Respiratory physiotherapy in patients with COVID-19 infection in acute setting: a Position Paper of the Italian Association of Respiratory Physiotherapists (ARIR)

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Introduction

On February 2020, Italy, especially the northern regions, was hit by an epidemic of the new SARS-Cov-2 coronavirus that spread from China between December 2019 and January 2020 [1].

The entire healthcare system had to respond promptly in a very short time to an exponential growth of the number of subjects affected by COVID-19 (Coronavirus disease 2019) with the need of semi-intensive and intensive care units.

In these regions, hospitals entire buildings and wards have been converted in semi-intensive and intensive care units and trained dedicated COVID-19 teams consisting of physicians (intensivists or pneumologists or other trained specialists as well as infectiologists and nurses have been recruited to work on and on with rest. Physiotherapists, mainly respiratory physiotherapists, are among the healthcare professionals involved in the management and care of these patient's population and play a key role in the non-invasive support management, postural changes, mobilization, as well as during the weaning from invasive mechanical ventilator support.

This document was drafted by ARIR (**Italian Association of Respiratory Physiotherapists)** in collaboration with AIFI (Italian Association of Physiotherapist) in order to support the work of the worldwide colleagues dealing with the COVID-19 emergency.

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. Therefore, our aim is to share information with worldwide physiotherapists involved in the management of patients affected by COVID-19. Considering the complexity and frailty of COVID-19 patients, we recommend, when possible, to have as a task force, physiotherapists with expertise and/or dedicated training in Respiratory Physiotherapy (RT).

Therapists who read this article should adjust or modify the procedures described in this document and in other official guidelines to their specific clinical setting.

Considering the fast and continuous evolution of the epidemiological framework, indications included in this document are not prescriptive, should **ALWAYS** be adapted to the guidelines coming from the "Crisis Unit", and approved by Directors of Institutes that manage COVID-19 patients, in the specific professional working environment of each hospital. Furthermore, it is anticipated that these guidelines will need further updates as further evidence on treatment approaches will become available in the near future.

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Italian Physiotherapists Experience with SARS-Cov-2 Patients

Patients affected by coronavirus disease (SARS-Cov-2) may develop pneumonia characterized by bilateral interstitial infiltrates, with severe hypoxic respiratory failure (ARDS - Acute

Respiratory Distress Syndrome). Indeed, this can cause serious alterations of the ventilation-perfusion ratio with possible shunt [2].

The acute hypoxemic patients may experience dyspnoea that may persist despite the administration of oxygen flows >10-15 L/min with a reservoir mask [3]. In these cases, other devices, such as High-Flow Nasal Oxygen (HFNO) or the application of Continuous Positive Airways Pressure (CPAP) or Non-Invasive Ventilation (NIV) may be useful. However, it is important to point out that these interventions have to be used only in appropriate hospital settings in order to be prepared for a more aggressive treatment.

A potential rapid worsening of hypoxemia with subsequent need of intubation and invasive mechanical ventilation has to be taken in account in patients with SARS-Cov-2. Considering the risk of NIV failure, it is necessary to manage these patients with immediate availability of a staff able to perform endotracheal intubation [4]. In our preliminary experience, the percentage of failure of CPAP/NIV is extremely high.

When indicated, the administration of CPAP/NIV can be carried out with various interfaces, depending on the availability and indications (oro-nasal mask, total face or helmet). When using CPAP/NIV, it is important to consider the potential environmental diffusion of aerosol particles of the virus [5]. In particular, one of the critical issues of the SARS-Cov-2 in the intermediate phase (between the onset of disease and potential critical evolution, also in relation to comorbidity) is represented by the selection of oxygen therapy and the level of care. Non-invasive supports (CPAP, NIV and HFNO) can correct hypoxemia and respiratory failure (even in the absence of clear evidence from proper randomized controlled studies), delaying or avoiding endotracheal intubation (and its potential complications and effects on the outcome) [6]. However, looking at SARS epidemic data, physiotherapists have to be careful when treating these patients because there is evidence that NIV may increase the risk of aerial spreading of the virus [5]. Thus, if a patient shows prognostic factors suggesting the need of invasive ventilation [7], it is preferable to carry out elective intubation, rather than emergency intubation in critical conditions. This action will allow minimizing complications of intubation itself for the patient, as well as reducing the risk of contamination due to potential errors in Protective Personal Equipment (PPE) usage of the healthcare personnel.

To date, there are no clear recommendations for the use of NIV in case of *de-novo* hypoxic acute respiratory failure or specifically hypoxemia associated with viral pneumonia. The delay in endotracheal intubation by prolonged use of NIV is associated with higher mortality rate, especially in the more severe cases [6-7].

1st ADVICE:

Consider the high risk of failure of non-invasive management and monitor carefully for potential sudden clinical deterioration.

Do not persist with non-invasive treatments, if the patient does not quickly respond to the treatment. Alert the team and prepare for invasive mechanical ventilation sooner rather than later!

2nd ADVICE:

It is appropriate to adopt shared strategies performed by a multidisciplinary team, taking into account the levels of care available, the equipment accessible and the feasibility of intensive assistance in dedicated settings.

Best Practice Recommendations for Spontaneously Breathing Patients or with Non-Invasive Ventilatory Support (NIV)

Conventional oxygen therapy: It is not recommended to use nasal cannulas, which may cause a higher dispersion of droplets than other systems. We recommend using a facemask with an oxygen flow up to 5 L/min, a reservoir mask up to 10 L/min of O_2 or a Venturi mask up to 60% of FiO_2. We also suggest the addition of a surgical mask covering the patient face where more dispersion of droplets can be observed. It has to be correctly positioned and it has to be changed every 6-8 hours [8-11].

High Flow Nasal Oxygen (HFNO): we suggest the use of a flow of at least 50 L/min and FiO_2 up to 60%. The nasal cannula must be well-positioned inside the nostrils and a surgical mask should be added over the nasal cannulas covering patient' mouth and nose as with the conventional oxygen therapy. The surgical mask has to be changed at least every 6 to 8 hours [12,13].

For subjects who adopt an open-mouth breathing pattern, a **non-vented** NIV mask connected by T-tube to the circuit can be used in order to improve oxygen saturation (SpO_2) (Figure 1).

Continuous Positive Airway Pressure/ Non-Invasive ventilation (CPAP/NIV): We suggest making a single attempt of non-invasive support for a maximum duration of 1 hour. If no substantial improvement is observed, notify the team and switch to the appropriate (invasive ventilatory) support [6-7].

Interface: to minimize the risk of nebulization of infected material, the safest interface is the helmet, which is relatively closed to the environment in comparison with a mask. Also, as the helmet acts as a reservoir, the addition of antiviral filters to the expiratory port in order to decrease the droplets, may produce less

Figure 1. Setting of a HFNO circuit for patients who adopt an open-mouth breathing pattern.

resistance to the patient breathing effort in comparison to a mask. When using a face mask, the best choice is to combine it with a double circuit with an expiratory valve. In the case there is need to combine a face mask with a single circuit, we suggest to use a circuit equipped with an integrated exhalation port instead of using vented masks. In addition, an antimicrobial and antiviral filter should always be installed [12]. An example of the mentioned circuit is described in Figure 2.

Antimicrobial filters: We highly recommend to verify the filter placement according to the ventilation setting and to the PPE available for the staff. Filters should be positioned to limit the dispersion of the exhaled air into the surrounding environment. The placement of double filters can alter the pressure in the circuit used for ventilation. Therefore, daily external monitoring of the pressure by manometers is recommended.

Posture changes: The posture assumed by the patients is crucial in this context. We recommend favouring an extended semi-sitting or sitting position avoiding a slumped position. When possible and in close collaboration with the team, favour alternations of the lateral decubitus, consider whether the semi-prone or prone position might be indicated [6]. It is necessary to minimize the patient effort even in maintaining postures. Hence, it is recommended to use cushions/aids that allow a stable position without active muscles work from the patient.

3rd ADVICE

In spontaneously breathing patients, the changes of position can modify the ventilation/perfusion ratio and may lead to a sudden change (improvement or deterioration) of gas exchange. Careful evaluation and clinical and instrumental monitoring of the patient are therefore required after a postural change.

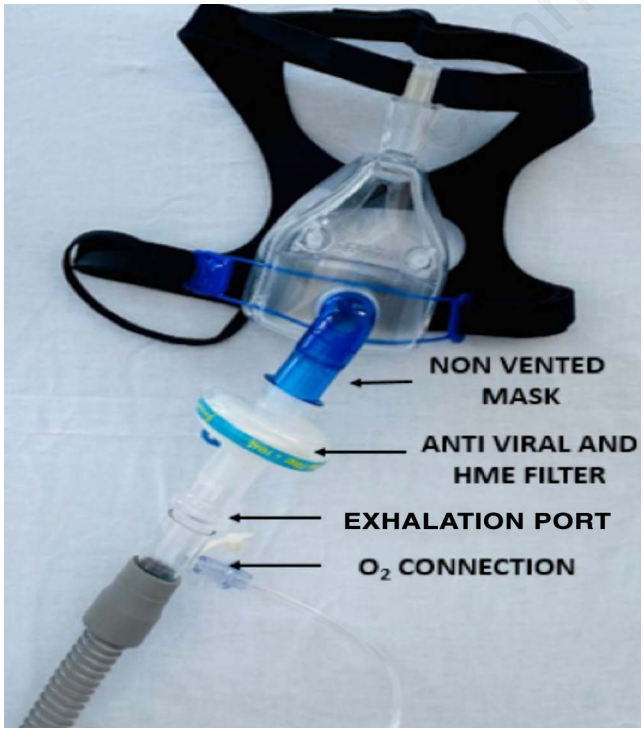

Figure 2. Setting of a circuit of a single-tube CPAP with exhalation port and with non-vented mask.

Recommendations for Patients in Invasive Mechanical Ventilation

In order to reduce droplets dispersion during the management of patients in invasive mechanical ventilation, we recommend: a) periodical verification of the pressure in the endotracheal cuff (25-30 cm H_2O); and b) to avoid delivering of inhaled therapy using a pneumatic jet nebulizer. A preferred option is to use dry inhalers or ultrasonic nebulizers connected to the mechanical ventilator in a closed circuit, without removing the antimicrobial filter on the expiratory branch of the circuit.

Airway clearance techniques: Since airway clearance causes massive droplet dispersion, airway clearance procedures should be administered only when considered strictly needed for the clinical improvement of the patient. To date, in our experience, airway clearance is not frequently required in COVID-19 patients.

Lung recruitment manoeuvres: These manoeuvres may be indicated in certain clinical circumstances, but they could be considered dangerous [14] and must be shared by the team.

Endotracheal suction: we do not recommend disconnections from the ventilator, in order avoid loss of Positive End Expiratory Pressure (PEEP) and atelectasis worsening. Therefore, we recommend to use close suction circuit [15]. Close circuit usage could also decrease the risk of droplets spreading. Bronchial suction manoeuvres should be performed only on strict indications.

Changes in posture: The prone position is recommended at least for 12 to 16 hours per day, preferably within 72 hours of endotracheal intubation. If these positions have been effective, repeat them until PaO_2 / FiO_2 ratio (P/F) ≥150mmHg with PEEP ≤10 cmH_2O and FiO2 ≤0.60 for at least 4 hours after supine position. The pronation procedure must be interrupted in case of oxygenation worsening (20% decrease in P/F compared to the supine position) or in case of serious complications [16].

Some suggestions to avoid side effects of prone position are described in Table 1.

5th ADVICE

Reduce unnecessary manoeuvres, particularly procedures that can generate PEEP reduction with a subsequent increased risk of lung de-recruitment and atelectasis.

6th ADVICE

Application of prone position during ventilation requires sufficient human resources and expertise to be performed safely.

It is very important to verify that prolonged prone position during ventilation does not cause side effects.

Prevention of complications: It is important to alert the staff in the prevention of the following side effects/ complications:

a) **Difficult weaning:** It is necessary to implement daily assessment of spontaneous breathing ability. It should be done following dedicated protocols [17].
b) **Ventilator-associated pneumonia (VAP).** To avoid VAP, we suggest to: i) keep the patient in a semi-sitting position (30-45°); ii) to use a closed tracheal-suction system; iii) to use a new ventilator circuit for each patient, and once the patient is

ventilated pay attention to change the circuit only when it is damaged [18].

- **Venous thromboembolism**
- **Pressure ulcers**
- **Critical Illness Myopathy and Neuropathy (CRIMYNE) and physical disability.** To avoid it, the best practice is to promote early patient mobilization as soon as disease course conditions allow it (clinical stability). It may be useful to use dedicated protocol [19-21].

7th ADVICE

Passive mobilization should be considered in order to prevent skin lesions and immobilization sequelae. Discuss with the team the possibility to start an early active mobilization program as soon as patient' sedation is reduced.

Procedures NOT to be applied in the Acute Phase

In the presence of acute respiratory failure that determines a reduction of lung compliance, the increase of respiratory work of breathing and alteration of blood oxygenation leads to a rapid and shallow respiratory pattern [2]. this pattern is usually spontaneously adopted by the subject representing a strategy to minimize inspiratory effort and maximize mechanical efficiency of breathing. Furthermore, in such clinical conditions, the strength of the respiratory muscles can also be reduced.

It is important that treatments and procedures used by physiotherapists do not cause a further burden on the work of breathing, exposing the patient to an increased risk of respiratory distress.

We list below some of the most common practices used in respiratory physiotherapy that we do not recommended on patients with COVID-19 during the acute phase:

– diaphragmatic breathing;
– pursed lips breathing;
– bronchial hygiene/lung re-expansion techniques (PEP Bottle, EzPAP®, cough machines, *etc.*);
– incentive spirometer;
– manual mobilization/stretching of the rib cage;
– nasal washings;
– respiratory muscle training;
– exercise training;
– mobilization during clinical instability (multidisciplinary assessment required).

8th ADVICE

In order not to increase the work of breathing, it is necessary to limit bronchial hygiene techniques to limited cases, always taking into strong consideration the risk of contamination of the environment and providing appropriate PPE for health personnel.

Measures for Prevention and Control of Infections

Health personnel must pay particular attention during the interventions that may expose them to a higher risk of contamination due to dispersion of droplets in the air [22].

The highest risk procedures are:

– aerosol nebulization (if aerosol drugs administration is needed, try to use pre-dosed MDI)
– mucous clearance (Forced Expiratory Techniques, cough and other manoeuvres or devices such as a cough-assist machine promoting expectoration)
– NIV (in particular with systems that use open-masks or other open systems)
– bronchoscopy
– tracheal intubation
– manual ventilation before intubation
– tracheotomy
– endotracheal aspiration
– cardiopulmonary resuscitation
– extubation.

We recommend following the instructions given in the document produced by World Health Organization (WHO) [23,24], or National Health Institutions in order to PPE use during the care of COVID-19 Patients. In Table 2 we list the main technical characteristics of disposable masks used during care of COVID-19 patients.

Table 1. Side effects and suggestion for pronation therapy.

COMPLICATIONS	SOLUTIONS
Pressure ulcers	Change of head and arm posture every 4-6 hours. Verify that the endotracheal tube is not pressed against the mouth/lips and that the gastric nose tube does not exert excessive pre sure against the nostril. Use adequate anti-decubitus equipment and protect the higher-pre sure areas, for example using high density or resilient foams
Facial / periorbital oedema	Keep the bed in anti-Trendelenburg position at 30°.
Corneal and/or conjunctiva damage	Clean and close eyelids and protect the eyes by applying ophthalmic ointment and a protective patch
Brachial plexus injury	Practice correct positioning and modify upper limb postures.
Poor positioning of the auricle	Verify that the lower ear is not bent.
Venous access and catheter stability problems	Make sure the accesses are well fixed and do not exert excessive pressure on the skin.
Staff injury	Correctly educate the operators and identify the appropriate number of healthcare practitioners involved in the prone position manoeuvre according to patient size and to the number of devices available. Correctly manage the devices and optimize staff coordination during the execution of the manoeuvre

Table 2. Technical characteristics of disposable masks used during care of COVID-19 patients.

Surgical mask 	• Limits the spread of potentially infectious particles by infected or potentially infected individuals into the environment • It has no filtering function in the inspiratory phase, therefore it does not protect against inhalation of small particles (aerosols) • **It must be worn by infected or potentially infected individuals.**
FFP1 	• Filters 80% of environmental particles with a diameter ≥0.6 µM • If equipped with an expiratory valve, it has no filtering function in the expiratory phase • **It is not recommended for protection from airborne pathogens**
FFP2 	• Filters 95% of environmental particles with a diameter ≥0.6 µM • If equipped with an expiratory valve, it has no filtering function in the expiratory phase (the expiratory valve is for operator comfort) • **It must be worn by healthcare professionals assisting infected or potentially infected individuals**
FFP3 	• Filters 98-99% of environmental particles with a diameter ≥0.6 µM • If equipped with an expiratory valve, it has no filtering function in the expiratory phase (the expiratory valve is for operator comfort) • **It must be worn by healthcare professionals assisting infected or potentially infected individuals, in particular during aerosol generating manoeuvres** (*e.g.* intubation, open circuit bronchial aspiration, bronchoscopy)

9th ADVICE

In order to protect the health personnel tray to reduce unnecessary manoeuvres, particularly the procedures that can generate droplets/aerosol.

Apply droplet precautions:

- *All patients should wear a surgical mask, also during HFNO treatment.*
- *Apply filters to CPAP/NIV circuit to reduce air contamination. Nevertheless, filters in the CPAP/NIV circuit can increase the work of breathing due to an increase circuit resistance in severely compromised patients, that's why it is important to monitor patient breathing pattern continuously.*
- *Verify with the team the best strategy to assist each patient but at the same time to protect the healthcare staff.*
- *Evaluate the use of Helmet instead of mask if you think the resistance of the circuit due to filters may increase the work of breathing of the patient.*

10th ADVICE

Organize the working environment and the shifts in order to reduce the risk of contamination and to optimize the availability of PPE.

Conclusions

Patients affected with Covid-19 who need to be hospitalized present a viral pneumonia often complicated by an Acute Respiratory Failure that may eventually evolve to ARDS.

To face this emergency, entire hospitals wards have been transformed into ICU and HDU in order to host patients requiring ventilatory support. Properly trained staff is required in order to manage in an efficient way such units.

All healthcare workers have been reacting with incredible commitment and willingness and of course, physiotherapists are also being called to contribute.

In principle they are well trained to execute these tasks [25], ARIR (Italian Association of Respiratory Therapists), in collaboration with AIFI (Italian Association of Physiotherapists), issued this document to provide a quick respiratory physiotherapist reference guide to set up treatments for the management in acute stages of patients suffering from severe COVID-19.

The main goal of such treatments is to reduce side effects in this patients' population while maximally protection of healthcare professionals.

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