Action Plan for Rehabilitation of COVID-19 Patients Admitted to the Intensive Care Unit

Portuguese Society of Physical and Rehabilitation Medicine

Plano de Ação para Reabilitação de Doentes com COVID-19 Admitidos em Unidade de Cuidados Intensivos

March 2020

Authors: Task-Force SPMFR - Rehabilitation of patients admitted to the ICU by COVID-19
Coordinators: Catarina Aguiar Branco, Afonso Rocha, Ines Machado Vaz, Jonathan Rios.
Collaboration: Anabela Pinto, Ana Rolo Duarte, Ricardo Henriques, Jorge Moreira, Catarina Matos, Sonia Tizon, Enio Pestana, Andre Maia, Ursula Martins, Paulo Couto, Joana Silva.

Contents

Attachments

Autor correspondente: Catarina Aguiar-Branco. email: catarinabranco@mccb.pt.
Data de submissão: julho 2020
Data de aceitação: julho 2020
Data de publicação: agosto 2020

List of abbreviations	
ARDS	Acute respiratory distress syndrome
BiPAP	Bi-level positive airway pressure
CoV	Coronavirus
COVID-19	Disease caused by SARS-CoV-2
CPAP	Continuous positive airway pressure
CPM	Cycles per minute
NMES	Neuromuscular electrical stimulation
PPE	Personal protective equipment
HR	Heart rate
FiO2	Fraction of inspired oxygen
ICU AW	Intensive Care Unit acquired weakness
RR	Respiratory rate
HFCWO	High frequency chest wall oscillation
MERS	Middle East respiratory syndrome
PRM	Physical and Rehabilitation Medicine
MRC-SS	Medical Research Council-Sum Score
WHO	World Health Organization
SBP	Systolic blood pressure
MBP	Mean arterial blood pressure
PaO2/FiO2	Ratio of arterial oxygen partial pressure to fractional inspired oxygen
SBP	Systolic blood pressure
PEEP	Positive end-expiratory pressure
PEP	Positive expiratory pressure
MIP	Maximum inspiratory pressure
RASS	Richmond Agitation-Sedation Scale
S5Q	5 Standardized questions for cooperation
SARS	Severe acute respiratory syndrome
SARS-CoV-2	Severe acute respiratory syndrome – Coronavirus 2
SatO2	Oxygen saturation
PICS	Post-intensive care syndrome
PTE	Pulmonary thromboembolism
DVT	Deep vein thrombosis
ICU	Intensive Care Unit
MV	Invasive mechanical ventilation

Background

Coronavirus disease 2019 (COVID-19) is the clinical expression of infection by the SARS-CoV-2 zoonotic virus, a single-stranded RNA beta-coronavirus with a phylogenetic similarity to SARS-CoV-1, which causes severe acute respiratory syndrome (SARS), and MERS-CoV of Middle East respiratory syndrome.[1]

Early unofficial reports identified the first COVID-19 case on November 17, 2019 in the city of Wuhan (Chinese province of Hubei), which was officially recognized as a disease after the epidemiological and microbiological investigation of a cluster of atypical pneumonia at the end of December 2019.[2] The disease suffered rapid spread locally, regionally, nationally and internationally, leading the World Health Organization (WHO) to declare, on March 11, 2020, COVID-19 a pandemic and a worldwide public health emergency.

Globally and at the date of this document (March 30, 2020), there were 693 282 confirmed cases and 33 106 deaths due to COVID-19 worldwide[3] and, in Portugal, 7443 confirmed cases had been identified, 188 patients in units intensive care (ICU) and a total of 160 deaths.[4]

The infection capacity stems from the considerable basic reproduction number, or attack rate (R0-average number of secondary cases of infection originating from a primary case only considering a population of susceptible individuals), estimated between 2.24 and 3.58,[5] depending on the method chosen for identifying cases and public health intervention measures, and providing estimates related to the expected rate of progression, the inflection point of the epidemic curve and its duration.[6]

Clinical presentation consists, in approximately 80% of cases, in mild to moderate forms (include non-pneumonias and non-severe pneumonias), 13.8% have severe illness requiring hospitalization and 6.1% will have critical illness requiring hospitalization in ICU.[2] The estimated death rate is around 2%, lower than that of SARS-CoV-1 (about 10%) and MERS-CoV (about 40%), but significantly higher than that of H1N1 (about 0.03 %).[4] The main risk factors associated with the most severe forms of the disease, especially the acute respiratory distress syndrome (ARDS) and death, are age (individuals aged ≥65 years are 3.26 times more likely to develop ARDS and 6.17 times higher risk of dying, compared to those <65 years old), temperature> 39ºC in the first evaluation, respiratory rate ≥24 cycles per minute (cpm) and the existence of comorbidities such as coronary heart disease, chronic obstructive pulmonary disease, diabetes and high blood pressure.[7,8] In-hospital transmission of COVID-19 infection (patient-patient, patient-health professional, health-professional) is an important source of spread of the disease and has a potential impact on the organizational capacity and hospital response to the pandemic.[9]

From the data presented from Wuhan, the proportion of hospitalized patients infected with COVID-19 by intra-hospital transmission can reach 41.3% of the cases, with 29% of total cases affecting health care professionals. Of the infected health professionals, the majority (77.5%) worked in general wards, 17.5% in the emergency department and 5% in the ICU.[10] This scenario reinforces the need for urgent safety and protection measures for health professionals who deal with suspected or infected cases by COVID-19.

Rehabilitation interventions in the context of critical illness, namely respiratory and neuromuscular rehabilitation, are associated with a greater likelihood of early extubation,[11] reduced incidence of ICU-acquired weakness (ICUAW) and improved quality of life and survival of patients admitted to the ICU.[12] However, the evidence for this type of interventions in COVID-19 is still scarce, and the interventions must be individualized and dynamic, adapting to the rapid changes that characterize the disease's progression, especially in the first 7 days of the disease's progression .[13]

The risk of infection and the level of protection, namely the type of equipment, are highly dependent on the procedure or intervention to be performed and on its potential to generate aerosols and/or dispersion of droplets from the airway. Non-invasive ventilation (CPAP or BiPAP), high flow oxygen therapy and procedures such as extubation, orotracheal intubation, tracheotomy, bronchoscopy, secretion aspiration, chest physiotherapy and assisted cough methods are classified as high risk and should therefore have enhanced contact, droplet and airway precautions.[14] In other interventions, such as neuromuscular rehabilitation, general protective care, contact and droplet precautions must be taken.

The aim of this document is to gather available information to support and guide evidence-based decisions regarding the rehabilitation of patients admitted to intensive care units by COVID-19.

Due to the dynamic nature of the disease, this clinical guidance document is subject to constant review and updating whenever deemed necessary.

General goals

With this document we aimed to achieve the following objectives:

1. Distinguish the types of intervention in the context of Rehabilitation (Respiratory, Neuromuscular)
2. Define the criteria for intervention by Physical and Rehabilitation Medicine (PRM)

3. Establish the eligibility and exclusion criteria for starting rehabilitation programs
4. Define the clinical and functional evaluation protocols (semi-automatic models)
5. Define intervention protocols (respiratory rehabilitation and / or neuromuscular rehabilitation)
6. Establish individual and equipment protection measures

Guidelines for intervention in ICU in COVID-19 patients

ICU admissions, either because of the severity of the underlying disease and the patient's comorbidities, or because of the associated technical and pharmacological interventions, are frequently prolonged and may result in serious clinical problems such as physical, cognitive and behavioral consequences collectively called post-intensive care syndrome (PICS).[15] Of the physical consequences, it is worth mentioning the ICUAW, characterized by a generalized flaccid tetraparesis affecting peripheral and respiratory muscles, resulting in difficult weaning from mechanical ventilation, high extubation failure rates, as well as longstanding deconditioning and functional disability.

The approach to critically-ill COVID-19 patients includes prolonged invasive mechanical ventilation, sedation and use of neuromuscular blockade, with higher risk for ICU-AW, with consequent worsening of morbidity and mortality.[16] The early start of a structured rehabilitation program contributes to the optimization of cognitive, respiratory, neuromuscular and musculoskeletal functions, shortening the length of stay in an ICU and its clinical and functional consequences.

a. Safety criteria for beginning rehabilitation at the ICU (Attachment 1)[13,17-28]

- **Assessment of the Respiratory System:**
  - Respiratory rate (RR) equal to or less than 30 cycles per minute[22]
  - Oxygen saturation (SatO2) equal to or greater than 90%[17-19,22,24]
  - Fractional inspired oxygen (FiO2) less than or equal to 0.6 or 60%[17,19,20,22,25,26]
  - Ratio of arterial oxygen partial pressure to fractional inspired oxygen (PaO2 / FiO2) ideally ≥ 200[24]
  - Positive end-expiratory pressure (PEEP) less than or equal to 10 cmH2O[17,19,20,22,24,25]
  - No significant desynchrony between ventilator and patient[22]
- **Assessment of the Cardiovascular System:**
  - Systolic blood pressure (SBP) between 90 and 180 mmHg[17]
  - Mean arterial pressure (MAP) between 65 mmHg and 110 mmHg[17,19]
  - Blood pressure (BP) variability less than 20%[18]
  - Heart rate (HR) between 40 and 120 beats per minute[17]
  - Absence of new arrhythmias or rhythm changes associated with hemodynamic instability[19,20,22,26]
  - No need for antiarrhythmics in the last 24 hours[25,26]
  - No history of recent acute coronary syndrome, particularly in the last 48 hours[22,23,25]
  - No need for continuous perfusion of vasopressors or absence of a recent increase in dose of vasopressors, namely in the last 2 hours[17,19,25]
  - No need for continuous perfusion of vasodilators[17,24-26]
  - No signs of shock or serum lactate levels greater than or equal to 4 mmol / L[22]
  - No deep venous thrombosis (DVT) or pulmonary thromboembolism (PTE) in the last 24 hours or, if any are present, anticoagulation already started at least for 24 hours[22,24-26]
  - No severe aortic stenosis with hemodynamic significance[22]
- **Assessment of the Nervous System:**
  - Richmond Agitation and Sedation Scale (RASS): recommended between minus 2 and plus 2 (below minus 2 it is possible to perform level 0 intervention - section 4.a)[20,22]
  - Intracranial pressure less than 20 cmH2O[22]
  - No need for increased sedation in the past 30 minutes[23]
- **Assessment of hematological and laboratory data**
  - Stable hemoglobin level above 7 g per deciliter1[8,24,26]
  - Platelet level above 20000/mm^3 (18, 27, 20, 26)
  - Blood pH higher than 7.25[25,26]
  - INR level less than 5.0[20,26]
- **Other safety criteria:**
  - No need for prone position[22]
  - No unstable limb or spine fracture[17]
  - No rapidly progressive liver or kidney dysfunction
  - No active hemorrage[17,22,23]
  - Body temperature between 36 and 38.5°C
  - Femoral catheter is not a contraindication, but hip flexion should be avoided

b. Specificities and recommendations in the area of Respiratory Rehabilitation Intervention within the ICU[13]

- COVID-19 infection is mainly associated with a dry, non-productive cough and involvement of the lower respiratory tract, with pneumonitis being more common than exudative consolidation.
- ARDS by COVID-19 is not usually associated with excessive secretion production, so rarely are bronchial hygiene techniques required, unless the patient develops concomitantly[15]:
  - Bronchial hypersecretion (due to underlying pathology or associated bacterial infection)
  - Atelectasis
  - Difficulty in managing and clearing secretions
  - ICUAW
  - Difficult/prolonged weaning from mechanical ventilation
- Most of the chest physical therapy techniques used in the context of the ICU, in intubated patients or when weaning from mechanical ventilation are potentially aerosol-generators[27]:
  - Techniques to promote bronchial hygiene involving cough stimulation and secretions elimination
  - Techniques for mobilizing secretions (expiratory flow modulation, positive expiratory pressure instruments, oscillatory PEP, assisted cough)
  - Nasopharyngeal or oropharyngeal aspiration, manual hyperinflation, saline instillation in the airway
  - Intrapulmonary percussive techniques
  - High frequency, intra and extra-pulmonary oscillation devices
  - Mechanical in-exsufflation (in this case there are important concerns due to the considerable risk of barotrauma, parenchymal injury, worsening hypoxic condition and aerosolization potential, especially when used in an open circuit after extubation)
  - Inspiratory muscle training - especially in ventilated patients who need disconnection from ventilation circuit
- Since these techniques are not formally recommended, their use must be decided on an individual basis, after a risk / benefit analysis, and should be performed only if and when necessary and preferably in isolation (ideally in a negative pressure room), with the minimum number of people, and all wearing the required protection equipment.

c. Evaluation by Physical and Rehabilitation Medicine[13]

Given the dynamic nature of the ARDS associated with COVID-19, regular clinical reassessments are needed to reassess readiness to initiate rehabilitation programs and decide on which components should be chosen. The interaction of the PRM and Intensive Care Units must be adapted to the local context, availability of experienced personnel and type of equipment available. Building a framework for regular monitoring of readiness criteria to start rehabilitation is required and should be set in place by the PRM and intensive care physicians.

The levels and types of interventions will be defined and reviewed regularly through close collaboration between the PMR physician, the intensive care physician, the nursing team, physiotherapists and speech therapists.

PRM Specialist evaluation[20,29]
All security criteria
should be met (see 3.a)

Scales in attachment
- RASS (Attachment 2)
- 5 Standardized questions for cooperation (S5Q) (Attachment 3)
- Medical Research Council Sum Score (MRC-SS) (Attachment 4)
  - For the purpose of defining ICU AW, the following motions should be tested and quantified, bilaterally:
    - Lateral shoulder elevation
    - Elbow flexion
    - Wrist extension
    - Hip flexion
    - Knee extension
    - Tibiotarsal dorsiflexion
  - ICU AW: sum of the muscle groups tested less than or equal to 48, from a total of 60 points.

ICU intervention protocol in COVID-19 patients (Attachment 5)

- Early respiratory rehabilitation is not recommended for critically ill patients, with clinical criteria of instability or progressive deterioration due to disease progression.[13]
- **Specific goals** (according to the stage of the disease and its progression, risk-benefit assessment and medical clinical decision)[30]:
  - Optimization of ventilation and oxygenation
  - Maintenance and / or recruitment of lung volume

- Prevention and treatment of atelectasis
- Facilitation of removal of tracheobronchial secretions
- Improve respiratory muscle strength
- Facilitate weaning ventilation with reduced mean extubation time and average ICU length of stay
- Improve functional outcome and survival of patients admitted with ARDS

- The proposed action plan, whether in the context of respiratory or neuromuscular rehabilitation, will consist of sequential interventions, initiated after the fulfillment of safety criteria, with progression and typology depending on the patient's level of awareness and collaboration, evaluated using the RASS, S5Q scales, their muscle strength measured with the MRC-SS and medical clinical decision.

- During the various phases of respiratory and neuromotor interventions, the procedures must be accompanied by permanent monitoring of vital signs and other ventilatory parameters.

- These intervention strategies are also aimed at optimizing resources, reducing the number of people in contact with the patient and reducing expenditure on personal protective equipment (PPE).

a. Intervention protocol in the area of Respiratory Rehabilitation[13,29,31]

Level 0:

- The initial phase of COVID-19 with acute respiratory failure, clinical instability and progression to ARDS, is frequently associated with:
  - Normal or slightly increased pulmonary compliance
  - Severe impairment of oxygenation
  - Increased work of breathing
  - Reduced respiratory muscle strength

At this stage, there is no indication for starting respiratory rehabilitation.

Level 1:

- Major inclusion criteria:
  - Clinical stability criteria
  - Evaluation by S5Q less than 3
  - Evaluation by RASS less than or equal to -2 (unconscious patient)
- At this level patients will be admitted under MV whenever start the weaning process is being considered.

Use of respiratory rehabilitation techniques that allow:

Optimization of the ventilation / perfusion ratio

- Alternating decubitus for localized alveolar recruitment
- Progression according to tolerance and clinical response
- Progressive head bed elevation up to 30º, 45º, 60º, until seated position
- Duration: between 20 to 30 minutes
- Frequency: 2 to 3 times a day
- Monitoring of respiratory and cardiovascular parameters

- **Volume recruitment maneuvers by adjusting ventilation parameters**
- **Management of secretions and bronchial hygiene**
  - Aspiration of secretions using a closed circuit, with previous hyperoxygenation to increase arterial O2 saturation[31]

Level 2:

- Major inclusion criteria:
  - Clinical stability criteria
  - Evaluation by S5Q greater than or equal to 3
  - Evaluation by RASS between -2 and +2 (conscious patient)

- This level includes patients weaning from mechanical ventilation or who have been recently weaned and extubated.

- Application of respiratory rehabilitation techniques that allow:
  - Optimization of the ventilation / perfusion ratio
    - Progression according to tolerance and clinical response
    - Progress to sitting and standing position
    - Duration: between 20 to 30 minutes
    - Frequency: 2 to 3 times a day
    - Monitoring of respiratory and cardiovascular parameters
  - **Ventilation rhythm control techniques**
    - Abdominal-diaphragmatic breathing
    - Pulmonary expansion exercises
  - **Volume recruitment maneuvers**
    - Weaning ventilation: by adjusting ventilation parameters

- Post-extubation (exceptional techniques, see 3b): recruitment maneuvers using an modified ambu bag or mechanical in-exsufflator

- **Management of secretions and bronchial hygiene** (techniques, see 3b):
- *High frequency chest wall oscillation* (HFCWO)[31]:
  - Frequency: 7–10 Hz
  - Pressure: 3 mmHg
  - Length: 15-minutes
  - Periodicity: 4x/dia
  - Stop if:
    - HR rise more than 20 bpm relative to basal
    - RR rise more than 10 cycles per minute
    - MAP fall more 20 mmHg relative to basal
    - $SatO_2$ less than 95%
  - There is little evidence regarding effectiveness and safety
- Mechanical in-exsufflator (not recommended in acute phase)
  - Consider to optimize bronchial hygiene in difficult and prolonged weaning.[26]
  - Associated risks: It implies disconnecting the ventilator; negative pressure can worsen the expiratory collapse airway, can generate significant amounts of aerosols during exsufflation phase (with high risk for healthcare professionals)
  - Contraindications: pneumothorax, cardiovascular instability, rib fracture with instability
  - Relative contraindications: pulmonary emphysema, traumatic brain injury and / or craniofacial trauma and severe hypoxemia.
  - Assembly of the circuit: double antibacterial filter, one at the outlet of the device and one before the patient interface
  - Used through an endotracheal tube (check the cuff pressure first)

    Note: It might be exceptionally performed immediately after extubation of benefit clearly outweighs the possible risks using an orofacial mask
  - Pressures: start at +/- 30 cmH2O
  - Mode: automatic
  - Times: inspiration 2 seconds, expiration 3 seconds, pause 3 seconds

b. Intervention protocol in Neuromotor and Functional Rehabilitation[18,20,21,29]

Level 0:

- This level includes patients who do not meet the defined safety criteria, so there is no formal indication for intervention in neuromotor rehabilitation.
- Strategies should be adopted to minimize the complications associated with immobilization, namely joint stiffness / ankylosis, capsule-ligament and myotendinous retractions, compression neuropathies or pressure ulcers.

Level 1:

- Major inclusion criteria:
  - Clinical stability criteria
  - Evaluation by S5Q less than 3
  - Evaluation by RASS less than or equal to -2 (unconscious patient)
  - MRC-SS equals to zero
  - Typical patients are those under MV who are deemed ready to start the weaning process are considered
- Application of neuromotor and functional rehabilitation techniques, namely:
  - Passive manual mobilization
  - Regular position changes (ideally 2 / 2 hours) aimed to avoid retractions, peripheral neuropathies or pressure ulcers.
  - Progressive elevation of the head bed elevation up to 30º, 45º, 60º, until seated position
  - Complementary techniques (according to the patient's availability and capacity):
    - Neuromuscular electrical stimulation (NMES)
    - Motorized continuous passive mobilization (including ergometers)

Level 2:

- Major inclusion criteria:
  - Clinical stability criteria
  - Evaluation by S5Q equals 3
  - Evaluation by RASS in between -2 and +2 (conscious patient)
  - Evaluation by sum of MRC-SS less than 36
- Application of neuromotor and functional rehabilitation techniques, namely:
  - Passive transfer to chair (manual or mechanical)
  - Sitting position with techniques for correcting posture

- Assisted verticalization strategies (bed with verticalization device)
- Active assisted multisegment manual joint mobilization
- Muscle strengthening in isometry or isotonic in closed kinetic chain
- Adjuvant techniques (according to the patient's availability and capacity):
  - NEMS
  - Motorized continuous passive mobilization (including ergometers), performed in patient bed.

Level 3:

- Major inclusion criteria:
  - Clinical stability criteria
  - Evaluation by S5Q greater than or equal to 3
  - Evaluation by RASS in between -2 e +2 (patient awake)
  - Evaluation by sum of MRC-SS in between 36 e 48
- Application of neuromotor and functional rehabilitation techniques, namely:
  - Active/active assisted transfer to chair
  - Assisted verticalization strategies
  - Active and active resistive multisegment manual joint mobilization
  - Seated and assisted standing positioning
  - Static sitting balance training, progressing to dynamic
  - Dynamic muscle strengthening
  - Adjuvant techniques according to the rehabilitation material availability and patient's capacity
    - NEMMS
    - Active and active-resisted ergometer upper and lower limbs exercises in bed and sitting on chair

Level 4:

- Major inclusion criteria:
  - Clinical stability criteria
  - Evaluation by S5Q equal to 5
  - Evaluation by RASS in between -2 e +2 (patient awake)
  - Evaluation by sum of MRC-SS higher than 48
- Use of neuromotor and functional rehabilitation techniques, namely:
  - Active
  - Assisted verticalization strategies
  - Active and active resistive multisegment manual joint mobilization
  - Seated and assisted standing positioning
  - Static balance training evolving to dynamic, sitting and standing
  - Dynamic muscle strengthening
  - Assisted gait training (walker or third person assistance)
  - Adjuvant techniques (according to the patient's availability and capacity):
    - Active and active-resisted ergometer upper and lower limbs exercises in bed and sitting on chair
    - Free weights and / or elastic bands with progressive resistance

Note: The introduction of adjuvant techniques such as NMES can be carried out with the following indications[33,34]:

- Muscle groups: quadriceps, gluteus and abdominal muscles (most frequently)
- Parameters: biphasic current, symmetrical, nonpolar, between 10-50 Hz; 400 microseconds in duration; 1.6 seconds on (including 0.8 seconds up and 0.8 seconds down) + 6 seconds off; intensity capable of "visible" contraction
- Duration: 15-20 minutes (*)
- Frequency: daily

c. Criteria for interrupting the intervention[13,35,36]

- **Respiratory system:**
  - SatO2 lower than 90% or SatO2 falling 4% or more
  - RR higher than 30 cpm
  - Asynchrony between ventilator and patient
  - Artificial airway disconnection
- **Cardiovascular system:**
  - SBP lower than 90 mmHg or higher than 180 mmHg
  - MAP lower than 65 mmHg or higher than 110 mmHg
  - Change MAP value higher or equal to 20% of basal value
  - HR lower than 40 bpm or higher than 120 bpm
  - Increase HR of 20% relative to basal value
  - New-onset arrhythmia
  - Signs of acute coronary syndrome by electrocardiogram or cardiac enzymes
- **Nervous system:**
  - Change in state of consciousness
  - New-onset agitation or restlessness

- **Other criteria for interrupting rehabilitation:**
  - Disconnection of monitoring and / or treatment catheter
  - Disabling pain from intervention: analgesia should be optimized before start of rehabilitation program
  - Respiratory or cardiovascular symptoms that prevent the patient from collaborating (eg dyspnea, fatigue, oppressive chest pain, palpitations, intolerance)
  - Falls

Note: The duration of the rehabilitation program depends on the stage of the disease, the patient's clinical situation, tolerance and individual response to specific interventions. We propose a multimodal rehabilitation intervention (as previously documented), ideally with an average duration of direct intervention up to 30 minutes / ideally twice a day or, at least, once a day, with an intensity adapted to the patient's cardio-hemodynamic and respiratory/ventilatory parameters / time of direct intervention / number and specificity of intervention modalities, to tolerance, level of fatigue and degree of patient collaboration. (*)

Individual protection measures and equipment

a. Treat a patient with confirmed / suspected COVID-19[37]

- All personnel who contact with the patient must be trained in the prevention and control of new infections,[37] namely the use of the most appropriate PPE, the correct dressing and donning technique and knowledge of the circuits in the COVID areas.
- Personal Protective Equipment recommended:
  - **Health professionals involved in the direct care of suspected or confirmed cases of COVID-19 must use contact and droplet PPE, and oblige by recommendations from the Portuguese Health Authorities Standard 007/2020:**
    - Disposable or single use clothing
    - Isolation gowns - with opening at the back, disposable, waterproof / fluid resistant, long sleeved and extending below the knee
    - Mask (with adequate facial adjustment)
    - Eye protection - glasses or visor (lower opening)
    - Gloves - non-sterile disposable
    - Boot covers (if you are not wearing dedicated and non-sanitizable shoes)
    - Cap
  - **In relation to respiratory PPE, with different types of PPE, the selection and use by professionals to provide direct care to patients suspected or confirmed of COVID-19, should be based on the following assumptions:**
    - Respirator FFP1: Alternative to the surgical mask in the provision of direct care to a patient at a distance ≤ 1 meter, outside the cohort or COVID-19 isolation room, provided no aerosol-generating procedures are to be performed
    - FFP2 or N95 respirator: must be used whenever aerosol-generating procedures are carried out. Also recommended inside a COVID-19 isolation room or cohort to provide direct care

b. Contact with patient subsequently confirmed with COVID-19

- Contact the Occupational Health Service

c. Equipment hygiene[27]

- Prefer disposable equipment
- Decontaminate according to the manufacturer's instructions
- Clean with a neutral detergent, followed by chlorhexidine-based disinfectant
- Dispose used protection equipment as medical waste
- Mechanical in-exsufflator
  - Use two antibacterial filter at each end of the circuit
  - Filters must be changed whenever dirty or every 24 hours
  - Change the complete circuit every 72 hours
- Avoid disconnecting the patient from the ventilator
- Always aspirate secretions with closed circuits
- Any other device that is taken to the patient's room (even if it does not come into contact with the patient) must be disinfected

Final Note

Critical illness associated with SARS-CoV-2 infection often results in prolonged periods of mechanical ventilation, sedation and neuromuscular blockade, leading to a high risk of developing PICS worsening clinical and functional outcomes both in in the short and medium term. Therefore, active, early and multi-professional participation of rehabilitation teams is desirable, in the context of the ICU and in the post-ICU period, under the coordination of the

Physiatrist in close interaction with the Intensive Medicine team and, later, with the Internal Medicine, Infectious diseases and Pulmonology teams. This document presents the action plan for Respiratory Rehabilitation and Neuromotor Rehabilitation for COVID-19 patients admitted to the ICU. The COVID-19 patient with post-extubation dysphagia will be approached in a later document.

The Physical and Rehabilitation Medicine Services must develop action plans based on the guidelines from national health authorities and on the local standards of the institution to which they belong, allowing for timely clinical response and the allocation of the human and material resources necessary to the different types and levels of intervention. However, the dynamic nature of the present epidemiological situation and the normative update, which occurs at a high pace, should be considered so that specific adaptations of these recommendations may be necessary.

Task-Force SPMFR - Rehabilitation of patients admitted to the ICU by COVID-19

Coordinators

Catarina Aguiar Branco, Afonso Rocha, Inês Machado Vaz, Jonathan Rios.

Collaboration

Anabela Pinto, Ana Rolo Duarte, Ricardo Henriques, Jorge Moreira, Catarina Matos, Sónia Tizon, Énio Pestana, André Maia, Úrsula Martins, Paulo Couto, Joana Silva.

Task-Force SPMFR - Reabilitação de doentes admitidos na UCI por COVID-19

Coordinators

Catarina Aguiar Branco, MD

Graduate PRM Hospital Assistant, Director of the PRM service at Centro Hospitalar Entre Douro e Vouga (Feira) – Responsible for the Exercise Reconditioning Unit (Cardiovascular Rehabilitation, Respiratory Rehabilitation) and Co-responsible for the Critical Patient Rehabilitation Unit in Intensive Care Medicine. President of SPMFR

Afonso Rocha*,MD*

Graduate PRM Hospital Assistant, Centro Hospitalar e Universitário São João – Head of the Cardiovascular and Respiratory Rehabilitation Unit

Inês Machado Vaz*, MD*

PRM Hospital Assistant, Coordinator of the Cardiorespiratory Rehabilitation and Effort Reconditioning Unit, General Rehabilitation Unit and Other Neurological Diseases, Centro de Reabilitação do Norte - CHVNGE

Jonathan Rios, MD

PRM Hospital Assistant at Centro Hospitalar Universitário do Algarve - Respiratory Rehabilitation Coordinator and Responsible for the Rehabilitation Team in Intensive Care Units.

Collaboration

Anabela Pinto, MD,PhD

PRM doctor, Air Care Centre (Linde Healthcare), IMM. Faculdade de Medicina da Universidade de Lisboa (FMUL)

Ana Rolo Duarte*, MD*

Graduate PRM Hospital assistant at Hospital Beatriz Angelo, Loures – Co-responsible for Respiratory Rehabilitation

Ricardo Henriques*,MD*

Graduate PRM Hospital assistant at Centro Hospitalar Universitário de Lisboa Norte, EPE – Hospital de Santa Maria, PRM Coordinator of Rehabilitation in Intensive Care Medicine.

Jorge Moreira*, MD*

Graduate PRM Hospital assistant at Centro Hospitalar Entre Douro e Vouga (Feira) – Co-responsible for the Critical Patient Rehabilitation Unit in Intensive Care Medicine

Catarina Matos*, MD*

PRM Hospital Assistant at Hospital Prof. Dr. Fernando Fonseca, EPE, Responsible for PRM support to the Intensive Care Service

Sónia Tizon*, MD*

Graduate PRM Hospital assistant at Hospital de Braga, Respiratory Rehabilitation responsible

Énio Pestana*, MD*

PRM Hospital Assistant at Hospital da Horta and Hospital CUF Cascais, Respiratory Rehabilitation

André Maia*, MD*

PRM Hospital Assistant at Hospital Senhora da Oliveira - Guimarães – Coordinator of the Rehabilitation Team to support the Multipurpose Intensive Care Unit and responsible for Respiratory Rehabilitation

Úrsula Martins*,MD;* ***Paulo Couto,*** *MD;* ***Joana Silva****.MD;*

PRM Hospital Assistant at Centro Hospitalar Entre Douro e Vouga (Feira) – Critical Patient Rehabilitation Unit in Intensive Care Medicine

Attachments

ATTACHMENT 1 - Safety criteria for Rehabilitation in ICU

Evaluation areas		Safety criteria	Exclusion criteria
Respiratory	RR	• ≤ 30 cpm	• ≥ 30 cpm
	Sat O_2	• > 90%	• < 90% • Decreased basal saturation > 4%
	FiO2	• < 0,6 or 60% • PaO2/FiO2 ≥ 200	• Dyspnea, fatigue
	Ventilator settings	• PEEP ≤10	• PEEP > 10 • Ventilator / patient asynchrony
	Airway	---	• Disconnection of the artificial airway
Cardiovascular	SBP	• 90-180 mmHg	• < 90 or > 180 mmHg • Change of more than 20% from baseline
	MBP	• 65-110 mmHg	• < 65 or > 110 mmHg • Change of more than 20% from baseline
	Heart rate	• 40-120 bpm	• < 40bpm e > 120 bpm
	Others	---	• Symptomatic arrhythmia • Addition of antiarrhythmics in the last 24 hours • Recent acute myocardial infarction - last 48 hours (ECG criteria, cardiac markers or angina) • Pharmacological intervention for continuous hemodynamic stability • Recent increase (last 2 hours) in the dose of vasopressors • Shock with lactate level> 4 mmol/L • With DVT or TEP again (24 hours), without adding anticoagulation • Absence of severe aortic stenosis with hemodynamic translation
Neurologic	Conscience level	• RASS -2 a +2 • Intercranial pressure < 20 cmH2O	• Change in consciousness level or agitation again • Sedation adjustment in the last 30 minutes
Hematologic	Lab values	• Hemoglobin > 7 g/dL • Platelets > 20000/mm3 • pH > 7.25 • INR < 5.0	• Hemoglobin < 7 g/d • Platelets < 20000/mm3
others	Others	• temperature 36-38.5°C	• Prone position • Unstable fracture of limbs or spine • Signs of rapidly progressive liver or kidney function decompensation • Active bleeding • Femoral catheter is not a contraindication, but hip flexion should be avoided • Disconnection of monitoring and / or treatment catheter • Disabling pain for the intervention

ATTACHMENT 2 – RASS ("Richmond Agitation Sedation Scale")[38-40]

4	Combative	Combative, violent, risk to the team
3	Very agitated	Aggressive conduct, pulls or removes tubes or catheters, aggressive verbally
2	Agitated	Frequent unreasonable movements, asynchrony with the fan
1	Restless	Anxious, without aggressive movements
0	Alert and calm	
-1	Sleapy	Asleep, easily awake, maintains more eye contact than 10 seconds
-2	Light sedation	Early awakening to verbal stimulation, maintains eye contact less than 10 seconds
-3	Moderate sedation	Movements and eye opening to verbal stimulus, but without contact visual
-4	Intense sedation	No response to verbal stimulus, but with movements or opening eyepiece to touch
-5	Not wake-up	No response to verbal or physical stimulus

ATTACHMENT 3 – S5Q – *5 standardized questions for cooperation*[20,30,39]

	no (0)	yes (1)
Opens and closes eyes		
Look at me		
Open your mouth and stick out your tongue.		
Say "yes" and "no" with your head.		
Frowns after I count to 5.		

ATTACHMENT 4 – MRC-SS3[0,41]

Evaluation of 6 movements bilaterally	MRC-SS scale
Lateral shoulder elevation Elbow flexion Wrist extension Hip flexion Knee extension Ankle dorsiflexion	0 - No visible or palpable contraction 1 - Contraction visible or palpable, but without movement 2 - Movement that practically completes the arc (eliminating gravity) 3 - Movement that practically completes the arc, against gravity 4 - Movement that overcomes moderate resistance, throughout the range of motion 5 - Preserved muscle strength
Total: 0-60	

Evaluation position

- Evaluation eliminating gravity (MRC-SS <3), head at 10º
- Movements against gravity (MRC-SS ≥ 3), head raised to 45º
- Fixing and positioning material must be removed
- Up to 3 attempts to evaluate each move

ATTACHMENT 5 – PRM performance protocol at the ICU level

<table>
<tr><th colspan="7">Intervention in respiratory rehabilitation</th></tr>
<tr><td rowspan="2">Evaluation</td><td colspan="2">S5Q</td><td colspan="4"><3</td></tr>
<tr><td colspan="2">RASS</td><td colspan="4">-2 (unconscious)</td></tr>
<tr><td colspan="3">Ventilatory weaning process with EOT</td><td colspan="4">Optimization of the ventilation / perfusion ratio
Management of secretions and bronchial hygiene</td></tr>
<tr><td colspan="3">Immediately after extubation</td><td colspan="4">Optimization of the ventilation / perfusion ratio
Volume recruitment maneuvers Secretion management / bronchial hygiene
Techniques to control rhythm ventilation</td></tr>
<tr><th colspan="7">Neuromotor rehabilitation intervention</th></tr>
<tr><td rowspan="3">Evaluation</td><td>S5Q</td><td>0</td><td colspan="2"><3</td><td>3</td><td>4 or 5</td><td>5</td></tr>
<tr><td>MRC-SS</td><td>0</td><td colspan="2">0</td><td>(Soma ≤ 36)</td><td>(Soma 37-47)</td><td>(Soma ≥ 48)</td></tr>
<tr><td>RASS</td><td colspan="3">-2 (unconscious)</td><td colspan="3">-2 a 2 (arousable)</td></tr>
<tr><td colspan="2">Intervention</td><td>Level 0</td><td colspan="2">Level 1</td><td>Level 2</td><td>Level 3</td><td>Level 4</td></tr>
<tr><td colspan="2">Positioning and technical measures for postural assistance and correction</td><td colspan="3">Positioning measures and techniques for assistance and correction postural</td><td>Passive transfer (chair)</td><td colspan="2">Active transfer (chair)</td></tr>
<tr><td colspan="2" rowspan="6">Neuromotor and functional intervention</td><td rowspan="6">Without targeted intervention</td><td colspan="2">Passive Manual Mobilization</td><td colspan="3">Manual Mobilization
(active assisted → active resisted)</td></tr>
<tr><td colspan="2">Continuous Passive Mobilization</td><td>Continuous Passive Mobilization</td><td colspan="2">----------</td></tr>
<tr><td colspan="2">Passive cycloergometer</td><td colspan="3">cycloergometer
(Passive → active assisted → Active → active resisted)</td></tr>
<tr><td colspan="2">EENM</td><td colspan="2">EENM</td><td>----------</td></tr>
<tr><td colspan="2">----------</td><td colspan="3">Muscle strengthening
(Isometry → Dynamic (concentric))</td></tr>
<tr><td colspan="2">---------</td><td>Upright and sit with support</td><td>Upright, sitting and standing position</td><td>Press exercises, lower limbs and assisted walking</td></tr>
</table>

Referências / *References*

1. 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;395:497-506.
2. World Health Organization. Report of the WHO-China Joint Mission on Coronavirus Disease 2019 (COVID-19) 2020 February 24. Geneve: WHO; 2020.
3. World Health Organization. Coronavirus disease 2019 (COVID-19) Situation Report – 70. 2020 19 March 2020. Geneve: WHO; 2020.
4. Direção Geral da Saúde. COVID-19: Relatório da situação epidemiológica em Portugal 2020. Lisboa: DGS; 2020.
5. Zhao S, Lin Q, Ran J, Musa SS, Yang G, Wang W, et al. Preliminary estimation of the basic reproduction number of novel coronavirus (2019-nCoV) in China, from 2019 to 2020: A data-driven analysis in the early phase of the outbreak. Int J Infect Dis. 2020;92:214-7.
6. Wu JT, Leung K, Leung GM. Nowcasting and forecasting the potential domestic and international spread of the 2019-nCoV outbreak originating in Wuhan, China: a modelling study. Lancet. 2020;395:689-97.
7. Zhou F, Yu T, Du R, Fan G, Liu Y, Liu Z, et al. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. Lancet. 2020;395:1054-62. doi: 10.1016/S0140-6736(20)30566-3.
8. Wu C, Chen X, Cai Y, Xia J, Zhou X, Xu S, et al. Risk Factors Associated With Acute Respiratory Distress Syndrome and Death in Patients With Coronavirus Disease 2019 Pneumonia in Wuhan, China. JAMA Intern Med. 2020 (in press). doi: 10.1001/jamainternmed.2020.0994.
9. Zhou P, Huang Z, Xiao Y, Huang X, Fan XG. Protecting Chinese Healthcare Workers While Combating the 2019 Novel Coronavirus. Infect Control Hosp Epidemiol. 2020;41:745-6. doi: 10.1017/ice.2020.60.
10. Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, et al. Clinical Characteristics of 138 Hospitalized Patients with 2019 Novel Coronavirus-Infected Pneumonia in Wuhan, China. JAMA. 2020 ;323:1061-9. doi: 10.1001/jama.2020.1585.
11. Wang TH, Wu CP, Wang LY. Chest physiotherapy with early mobilization may improve extubation outcome in critically ill patients in the intensive care units. Clin Respir J. 2018;12:2613-21
12. Thomas S, Mehrholz J, Bodechtel U, Elsner B. Effect of physiotherapy on regaining independent walking in patients with intensive-care-unit-acquired muscle weakness: A cohort study. J Rehabil Med. 2019;51:797-804

Anesthesiologists WFoSo. Coronavirus - guidance for anaesthesia and perioperative care providers 2020 [accessed April] Available from: https://www.wfsahq.org/resources/coronavirus.

13. Chinese Association of Rehabilitation M, Respiratory rehabilitation committee of Chinese Association of Rehabilitation M, Cardiopulmonary rehabilitation Group of Chinese Society of Physicai M, Rehabilitation. Recommendations for respiratory rehabilitation of COVID-19 in adult. Zhonghua Jie He He Hu Xi Za Zhi. 2020;43:E02
14. Needham DM, Davidson J, Cohen H, Hopkins RO, Weinert C, Wunsch H, et al. Improving long-term outcomes after discharge from intensive care unit: report from a stakeholders' conference. Crit Care Med. 2012;40:502-9.
15. Thomas P, Baldwin C, Bissett B, Boden I, Gosselink R, Granger CL, et al. Physiotherapy management for COVID-19 in the acute hospital setting: clinical practice recommendations. J Physiother. 2020;66:73-82. doi: 10.1016/j.jphys.2020.03.011.
16. Conceicao T, Gonzales AI, Figueiredo F, Vieira DSR, Bundchen DC. Safety criteria to start early mobilization in intensive care units. Systematic review. Rev Bras Ter Intensiva. 2017;29:509-19.
17. Miranda Rocha AR, Martinez BP, Maldaner da Silva VZ, Forgiarini Junior LA. Early mobilization: Why, what for and how? Med Intensiva. 2017;41:429-36.
18. Mendez-Tellez PA, Nusr R, Feldman D, Needham DM. Early Physical Rehabilitation in the ICU: A Review for the Neurohospitalist. Neurohospitalist. 2012;2:96-105.
19. Mayer KP, Hornsby AR, Soriano VO, Lin TC, Cunningham JT, Yuan H, et al. Safety, Feasibility, and Efficacy of Early Rehabilitation in Patients Requiring Continuous Renal Replacement: A Quality Improvement Study. Kidney Int Rep. 2020;5:39-47.
20. Hashem MD, Nelliot A, Needham DM. Early Mobilization and Rehabilitation in the ICU: Moving Back to the Future. Respir Care. 2016;61:971-9.
21. Hodgson CL, Stiller K, Needham DM, Tipping CJ, Harrold M, Baldwin CE, et al. Expert consensus and recommendations on safety criteria for active mobilization of mechanically ventilated critically ill adults. Crit Care. 2014;18:658..
22. Pohlman MC, Schweickert WD, Pohlman AS, Nigos C, Pawlik AJ, Esbrook CL, et al. Feasibility of physical and occupational therapy beginning from initiation of mechanical ventilation. Crit Care Med. 2010;38:2089-94.
23. Collings N, Cusack R. A repeated measures, randomised cross-over trial, comparing the acute exercise response between passive and active sitting in critically ill patients. BMC Anesthesiol. 2015;15:1.
24. Needham DM, Korupolu R. Rehabilitation quality improvement in an intensive care unit setting: implementation of a quality improvement model. Top Stroke Rehabil. 2010;17:271-81.
25. Drolet A, DeJuilio P, Harkless S, Henricks S, Kamin E, Leddy EA, et al. Move to improve: the feasibility of using an early mobility protocol to increase ambulation in the intensive and intermediate care settings. Phys Ther. 2013;93:197-207.
26. Chartered Society of Physiotherapy. Coronavirus: Respiratory Physiotherapy On Call Guidance. [accessed March 2020]. Available from: https://www.csp.org.uk/documents/coronavirus-respiratory-physiotherapy-call-guidance
27. MacIntyre NR. The ventilator discontinuation process: an expanding evidence base. Respir Care. 2013;58:1074-86.
28. Ambrosino N, Janah N, Vagheggini G. Physiotherapy in critically ill patients. Rev Port Pneumol. 2011;17:283-8.
29. 29.Jang MH, Shin MJ, Shin YB. Pulmonary and Physical Rehabilitation in Critically Ill Patients. Acute Crit Care. 2019;34:1-13.
30. First Affiliated Hospital ZUSoM. Handbook of COVID-19 Prevention and Treatment. 2020. [accessed March 2020] Available from: https://www.alnap.org/help-library/handbook-of-covid-19-prevention-and-treatment.
31. Routsi C, Gerovasili V, Vasileiadis I, Karatzanos E, Pitsolis T, Tripodaki E, et al. Electrical muscle stimulation prevents critical illness polyneuromyopathy: a randomized parallel intervention trial. Crit Care. 2010;14:R74.
32. Baron, M, Pinto, M, Koepp, J, Brandenburg, C, Martins, P, Santos, A, et al. Neuromuscular Electrical Stimulation in Intensive Care Unit Patients: Integrative Review. Mod Res Inflam. 2019; 8: 11-27.
33. Kuyrukluyildiz U, Binici O, Kupeli I, Erturk N, Gulhan B, Akyol F, et al. What Is the Best Pulmonary Physiotherapy Method in ICU? Can Respir J. 2016; 2016:4752467.
34. Adler J, Malone D. Early mobilization in the intensive care unit: a systematic review. Cardiopulm Phys Ther J. 2012;23:5-13.
35. Direção Geral da Saúde. Prevenção e controlo de infecção por SARS-CoV2 (COVID-19). Equipamentos de Proteção individual (EPI). Lisboa: DGS; 2020

36. Sessler CN, Gosnell MS, Grap MJ, Brophy GM, O'Neal PV, Keane KA, et al. The Richmond Agitation-Sedation Scale: validity and reliability in adult intensive care unit patients. Am J Respir Crit Care Med. 2002;166:1338-44.

37. Sommers J, Engelbert RH, Dettling-Ihnenfeldt D, Gosselink R, Spronk PE, Nollet F, etal. Physiotherapy in the intensive care unit: an evidence-based, expert driven, practical statement and rehabilitation recommendations. Clin Rehabil. 2015;29:1051-63.

38. Nassar Junior AP, Pires Neto RC, de Figueiredo WB, Park M. Validity, reliability and applicability of Portuguese versions of sedation- agitation scales among critically ill patients. Sao Paulo Med J. 2008;125:215-9.

39. De Jonghe B, Sharshar T, Lefaucheur JP, Authier FJ, Durand-Zaleski I, Boussarsar M, et al. Paresis acquired in the intensive care unit: a prospective multicenter study. JAMA. 2002;288:2859-67.