Recommendations for Respiratory Rehabilitation of COVID-19 in Adult.
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INTRODUCTION

Objective
Respiratory rehabilitation (RR) in hospitalized patients with COVID-19 infection, the goal of RR is to improve symptoms such as dyspnea, reducing anxiety, depression, complications and prevent and minimize respiratory dysfunction, reducing disability and preserving functioning, thus improving quality of life.

TIMING
Early RR is not recommended in COVID-19 patients in critical conditions and during unstable or progressive phase of the disease.
RR should be avoided during these phases and in case of contraindications. Regarding different residual clinical problems in patients dismissed from the post-acute phase, general recommendations and measures of RR can be used.

METHOD
For patients in isolated rooms we recommend to use videos, brochures or remote consultations, to guide patients during RR and save resources (IPD) and thus avoiding crossed infection of medical and nurse staff. Patients who are not in the isolation phase can undergo a typical rehabilitative treatment, tailored to their needs and functioning.

PERSONALISATION OF TREATMENT
Independently from RR methods, it is important to follow individualized principles, especially for patients with severe/critic disease, elderly, obese patients and for those with comorbidities and single or multi-organ complications. RR individual program should be adapted to the individual problems and needs of the patient.

EVALUATION
Assessment and monitoring should be continuous throughout the RR process.

PATIENTS WITH MILD SYMPTOMS

1. Patient Education
Help patients to understand the disease and the treatment, towards education, video tutorials or manuals/brochures
Defining working and rest time, allowing an adequate sleep
Nutritional advices
Stop smoking

2. Activity recommendation
Intensity of exercise: Borg scale ≤3 (Borg CR-10); it is useful to regularly monitor Borg scale
Frequency of treatment: 2x/day; training time: 15-45 min each, at least 1 hr after the meal.
Exercise: RR exercises, Taijiquan or square dance

3. Psychological interventions
Rapidly identify the kind of psychological dysfunction using auto-evaluation scales
If necessary, search for specialized help (clinical psychologist or psychiatrist)

2. HOSPITALIZED PATIENTS, IN ISOLATION ROOM (NON CRITICAL)

It is strongly recommended to moderate the intensity of physical exercise, to avoid deconditioning of the patient but also to avoid excessive fatigue.
Exclusion Criteria
- Body temperature >38°C
- Time from initial diagnosis ≤7 days
- Time from dyspnea onset ≤3 days
- Imaging: progression of disease (at CT-scan or X-Rays) within 24-48 h >50%
- Blood O2 saturation ≤95%
- Blood pressure <90/60 or >140/90

Criteria for exercise interruption
- During rehabilitation process, patients should stop RR when one of the following conditions appears (in this case a nurse and/or doctor should be informed and called):
  - Dyspnea index >3 (Borg CR-10)
  - Sense of thoracic oppression, burping, dizziness, blurred vision, palpitations, sweating, balance problems, etc
  - Other causes: medial team must individually decide if some situations are not adapted to physical activity

Typology of RR
1. Airway cleaning
2. Respiration control
3. Activity and physical exercise

1. Airway cleaning
Deep inspiration techniques and dilatation can be utilized to help sputum clearance
It is advised to utilize plastic bags to reduce virus spread

2. Respiration control training
Body positioning: usually in sit position. If the patient has excessive shortness of breath, the treatment can be done in lying position (or semi-supine position)
Intervention: relax accessory inspiratory muscles (shoulders and neck) during training; slowly inspiration through the nose, slow expiration and observing the expansion of the lower thorax

3. Recommendations for activity and physical exercise
Intensity: the recommended intensity is between 1 and 3 MET
Frequency: 2x/day, starting at least 1 hr after the meal
Duration: according to patient’s physical conditions. Each treatment should ideally last between 15 – 45 min. For
elderly or frail patients, an intermittent exercise should be recommended.

Exercise:
RR exercises
Stepping
Tai Chi
DVT prevention exercises
The managing of patients with significant disability and impaired exercise resistance is the same of severe patients

SEVERE AND CRITICAL PATIENTS

Foreword

Before any rehabilitative intervention in patients with severe disease or critical conditions, a comprehensive evaluation of general functional capacity of the patient is warranted. Clinicians must evaluate carefully: conscience, respiratory system, cardiovascular status and musculoskeletal comorbidities.

Patients who are eligible for RR should start as soon as possible
A medical team consent should be obtained before stating the treatment
Patients no eligible for rehabilitation should be re-evaluated daily, until they can be included in the rehabilitation treatment
If an adverse event happens during rehabilitation, the treatment must be stopped, the referring physician must be informed. Only when the underlying cause of the adverse event has been found, the treatment can eventually be restarted
Considering patient and staff security, and available resources, rehabilitation of patients in critical or severe conditions is recommended only at bedside.

Rehabilitation interventions should ideally cover these three areas:
- Posture
- Early activities
- Respiration management
Techniques must be adapted to conscience and functional status of the patient

**Timing of intervention**

RR can be started when ALL of the following conditions are met (18):

1. **Respiratory System**
   - Concentration of inspired O2 (FiO2) ≤ 0.6
   - Blood O2 saturation (SpO2) ≥ 90%
   - Respiratory Rate ≤ 40/min
   - Positive End Expiratory Pressure (PEEP) ≤ 10 cm H2O
   - No fight against ventilation
   - No issues about airways safety

2. **CVS system**
   - BAP ≥ 90 mmHg and ≤ 180 mmHg;
   - MAP ≥ 65 mmHg and ≤ 110 mmHg;
   - Cardiac frequency: ≥ 40 BPM and ≥120 BPM
   - No signs of novel arrhythmias and/or myocardic ischaemia
   - No signs of shock, accompanied by increase in blood lactate ≥ 4 mmol / L;
   - No novel DVT or pulmonary embolism
   - No aortic stenosis

3. **Nervous system**:
   - Richmond Agitation-Sedation Scale (RASS) between -2 and + 2;
   - Intracranial pressure <20 cm H2O.

4. **Other**:
   - No unstable limb or vertebral fracture
   - Absence of severe hepatic and renal disease or novel and progressive hepatic and renal dysfunction
   - Absence of active bleeding
   - T° ≤ 38,5 ℃.

**2. Interruption of Rehabilitative Treatment**

Rehabilitation must be immediately stopped when one of the following conditions are met:

1. **Respiratory System**
   - SpO2: <90% or lowering of basal SpO2 ≥ 4%
   - Respiratory Frequency: > 40/ min;
   - Patient fighting against mechanical ventilator
- Displacement of artificial airways

2. **CVS**
   - Blood Systolic Pressure: < 90 mmHg or > 180 mmHg;
   - MAP < 65 mmHg or > 110 mmHg, or a variation over 20% from basal
   - Cardiac Frequency < 40 BPM or > 120 BPM
   - New arrhythmias or myocardial ischemia

3. **Nervous system**
   - Agitation, Confusion
   - Modification of conscience

4. **Other:**
   - Disconnection from ventilation, oxygen supply or from patient monitoring
   - Palpitations, dyspnea, excessive fatigue or intolerance to exercise

3. **RR Interventions**

1. **Posture:**
   - If allowed, progressively increase antigravity positioning, until the patient can bear a vertical position. For example, an elevation of the bed up to 60° (the inferior border of the pillow should be placed over the scapula, to avoid for excessive head and neck hyperextension, a pillow should be placed over the popliteal fossa to relax abdomen and lower extremities)
   - Orthostatic treatments should be done 3x/day, 30 minutes each [19].
   - Patients with ARDS should be ventilated at least 12h/day [20].

2. **Initial activities:**
   - Take care to prevent disconnection of the patient from the ventilator, and carefully monitor vital signs during all the treatment.
   - **Intensity:** patients with reduced muscular strength can adapt the intensity and time of the exercise, to complete the rehabilitative intervention as much as
possible
- **duration:** training time should not exceed 30 min for each session, provided that the patient is not excessively fatigued

- **Treatment:**
  - Rollover and bedside activities, raise from the bed, transfer from bed to chair, sit on a chair, upright position and stepping forward, carefully step forward, following this progression
  - Then, progressing to a complete range of active and passive exercises, as tolerated by the patient [21];
  - Third, due to sedative drugs, or cognitive or physical limitations, recommended techniques include passive mobilization, joint contracture prevention and neuromuscular electrical stimulation [22].

3. **Respiration management:**
   - It mostly include lung expansion and expiration and sputum clearance. A prolonged treatment by the physiotherapist is not needed.
   - Be careful not to trigger a severe irritative cough or an increase in respiratory load. We strongly recommend high frequency thoracic oscillation (HFCWO) [23] or vibratory positive expiratory pressure (OPEP) [24].

4. **DISCHARGED PATIENTS**

**Patients discharged from mild disease**
Rehabilitation is aimed to reconditioning and optimize psychological recovery. It is possible to use aerobic reconditioning and gradually restore pre-morbid capacities, to maximize patient participation.

**Patients discharged from severe/critical disease**
Patients with severe COVID-19 disease with persistent respiratory function deficits after discharge must receive a respiratory rehabilitation. Following available evidence, patients discharged from SARS and MERS [25,26] and from clinical experience with patients who developed ARDS, patients with COVI-19 can show low respiratory functions,
exercise dyspnea, and muscle atrophy (both generalized and trunk/respiratory muscles) [27] and psychological problems as Post traumatic Disorder Syndrome (PTDS) [28].

Patients with pulmonary hypertension, myocarditis, congestive hearth failure, DVT and other diseases need a specialized advice before starting RR.

1. Exclusion Criteria:
   - FC > 100 BPM
   - BP < 90/60 mmHg or > 140/90 mmHg;
   - SpO2 ≤ 95%;
   - Comorbidities contraindicating physical exercise

2. Exercise Interruption Criteria
   - Fluctuations of body temperature > 37.2 °C;
   - Respiratory symptoms or fatigue worsen and are not reduced after rest

Immediately stop activities and seek for medical advice if one of the following symptoms appear: Sense of thoracic oppression, thoracic pain, dyspnea, severe coughing, dizziness, blurred vision, palpitations, sweating, balance problems, headache.

3. Assessment of functional and rehabilitative outcomes:

   1. Clinical Evaluation
      - Physical examination
      - Imaging
      - lab
      - Pulmonary function examinations
      - Nutritional screening
      - Ultrasound

   2. Assessment of exercise and respiratory function:
      - Respiratory Muscle Strength: maximal Inspiratory Pressure / Maximal Expiratory Pressure (MIP / MEP);
      - Muscle Strength
        o Muscle strength (MRC Scale)
        o Manual Muscle testing (MMT)
        o Isokinetic Test (IMT)

      - Measurement of Joint Range of Motion (ROM)
      - Balance:
- Berg Balance Scale (BBS)
- 6 minutes Walking Test (6MWT)
- Cardio-Pulmonary Exercise Test (CPET)
- Physical Activities evaluation:
  - International Physical Activity Questionnaire (IPAQ), Physical Activity Scale for the Elderly (PASE), etc.
- ADL Independence:
  - ADL e IADL
  - Barthel index

4. RR Interventions:

1. Patient Education
   - Create manuals, brochures or videos to introduce the importance, the content and precautions of RR interventions to improve patient compliance to the treatment;
   - Healthy life education
   - Encourage the patient to participate to familial and social life.

2. RR Recommendations:
   - Aerobic exercise: prescribe and specify aerobic activities for patients, such as: walking, fast walk, jogging, swim, etc. Starting from very low intensities and progressively increasing. Duration: 20-30 minutes, 3 to 5 times/week.
   - Intermittent exercise can be utilized for patient with significative fatigue symptoms.
   - Strength training: progressive resistance training is recommended for patients with strength deficit [25,29] and workout load for each muscular group target is 8 ~ 12 RM, from 1-3 times. Each training session of 2 minutes, 2-3 times/week. Duration 6 weeks and a weekly increase in workload charge of 5 to 10%;
   - Balance training: patient with balance problems should be recommended for balance training, including exercises supervised by a physiotherapist;
   - Respiratory Training: if the patient suffers from shortness of breath, wheezing, difficulties in sputum clearance, symptoms should be combined with
functional respiratory evaluations to tailor RR interventions [30, 31] and sputum clearance training [32].

- Respiration Training: body awareness, regulation of respiratory rate, accessory inspiratory and expiratory muscles recruitment;
- Sputum Clearance training: patients with pre-existing COPD can utilize breathing to help for airway cleaning before the training session. PEP/OPEP techniques and other system for mechanical cough assistance can be used.
- ADL:
  - Basic ADL: evaluate patient capacity of performing his/her ADL such as transfers, toilet, hygiene, bathing, etc. Evaluate for aids at home. [33]
  - Instrumental ADL: evaluate IADL and search for obstacles to patient participation, helped by Occupational Therapists.

5. RR in Chinese Medicine

RR using Chinese Medicine techniques is recommended only for patients with mild COVID-19 infection and after discharge. If not contraindicated, we recommend Baduanjin after a specialized [34,35,36] Taijiquan [34,35,36,37,38], guided respiration exercises [39,40], Liu Zi Jue [34,37], etc. We recommend to utilize more than a technique at the same time.

1. Ba Duan Jin:
During exercise the patient should be calm, natural, precise and flexible. The eight movements are repeated 6 to 8 times, for a total exercise time of 30 minutes, 1 / week.

2. Taijiquan:
 Movements are delicate, emphasizing conscience to guide respiration and cooperation of whole-body movements. Each session (with warming and relaxation) needs up to 50 minutes, 1x/week (https://mp.weixin.qq.com/s/NYY5Ts4N09zzZCpiL8nAvg).
5. **Respiration Guided Exercise**
6 free respiration periods, two-fields respiration, kidney and lung conditioning, lateral finger rotation, Moyun Shentang techniques, Qi nourishment techniques and recovery. Each session is 30 min, 1 x/ week (https: //mp.weixin.qq.com/s/1eNdxFWRoPKoxgIvZ9xpQw).

4. **Quigong Rehabilitation Method:**
Liu Zi Jue regulates respiration and visceral/meridian Qi dragging, as well as blood movement using organ sound techniques: 吞, 吸, 吆, 呼, 吁. 6 repetitions of each technique for each session, 30 minutes, 1 x/ week (https://mp.weixin.qq.com/s/ibsxWq5cDo40Jxz8mZzv-Q).

**CONCLUSIONS**

Combining last research on RR in patients with COVID-19 disease at home and abroad, and with cumulating clinical experience, we modified timing and duration of treatment according to the different phases of the disease. These recommendations hope to help and support first-line treatment to maintain physical functioning of patients with COVI-19 disease, promoting their physical and psychological recovery. A third edition will follow, mainly about home rehabilitation.

I would like to thank all medical staff fighting against this epidemic.