

# Joint Statement on the Role of Respiratory Rehabilitation in the COVID-19 Crisis: The Italian Position Paper

Michele Vitacca<sup>a</sup> Mauro Carone<sup>b</sup> Enrico Maria Clini<sup>c</sup> Mara Paneroni<sup>a</sup>  
Marta Lazzeri<sup>d</sup> Andrea Lanza<sup>e</sup> Emilia Privitera<sup>f</sup> Franco Pasqua<sup>g</sup>  
Francesco Gigliotti<sup>h</sup> Giorgio Castellana<sup>b</sup> Paolo Banfi<sup>i</sup> Enrico Guffanti<sup>j</sup>  
Pierachille Santus<sup>k</sup> Nicolino Ambrosino<sup>l</sup> on behalf of the Italian Thoracic Society (ITS-AIPO), the Association for the Rehabilitation of Respiratory Failure (ARIR) and the Italian Respiratory Society (SIP/IRS)

<sup>a</sup>Respiratory Rehabilitation of the Institute of Lumezzane, Istituti Clinici Scientifici Maugeri IRCCS, Brescia, Italy;

<sup>b</sup>Respiratory Rehabilitation of the Institute of Bari, Istituti Clinici Scientifici Maugeri IRCCS, Bari, Italy;

<sup>c</sup>Department of Medical and Surgical Sciences SMECHIMAI, University of Modena and Reggio Emilia, Modena, Italy;

<sup>d</sup>Department of Cardiothoracic and Vascular Surgery, ASST Grande Ospedale Metropolitano Niguarda, Milan, Italy;

<sup>e</sup>Sleep Medicine Center, Department of Neuroscience, ASST Grande Ospedale Metropolitano Niguarda, Milan, Italy;

<sup>f</sup>Health Professions Department Unit, Fondazione IRCCS Cà Granda Ospedale Maggiore Policlinico, Milan, Italy;

<sup>g</sup>Pulmonary Rehabilitation, Istituto Clinico Riabilitativo Villa delle Querce, Nemi, Rome, Italy; <sup>h</sup>Pulmonary Rehabilitation

Unit, IRCCS Fondazione Don Carlo Gnocchi Hospital, Florence, Italy; <sup>i</sup>Pulmonary Rehabilitation Unit,

IRCCS Fondazione Don Carlo Gnocchi Hospital, Milan, Italy; <sup>j</sup>Rehabilitative Pneumology, Former INRCA IRCCS,

Casatenovo, Lecco, Italy; <sup>k</sup>Division of Respiratory Diseases, Department of Biomedical and Clinical Sciences L. Sacco,

Ospedale Universitario L. Sacco – ASST Fatebenefratelli Sacco, Università degli Studi di Milano, Milan, Italy;

<sup>l</sup>Respiratory Rehabilitation of the Institute of Montescano, Istituti Clinici Scientifici Maugeri IRCCS, Pavia, Italy

## Keywords

Critical care medicine · Pulmonary medicine · Position paper

## Abstract

Due to the exponential growth of the number of subjects affected by coronavirus disease 2019 (COVID-19), the entire Italian health care system had to respond promptly and in a very short time with the need of semi-intensive and inten-

sive care units. Moreover, trained dedicated COVID-19 teams consisting of physicians were coming from different specialties (intensivists or pneumologists and infectiologists), while respiratory therapists and nurses have been recruited to work on and on without rest. However, due to still limited and evolving knowledge of COVID-19, there are few recommendations concerning the need in respiratory rehabilitation and physiotherapy interventions. The presentation of this paper is the result of a consensus promoted by the Italian societies of respiratory health care professionals who

contacted pulmonologists directly involved in the treatment and rehabilitation of COVID-19. The aim was to formulate the more proper and common suggestions to be applied in different hospital settings in offering rehabilitative programs and physiotherapy workforce planning for COVID-19 patients. Two main areas of intervention were identified: organization and treatment, which are described in this paper to face the emergency.

© 2020 S. Karger AG, Basel

## Introduction

The global outbreak of coronavirus disease 2019 (COVID-19) is having a dramatic effect throughout the world [1, 2]. The widespread diffusion of the virus in Italy [3] has led national and regional authorities to institute extraordinary measures to contain the spread. The disease can cause major alveolar damage resulting in hypoxemic acute respiratory failure, which necessitates mechanical ventilation in a high proportion of cases [4–6].

Italian societies of respiratory health care professionals promoted an audit among pulmonologists directly involved in the treatment of COVID-19 with the aim to formulate guidelines and propose a common management algorithm to apply in treating this condition in the hospital setting [7]. The audit identified two urgent areas for action: organization and treatment. The latter, we believe, should also include respiratory rehabilitation, as it is an important component of the therapeutic management of these patients. Respiratory rehabilitation (RR) is defined as “a multidisciplinary intervention based on personalized evaluation and treatment which includes, but is not limited to, exercise training, education, and behavioral modification designed to improve the physical and psychological condition of people with respiratory disease” [8]. In this context, and in relation to the topic of this document – patients affected by COVID-19 – physiotherapy interventions are particularly important (Tables 1–3).

Some international groups have tried to give suggestions related to rehabilitation in their national context [9–11]. Based on our general experience so far in dealing with the disease and on the existing knowledge (albeit still limited and evolving), we here propose a Consensus Statement on Respiratory Rehabilitation in patients with COVID-19. It represents an expert opinion of clinicians engaged in the field of RR, called – together with other specialties – to face this emergency.

## Literature Search

We carried out a search of the published literature in PubMed, Ovid, Embase online databases and relevant websites from the construction of databases to March 19, 2020, in order to retrieve guidelines and recommendations, meta-analyses, systematic reviews, state of the art, and randomized trials. The search terms were: “coronavirus pneumonia,” “acute respiratory distress syndrome (ARDS),” “acute hypoxemic respiratory failure,” “severe acute respiratory syndrome (SARS),” “Middle East respiratory syndrome (MERS),” “influenza,” “pulmonary rehabilitation or physical therapy AND infectious diseases, or acute respiratory failure or mechanical ventilation,” “noninvasive ventilation AND acute hypoxemic respiratory failure,” “weaning from mechanical ventilation.”

## Generation of Recommendations and Consensus

Based on the literature search, a small group of professionals produced a preliminary document which was then submitted to the participants. Consensus on the final document was achieved through a video conference meeting.

Below we summarize the recommendations that we consider most appropriate and urgent.

### General Recommendations

- The group takes into account the definition of severity based on the Italian Health Organization [12]: (a) *mild condition*: patient with pneumonia (clinical or radiological diagnosis) without any signs of severe pneumonia; (b) *severe condition*: fever or suspected respiratory infection, respiratory frequency >30 breaths/min, dyspnea, pulsed oxygen saturation ( $SpO_2$ ) <90% in room air; (c) *very severe condition* (assumed to mimicking ARDS): bilateral interstitial radiological signs, partial pressure of arterial oxygen versus percentage of inspired oxygen fraction ( $PaO_2/FiO_2$ ) <300.
- Health care operators assigned to RR need to be sufficiently skilled (appropriate curriculum vitae and experience with respiratory physiotherapy); if no dedicated staff is present, health professionals must pass a training test on few but clear principles of behavior and action.
- Operators and patients must follow all precautionary and preventive measures and wear all the protective gear specified in the relevant documents [13, 14].

**Table 1.** Physiotherapy for COVID-19 patients in the critical phase

---

*Ventilation support/weaning*

- Monitoring of clinical conditions (parameters and signs)
- Adjustment of the mechanical support and oxygen therapy
- Extubation protocols with or without NIV/CPAP

---

*Disability prevention*

- Passive/active mobilization
- Frequent posture changes
- Therapeutic postures (early sitting/pronation)
- Neuromuscular electrical stimulation

---

- RR is a structured nonpharmacological therapy with a process delivered in three phases: *assessment*, *intervention*, and *reassessment* (the assessment is above all of a functional nature, with particular attention paid to the state of consciousness, respiratory, cardiological, motor function, and quality of life).
- All interventions and activities must be performed to avoid or reduce the risk of droplet production (particularly concerning airway clearance interventions) [15].
- Regardless of the type of intervention, the intensity, timing, and modality must be tailored to the individual patient's needs, in particular for those with severe/critical illness, elderly patients, obesity, comorbidity, and other complications [16, 17].
- Assessment and monitoring should continue throughout the entire rehabilitation process. Patients who do not meet the standard set need to be reassessed daily.
- RR operators can also attend to reduce anxiety and depression in patients experiencing delirium, anger, fear, dysthymia, insomnia, panic attack, or sense of abandonment during isolation and intensive treatment, or exhibiting a risk of noncollaboration or noncompliance with treatment.

### Acute Phase (Very Severe Respiratory Condition)

*Setting: Emergency Room, First Aid, Emergency Care Unit, Intensive Care Unit, Step-Up Subintensive Care*

- The rehabilitative intervention in this phase had to be started when the patient had reached a minimum clinical stability. Treatments should be withdrawn in case of: high fever; worsening dyspnea; respiratory rate >30 breaths/min; pulse oximetry <93% on oxygen therapy or requiring FiO<sub>2</sub> >50% during noninvasive ventilation (NIV), positive end expiratory pressure (PEEP)/

**Table 2.** Physiotherapy for COVID-19 patients in the acute phase

---

*Ventilation support/weaning*

- Monitoring of clinical conditions (parameters and signs)
- Adjustment of oxygen therapy

---

*Disability prevention*

- Mobilization (getting patient out of bed)
- Frequent posture changes/continuous rotational therapy
- Therapeutic postures (early sitting/pronation)
- Active limb exercises (also with dedicated devices) and muscle reconditioning
- Strengthening the peripheral muscles
- Neuromuscular electrical stimulation
- Respiratory muscle training in case of inspiratory muscle weakness

---

*Chest physiotherapy*

- Nonproductive dry cough should be sedated to avoid fatigue and dyspnea
- Bronchial clearance techniques are indicated in hypersecretive patients with chronic respiratory diseases, by preferably using disposable devices with self-management (closed plastic bags for sputum collection help to prevent any spread of the virus)

---

- continuous positive airway pressure (CPAP) >10 cm H<sub>2</sub>O; respiratory distress, arterial hypertension, brady- or tachycardia, intercurrent arrhythmias, shock, deep sedation, evidence of radiological lesion progression (>50%) within 24–48 h [18].
- The usual respiratory physiotherapy procedures aimed at promoting the reduction of dyspnea, the tracheo-bronchial clearance, the training of the skeletal muscle and the maintenance/recovery of the activities of daily living are contraindicated as they can determine a further loading of the respiratory system exposing the patient to an increased risk of distress.
- When treating acute respiratory failure by NIV or weaning from mechanical ventilation, it is recommended to use similar protocols to those indicated for de novo acute respiratory failure (e.g., FiO<sub>2</sub> reduction, PEEP reduction) [19–22].
- Airways clearance techniques are not recommended during the acute phase in patients without major problems of bronchial obstruction. Indeed, the hypothetical benefits do not outweigh the contamination risks for operators. The risk/benefit ratio should be evaluated on a single case basis in patients with bronchiectasis or with evident bronchial encumbrance, using tools that guarantee a safe distance from the patient [18].
- Twice per day evaluation of respiratory clinical parameters (temperature, SpO<sub>2</sub>, SpO<sub>2</sub>/FiO<sub>2</sub>, cough, dyspnea,

**Table 3.** Physiotherapy for COVID-19 patients during the post-acute phase

*Weaning*

- Monitoring of parameters
- Mechanical ventilation weaning in tracheostomized patients
- Management of problems related to tracheostomy (phonation, secretion encumbrance)
- Adjustment of oxygen therapy

*Recovery from disability*

- Mobilization (getting patient out of bed)
- Frequent posture changes (sitting posture, prone positioning)
- Strengthening of peripheral muscles
- Reconditioning with specific aids (upper/lower limb devices/cycle ergometer)
- Neuromuscular electrical stimulation
- Respiratory muscle training in case of inspiratory muscle weakness

*Chest physiotherapy*

- Nonproductive dry cough should be sedated to avoid fatigue and dyspnea
- Bronchial clearance techniques are indicated in hypersecretive patients with chronic respiratory diseases, by preferably using disposable devices with self-management (closed plastic bags for sputum collection help to prevent any spread of the virus)
- PredischARGE counseling concerning physical activity
- Support to the care team
- Psychological advice and support

respiratory rate, thoracoabdominal dynamics) is indicated. We recommend to develop an algorithm to manage the assessment/intervention.

- Evaluation of the peripheral muscle strength trend (by the Medical Research Council scale and dynamometers) should be made as soon as practicable.
- Frequent changes of posture, passive mobilization and/or neuromuscular electrical stimulation should be planned in the unconscious patient [18, 20–33].
- Positional therapy (seated, semiorthopneic, prone) with close monitoring is indicated in order to improve the ventilation/perfusion ratio and to prevent damage from immobilization [18, 20–33].
- The prone position is recommended for several hours. If this positions have been effective, repeat them until  $\text{PaO}_2/\text{FiO}_2$  ratio  $\geq 150$  mm Hg with PEEP  $\leq 10$  cm  $\text{H}_2\text{O}$  and  $\text{FiO}_2 \leq 0.60$  for at least 4 h after the supine position. The prone position procedure must be interrupted in case of oxygenation worsening or in case of serious complications [34, 35].

**Acute Phase (Severe Condition)**

*Setting: Nonintensive Acute Care Hospital (Internal Medicine, Respiratory, Infectious Diseases, or Other Wards)*

- In hospitalized patients with mild/moderate disease, RR can improve symptoms (dyspnea, anxiety, and depression), physical capacity, and quality of life, at least potentially [13–16, 20, 22–33].
- Physiotherapy should be withdrawn in case of: high fever, worsening dyspnea; pulse oximetry  $<93\%$  or at least 4-point drop during exercise (desaturation), chest tightness, belching, dizziness, headache, unclear vision, palpitations, sweating, inability to keep balance, increased need for  $\text{O}_2$  or NIV support, evidence of radiological lesion progression ( $>50\%$ ) within 24–48 h [18].
- In patients under CPAP/NIV or during spontaneous breathing, the changes of position can modify the ventilation/perfusion ratio and may lead to a sudden change (improvement or deterioration) of gas exchange [35].

**Postacute Phase (after Discharge from Acute Care to an Intermediate Setting)**

*Setting: RR Department, Other Units for Specialist and Maintenance Rehabilitation, Intermediate Care Facilities, Subacute Wards*

- Similarly to patients recovering from ARDS due to severe influenza A (H1N1) pneumonia infection [36–39], those with an acute COVID event may present disability and functional damage (respiratory function, critical illness myopathy, and neuropathy), reduced participation and deterioration in quality of life, either in the short or long term following discharge.
- Recovery time is variable depending upon the degree of normocapnic respiratory failure, and the associated physical (asthenia, peripheral muscle weakness) and emotional (anxiety, depression, sense of abandonment, posttraumatic stress syndrome) dysfunction [39]. Patients with comorbidities will take a longer period to return to their former condition.
- Protocols for evaluating clinical parameters (temperature,  $\text{SpO}_2$ ,  $\text{SpO}_2/\text{FiO}_2$ , cough, dyspnea, respiratory rate, thoracoabdominal dynamics) are indicated on a daily basis [15, 18].
- Simple and repeatable treatment protocols to wean oxygen therapy are indicated.
- It is recommended to evaluate peripheral muscle strength with the Medical Research Council scale,

- manual muscle test, isokinetic muscle test, and measurement of joint range of motion.
- In weaned patients and those with prolonged weaning from mechanical ventilation and oxygen use, reconditioning interventions are indicated in order to improve the physical status and to correct the motor and cognitive effects of prolonged immobilization in the intensive care area [40–48].
  - As the effect of muscle activity in infections related to viral agents is not known, exercises aiming [15] at a gradual load increase based on subjective symptoms are recommended to maintain a normal function.
  - Low-intensity exercise (<3.0 metabolic equivalents), daily patient counseling, and education are indicated [15, 18].
  - For patients in isolation, rehabilitation programs can be eventually conducted remotely by a tele-health system (educational videos, tele-consultation, webcams etc., with disinfectable tools) [15, 18].
  - Patients discharged home or to other facilities in the community should receive indications on how to cope with physical activity, which need to be closely monitored regarding function, capacity, and participation when the patient is cured with no longer a risk of contagion.
  - An assessment of balance function is recommended as soon as possible (especially for patients who were bedridden for long).
  - As soon as possible, assessment of exercise capacity, oxygenation response during effort (by the 6-min walking test) and night time should be planned.

### Organizational Changes

The “war time” emergency which developed within few weeks has forced the world of rehabilitation to adapt to the circumstances and place itself at the disposal of the Regional/National Public Health Crisis Units.

- Hospitals dedicated to rehabilitation have expressed their willingness to set up, with flexibility, internal areas to cater for different categories of patients:
  - (a) isolated patients with suspected infection, awaiting confirmation of diagnosis;
  - (b) symptomatic positive patients;
  - (c) positive patients with respiratory failure on oxygen therapy, CPAP, and NIV;
  - (d) negative patients who require post-COVID rehabilitation programs.

- Rehabilitation teams coordinated by pulmonologists and respiratory therapists have now:
  - (e) become part of the hospital programs for COVID-19 patients;
  - (f) made their services available to other rehabilitation professionals and professional nurses to create multidisciplinary groups able to support the high load of demand for care and assistance;
  - (g) shared with the other professionals protocols useful for clinical decision-making “ceiling of treatment” (oxygen only, NIV/CPAP only, sedation), based on agreed criteria (patient characteristics, age, etc.).

### Reorganization of the Rehabilitation Pathway for Non-COVID Patients

- Following the organizational changes determined by the COVID-19 epidemic, it is abundantly clear that all the other noninfected patients with chronic respiratory diseases are suffering from these changes in their usual reference facilities as well as in the clinical and rehabilitative pathways.
- For the full period of emergency and in the postemergency period, the need for RR of patients not affected by COVID-19 infection will still have to be met, probably by new and diversified modalities of delivery (e.g., tele-rehabilitation paths, etc.) [49, 50].

### Conclusions

The dramatic spread of the current COVID-19 epidemic in Italy has spurred into action also RR specialists (pulmonologists and respiratory therapists), who have been engaged for years in the care of patients with disabilities secondary to respiratory diseases and/or conditions. Their experience acquired in the management of chronic and acute respiratory failure is proving to be a fundamental asset for the management of patients during the COVID-19 epidemic. Hence, it is likely that the reorganization involved in taking care of this scenario will not be a short-term matter.

### Acknowledgments

The authors thank Laura Comini for editorial support and Rosemary Allpress for the English revision, and Giuseppe Gaudello, Bruno Balbi, Ernesto Crisafulli, Mauro Maniscalco, Maria Aliani, Daniele Colombo, Giuseppe La Piana, and Andrea Vianello for their clinical and scientific support.

## Statement of Ethics

A synthesis of the document is published on the *European Respiratory Journal* (ERS) website and available at: <https://www.ersnet.org/covid-19-blog/rehabilitation-with-covid19-italian-guidance>.

## Disclosure Statement

The authors have no conflict of interest to disclose.

## References

- 1 Worldometer. COVID-19 coronavirus pandemic [cited 2020 Mar 19]. Available from: <https://www.worldometers.info/coronavirus/>
- 2 World Health Organization. Global surveillance for human infection with coronavirus disease (COVID-2019) [cited 2020 Mar 19]. Available from: [https://www.who.int/publications-detail/global-surveillance-for-human-infection-with-novel-coronavirus-\(2019-ncov\)](https://www.who.int/publications-detail/global-surveillance-for-human-infection-with-novel-coronavirus-(2019-ncov))
- 3 Istituto Superiore di Sanità. Coronavirus – epidemiological data [cited 2020 Mar 19]. Available from: <https://www.epicentro.iss.it/coronavirus>
- 4 Zhang Y, Xu J, Li H, Cao B. A novel coronavirus (COVID-19) outbreak: a call for action. *Chest*. 2020 Apr;157(4):e99–101. Epub.
- 5 Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al.; China Novel Coronavirus Investigating and Research Team. A novel coronavirus from patients with pneumonia in China, 2019. *N Engl J Med*. 2020 Feb;382(8):727–33.
- 6 Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet*. 2020 Feb;395(10223):497–506.
- 7 Vitacca S, Nava S, Pintus A, Harari S. Facing the respiratory SARS-CoV-2 emergency in Italy: from ward to trenches. *Eur Respir J*. DOI: 10.1183/13993003.00632-2020. Forthcoming.
- 8 Spruit MA, Singh SJ, Garvey C, ZuWallack R, Nici L, Rochester C, et al.; ATS/ERS Task Force on Pulmonary Rehabilitation. An official American Thoracic Society/European Respiratory Society statement: key concepts and advances in pulmonary rehabilitation. *Am J Respir Crit Care Med*. 2013 Oct;188(8):e13–64.
- 9 Yang F, Liu N, Wu JY, Hu LL, Su GS, Zheng NS. [Pulmonary rehabilitation guidelines in the principle of 4S for patients infected with 2019 novel coronavirus (2019-nCoV)]. *Zhonghua Jie He He Hu Xi Za Zhi*. 2020 Feb;43(0):E004.
- 10 Thomas P, Baldwin C, Bissett B, Boden I, Goselink R, Granger CL, et al. Physiotherapy management for COVID-19 in the acute hospital setting: clinical practice recommendations. *J Physiother*. 2020 Mar;66(2):S1836-9553(20)30028-X.
- 11 Spruit MA, Holland AE, Singh SJ, Troosters T. Report of an ad-hoc international task force to develop an expert-based opinion on early and short-term rehabilitative interventions (after the acute hospital setting) in COVID-19 survivors (version April 3, 2020) [cited 2020 Apr 7]. Available from: [www.ersnet.org](http://www.ersnet.org)
- 12 Istituto Nazionale per le Malattie Infettive Lazzaro Spallanzani – IRCCS. Protocollo di gestione clinica e raccolta dati dei casi confermati di malattia da infezione da coronavirus – 2019 (COVID-19) nel paziente adulto – 19 March 2020. A cura dell'INMI COVID-19 group, con la collaborazione della Rete Regionale di Malattie infettive, dei PS/DEA e delle Terapie Intensive [cited 2020 Mar 26]. Available from: <https://www.inmi.it/seresmi>
- 13 World Health Organization. Rational use of personal protective equipment for coronavirus disease 2019 (COVID-19) [cited 2020 Mar 19]. Available from: [https://apps.who.int/iris/bitstream/handle/10665/331215/WHO-2019-nCov-IPCPPE\\_use-2020.1-eng.pdf](https://apps.who.int/iris/bitstream/handle/10665/331215/WHO-2019-nCov-IPCPPE_use-2020.1-eng.pdf)
- 14 Ministero della Salute. Circolare Ministero della Salute n. 5443 del 22 February 2020 [cited 2020 Mar 24]. Available from: [http://www.prefettura.it/FILES/allegatinews/1181/Circolare\\_Ministero\\_della\\_Salute\\_n.\\_5443\\_del\\_22\\_febbraio\\_2020.pdf](http://www.prefettura.it/FILES/allegatinews/1181/Circolare_Ministero_della_Salute_n._5443_del_22_febbraio_2020.pdf)
- 15 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 adults. *Zhonghua Jie He He Hu Xi Za Zhi*. 2020 Apr;43(4):308–14. Chinese.
- 16 Ambrosino N, Clini EM. Response to pulmonary rehabilitation: toward personalised programmes? *Eur Respir J*. 2015 Dec;46(6):1538–40.
- 17 Wouters EF, Wouters BB, Augustin IM, Houben-Wilke S, Vanfleteren LE, Franssen FM. Personalised pulmonary rehabilitation in COPD. *Eur Respir Rev*. 2018 Mar;27(147):170125.
- 18 The first affiliated Hospital, Zhejiang University School of Medicine. Compiled according to clinical experience: rehabilitation therapy for COVID-19 patients. In Zhejiang University, editors. *Handbook of COVID-19, prevention and treatment 2020*: p. 47–8 [cited 2020 Mar 27]. Available from: <http://www.zju.edu.cn/english/2020/0323/c19573a1987520/page.htm>
- 19 Esquinas AM, Egbert Pravinkumar S, Scala R, Gay P, Soroksky A, Girault C, et al.; International NIV Network. Noninvasive mechanical ventilation in high-risk pulmonary infections: a clinical review. *Eur Respir Rev*. 2014 Dec;23(134):427–38.
- 20 Goselink R, Clini E. Rehabilitation in intensive care. In: Clini E, Holland A, Pitta F, Troosters T, editors. *Textbook of pulmonary rehabilitation*. Cham: Springer Nature; 2018. p. 349–66.
- 21 van der Lee L, Hill AM, Patman S. Expert consensus for respiratory physiotherapy management of mechanically ventilated adults with community-acquired pneumonia: A Delphi study. *J Eval Clin Pract*. 2019 Apr;25(2):230–43.
- 22 Doiron KA, Hoffmann TC, Beller EM. Early intervention (mobilization or active exercise) for critically ill adults in the intensive care unit. *Cochrane Database Syst Rev*. 2018 Mar;3:CD010754.
- 23 Ambrosino N, Makhbah DN. Comprehensive physiotherapy management in ARDS. *Minerva Anestesiol*. 2013 May;79(5):554–63.
- 24 Schweickert WD, Pohlman MC, Pohlman AS, Nigos C, Pawlik AJ, Esbrook CL, et al. Early physical and occupational therapy in mechanically ventilated, critically ill patients: a randomised controlled trial. *Lancet*. 2009 May;373(9678):1874–82.

## Funding Sources

This work was supported by the “Ricerca Corrente” Funding scheme of the Ministry of Health, Italy.

## Author Contributions

All the authors contributed substantially to writing the manuscript. All the authors approved the final version of the manuscript and declare that questions related to the accuracy or integrity of any part of it have been appropriately investigated and resolved.

M.V., as corresponding author, has been identified as guarantor of the paper, taking responsibility for the integrity of the work, from inception to published article.

- 25 Connolly B, O'Neill B, Salisbury L, Blackwood B; Enhanced Recovery After Critical Illness Programme Group. Physical rehabilitation interventions for adult patients during critical illness: an overview of systematic reviews. *Thorax*. 2016 Oct;71(10):881–90.
- 26 Hanekom S, Gosselink R, Dean E, van Aswegen H, Roos R, Ambrosino N, et al. The development of a clinical management algorithm for early physical activity and mobilization of critically ill patients: synthesis of evidence and expert opinion and its translation into practice. *Clin Rehabil*. 2011 Sep;25(9):771–87.
- 27 Segers J, Hermans G, Bruyninckx F, Meyfroidt G, Langer D, Gosselink R. Feasibility of neuromuscular electrical stimulation in critically ill patients. *J Crit Care*. 2014 Dec;29(6):1082–8.
- 28 Guarracino F, Bertini P, Bortolotti U, Stefani M, Ambrosino N. Flexible bronchoscopy during mechanical ventilation in the prone position to treat acute lung injury. *Rev Port Pneumol*. 2013 Jan-Feb;19(1):42–4.
- 29 Medrinal C, Combret Y, Prieur G, Robledo Quesada A, Bonnevie T, Gravier FE, et al. Comparison of exercise intensity during four early rehabilitation techniques in sedated and ventilated patients in ICU: a randomised cross-over trial. *Crit Care*. 2018 Apr;22(1):110.
- 30 Gattinoni L, Tognoni G, Pesenti A, Taccone P, Mascheroni D, Labarta V, et al.; Prone-Supine Study Group. Effect of prone positioning on the survival of patients with acute respiratory failure. *N Engl J Med*. 2001 Aug;345(8):568–73.
- 31 Karatzanos E, Gerovasili V, Zervakis D, Tripodaki ES, Apostolou K, Vasileiadis I, et al. Electrical muscle stimulation: an effective form of exercise and early mobilization to preserve muscle strength in critically ill patients. *Crit Care Res Pract*. 2012;2012:432752.
- 32 Fossat G, Baudin F, Courtes L, Bobet S, Dupont A, Bretagnol A, et al. Effect of in-bed leg cycling and electrical stimulation of the quadriceps on global muscle strength in critically ill adults: a randomized clinical trial. *JAMA*. 2018 Jul;320(4):368–78.
- 33 Fuke R, Hifumi T, Kondo Y, Hatakeyama J, Takei T, Yamakawa K, et al. Early rehabilitation to prevent postintensive care syndrome in patients with critical illness: a systematic review and meta-analysis. *BMJ Open*. 2018 May;8(5):e019998.
- 34 Guérin C, Reignier J, Richard JC, Beuret P, Gacouin A, Boulain T, et al; PROSEVA Study Group. Prone positioning in severe acute respiratory distress syndrome. *N Engl J Med*. 2013 Jun;368(23):2159–68.
- 35 Lazzeri M, Lanza A, Bellini R, Bellofiore A, Cecchetto S, Colombo A, et al. Respiratory physiotherapy in patients with COVID-19 infection in acute setting: a Position Paper of the Italian Association of Respiratory Physiotherapists (ARIR). *Monaldi Arch Chest Dis*. 2020 Mar;90(1): <https://doi.org/10.4081/monaldi.2020.1285>; Epub ahead of print.
- 36 Hsieh MJ, Lee WC, Cho HY, Wu MF, Hu HC, Kao KC, et al. Recovery of pulmonary functions, exercise capacity, and quality of life after pulmonary rehabilitation in survivors of ARDS due to severe influenza A (H1N1) pneumonitis. *Influenza Other Respir Viruses*. 2018 Sep;12(5):643–8.
- 37 Orme J Jr, Romney JS, Hopkins RO, Pope D, Chan KJ, Thomsen G, et al. Pulmonary function and health-related quality of life in survivors of acute respiratory distress syndrome. *Am J Respir Crit Care Med*. 2003 Mar;167(5):690–4.
- 38 Hill AD, Fowler RA, Burns KE, Rose L, Pinto RL, Scales DC. Long-term outcomes and healthcare utilization after prolonged mechanical ventilation. *Ann Am Thorac Soc*. 2017 Mar;14(3):355–62.
- 39 Pandharipande PP, Girard TD, Jackson JC, Morandi A, Thompson JL, Pun BT, et al; BRAIN-ICU Study Investigators. Long-term cognitive impairment after critical illness. *N Engl J Med*. 2013 Oct;369(14):1306–16.
- 40 Girard TD, Alhazzani W, Kress JP, Ouellette DR, Schmidt GA, Truwit JD, et al.; ATS/CHEST Ad Hoc Committee on Liberation from Mechanical Ventilation in Adults. An official American Thoracic Society/American College of Chest Physicians Clinical Practice Guideline: liberation from mechanical ventilation in critically ill adults. Rehabilitation protocols, ventilator liberation protocols, and cuff leak tests. *Am J Respir Crit Care Med*. 2017 Jan;195(1):120–33.
- 41 Vitacca M, Clini EM, Nava S, Ambrosino N. La riabilitazione ad alta complessità nel paziente con svezzamento prolungato: ruolo dello pneumologo. “Position paper” di un “experts’ panel.” *Rassegna di Patologia dell’Apparato Respiratorio*. 2013 Jul-Aug;28(4):179–87.
- 42 Ambrosino N, Vitacca M. The patient needing prolonged mechanical ventilation: a narrative review. *Multidiscip Respir Med*. 2018 Feb;13(1):6.
- 43 Ceriana P, Nava S, Vitacca M, Carlucci A, Paneroni M, Schreiber A, et al. Noninvasive ventilation during weaning from prolonged mechanical ventilation. *Pulmonology*. 2019 Nov - Dec;25(6):328–33.
- 44 Winck JC, Gilet H, Kalin P, Murcia J, Plano F, Regnault A, et al. Validation of the Multi-INdependence Dimensions (MIND) questionnaire for prolonged mechanically ventilated subjects. *BMC Pulm Med*. 2019 Jun;19(1):109.
- 45 Schreiber AF, Ceriana P, Ambrosino N, Malovini A, Nava S. Physiotherapy and weaning from prolonged mechanical ventilation. *Respir Care*. 2019 Jan;64(1):17–25.
- 46 Ambrosino N, Venturelli E, Vaghegghini G, Clini E. Rehabilitation, weaning and physical therapy strategies in chronic critically ill patients. *Eur Respir J*. 2012 Feb;39(2):487–92.
- 47 Bissett BM, Leditschke IA, Neeman T, Boots R, Paratz J. Inspiratory muscle training to enhance recovery from mechanical ventilation: a randomised trial. *Thorax*. 2016 Sep;71(9):812–9.
- 48 Vorona S, Sabatini U, Al-Maqbali S, Bertoni M, Dres M, Bissett B, et al. Inspiratory muscle rehabilitation in critically ill adults. A systematic review and meta-analysis. *Ann Am Thorac Soc*. 2018 Jun;15(6):735–44.
- 49 Donner CF, Raskin J, ZuWallack R, Nici L, Ambrosino N, Balbi B, et al. Incorporating telemedicine into the integrated care of the COPD patient: a summary of an interdisciplinary workshop held in Stresa, Italy, 7–8 September 2017. *Respir Med*. 2018 Oct;143:91–102.
- 50 Ambrosino N, Fracchia C. The role of telemedicine in patients with respiratory diseases. *Expert Rev Respir Med*. 2017 Nov;11(11):893–900.