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Recommendations for the respiratory rehabilitation of hospitalized and discharged COVID-19 patients: A systematic review

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ABSTRACT. Background. Pulmonary rehabilitation in COVID-19 patients, since the beginning, has focused the attention of healthcare professionals. At the moment, we can state that a multidisciplinary collaboration and a joint action is essential in order to provide a high quality scientific evidence based support. The aim of this review is to outline respiratory rehabilitation recommendations, for COVID-19 patients, and an effective and reasonable rehabilitation model for discharged patients. Methods. The literature review was carried out from 11/02/2020 to 15/07/2020 using the following keywords: (Respiratory rehabilitation or physiotherapy) and COVID-19. The following databases were consulted: MEDLINE (via PubMed), Web of Science, Scopus and PEDro. Studies selection was performed through the PRISMA method. Studies about the physiotherapy recommendations to follow for hospitalized e non-hospitalized COVID-19 patients have been included.

Results. The articles identified are 619, after reading the full text, 32 articles were found to be useful and relevant to the research. Currently, for patients hospitalized in serious/critical condition, it is not suggested to proceed early to pulmonary rehabilitation. In the post-acute phase, it is recommended to run a rehabilitation program of a minimum duration of six weeks which includes: aerobic exercises, strength training, balance training and respiratory training.

Conclusion. Relieve dyspnea, reduce anxiety and depression are the main goals in a short-term rehabilitation program whilst the long-term objects are: better preserve the functional capacity of the patient, improve his life condition and facilitate his return to the community.

Key words: respiratory physiotherapy, COVID-19, pulmonary rehabilitation, SARS-CoV-2.

RIASSUNTO. La riabilitazione polmonare nei pazienti COVID-19, fin dall'inizio, ha focalizzato l'attenzione degli operatori sanitari. Al momento, possiamo affermare che una collaborazione multidisciplinare e un'azione congiunta sono essenziali per fornire un supporto di alta qualità basato sull'evidenza scientifica. Lo scopo di questa revisione è quello di delineare le raccomandazioni nella riabilitazione respiratoria, per i pazienti COVID-19, e un modello di riabilitazione efficace e sicuro per i pazienti dimessi. La revisione della letteratura è stata effettuata dal 11/02/2020 al 15/07/2020 utilizzando le seguenti parole chiave: (riabilitazione respiratoria OR fisioterapia) AND Covid19. Sono stati consultati i seguenti database: MEDLINE (via PubMed), Web of Science, Scopus e PEDro. La selezione degli studi è stata effettuata attraverso il PRISMA Statement. Sono stati inclusi gli studi sulle raccomandazioni nella fisioterapia da seguire per i pazienti ospedalizzati e non ospedalizzati con Covid-19. Gli articoli identificati sono 619, dopo aver letto il testo completo, 32 articoli sono stati trovati utili e rilevanti per la

Introduction

COVID-19 is the infectious disease caused by the coronavirus, SARS-CoV-2, which is a respiratory pathogen. WHO first learned of this new virus from cases in Wuhan, People's Republic of China on 31 December 2019 (1). As of 15 July 2020, a total of 13.555.611 cases of COVID-19 have been confirmed in 202 countries including 580.582 confirmed deaths (1). As the global outbreak of coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), is rapidly evolving and expanding, its full spectrum of effects is becoming evident—from mild, self-limiting respiratory tract illness to severe acute respiratory distress syndrome (ARDS), multiple organ failure, and death (2). In addition, a small number of patients manifested gastrointestinal symptoms, with diarrhea (3.8%) and vomiting (5.0%). The clinical manifestations were in consistent with the previous data of 41, 99, and 138 patients' analysis in Hubei province (3,4,5). ARDS develops in 42% of patients presenting with COVID-19 pneumonia, and 61–81% of those requiring intensive care (6). Patients with fibrosing interstitial lung diseases who have shown progression, despite management deemed appropriate in clinical practice, are at high risk of further progression and early mortality (7). COVID-19 pneumonia tends to manifest on lung CT scans as bilateral, subpleural, ground-glass opacities with air bronchograms, ill-defined margins, and a slight predominance in the right lower lobe. Abnormal lung CT findings can be present even in asymptomatic patients, and lesions can rapidly evolve into a diffuse ground-glass opacity predominance or consolidation pattern within 1–3 weeks after onset of symptoms, peaking at around 2 weeks after onset. Old age, male sex, underlying comorbidities and progressive radiographic

ABBREVIATION

ADL (Activities of daily life), QoL (Quality of Life), ARDS (Acute respiratory distress syndrome), CT (Computed tomography), DLCO (Diffusing capacity of lung for carbon monoxide), GGO (Ground-glass opacification/opacity), ICU (Intensive care unit), MRC (Medical Research Council), PPE (personal protective equipment), WHO (World Health Organization).

ricerca. Attualmente, per i pazienti ospedalizzati in condizioni gravi/critiche, non si suggerisce di procedere precocemente alla riabilitazione polmonare. Nella fase post-acuta, si raccomanda di eseguire un programma di riabilitazione della durata minima di sei settimane che include: esercizi aerobici, allenamento della forza, allenamento dell'equilibrio e allenamento respiratorio. Alleviare la dispnea, ridurre l'ansia e la depressione sono gli obiettivi principali in un programma di riabilitazione a breve termine, mentre gli obiettivi a lungo termine sono: conservare meglio la capacità funzionale del paziente, migliorare le sue condizioni di vita e facilitare il suo ritorno alla comunità.

Parole chiave: fisioterapia respiratoria, Covid-19, riabilitazione polmonare, SARS-CoV-2.

deterioration on follow-up CT might be risk factors for poor prognosis in patients with COVID-19 pneumonia (8). Rehabilitation after COVID-19 is similar to that provided for many patients in geriatric rehabilitation units who have been affected by illness or injury. Some may present with a variety of sequelae associated with the viral illness and with a prolonged stay in the ICU, possibly including mechanical ventilation (9). Pulmonary rehabilitation for these recovered patients has become a major challenge for healthcare professionals, the resolution of which requires multidisciplinary collaboration and joint exploration so that evidence-based, high-quality support can be provided (10). It is important that plans are made now to rapidly identify whether the development of pulmonary fibrosis occurs in the survivor population. By doing this, we can hope to deliver appropriate clinical care and urgently design interventional trials to prevent a second wave of late mortality associated with this devastating pandemic (11). The aim of the study is to provide all the stakeholders recommendations, until now produced, about rehabilitation after COVID-19 disease in order to set, as soon as possible, the respiratory rehabilitation and prevent all the longterm sequelae. Furthermore, an early intervention prevents the patient from staying in ICU for long time that, eventually, could lead to cognitive and psychological disorders.

Methods

The literature review was carried out from 11/02/2020 to 15/07/2020 using the following keywords: (Respiratory rehabilitation OR physiotherapy) AND COVID-19.

The following databases were consulted: MEDLINE (via PubMed), Web of Science, Scopus and PEDro. No restrictions were placed on the publication date. Only articles in English have been included. Studies about the physiotherapy recommendations to follow for hospitalized e non-hospitalized COVID-19 patients have been included in this systematic review. We have included randomized controlled trials (RCTs), controlled clinical trials (CCTs), prospective and retrospective comparative cohort studies, cluster trials, letters to the Editor, reports, commentary, research letters, reviews, consensus and consensus statement, guidelines, handbooks and all articles referred to the topic. We excluded conference abstract and studies where

we could not retrieve the full text or essential data were missing.

The articles identified are 619, 49 duplicate articles have been removed by Endnote software. After reading the full text, 32 articles were found to be useful and relevant to the research: eight reviews, five letters to the editor, two special articles, one report, one consensus statement, one commentary, one original article: cross-sectional observational study, one research article, one comment, one special communication, one practice guideline, one short communication, one handbook, one open randomized controlled trial, one special section, one research letter, one article, one clinical guideline, one research paper and one consensus (Table I).

Out of all the articles found and analyzed, the Impact Factor and the ISSN (International Standard Serial Number) of the publication journals were assessed. The reviewer was not blinded to the journal or the author's name.

This systematic review was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Figure 1).

The following study was registered on Prospero, international database of prospectively registered systematic reviews, on 5/05/2020 with the following identification number CRD42020182490.

Rehabilitation in acute stage

Rehabilitation in the acute phase turns out to be a very delicate intervention. The damage caused by the virus determines the accumulation of sputum in the alveolar area, gas exchange disorders and a consequent inflammatory response.

During the respiratory physiotherapy session, it is recommended to position the patient prone or with the bed tilted in order to facilitate correct breathing and management of secretions.

The patient must be mobilized in its entirety, upper and lower limbs. The next stage is standing training and walking around the bed (12,13). In critically ill hospitalized patients, pulmonary rehabilitation is not recommended (12,14).

Bronchial hygiene techniques, given the dispersion of droplets in the air, specific should be considered only in case of strict necessity. However, contamination of the devices used and the surrounding environment is a high risk (15).

Early active mobilization can prevent the ICU-acquired weakness and determines the improvement of the strength and functional mobility necessary to carry out the activities of daily living (16). Rehabilitation in post-ICU phase does not only concern physical recovery but also cognitive disorders that may occur (17). Physiotherapy has proved to be a valid intervention in the prevention of delirium, one of the most frequent post-ICU cognitive pathologies (18).

In addition, electrical muscle stimulation (EMS) can be used, in order to stimulate the motor plate of the muscle through the use of a special device capable of generating electrical impulses on the patient's body. Moreover,

Tabella I. Caratteristiche degli studi inclusi

Author	Title	Article type	Methods	Database
1. Asly M, Hazim A	Rehabilitation of post-COVID-19 patients.	Letter to the Editors	N/A	N/A
2. Assaf G, Davis H, McCorkell L, et al.	An analysis of the prolonged COVID-19 symptoms survey by Patient-Led Research Team. Patient Led Research.	Report	N/A	N/A
3. Barker-Davies RM, O'Sullivan O, Senaratne KPP, et al.	The Stanford Hall consensus statement for post-COVID-19 rehabilitation.	Consensus statement	This consensus statement was developed by an expert panel in the fields of rehabilitation, sport and exercise medicine (SEM), rheumatology, psychiatry, general practice, psychology and specialist pain, working at the Defence Medical Rehabilitation Centre, Stanford Hall, UK. Seven teams appraised evidence for the following domains relating to COVID-19 rehabilitation requirements: pulmonary, cardiac, SEM, psychological, musculoskeletal, neurorehabilitation and general medical. A chair combined recommendations generated within teams. A writing committee prepared the consensus statement in accordance with the appraisal of guidelines research and evaluation criteria, grading all recommendations with levels of evidence.	PubMed, Google Scholar and specific COVID-19 repositories produced by Journal of the American Medical Association and The Lancet.
4. Bentley SK, Iavicoli L, Cherkas D, et al.	Guidance and Patient Instructions for Proning and Repositioning of Awake, Non intubated COVID-19 Patients.	Commentary	New York City Health + Hospitals/Elmhurst successfully developed and implemented the proning and positioning guide with awake, nonintubated patients as well as provided it to patients suspicious for or with confirmed COVID-19 who were discharged from the emergency department (ED). The guide was developed via expert consensus of an interdisciplinary team of emergency medicine physicians and physical therapists and iteratively revised based on usability testing and understandability feedback from providers and patients, with whom it was piloted through several rounds of revisions.	N/A
5. Bryant MS, Fedson SE, Sharafkhaneh A	Using Telehealth Cardiopulmonary Rehabilitation during the COVID-19 Pandemic.	Letter to the Editor	N/A	N/A
6. Candan SA, Elibol N, Abdullahi A	Consideration of prevention and management of long-term consequences of post-acute respiratory distress syndrome in patients with COVID-19.	Letter to the Editor	N/A	N/A
7. Ceravolo MG, de Sire A, Andrenelli E, et al.	Systematic rapid "living" review on rehabilitation needs due to COVID-19: update to March 31st.	Review	All selected papers were based on previous literature and not on the current COVID-19 pandemic. Main messages included: 1) early rehabilitation should be granted to inpatients with COVID-19; 2) people with restricted mobility due to quarantine or lockdown should receive exercise programs to reduce the risk of frailty, sarcopenia, cognitive decline and depression; 3) telerehabilitation may represent the first option for people at home. Further updates are warranted in order to characterize the emerging disability in COVID-19 survivors and the adverse effects on the health of chronically disabled people.	PubMed, PEDro and Google Scholar.
8. Chinese Association of Rehabilitation Medicine, Respiratory rehabilitation committee of Chinese Association of Rehabilitation Medicine, Cardiopulmonary rehabilitation Group of Chinese Society of Physical Medicine and Rehabilitation	Recommendations for respiratory rehabilitation of COVID-19 in adult (Version 2).	Rewiev	Proposed the recommendations for pulmonary rehabilitation of COVID-19 in adults based on the opinions of front-line clinical experts involved in the management of this epidemic and a review of the relevant literature and evidences: (1) for the inpatients with COVID-19, pulmonary rehabilitation would relieve the symptoms of dyspnea, anxiety, and depression; eventually improve physical function and the quality of life; (2) For severe/critical inpatients, the early performance of pulmonary rehabilitation is not suggested; (3) For isolating patients, the pulmonary rehabilitation guidance should be conducted through education video, instruction manual or remote consultation; (4) Assessment and monitor should be performed throughout the entire pulmonary rehabilitation process; (5) Taking proper grading protection following the guideline. These recommendations can serve as a clinical practice guidance and basis for pulmonary rehabilitation of COVID-19.	PubMed, Ovid, Embase, CBM, CNKI, CMJD.

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Tabella I. (segue)

Author	Title	Article type	Methods	Database
9. Curci C, Pisano F, Bonacci E, et al.	Early rehabilitation in post-acute COVID-19 patients: data from an Italian COVID-19 rehabilitation unit and proposal of a treatment protocol. A cross-sectional study.	Original Article: Cross-sectional observational study	Demographic, anamnestic and clinical characteristics, laboratory exams and medical imaging findings were collected for the entire cohort. Outcome measures evaluated at the admission in Rehabilitation Unit were: type of respiratory supports needed, fraction of inspired oxygen (FiO ₂), partial pressure of oxygen (PaO ₂), FiO ₂ /PaO ₂ , Barthel Index (BI), modified Medical Research Council (mMRC) Dyspnoea Scale, and 6-Minute Walking Test (6-MWT). Furthermore, proposed an early rehabilitation protocol for COVID-19 patients based on baseline FiO ₂ .	N/A
10. Halpin SJ, McIvor C, Whyatt G, et al.	Postdischarge symptoms and rehabilitation needs in survivors of COVID-19 infection: A cross-sectional evaluation.	Research Article	A purposive sample of 100 survivors discharged from a large University hospital were assessed 4 to 8 weeks after discharge by a multidisciplinary team of rehabilitation professionals using a specialist telephone screening tool designed to capture symptoms and impact on daily life. EQ-5D-5L telephone version was also completed.	N/A
11. Hosey MM, Needham DM	Survivorship after COVID-19 ICU stay. Nature reviews.	Comment	N/A	N/A
12. Iannaccone S, Castellazzi P, Tettamanti A, et al.	Role of Rehabilitation Department for Adult Individuals With COVID-19: The Experience of the San Raffaele Hospital of Milan.	Special Communication	This communication reports the experience of the San Raffaele Hospital of Milan and recommends the setup of specialized clinical pathways for the rehabilitation of patients with COVID-19. In this hospital, between February 1 and March 2, 2020, about 50 patients were admitted every day with COVID-19 symptoms.	N/A
13. Kalirathinam D, Guruchandran R, Subramani P	Comprehensive physiotherapy management in COVID-19 - a narrative review.	Review Article	This comprehensive narrative review aims to describe recent progress in the application of physiotherapy management in COVID-19 patients. Assessment and evidence-based treatment of these patients should include prevention, reduction of adverse consequences in immobilization, and long-term impairment sequelae. A variety of techniques and modalities of early physiotherapy in intensive care unit are suggested by clinical research. They should be applied according to the stage of the disease, comorbidities, and patient's level of cooperation.	N/A
14. Kiekens C, Boldrini P, Andreoli A, et al.	Rehabilitation and respiratory management in the acute and early post-acute phase. "Instant paper from the field" on rehabilitation answers to the COVID-19 emergency.	Special Article	This paper summarizes the second webinar on COVID-19 (230 live attendees, 11,600 viewers of the recorded version) organized by the Italian Society of Physical and Rehabilitation Medicine about rehabilitation and in particular respiratory management in the acute (Intensive Care Unit [ICU]) and immediate post-acute phases.	N/A
15. Lazzeri M, Lanza A, Bellini R, et al.	Respiratory physiotherapy in patients with COVID-19 infection in acute setting: a Position Paper of the Italian Association of Respiratory Physiotherapists.	Practice Guideline	The presentation of this manuscript is the result of a consensus between Italian physiotherapists with specific expertise in respiratory care, working with COVID-19 patients in the hospitals of the north of Italy. There fore, our aim is to share information with world wide physiotherapists involved in the management of patients affected by COVID-19.	N/A
16. Lechowicz K, Drożdżal S, Machaj F, et al.	COVID-19: The Potential Treatment of Pulmonary Fibrosis Associated with SARS-CoV-2 Infection.	Narrative review	This narrative review demonstrates similarity in pulmonary symptoms and the mechanisms of their formation, with previous forms of the coronavirus (SARS, MERS).	N/A
17. Lee AJY, Chung CLH, Young BE, et al.	Clinical course and physiotherapy intervention in 9 patients with COVID-19.	Short Communication	N/A	N/A
18. Liang T	Rehabilitation therapy for COVID-19 patients.	Handbook	N/A	N/A
19. Liu K, Zhang W, Yang Y, et al.	Respiratory rehabilitation in elderly patients with COVID-19: A randomized controlled study.	Open randomized controlled trial	This paper reported the findings of an observational, prospective, quasi-experimental study, which totally recruited 72 participants, of which 36 patients underwent respiratory rehabilitation and the rest without any rehabilitation intervention. The following outcomes were measured: pulmonary function tests including plethysmography and diffusing lung capacity for carbon monoxide (DLCO), functional tests (6-min walk distance test), Quality of life (QoL) assessments (SF-36 scores), activities of daily living (Functional Independence Measure, FIM scores), and mental status tests (SAS anxiety and SDS depression scores).	N/A

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Tabella I. (segue)

Author	Title	Article type	Methods	Database
20. Meng L, Qiu H, Wan L, et al.	Intubation and ventilation amid the COVID-19 outbreak: Wuhan's Experience. <i>Anesthesiology</i> .	Special Section	N/A	N/A
21. Nakamura K, Nakano H, Naraba H, et al.	Early rehabilitation with dedicated use of belt-type electrical muscle stimulation for severe COVID-19 patients.	Letter	N/A	N/A
22. Perchiazzi G, Pellegrini M, Chiodaroli E, et al.	The use of positive end expiratory pressure in patients affected by COVID-19: Time to reconsider the relation between morphology and physiology.	Review	N/A	N/A
23. Roesthuis L, van den Berg M, van der Hoeven H	Advanced respiratory monitoring in COVID-19 patients: use less PEEP!	Research Letter	N/A	N/A
24. Salawu A, Green A, Crooks MG, et al.	Proposal for Multidisciplinary Tele-Rehabilitation in the Assessment and Rehabilitation of COVID-19 Survivors.	Article	N/A	N/A
25. Thomas P, Baldwin C, Bissett B, et al.	Physiotherapy management for COVID-19 in the acute hospital setting: clinical practice recommendations.	Invited Topical Review	Through a web search and personal files, recently developed guidelines for COVID-19 management of critically ill patients were identified from international agencies (eg, World Health Organization), critical care professional societies or groups (eg, Australia and New Zealand Intensive Care Society, Society of Critical Care Medicine/European Society of Intensive Care Medicine), or physiotherapy professional societies up to 21 March 2020. These guidelines were used to inform the consensus recommendations developed in conjunction with expert opinion of the authorship group.	N/A
26. Vitacca M, Lazzeri M, Guffanti E, et al.	Italian suggestions for pulmonary rehabilitation in COVID-19 patients recovering from acute respiratory failure: results of a Delphi process.	Scoping review	There is a need of consensus about the pulmonary rehabilitation (PR) in patients with COVID-19 after discharge from acute care. To facilitate the knowledge of the evidence and its translation into practice. A steering committee identified areas and questions sent to experts. Other international experts participated to a RAND Delphi method in reaching consensus and proposing further suggestions.	PubMed, Google Scholar, the WHO official websites.
27. Vitacca M, Migliori GB, Spanevello A, et al.	Management and outcomes of post-acute COVID-19 patients in Northern Italy.	Letter to the Editor	N/A	N/A
28. Warrillow S, Austin D, Cheung W, et al.	ANZICS guiding principles for complex decision making during the COVID-19 pandemic.	Special Article	N/A	N/A
29. Yang LL, Yang T	Pulmonary Rehabilitation for Patients with Coronavirus Disease 2019 (COVID-19).	Review	N/A	N/A
30. Zhao H, Xie Y, Wang C	Recommendations for respiratory rehabilitation in adults with COVID-19.	Clinical Guidelines	The evidence assessment group employed the Appraisal of Guidelines for Research & Evaluation II tool for methodological quality assessment of the included guidelines, the Assessment of Multiple Systematic Reviews tool for quality assessment of systematic reviews, and the Cochrane bias risk assessment tool for bias risk assessment of randomized controlled trials.	PubMed, Ovid, Embase, Chinese databases, Chinese Biological Medical Literature database, China National Knowledge Infrastructure, Chinese Medical Journal Database.
31. Zhao YM, Shang YM, Song WB, et al.	Follow-up study of the pulmonary function and related physiological characteristics of COVID-19 survivors three months after recovery.	Research Paper	COVID-19 survivors were recruited for high resolution computed tomography (HRCT) of the thorax, lung function and serum levels of SARS-CoV-2 IgG antibody tests 3 months after discharge. The relationship between the clinical characteristics and the pulmonary function or CT scores were investigated.	N/A
32. Zhonghua Jie He He Hu Xi Za Zh	[Expert consensus on preventing nosocomial transmission during respiratory care for critically ill patients infected by 2019 novel coronavirus pneumonia].	Consensus	N/A	N/A

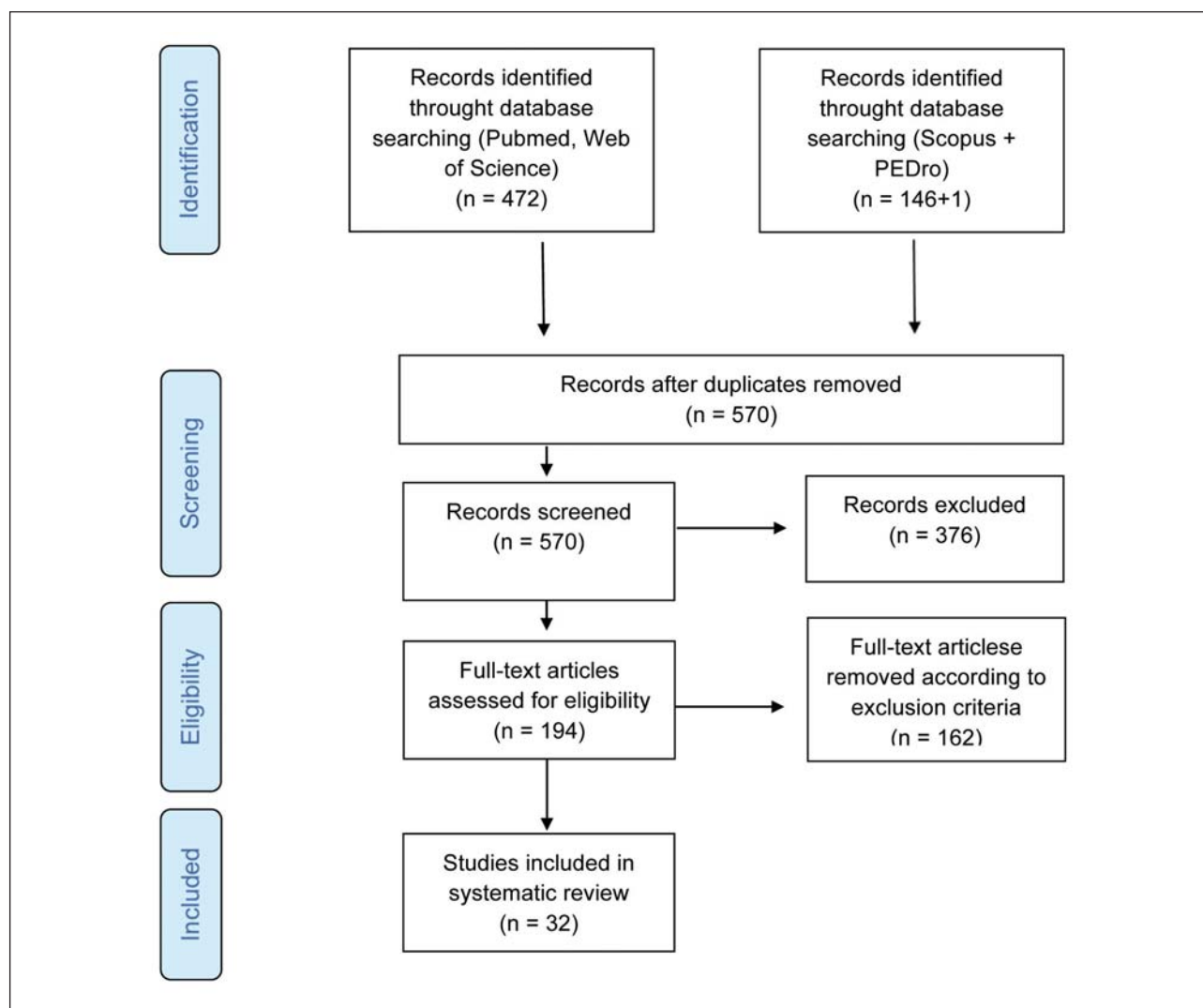


Figure 1. PRISMA flow diagram

among the various modes of EMS, belt-type EMS is expected to be effective for critical care because it can induce whole lower extremity exercise through whole muscle contraction between wrapped belts (19). The combination of EMS and increased protein intake given to the patient in intensive care helps to preserve muscle health (20).

When the clinical conditions are stabilized, the active cycle of respiratory techniques can be initiated. This technique involves different ways of breathing, such as breath control, chest expansion exercises and forced exhalation techniques (21).

As soon as possible, it will be appropriate to evaluate the patient through the “six minutes walking test” for the oxygenation response during exertion, Medical Research Council scale and dynamometers for peripheral muscle strength (22).

Healthcare professionals, particularly specialized in infectious diseases, such as COVID-19, should know how to use personal protective equipment (PPE) correctly. PPE does not affect the dangers and do not eliminate them. An inappropriate use may put a high risk of contamination workers and the surrounding community. Appropriate

training in the use of PPE with subsequent skill test is recommended (23).

An early training during the stay in ICU, is often more challenging. Technological development includes the bedside cycle ergometer for active or passive leg cycling during bed rest, permitting prolonged continuous mobilization and rigorous control of exercise intensity and duration. Training intensity can be continuously adjusted to the patient’s health status and physiological responses to exercise (24).

Indications for Invasive/ Non-invasive Ventilation

The performance of respiratory physiotherapy interventions on patients affected by COVID-19 has raised a debate on the potential risk of these procedures being at the origin of an airborne transmission of the virus. Indeed, despite more studies are required to confirm the aerosol-generating potential of various techniques, many of them seem to pose a risk for viral spread, especially when combined with cough-eliciting maneuvers aimed at clearing the airways (25).

Therefore, given the risk of creating an airborne transmission of COVID-19 during treatments, physiotherapists should carefully assess the risks and the benefits that these procedures produce and use airborne precautions.

Where aerosol-generating procedures are necessary, a negative-pressure room should be preferred for their performance (26). In case there are no negative pressure rooms, a single room with the door closed can be utilized as well. The access to the room should be limited to the required staff, discouraging people from entering and leaving the room during the procedure. All the staff must wear PPE, as described by the guidelines (27).

The application of these precautionary measures may be hampered by the high number of people requesting medical care, during the outbreaks of COVID-19.

As concerns ventilation, the use of positive end-expiratory pressure (PEEP) should be carefully evaluated based on the type and distribution of lung injury (28). Consequently, use remains specific and individualized. High PEEP levels probably cause hyperinflation and potentially right ventricular failure. It is recommended to apply lower PEEP levels as much as possible (29).

When managing patients affected by SARS-Cov-2, it is essential being prepared to face acute worsening of patient conditions, which may require intubation and invasive mechanical ventilation. In the light of the risk of NIV failure, it is fundamental the presence of a staff able to perform endotracheal intubation in the acute emergency setting (30).

During the invasive mechanical ventilation, any unnecessary maneuver should be avoided, particularly those with the potential of reducing the PEEP (Positive End Expiratory Pressure); indeed, PEEP reduction yields an increased risk of lung de-recruitment and atelectasis. Close suction circuits are recommended because they improve gas exchanges and reduce the respiratory rate which is physiologically increased when secretions accumulate in the airways. The use of these devices has the advantage of avoiding the dispersion of droplets and is thus considered safe since it does not pose a risk of contamination for the health professionals (14).

Early prone positioning of the patients after endotracheal intubation, preferably within 72 hours, is recommended. The patient should be kept in this position for at least 12-16 hours per day (31). The interruption is necessary where the oxygenation worsens following patient positioning (20% decrease in P/F compared to the supine position) or in the presence of serious complications (32).

Post-acute rehabilitation for COVID-19 patients

Post-acute COVID-19 symptoms vary widely. Even so-called mild COVID-19 may be associated with long term symptoms, most commonly cough, low grade fever, and fatigue, all of which may relapse and remit (33,34). New or worsened breathlessness (when compared with pre-COVID illness) was a significant symptom even several weeks post-discharge (35). Pulmonary rehabilitation should be performed throughout the entire disease man-

agement cycle, regardless of whether the patient is hospitalized or at home (10). Moreover, the measure of ADL impairment at home and the role of caregivers' availability have been underlined as crucial for recovery (36). The performance of mild to moderate intensity aerobic exercises is beneficial in increasing the function of the immune system in patients with COVID-19, the performance of high intensity aerobic exercises should be avoided for those patients because of its adverse effects on suppressing the function of the immune system (37). In the post-acute phase, inspiratory muscle training should be included if the inspiratory muscles are weak. Based on the assessments made, positive expiratory pressure devices, deep and slow breathing, chest expansion (with shoulder elevation), diaphragmatic breathing, respiratory muscle mobilization, airway release techniques (as needed) and positive expiratory pressure devices can be added (38,21). Six-week respiratory rehabilitation can improve respiratory function, QoL and anxiety of elderly patients with COVID-19, but it has little significant improvement on depression in the elderly (39). In addition to respiratory tract damage caused by pulmonary fibrosis, patients will also face psychiatric and neuropsychiatric disorders (40). To date, there are no protocols of respiratory rehabilitation post COVID-19 already tested given the new and recent outbreak of the pandemic and some articles begin to treat even the "Tele-rehabilitation" subject. Correct inhaler use, breathing patterns, coughing can be assessed easily with the virtual connection (41). Tele-rehabilitation approaches are welcome as they represent the first option for people capable of exercising at home under the guidance of rehabilitation professionals (42). According to an Italian study on the outcomes of post-acute patients, even undergoing short sessions of reconditioning and physiotherapy, still represent a challenge for the health care system due to the high need for monitoring, complex respiratory support, high risk of further decompensation and death (43). Therefore, there is a clear need to plan for post-acute and chronic rehabilitation of patients recovering from COVID-19 (44).

Discussion

COVID-19 patients may develop restrictive respiratory failure and pulmonary fibrosis, especially after a long stay in ICU. Furthermore, physical, cognitive or mental disability can persist for a long time after the discharge. This condition is called post-intensive care syndrome (PICS) (45). Prevention of this syndrome should begin in the ICU using the ABCDE bundle. In relation to the physical subdimension, the "E (early-stage rehabilitation and exercise)" part of the ABCDE bundle was recommended for suitable patients in the ICU. The early rehabilitation protocol by Curci et al. provides 2 sessions per day of 30 minutes for 2/3 weeks. For patients with oxygen support devices or nasal cannula ($FiO_2 \geq 40$ and $< 60\%$), posture changes and management are essential. Furthermore, since these patients are bedridden, it is necessary to mobilize the limbs and restore the capacity for muscle recruitment in order to prevent embolic events (46). In non-intu-

bated patients who are in stable clinical conditions it is recommended to change position every 30 minutes to two hours. To improve respiratory function, it is advised not to spend a lot of time lying on the back but rather to remain lying on the stomach or the sitting position (47). In addition to physical disabilities, clinically significant symptoms of anxiety, depression, and post-traumatic stress disorder (PTSD) can occur (48). In these cases, neuropsychological training, counseling sessions and psychological support should be provided.

During the post-ICU hospitalization phase, it is important to stay in touch with the family via calls or videos. Visits are often forbidden and this leads the patient to feel abandoned (49). Unfortunately, patients do not always have the opportunity to access early rehabilitation. Sometimes hospitals do not have sufficient specialized staff. This condition determines an increase in disability that must be managed by the patient once discharged from the hospital (50).

Significant complications of the respiratory system infection are represented by pulmonary fibrosis that can eventually lead to permanent disability (51). The level of D-dimer at admission is an important factor for abnormal carbon monoxide diffusion capacity (DLCO) (52). In order to counteract the possible scarring of the lung tissues, it is necessary to advise the patient some exercises to be done at home after hospital discharge. The prescription content mostly includes: Aerobic exercises, strength training, balance training and respiratory training (10). The possibility of a follow-up review via tele-rehabilitation should be explored (53). Tele-rehabilitation could provide an effective way of assessing and managing residual deficits (54). The rating scales used to assess and monitor the patient may include: Barthel Dyspnea Index (QoL), Modified Barthel Index (QoL), Berg Balance Scale (functional balance scale), Borg rating of perceived exertion for dyspnea and fatigue (during reconditioning training and 6-minute walk test), 30-second sit-to-stand test and 6-minute walk test (performed only before discharge) (55).

Conclusion

Rehabilitation program should start as soon as possible, COVID-19 patients not excluded although, in this case, “when” and “how” to set a reasonable model of intervention, represent the two main questions. After several months of experience in COVID-19 wards, we could certainly claim that pulmonary rehabilitation program should be introduced when patient’s conditions are stabilized.

At the beginning, in ICU, it is fundamental to mobilized constantly the patients until they are able recover the sitting position and eventually to walk.

Furthermore, considering the long terms sequelae, most of patient needs to continue, in presence or remotely, the treatment in order to reduce fatigue and respiratory disorders.

All the data we gathered and analysed, lead us to affirm that the combination of different trainings (aerobic,

fitness, strength, respiratory) without neglecting the neuropsychological aspect, improve the well-being in COVID-19 post-acute patients.

Key messages:

- Different types of training (aerobic, fitness, balance and respiratory) can lead to the recovery of physical well-being in COVID-19 post-acute patients
- The early performance of pulmonary rehabilitation is not suggested for severe/critical patients
- Pulmonary rehabilitation for mild and moderate cases should be introduced as soon as possible

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