

CORONAVIRUS

SARS-Cov-2

Recommendations for physiotherapy of adult patients with COVID-19

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COVID-19 is a disease caused by the new SARS-Cov-2 coronavirus. It is a highly contagious disease affecting the respiratory system, which in subsequent stages leads to its insufficiency and to a decrease in the physical and mental capacity of patients. On 30th January 2020, the World Health Organization (WHO) declared an epidemic and on 11th March 2020 COVID-19 was defined as a pandemic [1]. Since this is a new virus and the population is not immune to it (an effective vaccine has not yet been developed), it has the potential to spread rapidly. We are therefore all exposed to this virus: an ordinary citizen, a patient or a healthcare worker. The majority of people suffer from COVID-19 mildly at home, without the need for specific treatment, and the course of infection is comparable with cold or influenza [2]. However, a severe course of the disease is observed in 15-20% of people, and death occurs in 2-3% of cases. The most common symptoms are fever, fatigue, dry cough, dyspnea and muscle pain [3]. Pneumonia develops in many cases with the progress of symptoms [4]. The following diagram shows the clinical course of COVID-19.

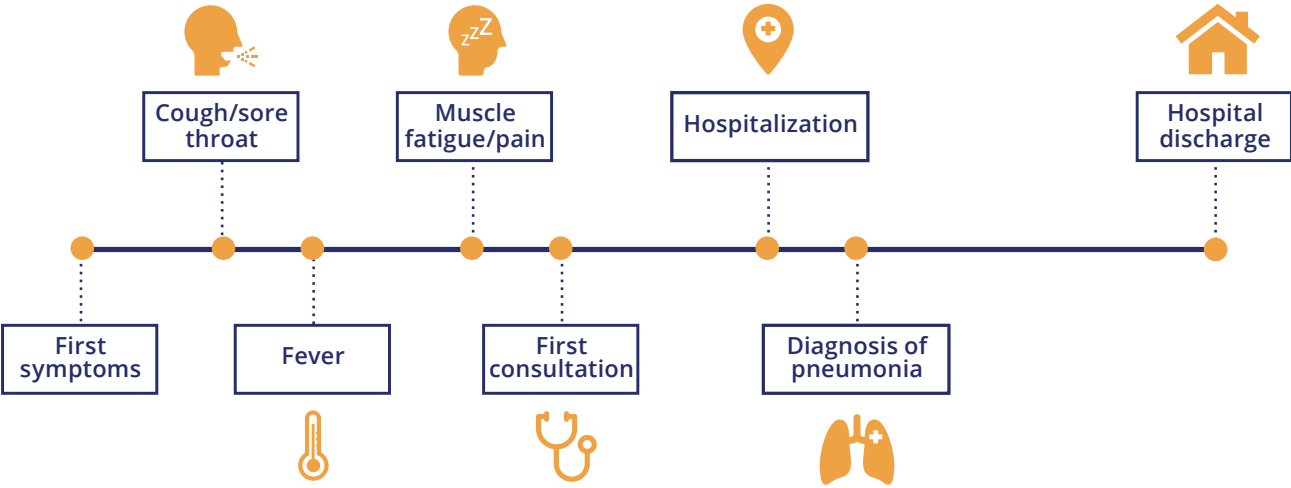


Fig. 1. COVID-19 clinical course over time.*

*This course differs from case to case; the most common one is presented here (fever and cough, followed by fatigue and pneumonia in some cases).

Based on Gaythorpe et al. 2020 [4].

Respiratory physiotherapy is an important part of multidisciplinary treatment and plays a very important role in the treatment, improvement and care of patients with respiratory dysfunctions. Through a wide range of activities, physiotherapists support the treatment of patients of various ages and diseases, with critical, acute or chronic conditions, in hospitals, clinics, home care or rehabilitation centers [5,6-8]. In the case of COVID-19, the ones most vulnerable to developing severe disease and death are elderly people with reduced immunity, which is accompanied by other, particularly chronic diseases (including cardiological, pulmonary, oncological) [9]. The role of physiotherapists in treating these patients is essential.

We currently have a small number of scientific reports on the physiotherapy of COVID-19 patients. However, there are international indications for respiratory physiotherapy in patients with acute and chronic respiratory failure [10], as well as indications for handling the contact with the infected patient. The study is based on clinical expertise, available recommendations for respiratory physiotherapy, review of available literature and experiences published by the Chinese Association of Rehabilitation Medicine (CARM) [11]. The aim of this study is to present indications for physiotherapeutic management in patients with COVID-19.

Epidemiological safety and protection

All healthcare workers, including physiotherapists, should prepare for the increased number of patients requiring hospitalization as a result of acute COVID-19 course. Personal protective equipment is required to fight the pandemic: masks, gloves, protective eye/face shields and aprons. This equipment is designed to protect the physiotherapists themselves to enable them to do their job, but first and foremost they protect against transmission of the virus to other, particularly vulnerable patients. Everyone working in high-risk departments, including intensive care units, and applies aerosol-generating procedures (AGD) should be protected with personal protective equipment [12]. You will find full indications here: https://kif.info.pl/file/2020/03/covid19_ecdc_soi.pdf. Reusable devices should be avoided due to contamination. If such devices are used, it is essential to use appropriate replaceable protective filters and thoroughly sterilize the devices between patients. Remember that your employer has a duty to provide you with the personal protective equipment listed above and to protect you and your patient from being sent to a workplace associated with a risk of infection.

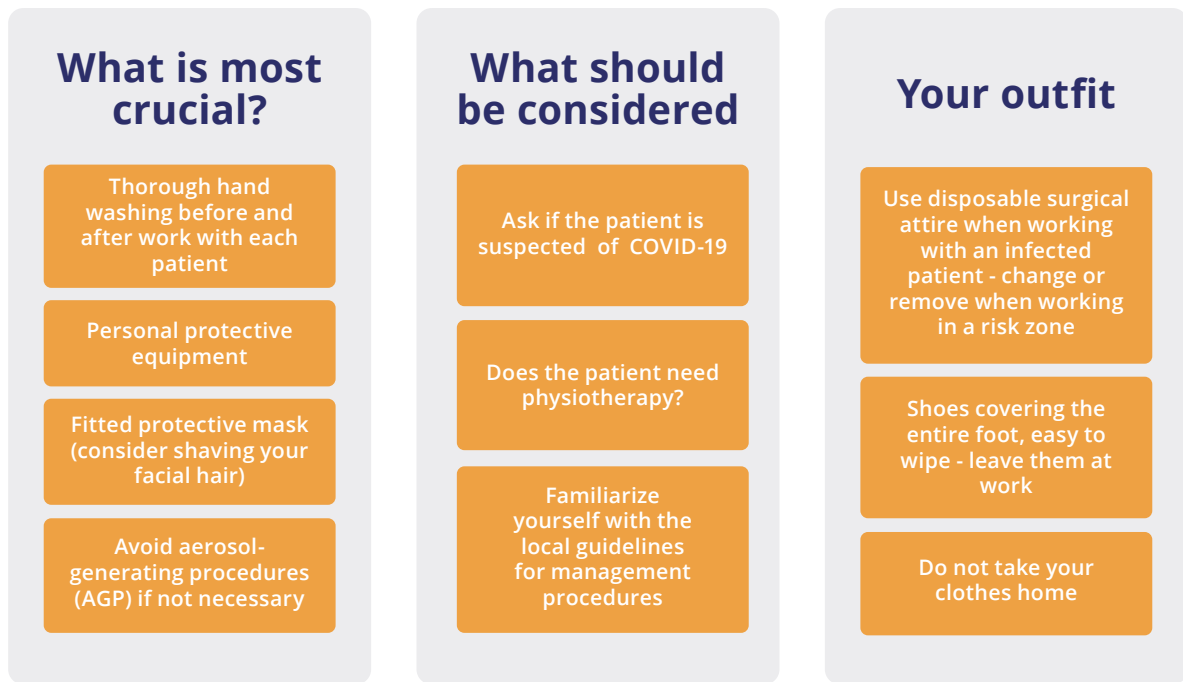


Figure 2. The diagram above shows safety recommendations for physiotherapists.

Aerosol-Generating Procedures (AGP)

Aerosol-Generating Procedures (AGP) during medical procedures are one of the COVID-19 transmission routes [12].

AGP procedures should only be performed on patients with COVID-19 if deemed necessary and should be performed in full compliance with the safety principles as described above.

The physiotherapeutic techniques of AGP include [13]:

- manual techniques to stimulate secretion, e.g. chest percussion;
- stimulation of effective coughing;
- therapeutic devices with positive respiratory pressure (e.g. IPPB - Intermittent Positive Pressure Breathing);
- devices producing high-frequency oscillations that stimulate coughing (internally or externally);
- any mobilization or therapy that can lead to coughing or expectoration of the secretion, e.g. change of position.

Each of the aforementioned techniques should be used in accordance with safety rules, additionally it is recommended that the physiotherapist should be behind the patient with a piece of tissue covering the patient's mouth or with the patient being secured with a special mask. Remember that not only specialized techniques can trigger the patient's secretion, it can be evacuated even by a change of position. Infected material should be placed immediately in

a container suitable for this type of material. If the patient's condition allows it, self-aid techniques such as positive expiratory pressure (PEP), oscillating positive expiratory pressure (OPEP), active cycle of breathing techniques (ACBT), glossopharyngeal breathing, forced expiratory technique (FET), effective coughing, controlled by a physiotherapist through an intercom or camera are recommended. After expectoration, the patient should wash his/her hands in warm soapy water.

Treatment of non-ventilated patients

In COVID-19 patients, the main goal of respiratory physiotherapy is to reduce the symptoms of dyspnea, improve lung capacity, counteract the complications resulting from respiratory failure and immobilization, reduce disability, improve the quality of life and reduce the level of anxiety and counteract depression [11].

After performing a physiotherapeutic examination assessing e.g. the condition of the respiratory system, the physiotherapist should determine the therapeutic problems in the patient's treatment process based on clinical conclusions. The aim of physiotherapeutic management at this stage of disease progression may include:

- reducing excessive respiratory action (e.g. with breathing techniques and positions that reduce dyspnea, inclined position, relaxation),
- purification of the remaining secretion,
- increasing lung capacity,
- improving the gas exchange,
- mobilizing and gradually increasing the activity,
- general fitness exercises, preventing the effects of immobilization and increasing physical activity tolerance.

Postural positions to reduce dyspnea

Breathlessness resulting from respiratory failure may lead to a decrease in the patient's exercise capacity and immobilization. By positioning the patient in a forward leaning position, we can optimize the activity of the respiratory muscles and reduce the sensation of dyspnea. It is advisable to mobilize the patient outside the bed as soon as patient capacity allows that [14,15].

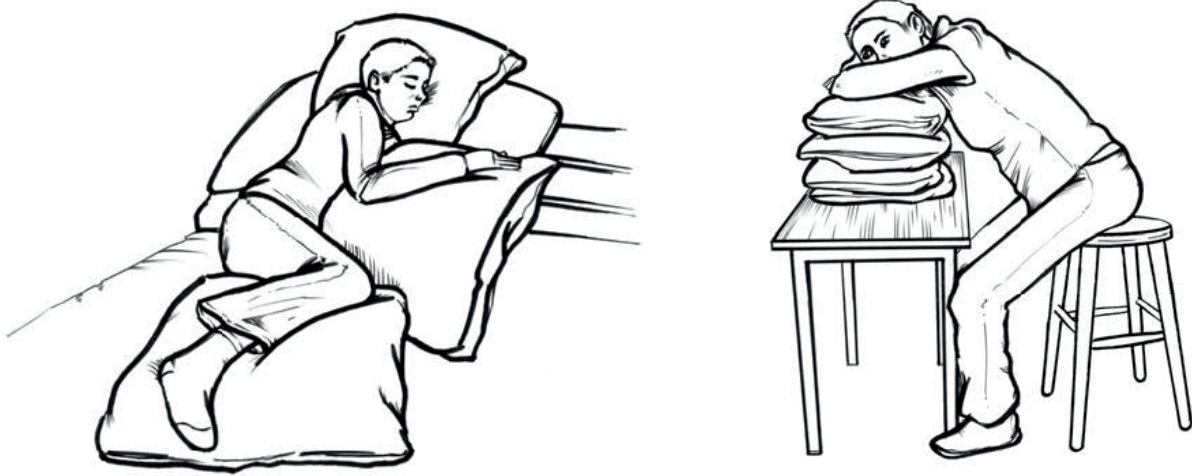


Fig. 3 Positions to reduce the sensation of dyspnea (based on patient information, BIS, Cambridge University Hospital).

Breathing techniques to reduce dyspnea:

- Breath control - this technique should be performed in a sitting position. If the condition of the patient does not allow for such a position, perform in a semi-supine position (as above). It is very important that the patient relaxes the accessory inspiratory muscles, especially those of the arms and neck, then starts by inhaling through the nose (thus heating and moisturizing the air), then performs a slow, extended relaxed exhalation with the activation of the appropriate airways (lower thoracic and abdominal breathing pathway). Breathing should be calm (shallow, slow) [14,15].
- The expiration should be performed with the so-called purse-lip breathing. This technique can be added to normal breathing during rest and while moving. It consists in slightly tightening the lips during exhalation [14,15].

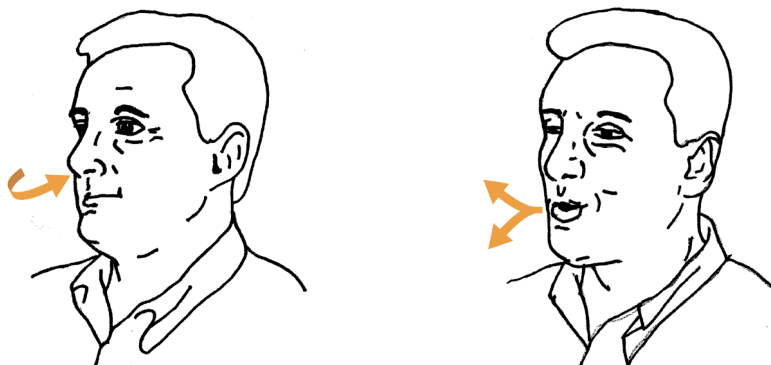


Fig. 4. Purse-lip breathing exhalation technique (developed based on Cleveland Clinic materials).

These techniques should be demonstrated to the patient and can be performed by the patient on his/her own when feeling dyspnea.

Techniques of secretion removal

When the secretion retention is confirmed by physiotherapeutic examination (e.g. through auscultation), the selection of the bronchial cleansing technique should be based on the patient examination, place of secretion retention, secretion density, availability of the equipment, the therapist's skills, acceptance of the procedure, existing contraindications, cooperation level, body position tolerance, possibilities of family education and safety for the patient and the therapist [16,17].

Consider using nebulization with hypertonic saline (3-7%) to relax the viscous secretion before applying bronchial cleansing techniques.

The following techniques can be used when cleansing the airways [14-17]:

1. Manual techniques (percussion, chest compressions).
2. Modified drainage positions (avoid positions with head hanging down).
3. Active Cycle of Breathing Techniques (ACBT).
4. Positive Expiratory Pressure with or without Oscillation (PEP, OPEP).
5. Forced Expiration Technique (FET), performed after PEP and OPEP techniques.
6. Manual Assisted Coughing (MAC) techniques.
7. When there is a high cough weakness <155 PEF, mechanical insufflation-exsufflation (MIE) should be considered in patients with respiratory muscle dysfunction during neurological diseases.

The techniques of bronchial cleansing have been described in detail in the literature related to respiratory physiotherapy; both their selection and method should be based on clinical conditions and potential effectiveness [14-17]. According to current reports we know that at the initial stage of COVID-19, the cough is dry and there are no problems with the discharge retention. However, physiotherapists should monitor patients and take coexisting diseases into account, such as chronic respiratory diseases.

Increasing decreased lung capacity [14,15]:

- Postural positions - inclined as above or, with one-sided changes, position on the side (on a healthy side). If possible, the patient should be mobilized to a sitting position or with his head raised. This position is more favorable for ventilation.
- Deep breath.
- When possible, apply rehabilitation that will automatically increase the breathing capacity.

Gas exchange improvement [14,15]:

- Postural positions, as above.
- Mobilization to improve ventilation when the patient is respiratorily stable.
- Oxygen therapy (maintaining the SpO₂ 95-100% blood oxygen level, but in patients at risk of hypercapnia, e.g. co-existing COPD, maintaining saturation at 88-89%) [30].

An important element of properly conducted physiotherapy is the time of its initiation, which should be determined based on the assessment of the patient's condition and after consultation with the medical team. In addition, every person undertaking physiotherapy of a person with COVID-19 should have knowledge of indications, contraindications and precautions relevant to the treatment of patients with acute and chronic respiratory insufficiency and the ability to conduct respiratory physiotherapy. Moreover, the physiotherapy of patients with COVID-19 should be carried out while observing safety rules, by equipping physiotherapists with special protective clothing [12].

It is extremely important to continue the assessment and monitoring of patient's vital parameters and well-being throughout the entire physiotherapy process. The treatment plan is always individual, dedicated to a specific patient. This is particularly important for patients in a severe or critical condition and the elderly, obese, cachexic, with many coexisting diseases (pulmonary and non-pulmonary) and single- or multiple-organ complications. In acute patients, it is recommended to take only those actions that may improve the patient's condition or prevent immobilization-related complications [11].

Working with a patient in isolation

Isolation treatment is an effective way to prevent the spread of the disease, but at the same time it limits the patient's living space and reduces their natural motor activity. This, in turn, combined with the remaining symptoms, may lead to decreased muscle strength, decreased expectoration efficiency, a significant increase in the risk of deep vein thrombosis, physical activity intolerance and mental problems [11,14-15].

In case of patients in contact isolation, it is recommended to use educational materials in the form of brochures or short instructional videos on maintaining physical activity. It is also possible to use physiotherapeutic consultations via cameras or ICT systems at the patient's place of stay, allowing to save protective equipment and, most importantly: protecting against cross-infection. Additional recommendations for the aforementioned group of patients include rest, proper amount of sleep, balanced diet and hydration, smoking cessation and avoiding air pollution. Patients who have reached the standard of treatment and have been released from isolation and observation may later require continued physiotherapy, the program of which will depend on their overall performance and the presence of possible complications associated with COVID-19 [18].

Mobilization and improvement of physical fitness

Patient rehabilitation may cause dyspnea, but it is a natural part of the capacity-increasing process. When improving patients with respiratory insufficiency, the respiratory and circulatory parameters (HR, BP, pulse, SpO₂) should be monitored and, if necessary, oxygen therapy should be used during patient mobilization. The patient's dyspnea should also be monitored and kept at a moderate to relatively severe level (3-4 points on the Borg scale or 5-6 points on the VAS scale).

The authors of CARM recommendations do not indicate one particular type of exercise and emphasize that their form may be arbitrary. The general condition training should depend on the patient's condition and may be conducted continuously or intermittently (when the patient shows signs of fatigue, dyspnea or weakness), 1-2 x a day, one hour after a meal. The training should be determined based on individual assessment of the patient and may include the following elements: verticalization, walking, bedside bike, capacity- and strength-increasing exercises. The intensity should be gradually increased with the support of a walker or a cane if necessary, e.g. 30 minutes, interval of 2 x 15 minutes or even one-minute long with a two-minute break, e.g. when the saturation decreases [11].

When a patient reports one or more symptoms during the therapy, it should be reported to the medical team [11]:

1. Heavy, sudden dyspnea.
2. Compression or pain in the thorax.
3. Vomiting.
4. Dizziness and headaches.
5. Blurred vision.
6. Heart palpitations.
7. Sweating.
8. Inability to maintain balance.

Clinical symptoms of patients in the initial phase of COVID-19 are mild and may manifest as one or more of the following symptoms: fever, fatigue, cough and muscle pains. Additionally, these patients may experience feelings of anger, fear, anxiety, depression, sleeplessness, anxiety and loneliness attacks during isolation and treatment. Psychological problems, such as lack of cooperation and abandonment of treatment for fear of disease, should be identified as soon as possible by the personnel taking care of the patient. If such symptoms are identified by a physiotherapist working with a patient, it may be necessary to seek psychological support [19].

Management of ventilated patients in the intensive care unit

Patients in severe and critical condition will require further treatment in the intensive care unit. As a result of acute respiratory failure, they may be subjected to intubation and invasive mechanical ventilation. Many COVID-19 patients using a ventilator completely lose their spontaneous breathing due to the use of strong sedatives and anesthetics. The initiation of physiotherapeutic interventions at the right time may significantly shorten the period of delirium and the time when the patient requires mechanical ventilation, as well as improve the functional condition of patients [20].

Before starting physiotherapy of severely and critically ill patients, a comprehensive assessment of the patient's general functional status should be carried out, particularly concerning the state of consciousness, respiratory system, cardiovascular system and musculoskeletal system. Patients meeting the physiotherapy inclusion criteria should start treatment as soon as possible. The decision to start the therapy is made by the physiotherapist after consultation with the medical team. Patients not meeting physiotherapy inclusion criteria should be re-evaluated on a daily basis until the criteria are met and the therapy begins. Taking into account safety and personnel possibilities, critical treatment and physiotherapy of patients shall commence only when the specific unit has sufficient personnel. Physiotherapy in patients ventilated in intensive care units should cover three main areas: respiratory optimization, preventing the negative effects of immobilization and mechanical ventilation, and in the next stage: gradual patient mobilization [21,22].

All kinds of techniques improving the patient's breathing, e.g. bronchial cleansing methods, performed in patients subject to invasive ventilation methods, should be carried out by a physiotherapist with the skills to work with the aforementioned patients.

It is important to remember about changes in body position in the initial period of the patient's stay in the intensive care unit, when there are contraindications for motor activation. Patients with severe Acute Respiratory Distress Syndrome (ARDS) undergo special ventilation for at least 16 hours a day in an appropriate position on the abdomen [23]. In the case of moderate and severe ARDS, appropriately higher PEEP values should be used for ARDS and $\text{PaO}_2/\text{FiO}_2 < 150$ mmHg [24]. During physiotherapy of a mechanically ventilated patient, care should be taken not to disconnect the closed respiratory system between the patient and the ventilator, and the remaining tubes connected to the patient – including a catheter with a urine collection bag, cardiac monitoring cables, central catheter, arterial line, stomach tube, Percutaneous Endoscopic Gastrostomy (PEG), etc.

The selection of methods used during the physiotherapy of a patient staying in the intensive care unit should be adjusted to the patient's current abilities and the competence of the physiotherapist. It should be remembered that due to the use of sedatives or patients with cognitive disorders or physical limitations, selected treatment techniques include passive techniques (e.g. passive exercises), muscle stretching and neuromuscular electrostimulation [25]. At this stage, the inclusion of a basal stimulation can also be considered. In subsequent stages of physiotherapy, patients should be gradually mobilized to antigravitational positions, until the patient is able to maintain an upright position, for example, by raising the bed by 60° (the lower edge of the pillow shall rest on the shoulder blades to prevent excessive head tilt, pillows are placed under the popliteal fossa to relax the lower limbs and the abdomen, or by using the "armchair" function available in standard hospital bed equipment for the ICU). The verticalization shall be performed gradually increasing the frequency and/or time, later moving to higher stages of verticalization. Active and assisted exercises should be introduced as the patient's condition improves. The physical activity intensity and duration should be limited in patients with limited physical capacity. It is important that the patient is able to perform all components of the scheduled physiotherapy program. In addition, regular changes should be introduced in postural positions. Detailed recommendations concerning the physiotherapy of a patient in the intensive care unit can be found e.g. in publications by Gosselinek et al. [11, 22, 26].

According to Hodgson et al., physiotherapy of a patient in the intensive care unit should be started only after consultation with the medical team, when all the following conditions are met [26]:

1. Fraction of Inspired Oxygen (FiO_2) $\leq 60\%$. (0.6).
2. Saturation (SpO_2) $\geq 90\%$.
3. Respiratory rate: ≤ 40 breath/min.
4. Positive End-Expiratory Pressure (PEEP) ≤ 10 cmH₂O.
5. Patent airways.
6. Systolic Blood Pressure (BP) ≥ 90 mmHg and ≤ 180 mmHg.
7. Mean Arterial Pressure (MAP) ≥ 65 mmHg and ≤ 110 mmHg.
8. Heart rate (HR): ≥ 40 BPM and $120 \leq$ BPM.
9. No new arrhythmias or myocardial ischemia.
10. No sign of shock with concomitant lactic acid ≥ 4 mmol/L.
11. No new unstable deep vein thrombosis and pulmonary embolism.
12. No suspected aortic constriction.
13. No serious liver and kidney disease or new and progressive damage to liver and kidney function.
14. Body temperature $\leq 38.5^\circ\text{C}$.

Physiotherapy should be discontinued immediately when the following conditions occur [15,27]:

1. Blood oxygen saturation: $< 90\%$ or drop $> 4\%$ from the baseline.
2. Respiratory rate > 40 breaths/min.
3. No synchronization between patient and ventilator.
4. Unsealing of the closed respiratory system.
5. Systolic blood pressure: < 90 mmHg or > 180 mmHg.
6. Mean Arterial Pressure (MAP) < 65 mmHg or > 110 mmHg or a change of more than 20% from the baseline or > 120 BPM.
7. Start of arrhythmia or myocardial ischemia.
8. No logical contact with the patient.
9. Patient's increasing anxiety.
10. High intensity of fatigue and intolerance of physical activity in the patient.

Patients who have been hospitalized in the ICU still suffering from respiratory dysfunction or muscle weakness, should continue physiotherapy after discharge, in the in-patient rehabilitation unit or at home, supervised by an experienced physiotherapist, in order to regain full function. According to the reports on patients discharged after suffering from SARS and MERS, as well as clinical experiences of working with ARDS patients, it is expected that patients with COVID-19 may have significantly impaired physical capacity, with dyspnea increasing after physical activity, and muscular atrophy (including respiratory and torso muscles, as well as the weakness syndrome acquired during their stay in the Intensive Care Unit - ICU-Acquired Weakness) [28], and mental disorders, such as in post-traumatic stress syndrome [29].

Summary

The current epidemiological situation is a huge challenge for all medical professionals. The intention of the authors of these recommendations is to present the possibilities of providing physiotherapy in the population of COVID-19 patients, and at the same time to emphasize the need to keep strictly defined safety rules.

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List of abbreviations used in the study:

- **CARM** - Chinese Association of Rehabilitation Medicine
- **AGT** - Aerosol Generating Techniques
- **NMES** - Neuromuscular Electrical Stimulation
- **IPPB** - Intermittent Positive Pressure Breathing
- **PEP** - Positive Expiratory Pressure
- **OPEP** - Oscillating Positive Expiratory Pressure
- **ACTB** - Active Cycle of Breathing Techniques
- **FET** - Forced Expiratory Techniques
- **MAC** - Manual Assisted Cough
- **PEF** - Peak Expiratory Flow
- **VAS** - Visual Analogue Scale
- **MIE** - Mechanical Insufflation-Exsufflation
- **ARDS** - Acute Respiratory Distress Symptom
- **ICU** - Intensive Care Unit

