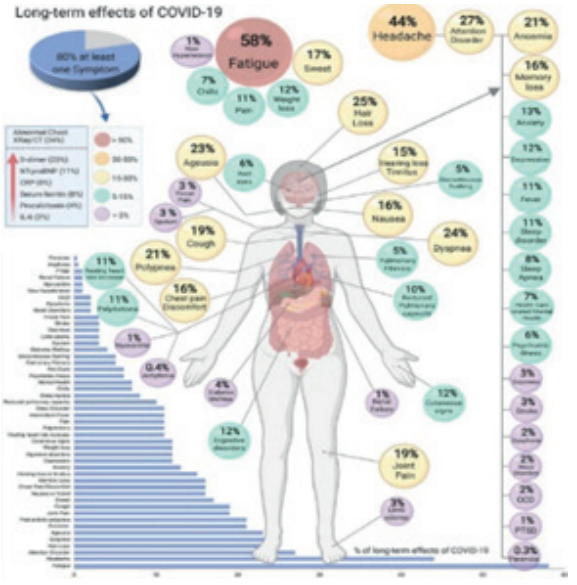

Fig. 2

all patients with Long Covid Syndrome. Therefore, on the basis of what has been said, the importance of physiotherapy, whether respiratory or motor, in the care and treatment of all those people who find themselves living in a real "health limbo" is even more evident. In this regard, it should be pointed out that, in order for patients to face and overcome the post-acute phase of the disease in the best possible way, it is important that physiotherapists also intervene in the acute phase. This is the reason why the paper takes into consideration the treatment of the patient in all the phases of the disease, starting from the most serious one, until the one of the hospital discharge, as if they were chained together and depended on each other.

MATERIALS AND METHODS

This study is the result of an accurate research conducted by means of the main research databases, including PubMed. For the drafting of the study, many studies were selected and included, including a position paper by AIPO (Italian Association of Hospital Pneumologists), ARIR (Association of Rehabilitators of Respiratory Insufficiency) and SIP (Italian Society of Pneumology) on respiratory rehabilitation, which accurately describes the different phases of treatment provided for each patient, based on the degree of severity of the pathology they suffer from, the SIAARTI recommendations for the management of the critical patient, reviews (SIMG) on physical rehabilitation, the results of a Delphi trial on pulmonary rehabilitation, indications for respiratory physiotherapy by ARIR in collaboration with AIFI (Italian Association of Physiotherapists), but also systematic reviews, some of which focus on the care of elderly patients, meta-analyses and randomised controlled clinical trials. In addition, the research group drew on the experience of a motor reconditioning programme of the U.O. of Rehabilitation Medicine of the Azienda Ospedaliera Marche Nord and on a clinical case of the Istituto Scientifico Maugeri of Bari.

RESULTS

Post COVID-19 rehabilitation involves the identification of rehabilitation projects and programs that vary based on three types of patients with whom you may come in contact:

- **Paucisymptomatic patients** who have spent the isolation period at home or in sheltered facilities;
- **Admitted to the infectious disease or pulmonology department**, discharged with mild respiratory and motor deficits;
- **Admitted to ICU**, usually intubated, discharged with significant respiratory, motor and neurological deficits.

In the therapeutic management of patients affected by COVID-19, a very important role is played by physiotherapists involved in respiratory rehabilitation and this is confirmed in a position paper by AIPO (Italian Association of Hospital Pneumologists), ARRI (Association of Rehabilitators of Respiratory Insufficiency) and SIP (Italian Society of Pneumology). This document accurately describes the different treatment phases envisaged for each patient, based on the degree of severity of the pathology they are suffering from: **mild form**: patient with pneumonia, but without the typical signs of a severe picture, **severe form**: patient with fever or suspected respiratory infection and at least one of the following parameters: FR (respiratory rate) >30 apm, dyspnea or SpO_2 (oxygen saturation) < 90% in room air and **very severe form (ARDS)**: patient with radiological picture of bilateral interstitial commitment and P/F (PaO_2/FiO_2, oxygen saturation/inhaled fraction of O_2) <300.

Acute phase (very severe form)

Setting: emergency room, emergency medicine, intensive care unit (ICU), step-up sub-intensive care. In this phase the rehabilitation program starts when the patient reaches a minimum level of stability and should be immediately interrupted in case of: high fever, worsening dyspnea, FR >30 apm, SpO2 <93% on oxygen therapy or need for FiO2 >50% during non-invasive mechanical ventilation (NIV), end-expiratory pressure (PEEP) or continuous positive pressure (CPAP) >10 cmH2O, respiratory distress, increased blood pressure, bradycardia or tachycardia, intercurrent arrhythmias, shock, deep sedation, evidence of radiological progression of lesions (>50%) within 24-48 h. Ventilatory support and weaning include: monitoring of clinical conditions, adjustment of respiratory support and oxygen therapy, and extubation protocols with or without NIV/CPAP. In addition, to reduce the risk of respiratory distress, physiotherapy rehabilitation techniques aimed at promoting dyspnea reduction, tracheobronchial clearance, musculoskeletal training, and maintenance or recovery of ADLs (Activities of Daily Living) should be avoided. Airway clearance techniques are not recommended in the acute phase unless there is significant bronchial obstruction as they may increase the risk of infection by the healthcare worker. For this reason, it is fundamental to evaluate the risk-benefit ratio for each individual patient in the use of a specific physiotherapy intervention, using, if possible, instruments that ensure an adequate safety distance. In the treatment of IRA (acute respiratory failure) with NIV and weaning from mechanical ventilation it is recommended to use protocols similar to those adopted for de novo acute respiratory failure, such as reduction of FiO2 and PEEP. With regard to the evaluation of clinical parameters (temperature, SpO2, P/F, cough, dyspnea, RF and thoraco-abdominal dynamics), it is usual to

COMPLICANZE	SOLUZIONI
Lesioni da decubito	Modifica della postura della testa e delle braccia ogni 4-6 ore. Controlla che il tubo endotracheale non sia premuto contro bocca/labbra e il SNG non eserciti eccessiva pressione contro la narice. Utilizza presidi antidecubito idonei e proteggi le zone soggette a maggior pressione ad esempio utilizzando schiume ad alta densità o resilienza.
Edema facciale/peri orbitale	Tenere il letto in anti-trendelemburg a 30°
Danni della cornea e/o congiuntiva	Pulizia e chiusura delle palpebre e protezione degli occhi applicando pomata oftalmica e cerotto di protezione
Lesione del plesso brachiale	Corretto posizionamento e modifica delle posture degli arti superiori
Mal posizionamento del padiglione auricolare	Controllare che l'orecchio sottostante non sia piegato.
Stabilità degli accessi venosi e problemi di linea CRRT	Assicurarsi che siano ben fissati e non esercitino eccessiva pressione sulla cute.
Infortunio del personale	Istruire correttamente gli operatori, individuarne il numero adeguato in base alla taglia del paziente e ai dispostivi/presidi presenti da gestire e ottimizzare la coordinazione durante l'esecuzione della manovra.

Tab. 2

perform it twice a day, while the evaluation of muscle strength involves the use of MRC (Medical Research Council Scale) and dynamometer. Among the main interventions implemented by physiotherapists to prevent the onset of complications there are: passive mobilization and, when possible, active, frequent postural changes, postural therapy and neuromuscular electrical stimulation, which is practiced especially in patients with altered state of consciousness. Postural therapy with close monitoring involves the assumption of a seated, semi-orthopnopic or prone posture and is useful to increase the ventilation-perfusion ratio, but also to prevent complications arising from prolonged immobilization. It has been demonstrated, in fact, that the sitting posture facilitates breathing and allows maximum thoracic expansion, increasing lung volume by 25%. As highlighted in the indications for respiratory physiotherapy in patients with COVID-19 infection by ARIR in association with AIFI (Italian Association of Physiotherapists), slumped posture in bed should be avoided by favouring a correct posture in a semi-sitting or sitting position and, when possible, alternating lateral decubitus and possibly semi-prona or prona position. In order to minimize the patient's effort, it is recommended to use cushions and aids to maintain a stable posture. Pronation is recommended for at least 12-16 hours/day, preferably within 72 hours of endotracheal intubation. If effective, it should be repeated until a P/F $\geq$ 150 is achieved with PEEP $\leq$ 10 cmH2O and FiO2 $\leq$ 60% for at least 4 h after supination. This posture should be discontinued in case of worsening of oxygenation (20% reduction in P/F compared to supine) or in case of severe complications. The table below shows all the precautions to be taken to counteract complications that may arise in patients subjected to pronation.

Acute phase (severe and mild form)

Setting: non-intensive acute care hospital (internal medicine, pulmonology, infectious diseases or other departments). In the treatment of patients suffering from the severe or mild form of the disease, respiratory rehabilitation serves to improve both the symptoms caused by the disease and physical capacity and quality of life. In this case, respiratory support and weaning include monitoring of clinical conditions and adjustment of oxygen therapy. Treatment should be discontinued in the presence of: fever, worsening of dyspnea, SpO2 < 93% or desaturation of at least 4% during exercise, chest tightness, belching, dizziness, headache, visual disturbances, palpitations, sweating, inability to maintain balance, increased O2 requirement or ventilatory support, evidence of radiological progression of lesions (> 50%) within 24-48 h. From a physiotherapeutic point of view it is necessary to focus the rehabilitation treatment on: de-alerting, frequent postural changes (early sitting position), continuous rotational therapy, active limb exercises, muscle reconditioning, peripheral muscle strengthening and neuromuscular electrical stimulation. After prolonged VM, weakness of the respiratory muscles may also occur, which is due to proteolysis of the diaphragm. For this reason, it is important to train the inspiratory muscles, which can take place during weaning trials. Finally, thoracic physiotherapy techniques, sedation of dry cough to reduce fatigue and dyspnoea, half-lipped breathing and airway clearance techniques are particularly effective. These are mainly indicated in hypersecretory patients with chronic respiratory pathologies, where it is preferable to use devices that can be used by the patient independently and the collection of sputum inside special plastic bags, in order to prevent the circulation of the virus. Diaphragmatic breathing is useful because it allows the patient to exploit the diaphragm by reducing the action of the accessory muscles. In order to promote the use of the diaphragm, inhalation through the nose is indicated, which simultaneously determines a greater humidification and the contraction of the abdominal muscles during exhalation, in order to increase the abdominal pressure and determine a greater diaphragmatic functionality. Half-lipped breathing, on the other hand, consists of inhaling through the nose and exhaling slowly with half-closed lips in order to increase airway pressure and prevent airway collapse. Airway clearance techniques include autogenous drainage, postural drainage, ABCT (active cycle breathing technique), flutter, PEP (positive pressure exhalation) and acapella.

Post-acute phase

Settings: rehabilitation pneumologies, other specialist and maintenance rehabilitations, intermediate facilities, inpatient wards for sub-acute patients. Overcoming the acute phase varies from patient to patient both on the basis of the degree of normocapnic respiratory insufficiency and in relation to the level of physical dysfunction (asthenia and weakness of peripheral muscles) and emotional dysfunction (anxiety, depression, sense of abandonment and PTSD (Post Traumatic Stress Disorder) associated with it. Of course, patients with comorbidities are the ones who require a longer period of time to recover from the acute phase. However, as with patients recovering from ARDS caused by H1N1 infection, patients with COVID-19 in the acute phase may have disability and functional impairment (respiratory function deficits, neuropathy and myopathy from acute critical illness), reduced participation and deterioration in quality of life, both in the short and long term following discharge. The weaning of post-acute patients includes,

Topics and recommendation	Level of concordance			A=Approved NA = NOT approved
	Low	Unclear	High	
19. Quando e quali strategie e dispositive per l'igiene bronchiale?	↓	⇄	↑	
19.1 Le strategie e le tecniche di supporto alla clearance tracheobronchiale (ACTs) dovrebbero proseguire, se necessario con adattamenti, per tutti i pazienti cronici ipersecretivi e dovrebbero essere introdotte nel trattamento di coloro che presentano ingombro catarrale e/o tosse produttiva	0.0%	12.5%	87.5%	A
19.2 Nei pazienti ipersecretivi, l'uso di dispositivi a pressione espiratoria positiva continua o temporanea, con o senza oscillazione (PEP, TPEP, OPEP) dovrebbero essere presi in considerazione, da soli o in associazione a strategie di riespansione polmonare, al fine di aumentare il reclutamento di volume, controllare meglio il flusso espiratorio e facilitare la mobilizzazione del muco nelle vie periferiche e prossimali	11.1%	0%	88.8%	A
19.3 I sistemi PEP flusso dipendenti a bassa resistenza, con filtri antibatterici posizionati nella via espiratoria, sono meglio tollerati e sono preferibili rispetto a sistemi ad alta resistenza o a soglia, soprattutto per i pazienti più debilitati o sintomatici	6.6%	6.6%	86.6%	A
19.4 Poiché la tosse è tra i sintomi del coinvolgimento polmonare da CoVID-19 più irritanti e può acuire il senso di dispnea e il dolore toracico, per espettorare è preferibile utilizzare flussi espiratori forzati (Huff)	0.0%	13.3%	86.7%	A
19.5 Tra le ACTs, è preferibile suggerire quelle che permettono al paziente di svolgere il trattamento in autonomia	0.0%	6.7%	93.3%	A
19.6 I nebulizzatori *jet/mesh* (possibilmente con boccaglio) e i sistemi di umidificazione attiva possono essere utilizzati in associazione agli interventi di disostruzione bronchiale	14.2%	14.2%	71.4%	A
19.7 Durante la ventilazione meccanica, l'aspirazione con sondino dovrebbe essere effettuata con sistemi a circuito chiuso con filtro antivirale posto sulla linea di aspirazione	5.9%	0.0%	94.1%	A
20. Quale ruolo per l'allenamento dei muscoli respiratori nel programma di RP?	↓	⇄	↑	
20.1 L'allenamento dei muscoli respiratori non è raccomandato come intervento di routine, ma dovrebbe essere proposto in caso di debolezza dei muscoli respiratori, in particolare per i pazienti candidati alla decannulazione o con dispnea persistente	5.9%	11.8%	82.4%	A
20.2 È ancora da verificare la tipologia, la durata e l'eventuale efficacia dell'allenamento dei muscoli respiratori nella CoVID-19, sia nella fase post-acuta sia nel lungo termine al domicilio	0.0%	5.9%	94.1%	A
20.3 L'allenamento dei muscoli respiratori dovrebbe iniziare a bassa intensità. La progressione deve essere guidata dai sintomi di dispnea/fatica muscolare e dal monitoraggio dei segni vitali	6.3%	18.8%	75.0%	A
20.4 MIP e MEP o misure surrogate possono essere considerate come le principali misure di risultato dell'allenamento dei muscoli respiratori	11.7%	11.7%	76.5%	A
20.5 L'allenamento dei muscoli respiratori dovrebbe essere effettuato utilizzando dispositivi monouso dedicati	12.5%	6.3%	81.3%	A
21 In questi pazienti è possibile, efficace e sicuro utilizzare i sistemi di tele-consulto, tele-monitoraggio e tele-riabilitazione?	↓	⇄	↑	
21.1 La tele-riabilitazione (TR) potrebbe rappresentare la risposta appropriata nella fase post-acuta poiché combina la necessità di RP con quella del distanziamento sociale	0.0%	6.7%	93.3%	A
21.2 La TR può favorire l'accessibilità alla RP eliminando le problematiche di spostamento, di trasporto, dei relativi costi e disagi legati al tempo atmosferico	0.0%	6.7%	93.3%	A
21.3 La TR dovrebbe essere adottata per quei pazienti con disabilità lieve-moderata che necessitano di monitoraggio frequente, coloro che hanno disabilità residue e che risiedono in aree isolate o lontane da strutture che offrono programmi di RP	6.7%	13.0%	80.0%	A
21.4 I parametri vitali (SpO_2, FC, PA, FR) e i sintomi dovrebbero essere registrati prima dell'intervento in tele-riabilitazione e poi monitorati quotidianamente	6.7%	0.0%	93.3%	A
21.5 Sono necessari la preparazione specifica dei professionisti sanitati coinvolti e la verifica dei requisiti tecnologici, in particolare al domicilio del paziente	0.0%	0.0%	100.0%	A
21.6 Potrebbe essere necessario un adeguato supporto dei caregiver nel caso di pazienti con disabilità residua o per la predisposizione degli apparati tecnologici	0.0%	6.7%	93.3%	A
22. Quando e che tipo di rivalutazione è raccomandata? Quando è necessario effettuare un follow-up multidisciplinare? In quale setting?	↓	⇄	↑	
22.1 La rivalutazione dovrebbe essere effettuata al termine della fase post-acuta, prima del trasferimento (presso centri di riabilitazione intensiva respiratoria o al domicilio) e poi ogni 3 mesi per un anno nei casi più gravi	0.0%	0.0%	100.0%	A
22.2 Il setting dopo la fase post-acuta dovrebbe essere scelto in base alle caratteristiche dei pazienti. Un setting ospedaliero (istituto di riabilitazione per una riabilitazione intensiva) può essere indicato per pazienti con 1) tracheostomia, in terapia con CPAP o BIPAP, in ossigenoterapia a riposo, 2) presenza di comorbidità extra-polmonari o disabilità importanti con deficit di autonomia nelle attività della vita quotidiana. Un setting domiciliare può essere indicato per i pazienti con sufficiente grado di autonomia, adeguato supporto famigliare, disabilità lieve, una o nessuna comorbidità e nessuna necessità di monitoraggio	0.0%	11.8%	88.2%	A
22.3 Per valutare l'evoluzione delle condizioni nel tempo, il follow-up multidisciplinare è raccomandato per i pazienti che sono stati colpiti dalla malattia in modo grave, che hanno avuto manifestazioni extra-polmonari da CoVID-19 e per coloro con pregresse disabilità	0.0%	5.9%	94.1%	A
15. Come gestire l'ossigeno-terapia e le interfacce? Come dosare e regolare l'ossigeno a riposo e durante attività fisica?	↓	⇄	↑	
15.1 Il bisogno di ossigeno a riposo, durante lo sforzo o il sonno dovrebbe essere valutato prima di definire il programma di RP	0.0%	11.1%	88.9%	A
15.2 L'interfaccia di somministrazione più adatta (in termini di efficacia e tolleranza per il singolo paziente) dovrebbe essere testata prima di definire il programma di RP	0.0%	5.6%	94.4%	A
15.3 Il volume di ossigeno necessario durante lo sforzo dovrebbe essere valutato attraverso un test standardizzato (test del cammino dei 6 minuti o altri test da campo) e rivalutato durante il programma di RP in base alla progressione dell'esercizio	0.0%	0.0%	100.0%	A
15.4 Durante la somministrazione di ossigeno si deve tener conto di specifiche precauzioni che limitino la distanza di dispersione dei *droplet*	0.0%	5.6%	94.4%	A
16. Quale FITT per il programma di esercizio fisico?	↓	⇄	↑	
16.1 La riabilitazione dei pazienti affetti da CoVID-19 in fase post-acuta può migliorare i sintomi, la capacità funzionale e la QoL; in ogni caso al momento non è possibile definire quale possa essere il miglior programma di allenamento	0.0%	0.0%	100.0%	A
16.2 I principi di allenamento utilizzati con i pazienti con malattia respiratoria cronica possono essere considerati nell'impostazione dei programmi per i pazienti post-CoVID-19	0.0%	18.8%	81.3%	A
16.3 Per favorire il recupero della funzione, nei pazienti con disabilità di grado medio o assente (SPPB > 10; Barthel index > 70), è raccomandato un esercizio aerobico con intensità <3.0 METs, che può aumentare progressivamente in base ai sintomi (scala di BORG dispnea e/o fatica al di sotto del punteggio di 3)	0.0%	0.0%	100.0%	A
16.4 Per migliorare l'autonomia, la forza dei muscoli periferici e respiratori, l'equilibrio, la capacità di deambulare, i sintomi e la QoL, nei pazienti con disabilità moderata o grave (SPPB <10; Barthel index <70) è necessario attivare un programma completo di RP	0.0%	11.70%	88.2%	A
16.5 Il programma di esercizio fisico dovrebbe includere esercizi aerobici (cyclette, treadmill, cammino libero) e di resistenza (finalizzato all'aumento della forza muscolare)	0.0%	5.8%	94.1%	A
16.6 È necessario monitorare la SpO_2 durante esercizio e il supporto di ossigeno dovrebbe essere prescritto quando la SpO_2 è <93%, consapevoli delle possibilità di contaminazione ambientale	5.8%	11.8%	82.4%	A
16.7 La NIV durante l'allenamento dovrebbe essere utilizzata con particolare attenzione per evitare la contaminazione ambientale	22.2	5.5%	72.2%	A
16.8 In caso di tracheostomia, l'uso della valvola fonatoria è preferibile rispetto ai filtri HME aperti	0.0%	6.3%	93.8%	A
17. Quando e quali esercizi di riespansione polmonare? Quali strategie e dispositivi?	↓	⇄	↑	
17.1 Strategie individualizzate di reclutamento, come esercizi di riespansione della gabbia toracica attraverso il controllo del respiro, associati a posture favorenti la riespansione, dovrebbero essere incluse nel programma di RP	0.0%	17.6%	82.4%	A
17.2 L'utilizzo delle posture dovrebbe essere guidato da immagini Rx/TAC (quando disponibili), auscultazione, variazioni di SpO_2 e sintomi riferiti dal paziente	0.0%	5.9%	94.1%	A
17.3 Dispositivi a pressione espiratoria positiva continua o temporanea (PEP, TPEP), che includano anche feedback visivi, dovrebbero essere considerati per la riespansione, da soli o in associazione alle posture facilitanti	0.0%	12.5%	87.5%	A
17.4 Per sfruttare al meglio la trazione pleurica sulle regioni periferiche del polmone, è possibile utilizzare una resistenza inspiratoria flusso-dipendente per ridurre il flusso inspiratorio e aumentare il tempo inspiratorio	6.7%	20.0%	73.33%	A
18. Come gestire l'aerosolterapia e i dispositivi? Come usarli in modo sicuro?	↓	⇄	↑	
18.1 La somministrazione di aerosolterapia/nebulizzazione non è raccomandata	11.7%	11.7%	76.4%	A
18.2 Se il paziente è ventilato meccanicamente, la terapia per inalazione dovrebbe essere somministrata durante la ventilazione, usando inalatori predosati (MDI) o nebulizzatori a ultrasuoni connessi al ventilatore in un circuito chiuso, senza rimuovere i filtri antibatterici posizionati sulla via espiratoria del circuito	5.5%	5.5%	88.8%	A
18.3 Per somministrare la terapia per inalazione durante la ventilazione meccanica, la terapia per inalazione dovrebbe essere somministrata durante la ventilazione, l'uso degli inalatori predosati (MDI) o nebulizzatori a ultrasuoni connessi al ventilatore in un circuito chiuso è raccomandato, senza rimuovere i filtri antibatterici posizionati sulla via espiratoria del circuito	0.0%	18.8%	81.3%	A
18.4 Quando necessaria la broncodilatazione, considerare l'utilizzo di inalatori predosati (MDI) con distanziatore o polveri per inalazione (DPI)	5.5%	5.5%	88.8%	A
18.5 Se la capacità inspiratoria del paziente è sufficiente ad attivare l'inalatore, è preferibile utilizzare farmaci inalatori in polvere (DPI)	0.0%	6.3%	93.8%	A

Tab. 3 e 4

in addition to daily monitoring of parameters, weaning from VM in tracheostomized patients, management of tracheostomy-related problems (phonation and airway obstruction due to the presence of excess bronchial secretions) and optimization of oxygen therapy. It is also important to evaluate the strength of the peripheral respiratory muscles by means of the MRC scale, manual muscle testing, isokinetic muscle testing and ROM (range of motion) measurement. For patients weaned or with prolonged weaning from VM and oxygen therapy, reconditioning interventions are opted for in order to improve physical conditions and correct the alterations in mobility and cognitive functions secondary to the prolonged immobilization that occurred in the ICU. With regard to physical exercise, low-intensity exercises (<3.0 METs) are recommended with a gradual increase in workload based on subjective symptoms, paying attention to education and daily supervision of the patient, even at a distance, in cases of isolation. In patients discharged home or to other facilities it will be necessary to provide indications on useful strategies to be adopted to ensure a continuation of physical activity with close monitoring of function, ability and participation, if it is healed and no longer at risk of infection. As soon as possible, a balance assessment is important, especially in patients who have been bedridden for a long time. The assessment of exercise capacity and the trend of saturation under stress is performed by means of the six-minute walk test. In some cases, a nutritional assessment followed by appropriate treatment may also be useful, should the need arise. In addition, since cognitive and psychological deficits often occur after 6 months to 1 year in post-ARDS patients with COVID-19, it may be useful to have an accurate cognitive assessment. In this phase the objectives of the rehabilitation program are the same as in the previous phase, with the addition of physical reconditioning with the use of special devices, such as cranks, cranks and cycle ergometers. In order to promote the knowledge of the fundamental aspects characterizing the rehabilitation activity in the respiratory field and the implementation of the main pulmonary rehabilitation techniques in patients affected by COVID-19 in the post-acute phase, the Italian societies of health professionals in the respiratory and rehabilitation area AIPO (Italian Association of Hospital Pneumologists), ARIR (Association of Rehabilitators of Respiratory Insufficiency), SIP (Italian Society of Pneumology), AIFI (Italian Association of Physiotherapists) and SIFIR (Italian Society of Physiotherapy and Rehabilitation) have promoted an international multidisciplinary consensus table, through a Delphi process. Through this process, starting from the evaluation of two different settings, i.e. hospital stay for post-acute patients and home, some recommendations have been drawn up, based on the opinion of physiotherapists and pulmonologists, concerning 4 different aspects: personal protective equipment, phenotyping, assessment procedures and rehabilitation interventions. Among the main recommendations, those concerning treatment are listed below.

Rehabilitation in patients cured by COVID-19

Post COVID-19 rehabilitation is addressed to all those subjects who have obtained two negative swabs at least 24 h apart. To understand the importance of rehabilitation in this phase, it is necessary to make some assumptions: approximately 75-80% of patients hospitalized for COVID-19 have a prolonged average hospital stay (± 21 days), 20% have severe or critical illness (respiratory failure, septic shock and/or multi-organ failure), 20-25% of hospitalized patients will require care in an ICU (intensive care unit), with prolonged hospital stay, and most patients who have access to ICUs have organ failure, especially ARDS (76%). It should be pointed out that the enormous burden caused by these problems often persists despite optimal pharmacological treatment. This results in COVID-related respiratory and motor disabilities, which may be associated with neurological, cardiological and psychiatric disabilities. In this regard, it is important to distinguish between COVID-related disabilities and COVID-related disabilities in subjects with previous disabilities. From the sample collected by the Unit of Pulmonology of 'ICS (Istituto Clinico Scientifico) Maugeri shows that more than 50% of people with disabilities due exclusively to coronavirus infection, develop moderate or severe disability, while among subjects with previous disability, which is associated with that due to the virus, none has a mild form of disability, while 85% develop a severe form. While it is true that there are no data on the severity and short- and long-term evolution of these disabilities, some data can be acquired from studies conducted on patients recovered from ARDS due to severe influenza A (H1N1) pneumonia during the 2009 pandemic. In a study conducted on 9 patients recovered from ARDS, subjected to periodic evaluation at 1,3 and 6 months after a 2-month course of RR, it was highlighted that all patients, at 6 months distance, had a perfectly normal FEV1, 80% had an optimal FVC, but 44% had a slight reduction in total lung capacity (TLC) and alveolar-capillary diffusion of carbon monoxide (DLCO). QoL showed improvement only from the third to the sixth month, while most of the functional improvement occurred rapidly in the first three months. A second study, carried out on a sample of 37 patients recovered from H1N1 ARDS, followed for one year, showed that: at the end of the one-year follow-up, only 5.4% had a mild obstructive deficit, while 67.6% showed reduced DLCO. This study emphasizes the importance of recognizing both psychiatric disabilities, such as anxiety (50%), depression (28%) and posttraumatic stress (40%), present in a very high percentage of cases, and radiological alterations represented by mild distortion of septa and parenchymal bands. These studies allow us to understand the role of RR, which represents a fundamental component of the integrated care of patients with acute or chronic respiratory diseases and must be considered a standard of care along with other established treatments (medical therapy, oxygen therapy and NIV). The information we have and the experts' conclusions about respiratory rehabilitation are described in the ERS task force document of 2020, which emphasizes the importance, close to the discharge of patients, of assessing: general status, presence of adequate home support and ability to move. In reference to this, the essential role of rehabilitation specialists in defining the optimal setting for patients following clinical recovery is highlighted. An aspect that distinguishes post-neglect respiratory rehabilitation is related to the personalization of the intervention, in fact frequency, intensity, time and type (FITT) of treatments must be customized according to the initial and subsequent evaluation. The evaluation is generally performed by a multidisciplinary team composed of: pulmonologist and cardiologist specialists, respiratory physiotherapist, occupational therapist, psychologist and dietician. It is a multi-parametric evaluation, which is not only aimed at objective data such as ECG, X-rays and blood gas analysis, but also at the subject's motor and subjective parameters. In this way, the intervention is personalised on the basis of the severity of the pathology, the comorbidity present and the patient's needs. The rehabilitation response to the COVID-19 pandemic can be of three types:

1. Intensive respiratory rehabilitation
2. Home rehabilitation with periodic outpatient follow-up
3. Rehabilitation through advice for physical activity with brochures and educational videos (telerehabilitation) for patients with the best recovery

Intensive respiratory rehabilitation is indicated in those patients who, once they have recovered, still need CPAP (Continuous Positive Airway Pressure)/BIPAP (Bilevel Positive Airway Pressure), in tracheotomized patients in RS (spontaneous breathing) or VAM (Artificial Mechanical Ventilation), in those with significant comorbidities (cardiological, neurological and motor) or who require oxygen therapy at rest and, finally, in subjects with reduced autonomy in ADLs or who do not have adequate management support at home. Home respiratory rehabilitation with periodic outpatient follow-up is indicated in patients who, although not requiring oxygen therapy at rest, show a desaturation at the walk test or at night, have difficulty reaching the rehabilitation facility, but adequate home support, sufficient autonomy in ADLs and dyspnoea symptoms at rest or during activities of daily living. In this case, however, there are some limitations, such as the lack of opportunity to use a multidisciplinary team, variable availability of exercise equipment and the cost of visits by health professionals. Maugeri's PDTAs (Diagnostic Therapeutic Treatment Paths) personalize respiratory and motor interventions on the basis of the SPPB (Short Physical Performance Battery) score, which is a test used to assess the functionality of the lower limbs that provides:

Evaluation of balance in three tests: keeping the position in united feet for 10", keeping the semi-tandem position for 10" and keeping the tandem position always for 10". The score varies from a minimum of 0, if the patient does not manage to keep the position in united feet for at least 10" to a maximum of 4, if he manages to complete all three tests.

2. Evaluation of walking on 4 linear meters: the score varies on the basis of the time taken by the patient to finish the test (from 0, if unable to do it, to 4, if he/she manages to complete the task in less than 4.1").

3. Evaluation of the ability to perform, 5 times in a row, the sit to stand from a chair without using the upper limbs which, for the test, must be crossed in front of the chest. The score varies from 0, if unable, to 4, if the test is performed in less than 11.2". The total scale

score therefore has a range from 0 to 12.
Therefore, the test is able to identify patients with very severe (SPPB=0), intermediate (SBBP > 3 and < 10) or mild (SBBP > 10) disabilities. Starting from motor interventions, in the case of subjects belonging to the first group, it is usual to focus the rehabilitation programme on posture changes and therapeutic postures, passive and active or active assisted mobilisation, neuromuscular electrostimulation, gradual recovery of the upright position and balance exercises; Those in the second group opt instead for active mobilization, assisted walking, reconditioning to the effort by means of special devices (crank or treadmill), aerobic training by means of exercise bike or treadmill and balance exercises; finally, in those in the third group, peripheral muscle strengthening by means of weights or elastic bands is added to the reconditioning to the effort and aerobic training. Respiratory interventions should be selected on the basis of the patient's condition: weaning from MV/NIV, weaning or optimizing oxygen therapy, decannulation programs, respiratory muscle training, evaluation of cough efficiency with possible initiation of bronchial disconstruction procedures. Finally, there is the psychological treatment at the expense of patients who present the psychological problems already mentioned, including a sense of abandonment as a result of isolation. Also on the proposal of PTDA Maugeri, the follow up varies according to the characteristics of the patients, in fact in subjects with spontaneous breathing in AA (room air), SaO2 ≥ 94%, 6'WT > 80%, Borg-D/Borg-A during ADL <3, a follow up at three months and advice for physical activity is chosen. Spontaneous breathing patients in AA with SaO2 ≥ 94%, 6'WT < 89% and > 50% or Borg-D/Borg-A during ADL ≥ 3 are advised a three-month follow-up, advice for physical activity and toll-free number for specialist advice. Finally, in subjects under oxygen therapy or in spontaneous breathing in AA and SaO2 < 94% or 6'WT < 50%, telemonitoring and telerehabilitation interventions can be used, in addition to what is provided in the previous case. However, in order for rehabilitation to fully perform its task, some barriers must be overcome and adequate accessibility to patients must be ensured. Studies of COPD patients have shown that less than 5% of eligible persons receive RP on an annual basis. This is due to reduced capacity of existing systems, uneven availability of intensive respiratory rehabilitation programs, outpatient or home-based rehabilitation programs in different regions, suboptimal awareness of RR by patients and healthcare professionals, and inadequate allocation of the healthcare system. Nevertheless, the emergence of COVID-19 can be considered as an opportunity since it has allowed to increase awareness of RR among health professionals and patients, to create new programs or expand existing ones, to set up suitable infrastructures and to train adequate personnel. In this context, a decisive role has been played by telerehabilitation, which guarantees a valid aid in the management of chronic respiratory diseases and provides the possibility of increasing the pool of patients who can have access to rehabilitation programs, allows to combine the rehabilitation intervention with the continuous monitoring of people living in isolated areas and/or with a certain degree of disability and, finally, can be considered as a guarantee of safety for all healthcare professionals, allowing both individual and group sessions to be carried out online. In addition, there are studies that have documented an equality of effectiveness of telerehabilitation with traditional respiratory rehabilitation in patients with COPD. In particular, there is an online platform where the patient registers and there are some exercises supported by videos, which the patient can perform by himself, as well as the objectives to be achieved and the motivational interventions useful to maintain high patient adherence to rehabilitation treatment, even if at home. In addition, once a week there is contact with the rehabilitation specialists, which can be direct, by telephone or by e-mail, in order to answer questions raised by the patient, verify the correct execution of respiratory exercises and educate the patient by increasing his awareness of the disease and the exercises he performs. Finally, telerehabilitation gives the possibility to schedule meetings with the entire rehabilitation team. All this can be implemented through the use of mobile phones and tablets which bring the rehabilitation programme even closer to people's everyday lives.

Respiratory rehabilitation in elderly patients with COVID-19

Community-acquired pneumonia in the elderly population leads to a reduction in ADL and QoL (quality of life), which is followed by a reduction in psychophysical function. Over time, psychophysical disturbances can cause the onset of diseases such as apraxia and lung infections. For this reason, the restoration of respiratory function plays a very important role in improving quality of life and performance of activities of daily living in elderly patients with COVID-19. In fact, respiratory rehabilitation is also used in the treatment of elderly patients discharged from the hospital with SARS-Cov-2 infection and this was demonstrated by a randomized controlled trial by Kai Liu, Weitong Zhang et al. in which 72 participants were recruited, of whom 36 underwent respiratory rehabilitation, in contrast to the remainder, for whom no intervention was planned. The assessment tools that each patient underwent were: pulmonary function test, including plethysmography and diffuse lung capacity for carbon monoxide (DLCO), functional tests such as the 6'WT (six minute walking test), the 36-Item Short Form Survey (SF-36) for quality of life, the Functional Independence Measure (FIM) for activity of daily living and, finally, two scales to assess mental status: Zung Self-Rating Anxiety Scale (SAS) and Zung Self-Rating Depression Scale (SDS). This study pointed out that in the intervention group, after six weeks of respiratory rehabilitation, improvements in: Forced Expiratory Volume in the 1st second (FEV1), Forced Vital Capacity (FVC), FEV1/FVC%, DLCO% and six-minute walk test. In addition, SF-36 scale scores revealed an increase in health level in the intervention group, compared to the control group, while those of SAS and SDS decreased after respiratory rehabilitation, although only anxiety had significant statistical significance between the two groups. Subjects belonging to the intervention group underwent a RR program that included exercises to be performed once a day for ten minutes (two sessions per week for six weeks). Specifically, the patients underwent respiratory muscle training, coughing exercises, diaphragm training, stretching and exercises at home. Specifically,

TABELLA II.
Strumenti di valutazione funzionale.

Nome	Parametro	Tipologia	Scoring
Scala di Borg	Fatica e dispnea	Scala	6-20
Barthel Index modificato	Dispnea nelle ADLs	Scala	0-99
FIM	Disabilità	Questionario	1-7 x 18 item
SGRQ	QoL	Questionario	0-100
Berg Balance	Equilibrio-rischio di caduta	Scala	0-56
30CST	Forza funzionale degli AAII	Test	0-30 sec
6MWT	Capacità funzionale residua	Test	0-6 min
Test di forza	Forza e ROM	Test	

Tab. 5

respiratory muscle training consisted of three sets of ten breaths each, combined with the use of a commercial manual resistance known as Threshold PEP. The parameters were set at 60% of maximum expiratory pressure (MIP), with a one-minute break between the two sets. Cough exercises included three sets of ten active coughs. Diaphragmatic training was performed in supine decubitus by performing thirty maximum contractions of the diaphragm with a weight of 1-3 kg on the anterior abdominal wall in order to resist its descent. Stretching exercises were performed with the guidance of the physiotherapist in order to stretch the respiratory muscles. In particular, patients were placed in supine or lateral decubitus with both knees flexed to correct lumbar lordosis and, subsequently, they were asked to move the upper limbs in flex-extension, abduction and external rotation. Finally, for home exercises, the subjects were instructed on how to perform half-lipped breathing and cough exercise (30 sets per day). Respiratory function parameters (FEV1, FVC and DLCO) were assessed by means of a computerized automatic spirometer, while exercise endurance by means of the six-minute walk test. Finally, percutaneous oxygen saturation (SpO_2), heart rate, systolic blood pressure, diastolic blood pressure, respiratory rate and perceived exertion (Borg scale) were measured using a saturated pulse oximeter, before and after the six-minute walk test. Independence in performing activities of daily living was assessed using the FIM scale. The 6'WT showed that the distance covered in 6-minute walk after 6 weeks of respiratory rehabilitation in the intervention group was much longer than before the physiotherapy program, even compared to the control group. QoL increased in the intervention group, where lower anxiety and depression were also found. Maki et al. conducted a study of a large number of COPD patients and found that following exercise training, the patients' muscle strength increased by 78%, muscular endurance by 92% and muscle mass by 88%. This was due to improvements in: pulmonary ventilation, gas exchange, cardiovascular function, tone-trophism and muscle strength. In reference to this, the study showed that exercise training results in similar outcomes in COVID-positive elderly patients.

Motor physiotherapy interventions

Motor physiotherapy allows, through movement, to restore proper joint, muscular and postural function through a series of exercises that aim to fully or partially recover, depending on the severity of the case, the motor skills lost or altered as a result of the disease, improve coordination, increase strength and endurance of muscles and tissues and facilitate the return to daily activities. Before moving on to the actual rehabilitation treatment, it is necessary to start with the assessment. With the evaluation not only does the physiotherapy treatment begin, but also a relationship is established between physiotherapist and patient known as the "therapeutic alliance" which, by actively involving the patient and making him or her take a central role in the treatment process, allows for the best possible recruitment of all the potential resources the patient possesses. In the therapeutic alliance two aspects of the pathology must be taken into consideration: the biological one (*disease*) and the one linked to the experience of *illness*. It is precisely on the basis of this alliance that the patient implements coping strategies and resilience processes that enable him to cope with the disease in the best possible way. Every evaluation is carried out by means of technical actions that are not only and exclusively evaluative, but also communicative, in fact they inevitably convey messages that lead to a real "hand to hand" dialogue between physiotherapist and patient, for a better communication that allows the patient to feel protagonist of what he is doing in a spontaneous way. In this case, the evaluation of the patient includes both a *static evaluation*, which takes into account, for example, any asymmetry of the thoracic cage or the body mass index (a BMI or Body Mass Index >30 determines important variations in respiratory mechanics) and a *dynamic evaluation* that takes into account the recruitment of inspiratory and expiratory muscles, the activation of accessory muscles and the presence of any paradoxical breathing. Clinical parameters to be assessed before, during and after the session include blood pressure, heart rate, respiratory rate and saturation. The main functional assessment tools used in the evaluation of patients post COVID-19 are listed in the table.

Changes and recovery in function and fitness after coronavirus infection related to severe acute respiratory syndrome

During the period of critical illness and hospitalization, patients experience a loss of physical function due to the development of new motor disabilities or the worsening of pre-existing disabling conditions, resulting in difficulty in performing activities of daily

living. Post-viral fatigue, which is present in 40% of people following infection, is also responsible for reduced physical function as it leads to an increased perception of effort when performing functional activities. This occurs particularly in patients with a severe stage of the disease or those with comorbidities. It is believed that physical deconditioning, which in turn is responsible for reduced muscle strength and aerobic activity, begins with long periods of immobility in hospital and may persist for up to 1 or 2 years after infection. During periods of immobility, 25% of patients have significant muscle weakness, especially in the lower limbs, which can be attributed to a reduction in both muscle cross-sectional area and muscle fibre size, especially type II muscle fibres. At this stage patients are also at risk of developing polyneuropathy and critical illness myopathy (50%), two conditions that alter neuromuscular function resulting in reduced recruitment of motor units and muscle strength. Lower levels of aerobic capacity in turn cause reduced physical function and independence in activities of daily living. In the most severe cases, acute respiratory distress syndrome (ARDS), which accounts for more than 30% of admissions to intensive care, causes physical deconditioning and alterations in long-term motor skills. What has been said so far allows us to understand why many patients, once recovered and discharged from the hospital, require a rehabilitation program aimed at recovering physical function, mobility, strength and resistance to effort. A systematic review by Scott Rooney, Amy Webster et al. on changes and recovery of function and fitness after coronavirus infection related to severe acute respiratory syndrome showed that aerobic and resistance training significantly improved physical performance of subjects in the intervention group, compared to those in the control group. Since at the beginning of the pandemic there were still no studies on the effects of COVID-19 on function and fitness, this review drew on those caused by SARS-Cov-2 in the 2003 outbreak, with the aim of:

1. To make a comparison of physical function and fitness outcomes between subjects with severe acute respiratory syndrome (SARS) and healthy controls;
2. Quantifying recovery of function and fitness post SARS-CoV-2 infection;
3. To determine the effects of post-infection exercise on SARS-CoV-2.

The studies selected by the review have two characteristics:

1. They longitudinally evaluate physical function in the post SARS-CoV-2 infection period compared to a control group based on objective measurement;
2. They analyze the effects determined by exercises in the post SARS-CoV-2 infection period as a stand-alone intervention and as part of a rehabilitation program.

All observational studies compared measures of function and physical fitness between patients with SARS-CoV-2 and healthy controls. Specifically, four studies measured physical function and two measured physical fitness. Physical fitness was measured by maximum oxygen consumption (VO_2 max) during the cardiopulmonary exercise test, while physical function relied on the six-minute walk test. Physical fitness was found to be impaired in the study by Ong et al, in which VO_2 max values in patients with SARS-CoV-2 infection were 78.6% lower than standard values at three months after hospital discharge. Furthermore, this study showed that none of the exercise tests in SARS-CoV-2 positive persons were negatively affected by pulmonary or ventilatory function. In contrast, the study by Su et al. found no particular differences in VO_2 max between people with SARS-CoV-2 and healthy controls. It should be noted, however, that the latter recruited subjects who had been discharged from hospital for 14 months and not 3 and, in addition, had a smaller sample size (13 vs. 46) than the previous study. All studies that measured physical function showed reduced performance on the six-minute walk test in patients with COVID-19. In the cross-sectional study by Lau et al. the distance measured via the 6'WT was significantly lower in sick patients compared to healthy controls two weeks after hospital discharge, while in those by Tansey et al. and Li et al. the distance walked by patients with SARS-CoV-2 had been reduced from 67% to 81% compared to that of healthy controls three months after hospital discharge. This reduction affected especially the patients who had undergone mechanical ventilation. Finally, it was seen that impairment of physical function persists for a long time after infection and it was found that the distance covered by the six-minute walk test in infected persons was reduced from 74% to 83% compared with that recorded for healthy controls at twelve months after hospital discharge. With regard to short-term recovery of physical function following recovery, it was found that, in the absence of an exercise programme, the distance travelled on the six-minute walk test increased between 3 and 6 months. However, there were no significant long-term changes in the same after 6 months. To address this problem, the randomized controlled trial by Lau et al. focused on the effect of a 6-week rehabilitation program on both function and fitness and quality of life after SARS-CoV-2 infection. Subjects belonging to the intervention group underwent two weekly sessions lasting 60-90 minutes, which included 30 to 45 minutes of aerobic exercise at 60-70% of the maximum expected heart rate and resistance training of upper and lower limbs. Subjects in the control group, on the other hand, were given general exercise advice, which was associated with weekly telephone calls with a physiotherapist. At 6 weeks Lau et al. reported that both 6'WT distance and VO_2 max, measured sub-maximally using the Chester Step Test, had increased in the intervention group compared to the control group. (77.4 m versus 20.7 m and 3.6 mL/kg/min versus 1, mL/kg/min). These results demonstrate that exercise can significantly improve function and fitness in the elderly who have been affected by coronavirus and have recovered from the disease.

Motor reconditioning program in patients with Long Covid

A decisive role in the rehabilitation of patients with "Post-Covid" or "Long Covid" syndrome is determined by the motor reconditioning program, aimed at the functional recovery and autonomy of those patients who, despite being cured of the disease, still

have neuro-musculoskeletal, cardio-respiratory and / or mental problems, which persist for more than 12 weeks (NICE or National Institute for Health and Clinical Excellence NICE, 2020). In fact, it has been shown that breathing exercises, mobilization and muscle strengthening of upper and lower limbs associated with aerobic physical activity can provide many benefits if carried out consistently at home, independently and under the supervision of a physiotherapist. With reference to the above, the O.U. of Rehabilitation Medicine of the Marche Nord Hospital has formulated a therapeutic education project for patients affected by Long Covid through the creation of an information booklet, both in paper form and available online, which accurately explains how to perform and the purpose of the exercises proposed. These exercises are designed to reduce some of the main deficits that can occur in these patients, such as: fatigue, dyspnea, bone-myo-articular pain, difficulty in making postural transitions, walking (even for short distances) and climbing and descending stairs. The recommendations for patients are that the exercises should be performed twice a day, automatically and for a duration of at least five minutes per session. The exercises should be performed slowly, without causing excessive pain or fatigue. Depending on the characteristics of each patient and the results achieved by each of them, it will be possible to increase or decrease the intensity of the effort, without forgetting that exercises carried out sitting or standing require the supervision of a caregiver or physiotherapist. The exercises are strictly contraindicated in patients with: acute pneumonia, recent myocardial infarction (within the last 3 months), cardiac arrhythmias with palpitations, hypertension not controlled by medication, heart failure and severe respiratory failure.

Breathing exercises

A) Become *aware of physiological respiration*: the patient is lying supine with one hand resting on the chest and the other on the abdomen. During inhalation the belly swells, while in exhalation it deflates.

B) *Relaxation technique: "square" exercise:* the patient is lying supine and is asked to close his eyes and imagine a square. The exercise is carried out in four phases, mentally following the sides of the square: you start by performing a slow and deep inhalation for 3-4 seconds, you hold your breath for the same period of time, then you exhale, always for 3-4 seconds, and finally you remain in apnea again for another 3-4 seconds. This exercise should be carried out for 2 minutes and, if it should prove excessively difficult for the patient, it is possible to resort to two alternatives:

Breathing exercises through mobilization of the upper limbs

A) The patient lies supine with knees flexed and, while inhaling slowly and deeply, flexes the shoulders bringing the upper limbs up. In this position, hold your breath for a few seconds and, as soon as you lower your limbs, exhale slowly and deeply. The exercise is repeated 2 times, with a pause of 30 seconds between one repetition and the other.

B) The same exercise can be performed by abducting the upper limbs and bringing them back to the starting position, remembering never to arch the back during the exercise.

Open mouth breathing exercises:

the patient is lying in lateral decubitus with an upper limb lying on top of the head and performs a slow and deep inhalation with the nose. Once the maximum lung expansion is reached, the patient holds the air for about 2 seconds and then slowly pushes it out while keeping the mouth open, as if to fog up a glass. The exercise should be repeated 3 times with a pause of about 30 seconds between one repetition and the other, even in decubitus on the contralateral side.

Lower limb mobilisation and strengthening exercises

A) *Flexion-extension of the ankles*: the patient is lying supine with upper and lower limbs extended. Through the dorsal flexion of the ankles, he/she brings the tip of the feet towards him/herself while, by performing the plantar flexion, he/she tilts it on the opposite side. The movement should be repeated for 5-8 times with a pause of 30 seconds between one series and the other.

B) *Knee extension*, placing a rolled up towel or pad underneath. The patient lifts the heel off the couch without lifting the knee from the towel. Finally return to the starting position. The exercise should be performed 6-8 times with both limbs and with a pause of about 30 seconds between each series.

C) *Hip flexion*: the patient bends his or her knees one after the other and, after making sure that both feet are on the couch, bends the hips, bringing the knees closer to the body. The exercise should be performed 5-8 times with a pause of 30 seconds between each series.

D) *Hip abduction*: is performed by the patient by bending both knees, bringing legs and feet together and abducting the hips, with the feet in contact with each other. In this position, the patient should alternately open and close the legs. The movement should be repeated 5-8 times with a pause of 30 seconds between each series.

E) *Bridge*: the patient bends both knees and, contracting the buttocks, lifts the pelvis from the bed for 5 seconds. The exercise should be repeated 4-6 times with a pause of 30 seconds between each series. This is an isometric exercise that consists of performing static muscle contractions. This practice is designed to train the muscles without subjecting them to stretching and without tiring them by moving a load.

Mobilization and strengthening exercises for upper and lower limbs

A) *knee flexion-extension:* the patient is seated with the feet resting on the ground and the back straight. Starting from this position, extend and flex the knee, repeating the movement with the contralateral limb. The exercise should be repeated 5-8 times with a pause of 30 seconds between each series.

B) *Hip flexion:* starting from the previous position, the patient raises one thigh slightly from the couch and, shortly after, rests it again. Subsequently repeat the exercise with the contralateral limb. The exercise must be repeated 5-8 times, with a pause of 30 seconds between each series.

C) *Elevation of the upper limbs*: from a seated position, the patient holds a stick in his hands and raises it above his head, extending the elbows well. Finally, return to the starting position, resting it on the knees. The exercise should be repeated 5-8 times with a pau-

se of 30 seconds between each series.
D) *Flexion-extension of the elbows*: the patient, seated, flexes and extends the elbows with a stick in the hands. Repeat the exercise 5-8 times, with a 30-second pause between sets.
E) *Flexion-extension of the elbows and elevation of the shoulders*: from a seated position, the patient rests his hands on his shoulders, brings one hand out and rotates the head, following it with his eyes. Then return to the starting position. Perform the exercise 4-5 times per limb, pausing for 30 seconds between each series.
F) *Coordination exercises for the upper limbs*: from a seated position, the patient rests his/her hands on his/her shoulders, then brings them outwards, upwards and forwards, and finally returns to the starting position. Perform the exercise 2-3 times, pausing for 30 seconds between each set.

Lower limb mobilisation and strengthening exercises

(repeat all exercises 5-8 times with a 30-second break between each set)
A. *Knee bends*: the patient is in orthostatic position with hands resting on the couch and begins to flex and extend the knees in a slow manner.
B. *Extension on the tip of the toes*: keeping this position the patient lifts on the tip of the toes performing a plantar flexion of the ankles.
C. *March in place*: the patient flexes the knees while lifting one leg at a time.
Exercise re-training involves both **aerobic activity,** which involves large muscle groups and includes cyclic and repeated exercises of low intensity and long duration, such as: walking, jogging, exercise bike, treadmill, low-intensity swimming , Tai Chi and Qui Gong (disciplines belonging to the martial arts that allow patients to increase the elasticity of tendons and muscles, improve joint ROM, posture and balance, preventing the risk of falling, and increase lung function) and **anaerobic activity,** which involves intense, but short duration efforts and requires the use of weights or resistance such as elastic bands or dumbbells. Aerobic exercises include running and cycling up hills. Generally, in patients with post-COVID-19 syndrome, aerobic activity is more recommended, but it must have specific characteristics: it must be performed gradually but consistently, it must be of mild to moderate intensity, it must be adapted to the age of each patient, and it must be self-manageable. The objectives at which aerobic activity aims are, first of all, to combat sedentariness and begin to walk again with and without a device while, once adequate mobility and autonomy have been achieved, patients will be shown programmes of re-training for effort which vary according to age and functional capacity. In particular, for adults (18 - 64 years old) about 150 minutes of moderate aerobic activity or 75 minutes of vigorous aerobic activity (or a mix of the two) in sessions of about 10 minutes twice a week are recommended, with strengthening of major muscle groups, while for the elderly aged 65 and over the indications are the same as above, with the addition of activities useful to improve balance, in order to prevent the risk of falls. Those who do not have the possibility to respect these recommendations should practice physical activity at least 3 times a week, adopting an active lifestyle according to their state of health and physical condition. Moderate intensity aerobic activity, if done correctly and consistently, provides many beneficial effects in fact improves both cardiovascular function (decreases heart rate), respiratory (increases lung function) and metabolic function and mood, leading to greater resistance to effort and a lower sense of fatigue. To carry out aerobic physical activity it is necessary to follow three steps:

1. *Warm-up*: performed before the actual physical performance in order to prepare adequately for it and to prevent myo-articular trauma such as muscle contractures or stretches, tears and tendon and ligament injuries;
2. *Gradual transition to moderate aerobic activity*, keeping frequency (at least 2 to 3 times per week) and time constant;
3. *Muscle stretching*, especially in the lower limbs.

In order to assess the intensity of the effort, patients can carry out the *talk test themselves: light activity*: can be done by singing or chatting animatedly, *moderate activity:* can only be done by talking, and *intense activity:* no more talking is possible due to accelerated breathing.

The role of home and community-based physiotherapists during pandemic COVID-19

In the United States during the COVID-19 pandemic, physiotherapy rehabilitation services were considered as non-essential, and therefore suspended in attendance, federal and state guidelines state that physiotherapy has a key role in both the treatment of acute and non-acute COVID patients and in the treatment of Long Covid patients. For the same reason, the American Physical Therapy Association, believes that home physiotherapists are indispensable in the treatment of patients who, once discharged from the hospital, may be harmed by not undergoing physiotherapy programs that, in cases such as these, significantly reduce the risk of hospitalization. Allowing our profession to be considered optional and universally non-essential in a critical moment like the one we are living, besides being disadvantageous for the most vulnerable patients, conveys a wrong message at a social level about the importance of the professional figure of the physiotherapist, causing it to be underestimated. In fact, physiotherapists, operating in compliance with the regulations in force and respecting all the prevention measures, can help in achieving three public health objectives: reducing the risk of hospitalization, avoiding overcrowding in the emergency department (ED) and meeting the needs of those who have been discharged from the hospital for clinical recovery, but still require a targeted rehabilitation pathway because they are affected by Long Covid outcomes. These subjects, due to psycho-physical deconditioning, have a risk of re-hospitalization higher than 20%, which is why they require immediate treatment, associated with the evaluation of the safety of the home environment and the education of a possible caregiver by the physiotherapist. It was also very important to use physiotherapy interventions in the emergency room in order to reduce waiting room time and not increase the hospitalization rate. The following is an example of a home protocol from a prospective observational study conducted on people with musculoskeletal conditions being treated during the COVID-19 pandemic.

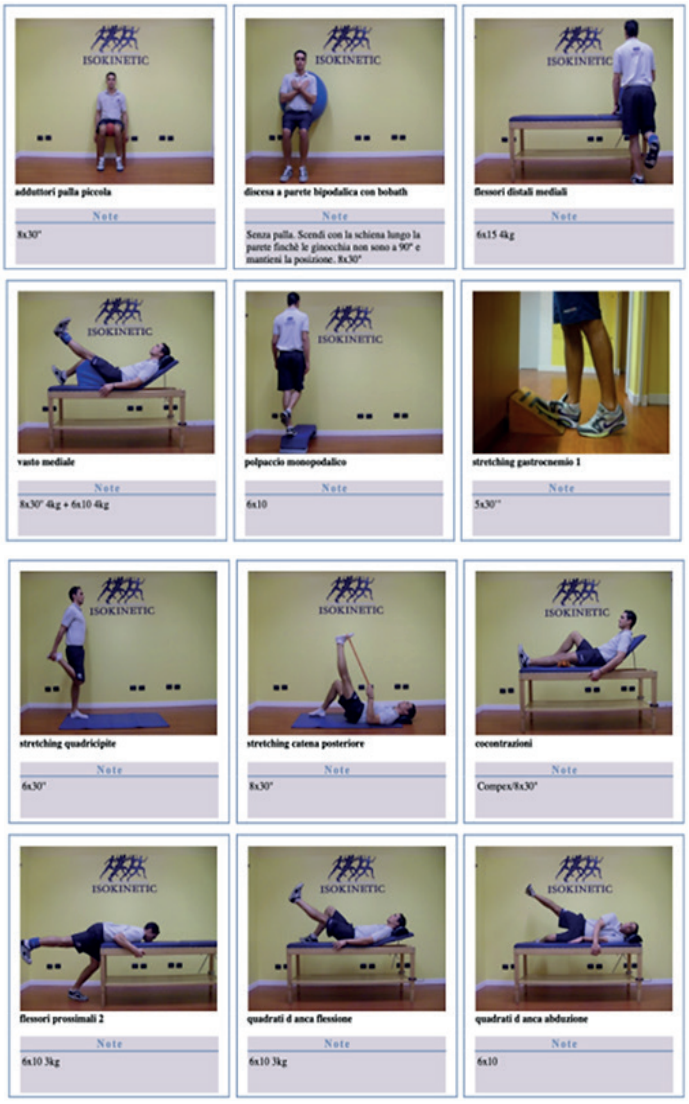

Fig. 3 e 4

Clinical case of the Maugeri Scientific Institute of Bari

A clinical case is briefly presented, exemplifying the course of treatment carried out by the patient. The physiotherapy program began on April 8, 2020. At evaluation, the following were noted:

- Dyspnea (mMRC=3)
- EOT (Objective Examination of the Chest): MV reduced over the whole area, mainly at the left base with hypotransmitted FVT and plexic hypophonesis
- Radiography: diffuse infiltrates, especially in the middle and lower fields and slight affastellation of the ribs in the lower left area
- SpO2 in AA REST: 98%.
- Physiotherapy evaluation: SPPB=0, Bartel motor=5 (significant limitation, even in carrying out activities of daily living), Bartel dyspnea=7 (severe), gait test can not be performed due to the inability of the patient to assume even the sitting posture.

The planned therapy for this patient was both medical and rehabilitative. Medical therapy: ciprofloxacin, acetyl cysteine, vitamin C and D, bisoprolol, clexane 4000x2, ivabradine, lorazepam and mirtazapine. Physiotherapy intervention: postural transitions, passive and active mobilization in bed, breathing exercises with diaphragmatic gymnastics, recovery of the upright station, trunk control, beginning of walking and re-training to the effort with crank. The results of this intervention at a distance of just over two weeks were: reduction of dyspnea (mMRC=2), significant improvement of MV with slight reduction in left basal area, SpO2 unchanged and, as regards the physiotherapy evaluation: SPPB=9, Bartel motor=85, Bartel dyspnea=30 (mild). In addition, the patient was able to perform the 6'WT covering 120 m, with desaturation of 4% and minimum SpO2 of 94%, continuing however to complain of intense dyspnoea on exertion. The experience of rehabilitation specialists in the management of acute and chronic respiratory failure is proving to be fundamental and valuable in the management of the current COVID-19 pandemic and is simultaneously giving us the opportunity to enhance this area of rehabilitation so that, even after the coronavirus era, we can continue to promote this indispensable weapon against complex respiratory pathologies.

REFERENCES

1. Lopez-Leon, S., Wegman-Ostrosky, T., Perelman, C., Sepulveda, R., Rebolledo, P., Cuapio, A., & Villapol, S. (2021). *More Than 50 Long-Term Effects of COVID-19: A Systematic Review and Meta-Analysis*. Research square, rs.3.rs-266574.
2. Jason R Falvey, Cindy Krafft, Diana Kornetti, *The Essential Role of Home- and Community-Based Physical Therapists During the COVID-19 Pandemic*, Physical Therapy, Volume 100, Issue 7, July 2020, Pages 1058-1061.
3. ARIR, AIFI, *indications for respiratory physiotherapy in patients with COVID-1 infection,16.03.2020*
4. Carfì A, Bernabei R, Landi F, for the Gemelli Against COVID-19 Post-Acute Care Study Group. *Persistent Symptoms in Patients After Acute COVID-19*. JAMA. 2020;324(6):603-605.
5. Wang, T. J., Chau, B., Lui, M., Lam, G. T., Lin, N., & Humbert, S. (2020). *Physical Medicine and Rehabilitation and Pulmonary Rehabilitation for COVID-19*. American journal of physical medicine & rehabilitation, 99(9), 769-774.
6. Paolo Pedersini, Camilo Corbellini, Jorge Hugo Villafañe, *Italian Physical Therapists' Response to the Novel COVID-19 Emergency*, Physical Therapy, Volume 100, Issue 7, July 2020, Pages 1049-1051.
7. Marina Simoncelli, Lucia Paoloni, *Motor reconditioning program of the patient with post-Covid-19 syndrome,* the places of care (online), 2020
8. Vitacca, M., Carone, M., Clini, E. M., Paneroni, M., Lazzeri, M., Lanza, A., Privitera, E., Pasqua, F., Gigliotti, F., Castellana, G., Banfi, P., Guffanti, E., Santus, P., Ambrosino, N., & ITS - AIPO, the ARIR and the SIP/IRS (2020). *Joint Statement on the Role of Respiratory Rehabilitation in the COVID-19 Crisis: The Italian Position Paper*. Respiration;

international review of thoracic diseases, 99(6), 493-499.

9. Fichera F, Paolini I, Fichera F, Francesco Paolo Lombardo, *Physical rehabilitation in the post COVID patient*. SIMG Magazine 2020; 27(3):25-28.
10. N. Ambrosino, A. Bellone, F. Gigliotti, A. Murgia, K. Foglio, *Recommendations on Respiratory Rehabilitation*, Review of Respiratory Pathology, 2001; 16: 164-180.
11. Vitacca, M., Lazzeri, M., Guffanti, E., Frigerio, P., D'Abrosca, F., Gianola, S., Carone, M., Paneroni, M., Ceriana, P., Pasqua, F., Banfi, P., Gigliotti, F., Simonelli, C., Cirio, S., Rossi, V., Beccaluva, C. G., Retucci, M., Santambrogio, M., Lanza, A., Gallo, F., Arir Associazione Riabilitatori dell'Insufficienza Respiratoria Sip Società Italiana di Pneumologia Aifi Associazione Italiana Fisioterapisti And Sifir Società Italiana di Fisioterapia E Riabilitazione, O. (2020). *Italian suggestions for pulmonary rehabilitation in COVID-19 patients recovering from acute respiratory failure: results of a Delphi process.* Monaldi archives for chest disease = Archivio Monaldi per le malattie del torace, 90(2), 10.4081/monaldi.2020.1444.
12. Liu, K., Zhang, W., Yang, Y., Zhang, J., Li, Y., & Chen, Y. (2020). *Respiratory rehabilitation in elderly patients with COVID-19: A randomized controlled study*. Complementary therapies in clinical practice, 39, 101166.
13. Ida Di Giacinto Giacomo Grasselli Salvatore Maurizio Maggiore Jessica Maugeri Daniela Pasero Bruno Viaggi, *Care pathway for the COVID-19 patient: recommendations for the management of the critical* COVID-19 *patient*, SIIARTI, 09.11.2020
14. Rooney, S., Webster, A., & Paul, L. (2020). *Systematic Review of Changes and Recovery in Physical Function and Fitness After Severe Acute Respiratory Syndrome-Related Coronavirus Infection: Implications for COVID-19 Rehabilitation*. Physical therapy,pubmed, 100(10), 1717-1729.

SITOGRAPHY

1. *Long COVID*, taken from: https://it.wikipedia.org/wiki/Long_COVID
2. Giorgio Castellana, Michele Vitacca, *COVID 19: the role of respiratory rehabilitation,* from: https://www.youtube.com/watch?v=rXD-PsZrSpc, 23.04.2020
3. https://amslaurea.unibo.it/21988/