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Physiotherapy Care of Patients with Coronavirus Disease 2019 (COVID-19) - A Brazilian Experience

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Some patients with coronavirus disease (COVID-19) present with severe acute respiratory syndrome, which causes multiple organ dysfunction, besides dysfunction of the respiratory system, that requires invasive procedures. On the basis of the opinions of front-line experts and a review of the relevant literature on several topics, we proposed clinical practice recommendations on the following aspects for physiotherapists facing challenges in treating patients and containing virus spread: 1. personal protective equipment, 2. conventional chest physiotherapy, 3. exercise and early mobilization, 4. oxygen therapy, 5. nebulizer treatment, 6. non-invasive ventilation and high-flow nasal oxygen, 7. endotracheal intubation, 8. protective mechanical ventilation, 9. management of mechanical ventilation in severe and refractory cases of hypoxemia, 10. prone positioning, 11. cuff pressure, 12. tube and nasotracheal suction, 13. humidifier use for ventilated patients, 14. methods of weaning ventilated patients and extubation, and 15. equipment and hand hygiene. These recommendations can serve as clinical practice guidelines for physiotherapists. This article details the development of guidelines on these aspects for physiotherapy of patients with COVID-19.

KEYWORDS: COVID-19; Physiotherapy; Mechanical Ventilation; Oxygen Therapy; Severe Acute Respiratory Syndrome Coronavirus 2.

INTRODUCTION

The current outbreak of coronavirus disease 2019 (COVID-19) originated in the Hubei Province of the People’s Republic of China (1,2), and on March 11, 2020, it was declared a pandemic by the World Health Organization Emergency Committee (2).

The most common symptoms include fever (89%), cough (68%), fatigue (38%), sputum production (34%), and shortness of breath (19%) (3). A considerable proportion of the population with COVID-19 will not require hospitalization as the patients present a mild or uncomplicated form of the disease with a favorable prognosis. However, older patients and those with chronic underlying conditions can develop severe illness and present complications such as acute respiratory disease syndrome (ARDS), sepsis, septic shock, and kidney and cardiac failure, which require treatment in an intensive care unit (ICU) with invasive support (4).

Approximately 14% of patients develop a severe form of COVID-19, requiring hospitalization, and 5% require admission to an ICU (5).

Physiotherapists are recognized in several countries as professionals working in primary and tertiary care (6-8) who play a fundamental role in multi-professional teams providing ventilatory support during the acute illness phase and rehabilitation interventions thereafter to promote functionality (9,10).

This paper describes the different actions and practices adopted by the Rehabilitation Service of Hospital Sirio-Libanês (São Paulo, Brazil) to face the challenges in treating and containing the spread of COVID-19. Issues pertaining to clinical practice in the adult hospital setting were identified on the basis of the experience and opinions of front-line experts as well as a review of the relevant literature.

To provide the maximum level of care and ensure staff protection, recommendations were developed regarding protective equipment, conventional chest physiotherapy, exercise and early mobilization, oxygen therapy, nebulizer treatment, non-invasive ventilation and high-flow nasal oxygen, endotracheal intubation, protective mechanical ventilation, management of mechanical ventilation in severe and refractory cases of hypoxemia, prone positioning, cuff pressure, tube and nasotracheal suction, humidifier use for ventilated patients, methods of weaning ventilated patients, and equipment and hand hygiene.
PERSONAL PROTECTIVE EQUIPMENT (PPE)

Several procedures performed by physiotherapists may generate aerosols and droplets, which are sources of lung and respiratory pathogens. These procedures include non-invasive ventilation, high-flow oxygenation, endotracheal intubation, airway tracheostomy and endotracheal tube suction, cardiopulmonary resuscitation, high-frequency oscillatory ventilation, chest physiotherapy, prone patient positioning, disconnection of the ventilator, administration of nebulized treatment, and sputum induction (11-14). Furthermore, severe acute respiratory syndrome coronavirus 2 can remain in the air for hours and on surfaces of various materials for days upon aerosolization, with risks of possible human infection (15). However, when aerosol-generating procedures cannot be avoided, they should be performed in a negative-pressure room. In the absence of negative-pressure rooms, the procedures must be performed in a room with closed doors and open windows; with minimum number of qualified professionals to perform the procedures; with appropriate PPE; and avoiding the presence other people (16,17). Therefore, physiotherapists must adopt protective measures to avoid aerosol exposure and for contact isolation by using adequate PPE, namely, surgical caps, safety goggles, face shields, N95 masks or equivalent, gowns, and gloves (17-19).

CONVENTIONAL CHEST PHYSIOTHERAPY

Currently, no evidence exists indicating that conventional chest physiotherapy changes the course of COVID-19 in the acute phase of the disease in patients with hypoxic respiratory failure and dry cough. However, some patients with productive cough may benefit from bronchial hygiene maneuvers and techniques that stimulate coughing (20,21). Patients with a mild form of the disease should be instructed to perform breathing exercises independently. Patients with moderate and severe conditions should be constantly monitored for pulmonary disease (22). In these cases, physiotherapists should contact the patient only for respiratory and pulmonary assessments, especially during orotracheal intubation and oxygen supplementation and for patients who are candidates for non-invasive ventilation or high-flow oxygen administration (22,23). The professional exposure time should be the minimum necessary for evaluation and assistance (22,24).

EXERCISE AND EARLY MOBILIZATION

Patients usually present with a debilitated physical condition because of the disease, which reduces their exercise capacity, especially when they present with fever, dyspnea, myalgia, and fatigue (20); the debilitated physical condition can also be a result of prolonged mechanical ventilation and immobilization. Hospitalized patients, even those with moderate disease severity, can spend weeks in hospital isolation, with a significant decrease in their activity levels, and are thus prone to a reduction in their muscle strength and cardiorespiratory capacity (25). Therefore, patients in the acute phase with mild disease should be encouraged to perform light-intensity exercises to maintain minimal functional capacity. The exercises can be tailored for maintenance of a Borg rating of <3 (on a 10-point scale) (22). Although there are no studies specific to patients with COVID-19, classically critical patients who underwent early mobilization showed a reduction in delirium and duration of mechanical ventilation (26); thus, early mobilization should be started as soon as possible, as long as the patient presents suitable clinical conditions (27). This mobilization can include neuromuscular stimulation, therapeutic exercises, and early verticalization (28-31).

OXYGEN THERAPY

The prevalence of hypoxic respiratory failure in adults with COVID-19 is 19%; thus, oxygen therapy represents a major treatment intervention for patients with severe pulmonary dysfunction (2,22). Adults with COVID-19 should be started on supplemental oxygen if the peripheral oxygen saturation (SpO2) is <93% and maintained oxygen saturation is no higher than 96% (23). Mechanical ventilation may be necessary in cases of respiratory failure refractory to oxygen therapy (2,23).

The interfaces used for oxygen supplementation can generate aerosols. Therefore, health care workers should take adequate precautions and wear proper PPE when providing respiratory support to patients with COVID-19 complicated by respiratory failure (19,33). Oxygen humidification should not be used (34). The prescription of moisturizers such as self-applied nasal sodium chloride gel may be suggested for complications such as dryness of the upper airways or epistaxis. The oxygen supply device should be changed if these complications persist.

Figure 1 shows our institutional proposal for oxygen therapy and early transfer to the ICU for patients with respiratory distress and hypoxemia on the basis of the Surviving Sepsis Campaign: Guidelines on the Management of Critically Ill Adults with Coronavirus Disease 2019 (COVID-19).

NEBULIZER TREATMENT

All forms of nebulization (including inhalation) are potential aerosol generators and should be avoided (2,35). Bronchodilators should be administered with metering units (puff or spray) in an air chamber/spacer (2).

NON-INVASIVE VENTILATION AND HIGH-FLOW NASAL OXYGEN

For the treatment of acute hypoxemic respiratory failure, the use of high-flow nasal oxygen is suggested over conventional oxygen therapy and non-invasive positive pressure ventilation (36-38). If high-flow nasal oxygen is not available, a trial of non-invasive ventilation is suggested (39). An experiment in a human model showed that non-invasive ventilation or high-flow nasal oxygen, when well applied with an optimal fit, resulted in minimal aerosolization of exhaled air (40). However, the specific models of masks and interfaces tested in the study are not universally used in all hospitals. Therefore, to avoid potential harm, we recommend using adequate precautions and PPE and discourage the use of this procedure if an airborne infection isolation room is unavailable (2,16). Monitoring for worsening respiratory status and subsequent early intubation is recommended (39).

Patient candidates for non-invasive ventilation admitted to the ICU in negative-pressure rooms must be ventilated with positive end-expiratory pressure (PEEP) ≥ 8 cmH2O, support
pressure for a tidal volume (TV) \( \leq 8 \text{ mL/kg} \) of the predicted weight, and fraction of inspired oxygen (FiO\(_2\)) to maintain SaO\(_2\) > 92%. Facial or full-face masks must be used during application of the ventilator. Devices with double branches for ventilation are indicated in these cases, with a heat moisture exchange filter (HMEF) between the face mask and the device and another high-efficiency particulate arrestance (HEPA) filter on the exhalation outlet of the ventilator. For high-flow oxygen, a flow rate of 40 to 50 L/min should be maintained, and FiO\(_2\) to maintain SaO\(_2\) > 92% should be started.

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**Figure 1** - Proposal for oxygen therapy and early transfer to intensive care units for patients with respiratory distress and hypoxemia based on Surviving Sepsis Campaign: Guidelines on the Management of Critically Ill Adults with Coronavirus Disease 2019 (COVID-19). SaO\(_2\): arterial oxygen saturation; ICU: intensive care unit; PPE: Personal protective equipment; NIV: non-invasive ventilation; HFNO: high-flow nasal oxygen.
The criteria for orotracheal intubation and invasive mechanical ventilation are FiO₂ > 60% in non-invasive ventilation or TV ≥ 9 mL/kg or inability to tolerate <2 hours without non-invasive ventilation or presence of other organic dysfunctions. For high-flow oxygen, the criteria for orotracheal intubation are FiO₂ > 60% or signs of respiratory distress, or other organic dysfunctions. It is important to reassess the patient after 30 to 60 minutes; if there is no improvement or if there is worsening of ventilatory parameters, endotracheal intubation and invasive mechanical ventilation should be considered (Figure 2) (2,23,36-38).

ENDOTRACHEAL INTUBATION

When aerosol-generating procedures are required, they are recommended to be performed in a negative-pressure room and with the use of appropriate PPE (16). Only the professionals needed to perform orotracheal intubation should remain in the room.

Patients with COVID-19 are at risk of a rapid decrease in arterial oxygen levels; therefore, effective pre-oxygenation is mandatory. Patients must be administered a sufficient oxygen flow to maintain SpO₂ > 93%, and intubation should be performed with a rapid sequence of induction and intubation. Pre-oxygenation with a non-rebreather mask with the lowest possible airflow to maintain effective oxygenation (SpO₂ > 93%) (41) is required. It is also important to avoid assisted ventilation with the Bag-Valve-Mask device or the use of a supraglottic device because of the potential for aerosolization and contamination of health workers. However, if necessary, we suggest adding a filter between the simple respirator and the Bag-Valve-Mask or artificial airway during use (Figure 3) to reduce the spread of the virus in the patient’s airway to the indoor air (19).

After orotracheal intubation, checking the proper positioning of the orotracheal tube and inflating the cuff are recommended. The patient can then be connected to the ventilator associated with the HMEF and with a HEPA filter in the expiratory valve of the mechanical ventilator. These filters can filter bacteria and viruses and reduce room contamination (2,41-43). Airway interventions must be carried out by experienced individuals. After each procedure, appropriate hand hygiene is required (41).

PROTECTIVE MECHANICAL VENTILATION

Invasive mechanical mode volume-controlled ventilation (in the presence of neuromuscular block or the absence of
inspiratory effort) or pressure-controlled ventilation (in the absence of neuromuscular block and mild respiratory effort and asynchrony) should be performed with lower TVs (4 to 6 mL/kg predicted body weight) and lower inspiratory pressures, reaching a plateau pressure (Pplat) of <28-30 cmH2O (44). The PEEP must be as high as possible to maintain the driving pressure (Pplat – PEEP) as low as possible (<15 cmH2O) and SpO2 88-95% (44,45). Moreover, disconnection from the invasive mechanical ventilator must be avoided to prevent loss of PEEP and consequent atelectasis.

**MANAGEMENT OF MECHANICAL VENTILATION IN SEVERE AND REFRACTORY CASES OF HYPOXEMIA**

For patients with PaO2/FiO2 <150 and an inability to maintain protective ventilation or with the presence of asynchrony or severe hypercapnia (pH <7.25), we suggest sedation and continuous neuromuscular block to reduce respiratory drive and maintain protective ventilation. The multidisciplinary team can discuss the following: 1. prone positioning; 2. alveolar recruitment maneuvers and PEEP adjustment for better pulmonary compliance; 3. recruitment in the prone position for patients who responded to the supine recruitment maneuver; 4. nitric oxide administration in cases with a clinical history of “cor pulmonale” or as a recruitment maneuver for hypoxemia; and 5. extracorporeal membrane oxygenation (ECMO) (2,44,46,47).

**PRONE POSITION**

Prone ventilation for 12 to 16 hours a day is recommended in adult patients with severe ARDS (PaO2/FiO2 <150), (2,44). It is strongly recommended for adult patients with severe ARDS but requires sufficient human resources and knowledge to be performed safely. Protocols and videos are available in the study by Guérin et al., 2013. A satisfactory response is defined as a patient achieving an increase of 10 mmHg in PaO2 or an increase of 20 mmHg in the PaO2/FiO2 ratio. Prone positioning should be repeated when a PaO2/FiO2 ratio <150 mmHg is observed after 6 hours in the supine position. PaO2/FiO2 reductions of 20% in the supine position should be considered criteria for interrupting the prone position after two consecutive attempts at pronation or hemodynamic instability (48,49).

**CUFF PRESSURE**

Invasive mechanical ventilation is a risk factor for aerosols (50). Therefore, it is important to maintain a cuff pressure between 20 and 30 cmH2O or 25 and 35 mmHg, with sufficient pressure to prevent leakage and aerosol spread (51). We suggest cuff measurement either at every shift or at least daily (51).

**TUBE AND NASOTRACHEAL SUCTION**

Suction of the artificial airway because of ventilator disconnection must be avoided so that there is no loss of pressure in the respiratory system, atelectasis, or spread of aerosols in the room. The use of a closed suction system in all cases of intubation and invasive mechanical ventilation is recommended (2,50). In situations requiring open suction, we suggest the use of the “stand by” mode of the mechanical ventilator to minimize the spread of aerosols. Nasotracheal suction should be performed with careful evaluation by the physiotherapist because of the generation of aerosols. To perform these procedures, the use of proper PPE is recommended. Whenever possible, this procedure should be performed in a negative-pressure room.

**HUMIDIFIERS FOR VENTILATED PATIENTS**

Heat and moisture exchangers or heated humidifiers are more effective in preventing complications such as airway blockages and pneumonia in adults who receive invasive mechanical ventilation (52). Therefore, patients with COVID-19 should use devices that humidify and filter their inhaled and exhaled air, respectively. Thus, HMEF is more suitable for the humidification of exchanged air as it also has filtering capacity for viruses and bacteria, thus reducing air contamination. Additional protection can be provided by placing a HEPA filter on the exhalation valve of the mechanical ventilator. The use of heated humidifiers is discouraged in these patients (43).

**WEANING FROM MECHANICAL VENTILATION AND EXTUBATION**

All patients must be evaluated daily regarding the eligibility criteria for the spontaneous breathing test, considering adequate oxygenation: PaO2/FiO2 >200 with PEEP ≤5-7 cmH2O, hemodynamic stability with low and stabilized doses or without vasopressor drug infusion, an adequate level of consciousness (easily awake or wakened), and adequate cough and secretion management with the presence of a cough reflex during closed aspiration (53,54).

To wean patients with COVID-19 from mechanical invasive ventilation, we recommend the use of the pressure support ventilation (PSV) mode for spontaneous breathing tests. The use of the T-tube method should be avoided as it can increase aerosolization (43). Table 1 shows the parameters suggested for the spontaneous breathing test in PSV (A), success criteria (B), and failure criteria (C) (55-60). The cuff leak test should not be performed routinely before extubation because of the risk of aerosolization. However, its use should be considered for the clinical suspicion of upper airway edema or the presence of risk factors for post-extubation stridor (61).

Patients who pass the spontaneous breathing test should preferably be extubated in a negative-pressure room or in respiratory isolation. Physiotherapists and other health professionals present in the environment during extubation must follow PPE aerosol isolation precautions. During the procedure, extra care must be taken during extubation, including keeping the HMEF and closed endotracheal suction (e.g. Trach-Care®) connected to the endotracheal tube when deflating the cuff. The endotracheal tube should be removed as gently as possible to avoid vigorous manipulation and coughing. If it is necessary to stimulate the patient’s cough, the patient should be instructed to adopt cough etiquette. The tube must be discarded in the infectious waste collector. In the ICU, the availability of a professional with experience in intubation is always recommended during the extubation of patients diagnosed with COVID-19, in case rapid reintubation is necessary. The rate of reintubation of these patients should be as low as possible; therefore, we recommend that the
Table 1 - Parameters suggested for the spontaneous breathing test in pressure support ventilation (PSV) (A), success criteria (B), and failure criteria (C).

A

Spontaneous breathing test parameters
Mode of ventilation: Pressure Support Ventilation
Pressure support: 5 to 7 cmH2O
PEEP: 5 to 7 cmH2O
FiO2: 30%
Test time: 1 hour

B

Criteria for success
Respiratory rate < 35 bpm
Good tolerance to spontaneous breathing trials
Heart rate < 120 per minute or heart rate variability of <20%
SaO2 > 90% or PaO2 > 60 mmHg with FiO2 < 30% (preferably)
Systolic blood pressure > 80 and < 170 mmHg or < 20% change from baseline
No signs of labored breathing or distress
Rapid shallow breathing index < 100

C

Criteria for failure
Decreased level of consciousness
Nasal flaring
Diaphoresis
Apnea
Tachycardia with increased heart rate > 40 per minute
Hypotension
Cardiac arrhythmias
Increasing respiratory effort
Increase of PetCO2 > 10 mmHg
Decrease of arterial pH < 7.32
Decline in arterial pH > 0.07
PaO2 < 60 mmHg with FiO2 > 30% (PaO2/FiO2 ratio < 150)
Fall in SpO2 > 5% compared to the basal value

Legends: PEEP: positive end-expiratory pressure; FiO2: fraction of inspired oxygen; bpm: breaths per minute; SaO2: arterial oxygen saturation; PetCO2: end-tidal carbon dioxide pressure; pH: potential of hydrogen; PaO2: arterial oxygen pressure; SpO2: peripheral oxygen saturation.

Figure 4 - Spontaneous breathing test device for tracheostomized patients: (A) heat moisture exchange filter (HMEF), (B) closed endotracheal suction (Trach-care), (C) site for connection of oxygen therapy in HMEF, (D) connection for the tracheostomy.

decision regarding the patient’s extubation be rigorously discussed within the multidisciplinary team (62,63).

Tracheostomy may be indicated for patients who consecutively fail to wean or with long periods of intubation. Tracheostomy is considered a high-risk procedure for the formation of aerosols. Weaning patients using tracheostomy masks (e.g., Trach-Vent® and T-tube) is not recommended for patients with COVID-19. Rather, for spontaneous breathing training periods, the use of HMEF connected to Trach-Care® (Figure 4), with oxygen supplementation directly in the HMEF to maintain SpO2 between 93 and 96%, is recommended. If aspiration is required during the spontaneous breathing test, the closed suction system must be used. We emphasize that the use of HMEF to wean tracheostomized patients requires constant assessment of clinical signs of discomfort or instability. Spontaneous breathing time should be progressive as patients improve breathing performance and resistance (64).

■ EQUIPMENT AND HAND HYGIENE

The cleaning of the equipment with 70% alcohol or chlorine-based substances is recommended immediately after use. Health workers should wash their hands frequently, especially after contact with infected people or their environment (2).

■ CONCLUSION

COVID-19 is a new disease that presents challenges to inpatient care. These recommendations can serve as clinical practice guidelines for physiotherapists. Physiotherapy plays a fundamental role throughout patient hospitalization. However, the hospital physiotherapy team must be well-oriented regarding specific care to both reduce infection risk and provide the best patient care. The Appendix section presents cards from our institution, Hospital Sírio-Libanês, in English and Portuguese languages for the respiratory management of patients with suspected or confirmed COVID-19 infection.

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■ AUTHOR CONTRIBUTIONS

Righetti RF, Onoue MA, Politi FVA, Teixeira DT, Souza PN, Kondo CS, Moderno EV, Moraes IG, Maídia ALV, Pastore Junior L and Silva FD helped in the manuscript design and drafting. Righetti RF and Yamaguti WP were responsible for the study conception and manuscript design and drafting. Brito CMM, Baia WRM and Yamaguti WP were responsible for study supervision and revision of the final manuscript version. All authors approved the final manuscript version.

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# GUIDELINES FOR THE ASSISTANCE TEAM
## MANAGEMENT OF THE PATIENT WITH SUSPECTED OR CONFIRMED INFECTION BY COVID-19

### CRITERIA FOR SUSPECTED COVID-19
- Hypoxemia: SaO₂ < 93% in room air
  - value depending on clinical conditions, age, etc.
- Dyspnea
  - Any sign of respiratory distress, including:
    - Tachypnea, especially if respiratory rate (RR) ≥ 28
    - Use of accessory musculature
    - Nose wing flapping
    - Change in level of consciousness (drowsiness, agitation and mental confusion)

### PERSONAL PROTECTION EQUIPMENT (PPE)
- Surgical cap
- N95 mask or equivalent
- Safety goggles and face shield
- gown
- gloves

### AEROSOL GENERATING PROCEDURES
- Huffing
- Inhalation
- Intubation and manipulation procedure of the endotracheal tube
- Nasotracheal aspiration, endotracheal tubes and tracheostomies
- Secretion collections
- Bronchoscopy and endoscopy
- Non-invasive ventilation (NIV)
- High-flow nasal oxygen (HFNO)
- Bronchial hygiene maneuvers
- Cardiopulmonary resuscitation
- Ventilation and maneuvers with the bag-valve-mask device

### TYPE OF INSOLATION
- Respiratory droplet isolation and negative pressure room (if available)
- Aerosol generating procedures: respiratory aerosol isolation

### CRITERIA FOR ICU STAY (one of the criteria below is required to maintain SaO₂ between 93-96%)
- Signs of respiratory distress
- Flow > 3 L/min
- Venturi mask > 25%
- Organic dysfunctions

### Oxygen Therapy

#### STEP 1
- Hypoxemia (SaO₂ < 93%) and/or signs of respiratory distress
- Supplemental oxygen for 93%< SaO₂<98%
- Oxygen flow ≤ 3 L/min OR Venturi mask ≤ 25% WITHOUT signs of respiratory distress OR organic dysfunctions
- Oxygen flow > 3 L/min OR Venturi mask > 25% OR signs of respiratory distress OR organic dysfunctions

- Provide contact and respiratory isolation with negative pressure room
- ICU admission

#### STEP 2
- Intensive Care Unit
- Supplemental oxygen for 93%< SaO₂<98%
- Oxygen flow ≤ 6 L/min OR Venturi mask ≤ 30% WITHOUT signs of respiratory distress
- Oxygen flow > 6 L/min OR Venturi mask > 30% OR signs of respiratory distress

- Maintain contact and respiratory isolation with negative pressure room
- Aerosol generating procedures: PPE for aerosol isolation
- Evaluate the possible of NIV and HFNO

#### STEP 3
- Intensive Care Unit - without negative pressure room
- Supplemental oxygen for 93%< SaO₂<98%
- Oxygen flow ≤ 10 L/min OR Venturi mask ≤ 50% WITHOUT signs of respiratory distress
- Oxygen flow > 10 L/min OR Venturi mask > 50% OR signs of respiratory distress

- Strict monitoring
- Maintain contact and respiratory isolation with negative pressure room
- Aerosol generating procedures: PPE for aerosol isolation
- Endotracheal intubation and mechanical ventilation

* DO NOT USE HUMIDIFICATION TO SUPPLEMENT OXYGEN

### VENTILATORY SUPPORT
Candidates for non-invasive ventilation (NIV) and high-flow nasal oxygen (HFNO)

- NIV start with:
  - CPAP ≥ 10 cmH₂O
  - PEEP ≥ 3 cmH₂O of the predicted body weight
  - V̇̇O₂ ≥ 30 ml/kg or signs of respiratory distress or dependence on NIV (tolerates < 2 hours without NIV or HFNO)

- HFNO start with:
  - Flow 40 - 50 L/min
  - PEEP ≥ 5 cmH₂O
  - FiO₂ ≥ 60% or signs of respiratory distress

- Other organ dysfunction
- Endotracheal intubation and mechanical ventilation

### CONSIDERATIONS
- The application of NIV or HFNO should preferably be performed in a room with negative pressure and an ICU environment
- Patients worsening, do not insist on NIV and HFNO
- If within 1 hour during the application of NIV or HFNO there is no improvement or there is worsening, the team should consider OTG and mechanical ventilation
- Use NIV equipment with double circuit, heat and humidity exchanger filter (HMEdF) and filter at the expiratory outlet
- In exceptional situations, NIV or HFNO may be indicated in beds without negative pressure, for the shortest possible time
- Give preference to the high-flow catheter to NIV
- When adapting the NIV mask, we suggest switching on the device only after adapting the interface to the patient
- To turn off, we recommend turning off the equipment before removing the interface, to reduce the emission of aerosols
RAPID SEQUENCE INTUBATION
- All patients should be intubated in a rapid sequence of intubation
- It should preferably be performed in respiratory isolation rooms with negative pressure
- Professionals: physician, physiotherapist, nursing technician and nurse
- Perform pre-oxygenation with a reservoir mask with the lowest possible air flow to maintain effective oxygenation
- Do not perform assisted ventilation with the Bag-Valve-Mask device or the use of supraglottic devices, due to the potential for aerosolization and contamination of the environment and professionals
- Cuff inflation and maintenance of cuff pressure between 20-30 cmH₂O and without leak
- Use Heat moisture exchanger filter (HMEF) and placement of appropriate filter in the expiratory circuit
- All patients must use a closed suction system (trach-care)
- When fixing the tube, it is recommended to use the Tenoplast® associated with the shoe-like fixator fixator the endotracheal tube

INVASIVE MECHANICAL VENTILATION
Evaluation parameters:
- Calculation of respiratory mechanics
- Tidal volume: 4-6 mL/kg of the predict body weight
- Plateau pressure <28 – 30 cmH₂O
- Driving Pressure <13 to 15 cmH₂O
- PEEP for FiO₂ <60% and SaO₂ >92% (PEEP table - ARDSNET - 2017)
- Permissive hypercapnia for pH >7,20 [AV=RRd(TV-Ds)]
- PEEP table - ARDS Network: Low PEEP/High FiO₂

| FiO₂ | 0.3 | 0.4 | 0.4 | 0.5 | 0.5 | 0.6 | 0.7 | 0.7 |
|------|-----|-----|-----|-----|-----|-----|-----|-----|
| PEEP | 5   | 5   | 8   | 8   | 10  | 10  | 10  | 12  |

| FiO₂ | 0.7 | 0.8 | 0.9 | 0.9 | 0.9 | 1.0 |
|------|-----|-----|-----|-----|-----|-----|
| PEEP | 14  | 14  | 14  | 16  | 18  | 18 - 24 |

INITIAL MECHANICAL FAN SETTINGS
- Ventilation mode: controlled volume (if neuromuscular block or absence of inspiratory effort) or controlled pressure (if without neuromuscular block and mild respiratory effort without asynchrony)
- Tidal volume: 6 mL/kg of the predict body weight
- Respiratory rate: 20 - 28 rpm
- Maintain Plateau pressure <28 – 30 cmH₂O
- Driving Pressure <13 to 15 cmH₂O
- PEEP: 0 cmH₂O
- FiO₂: 100%

MECHANICAL MANAGEMENT IN REFRACTORY CASES
PaO₂ / FiO₂ ratio <150, or inability to maintain protective ventilation, or the presence of asynchrony or severe hypercapnia (pH <7.25):
- Sedation and continuous neuromuscular block (reduce respiratory drive and maintain protective parameters)
- Prone Position
- Alveolar recruitment maneuvers and PEEP adjustment for the best complicity
- Recruitment in the prone position, if response to the maneuver of bench press recruitment
- Consider nitric oxide if history of “cor pulmonale” or as rescue maneuver for hypoxemia
- Remove unnecessary dead space from the mechanical fan, checking pipe and connection reductions
- Maintain HMEF due to the risk of spreading aerosols
- Control of CO₂ production at temperature at 36°C
- Consider extracorporeal membrane oxygenation (ECMO)

SERIOUS HYPOXEMIA
Preferred Indication sequence for PaO₂ / FiO₂ <100:
1. Prone position - 2. Alveolar recruitment maneuvers and PEEP adjustment for better pulmonary compliance - 3. Consider ECMO

Special considerations:
- Maintain protective ventilation on average for at least 3 to 5 days
- Avoid disconnections so as not to increase the spread of aerosols. If necessary, it must be done with a clamped tube
- Use HMEF. Do not use active humidification
- If inhalation medication is necessary, use spray with spacer
- For the spontaneous breathing test, when weaning from MV, use pressure support mode with minimum parameters (do not use T tube)
- More information and guidance on alveolar recruitment maneuver alveolar, PEEP adjustment, prone position, and nitric oxide, see General ICU Guidelines - Invasive and Non-Invasive Mechanical Ventilation

PRONE POSITION
- Consider for patients with severe ARDS (PaO₂ / FiO₂ <150)
- Prone ventilation is recommended for 12 to 16 hours a day
- Recruit enough people to ensure the safety of the procedure
- Protocols and our institutional video available on the ICU Ward 1 computers Hospital Sírio-Libanés (Belas Vista Unit) and also in the Workplace (Rehabilitation Group) or another video on the website:
  - https://www.nejm.org/doi/full/10.1056/NEJMoa1214103
- Criteria for assessing the response to the prone position:
  - Responders: 10 mmHg increase in PaO₂ or increase in 20 in the PaO₂ / FiO₂ ratio. It will be repeated when a PaO₂ / FiO₂ ratio <150 mmHg after 6 (six) hours in supine position
  - Non-responders: 20% reductions in the PaO₂ / FiO₂ ratio in relation to the supine position, after two consecutive attempts of pronation or hemodynamic instability

OTHER GUIDELINES
- Do not inhale, give preference to puff and spray with spacer chamber
- Endotracheal intubation:
  - When the procedure is necessary, PPE for aerosols and contact isolation should be used
  - Whenever possible, this procedure should be performed on negative pressure room
- Endotracheal intubation + mechanical ventilation:
  - Endotracheal duction with closed suction systems (trach-care)
  - Use the “stand by” system and not the “assisted breathing” device of the mechanical ventilator to minimize the spread of aerosols
  - Change the HME filters every 72 hours or if they are dirty

EQUIPMENT CLEANING
- It is recommended that the cleaning of the equipment takes place immediately after use using 70% alcohol or chlorine-based substance
- For equipment in continuous use and which remains within the isolation environment, maintain the concurrent cleaning routine recommended by the institution

HOSPITAL SÍRIOD·LIBANÉS
GUIDELINES FOR THE ASSISTENCIAL TEAM
MANAGEMENT OF THE PATIENT WITH SUSPECTED OR
CONFIRMED INFECTION BY COVID-19

CARDIORESPIRATORY ARREST
• Treatment plans should be a priority
• Patients who are not candidates for cardiopulmonary resuscitation must be signed and well documented in medical records and shared with the multiprofessional team and patient’s family

For the assistance of cardiopulmonary resuscitation:
• Check responsiveness
• Recognize cardiac arrest due to the absence of the carotid pulse or not visualising the breathing. Do not try to hear the breath if approaching the patient’s face - risk of contamination
• Cardiac arrest identified:
  • ACTIVATE BLUE CODE (Extension 333) + DIFFICULT AIRWAY RESPONSE TEAM (Extension 2222 + option 4) - emergency room and non-critical units
  • Team: Physicians + nurse + physiotherapist + nurse assistant
  • The team must be dressed before approaching the bed with Personal Protective Equipment (PPE):
    • Surgical cap + safety goggles and face shield + gown + gloves + N95 mask or equivalent
  • The materials needed for the intubation procedure should be checked in advance, including preparation of the bag-valve-mask (Ambu®), following:
    • face mask > HMEF and Ambu® connected with oxygen (Figure 1)
    • Heart monitoring should start as early as possible
    • After intubation, the ventilation check must be performed using the Ambu® + heat and moisture exchanger filter (HMEF) + closed suction system (Figure 2).
    • The capnography curve can be used at this time to check ventilation. If cardiac arrest persists, this device should be used for ventilation.
    • It is necessary to defibrillate shockable rhythms quickly. At the time of defibrillation, keep the tube connected to the HMEF and do not clamp or connect to the mechanical ventilator
    • Early restoration of circulation prevents the need of pathways for artificial airways and ventilatory support
    • The insertions of the supraglottic airways (laryngeal mask) or endotracheal intubation must be performed by experienced physicians

  • Identify and treat reversible causes (for example, hypoxemia) before considering resuscitation arrest
  • Materials used for intubation should not be supported without protection on the patient’s bed and must be disposed of in the trash appropriate waste in the isolation environment
  • Equipment must be disposed of or sanitized in accordance with with manufacturers’ instructions and institutional guidelines
  • After the procedure, the cleaning of the entire environment and equipment must be performed
  • Remove disposable PPE (apron and gloves) and throw them in the trash appropriate waste in accordance with the institutional and Hospital Infection Control Commission (HICC).
    • Safety goggles and face shield must be sanitized with soap and water or chlorine. The surgical cap must be discarded at the end of the workday.
    • N95 or equivalent masks must be changed every 7 days or if soiled

For patients who are not in orotracheal intubation, avoid ventilation with the bag-valve-mask device (Ambu®) and always recommend the mask with a reservoir attached to the patient’s face, as this can limit the spread of the aerosol.

Note: the use of the bag-valve-mask (Ambu®) will be avoided due to the rapid intubation sequence technique, but in certain situations it may be necessary, and the proper connection must be at least prepared and tested (avoiding surprises of non-functioning) in case of need for ventilation

At the end of resuscitation, all professionals involved must record the procedures involved in the cardiopulmonary resuscitation maneuver on medical records.

ENDOTRACHEAL INTUBATION

1. HEALTH-CARE TEAM
• The team should be made up of as few people as possible. In controlled situations, it must consist of a single professional, following:
  • Physicians + nurse + physiotherapist
  • In emergency situations, in cases of airway known to be difficult, or whenever the doctor deems it necessary, the team must be constituted by 2 physicians, a nurse, a nursing assistant and a physiotherapist
  • For the emergency room environment, of non-critical and semi-critical inpatient units, the airway team should be called whenever the need for intubation is identified, using Extension 2222, option 4
  • Orotracheal intubation (OTI) should be performed by the most experienced doctor on the team

2. PERSONAL PROTECTIVE EQUIPMENT
• All team members must be dressed before entering the isolation bed with:
  • Gown + gloves + N95 mask or equivalent + Safety goggles and Face shield + Surgical cap

Ventilation devices
• (A) Face mask
• (B) Heat and moisture exchanger filter (HMEF)
• (C) Bag-valve-mask device (Ambu®)
• (D) Capnography connection location
• (E) Closed secretion suction system (Trach-Care)
• (F) Endotracheal tube connection site
3. MATERIAL PREPARATION
- Video laryngoscope (there is an exclusive difficult airway bag available in wing I and the Emergency Room, in addition to the standard locations, as quality document NCR- CORP-NOR-014), if available
- Orotracheal cannula / guide
- Vacuum
- Mask-bag (Ambu®), HMEF filter, closed secretion suction system and face mask.
- The connection order:
  - Ambu® > HMEF > face mask (Figure 1)
  - Note: outside the ICU, if a capnograph is available, it must be connected between the Ambu® and the HMEF or to the HMEF for new capnograph models:
    - Ambu® > capnograph (or directly on HMEF) > HMEF > closed secretion suction system (Figure 2)
- Drugs for sedation and neuromuscular block
- Sedation should be performed with drugs defined by the doctor
- Neuromuscular block in order to facilitate intubation and prevent the patient from coughing should be performed with:
  - Succinylcholine 1 to 1.5 mg / kg (each ampoule has 100 mg) or Rocuronium 1.2 mg / kg (each ampoule has 50 mg and it is usually necessary to aspirate 2 ampoules), depending on the characteristics of each patient
- Whenever possible, the material should be prepared outside the patient’s box. In emergency cases, use available emergency cart

4. INTUBATION PROCESS
- Appropriate patient positioning and monitoring
- Pre-oxygenation with a non-rebreather mask at the lowest oxygen flow required to ensure adequate patient saturation. If the patient is already using non-invasive ventilation (NIV) or high-flow nasal catheter (HFNC) in a negative pressure environment, you can have these devices be used for pre-oxygenation
- Airway ventilation should be avoided as much as possible with the bag-mask valve (Ambu®). If necessary, ventilation can be done with the face mask firmly attached to the patient’s face to prevent leakage
- In cases of difficult airway, use the Bougie available in the airway bag when the physicians deems it necessary
- A plastic disposable bag should be positioned next to the patient’s headboard, so that all the material used is discarded
- After introduction, the cuff of the orotracheal tube must be inflated and the tube connected to the set by the closed suction system:
  - Ambu® > capnograph (or available) > HMEF > closed secretion suction system (Figure 2)
- To confirm ventilation: chest expansion and capnography curve
- After confirming ventilation, plug the tube with HMEF and connect it to the mechanical ventilator
- Only start ventilation after the cuff is inflated
- Leave the ventilator regulated before the procedure, connect it on standby mode and switch on after connecting to the patient
- Measure cuff pressure as soon as possible

### INTRAHOSPITAL TRANSPORT

| Transport from emergency room to the hospital inpatient unit or ICU | Transport for imaging exams | Transport to other institutions |
|------------------------------------------------------------------|-------------------------------|----------------------------------|
| • Critical cases should be transferred directly to the ICU       | • Avoid CT scans, prioritize ultrasound | • Anticipate transfers before the worsening of clinical condition |

### PROTECTION OF HEALTH-CARE PROFESSIONALS

- Use PPE: surgical cap, safety goggles, face shield, N95 mask or equivalent and gown
- Transport: prioritize SERVO I® with HMEF in the tube and high efficiency particulate air (HEPA) filter at the outlet valve exhalation. Single-branch ventilator, use HMEF between the tube and the ventilator
- Spontaneous breathing patients should be transported with a surgical mask (even on oxygen therapy). Do not use NIV or high flow during transportation
- Avoid unnecessary disconnections as they generate aerosols
- If disconnecting, clamp the tube with the clamp forceps

### SECURITY PROFESSIONAL ON THE WAY

- The security team must ensure that no spectators are on the route and must wear a surgical mask

### ANTICIPATION OF TRANSPORT COMPLICATIONS

- Unstable patients should be intubated before transportation and preferably in an ICU environment and in a room with negative pressure
- All materials and drugs used for cardiorespiratory arrest, accidental extubation and hypotension must be checked in advance
- If necessary, use the mask-bag to connect it to the HMEF

### POST-TRANSPORT DECONTAMINATION

- PPE withdrawal as recommended by the HICC
- Equipment cleaning: 70% alcohol or chlorine
- It is recommended that the environment be cleaned (corridors and elevators) after each transportation and competing cleanings maintained as recommended by the institution
- Cleaning of routes and elevators recommended by HICC
- Cleaning: 70% alcohol or chlorine
- Discard insulation gloves and apron after
- Accommodating the patient in the final institution
- Put on new PPE when return back
- Terminal ambulance cleaning
WEANING FROM MECHANICAL VENTILATION

Eligibility criteria for the spontaneous breathing test (SBT):
• Patients should be screened daily
• Adequate oxygenation: PaO₂ / FiO₂ > 200 with PEEP ≤5 to 7 cmH₂O
• Hemodynamic stability (low dose dexamethasone or without vasopressor infusion)
• Adequate level of consciousness: awake or easily awake
• Cough and secretion management: presence of cough reflex during closed suction
• Patients who meet the eligibility criteria are SBT candidates
• Perform the SBT as the mechanical ventilator with the system closed
• Do not test with T-tube - risk of aerosol formation and environmental contamination

Criteria of success:
• Respiratory rate ≤35 bpm
• Good tolerance to SBT
• Heart rate ≤120 bpm or cardiac frequency variability <20%
• S(0.1) > 90% of PaO₂, PaO₂ ≥60 mmHg with FiO₂ ≤30% (preferably)
• Static blood pressure >80 and ≥130 mmHg when ≤20% change in relation to baseline
• Absence of respiratory distress, characterized by absence of signs: use of accessory muscles, paradoxical breathing or with the presence of inspiratory, intercostal and abdominal agitation
• Rapid and shallow breathing index (RV/TI) ≤100 (performed in ventilation with support pressure)
• S(0.1) > 90% or PaO₂ ≥60 mmHg with FiO₂ ≤30% (preferably)

Criteria of failure:
• Lowering of the level of consciousness and agitation
• Severe sweating
• Nasal wing flapping
• Increased respiratory distress
• Tachycardia: increase of 40 bpm compared to baseline
• Cardiac arrhythmias
• Hypotension
• Alpina
• Increase in PetCO₂ > 10 mmHg
• Arterial pH reduction ≤7.32
• Reduction of arterial pH ≤6.87
• PaO₂ ≤60 mmHg with FiO₂ ≤30% (PaO₂ / FiO₂ ratio ≤150)
• 5% drop in SpO₂ compared to baseline

Exubation:
• Physiotherapists and other health professionals present in the environment during exubation must follow isolation precautions for aerosols, including: Gown + Gloves + Surgical cap + N95 masks or equivalent + Safety goggles and face shield

Pre-exubation care:
1. Turn off the mechanical ventilator before disconnecting from the patient
2. Keep the heat and moisture exchanger filter (HMFF) and the suction system closed (Trach-Care®) connected to the endotracheal tube at the moment of defining the cuff
3. If the exubation is required use Trach-Care®
4. The endotracheal tube should be removed as smoothly as possible to avoid vigorous manipulation and cough stimulation
5. If it is necessary to stimulate the patient’s cough, the patient should be instructed to adopt cough etiquette
6. The tube must be discarded as recommended by the Hospital Infection Control Committee (HCIC)
7. It is always recommended that during exubation of patients diagnosed with COVID-19 have a doctor with experience in stand by in case of complications or need of reintubation

Post exubation care:
1. The application of supplemental oxygen in the smallest possible fraction of inspired oxygen (FiO₂) preferably by nasal cannula low-flow
2. As patients are often extubated while still presenting active infection, we recommend the adoption of a similar approach to oxygen delivery to that before intubation
3. The use of high-flow nasal cannula and non-invasive ventilation should be considered and we guide its use in the indications classic for the risk of exubation failure
4. Oxygen patients
5. Diagnosis of chronic obstructive pulmonary disease
6. Cardiac insufficiency
7. Ineffective cough
8. Consecutive loose multifaceted cough
9. Presence of more than one connectivity
10. Patient aged ≥60 years
11. APACHE ≤12 on the day of extubation
12. Patients with more than 72 hours in invasive mechanical ventilation

Tracheostomized patients:
• For patients who failed non-invasive or face mask ventilation with long periods of intubation, tracheostomy may be indicated. Tracheostomy is considered a high risk procedure for the formation of aerosols and must follow the institutional guidelines of “Care for the Surgical Patient”

Cautions when weaning from mechanical ventilation:
• Do not use the devices: tracheostomy mask, Trach Vent® and T tube - risk of aerosol formation and contamination of the environment
• For spontaneous breathing training periods we suggest using the system: HMFF + Trach-Care® (Figure 1) - connected to tracheostomy
• Oxygen supplementation should be performed directly at the HMFF to keep SpO₂ between 95-98%
• If aspiration is required during the spontaneous breathing test, use trach care®

Guidelines for the assistance team management of the patient with suspected or confirmed infection by COVID-19

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Note: In the case of need of IV, it should preferably be done in an environment with negative pressure and the use should be in double branch fum and the use of HMFF between the mask and the mechanical fanning circuit and an additional high efficiency particulate air (HEPA) filter at the outlet of the expiratory valve to prevent the formation of aerosols.
**ORIENTAÇÕES PARA A EQUIPE ASSISTENCIAL NO MANEJO DO PACIENTE COM INFEÇÃO SUSPEITA OU CONFIRMADA PELA COVID-19**

**CRITÉRIOS PARA SUSPEITOS DE COVID-19**
- Hipoxemia - SaO₂ <93% em ar ambiente
- Valor relativo a depender das condições clínicas, idade, etc.
- Dispnéia
- Qualquer sinal de desconforto respiratório, dentre eles:
  - Taquipnéia, principalmente se frequência respiratória (FR) ≥28
  - Uso de musculatura acessória
  - Batimento de asa de nariz
  - Sudorese
  - Alteração do nível de consciência (conolência, agitação e confusão mental)

**EQUIPAMENTOS DE PROTEÇÃO INDIVIDUAIS (EPI)**
- Gorro
- Máscara de proteção para aerossóis (N95 ou equivalente)
- Óculos de proteção e protetor facial (face shield)
- Avental de isolamento
- Luvas de procedimento

**PROCEDIMENTOS QUE GERAM AEROSÓIS**
- Huffing
- Inalação
- Procedimento de intubação e manipulação do tubo endotraqueal
- Aspiração nasotraqueal, tubos endotraqueais e traqueostomias
- Coletas de secreção
- Broncoscópia e endoscopia
- Ventilação não-invasiva
- Sistemas de alto fluxo
- Manobras de higiene brônquica
- Ressuscitação cardiopulmonar
- Ventilação e manobras com o dispositivo bolsa-válvula-máscara

**TIPO DE ISOLAMENTO**
- Isolamento respiratório por gôtica em ambiente com pressão negativa (se disponível)
- Na formação de aerossóis, alterar o isolamento para aerossóis

**OXIGENOTERAPIA NA UNIDADE DE INTERNAÇÃO**

**Avaliação e início da oxigenoterapia**
- Hipoxemia (SaO₂ <93%) e/ou sinais de desconforto respiratório
- Óxigeno Supplementar para 93% SaO₂ ≥96%
- Fluxo de O₂ ≥3 L/min OU Venturi ≥25% E AUSÊNCIA de desconforto respiratório E de outras disfunções orgânicas
- Intubação em quarto com pressão negativa ou ata de isolamento
- Isolamento (respiratório e contato)

**OXIGENOTERAPIA NA UTI (necessário um dos critérios abaixo para manter SaO₂ entre 93-96%)**

- Sinais de desconforto respiratório
- Fluxos > 3 L/min O₂
- Máscara de Venturi >25%
- Disfunções orgânicas

**SUPORTE VENTILATÓRIO**

**Candidatos à ventilação não-invasiva e sistemas de alto fluxo**
- UTI - Leito com pressão negativa
  - VNI iniciar com:
    - FFM 18 cmH₂O
    - IPPV para VE ≥5 mL/kg peso predito
    - FO₂ para SaO₂ >92%
    - máscara facial ou facial total

**Intubação orotraqueal (IOT) precoce**
- UTI - Leito sem pressão negativa
  - HFO (alto fluxo) iniciar com:
    - Fluxo 40 a 50 L/min
    - FOICO para SaO₂ >92%

**CONSIDERAÇÕES**
- Pacientes apresentando piora, não insistir com VNI e HFO
- A aplicação da VNI ou HFO deve ser preferencialmente realizada em quarto com pressão negativa e ambiente de UTI
- Se em até 1 hora durante a aplicação da VNI ou HFO não houver melhora ou houver piora, a equipe deve considerar a IOT e ventilação mecânica
- Utilizar equipamento de VNI com circuito duplo, trocador de calor e umidade (HME) e filtro na saída respiratória
- Em situações de exceção pode ser indicado VNI ou HFO em leitos sem pressão negativa, pelo menor tempo possível
- Dar preferência para o cateter alto fluxo à VNI
- Na adaptação da máscara de VNI sugerimos ligar o aparelho somente após a adaptação da interface no paciente
- Para desligar, recomendamos desligar o equipamento antes da retirada da interface, para reduzir a emissão de aerossóis
**SEQUÊNCIA RÁPIDA DE INTUBAÇÃO**
- Todos os pacientes devem ser intubados em sequência rápida de intubação.
- Deve ser preferencialmente realizado em salas de isolamento respiratório com pressão negativa.
- Profissionais: médico, fisioterapeuta, técnico de enfermagem e enfermeiro.
- Realizar a pré-oxygenação com máscara reservatório com o menor fluxo de ar possível para manter oxigenação efetiva.
- Não realizar ventilação assistida com o dispositivo de Boasa-Válvula-Máscara ou o uso de dispositivos supraglóticos, pelo potencial de aerosolização e contaminação do ambiente e profissionais.
- Insuflação do balonete e manutenção da pressão de cuff entre 20-30 cmH2O e sem escape.
- Utilizar filtro HME e colocação de filtro apropriado no circuito respiratório.
- Todos os pacientes devem usar sistema de aspiração fechado (trach-care).
- Na fixação do tubo, recomenda-se a utilização do "Endotracheal Tube Holder" associado com o caderço para a fixação do tubo endotraqueal.

**VENTILAÇÃO MECÂNICA INVASIVA**
**Parâmetros de avaliação:**
- Cálculo da mecânica respiratória.
- Volume corrente de 4-6 mL/Kg de peso ideal.
- Pressão de platô <28 – 30 cmH2O.
- Driving Pressure <13 a 15 cmH2O.
- PEEP para FIO2: <60% e Sao2: >92% (tabela ARDSNET - 2017).
- Hipercapnia permissiva para pH >7,20 [VA=Fr(FiO2-Vd)]
- Tabela ARDS Network - Baixa PEEP/Alta FIO2

| FIO2 | 0.3 | 0.4 | 0.4 | 0.5 | 0.5 | 0.6 | 0.7 | 0.7 |
|------|-----|-----|-----|-----|-----|-----|-----|-----|
| PEEP | 5   | 5   | 8   | 8   | 10  | 10  | 10  | 12  |

| FIO2 | 0.7 | 0.8 | 0.9 | 0.9 | 0.9 | 1.0 |
|------|-----|-----|-----|-----|-----|-----|
| PEEP | 14  | 14  | 14  | 16  | 18  | 18 – 24 |

**AJUSTES INICIAIS DO VENTILADOR MECÂNICO**
- Modo ventilatório: volume controlado (se bloqueio neumomuscular ou ausência de esforço inspiratório) ou pressão controlada (se bloqueio neumomuscular e esforço respiratório leve e sem asincronia).
- Volume corrente de 6 mL/kg de peso predito.
- Frequência respiratória entre 20 a 28 ciclos por minuto.
- Manter Pressão de platô <28 – 30 cmH2O.
- Driving Pressure <13 a 15 cmH2O.
- PEEP de 10 cmH2O.
- FIO2: 100%

**MANEJO DO VENTILADOR MECÂNICO EM CASOS CRÍTICOS**
Relação PaO2/FIO2 <150, ou impossibilidade de manter ventilação protetora, ou presença de asincronias ou hipercapnia grave (pH <7,25):
- Sedação e bloqueio neuromuscular contínuo (reduzir drive respiratório e manter parâmetros protetores), caso ainda não estejam em uso.
- Posição Própria.
- Manobras de recrutamento alveolar e ajuste da PEEP pela melhor compliacência.
- Recrutamento na posição prona, se responder à manobra de recrutamento em supino.
- Considerar oxido nítrico se histórico de “cor pulmonale” ou como manobra de resgate para hipoxemia.
- Retirar o espaço morto desnecessário do ventilador mecânico, checando reduções de tubos e conexões.
- Manter HME pelo risco de disseminação de aerossóis.
- Controle da produção de CO2 em temperatura em 36°C.
- Considerar oxigenação por membrana extracorpórea (ECMO).

**HIPOXEMIA GRAVE**
Seqüência preferencial de indicação para relação PaO2/FIO2 <100:
1. Posição Própria - 2. Manobras de recrutamento alveolar e ajuste da PEEP pela melhor compliacência - 3. Considerar ECMO
Considerações especiais:
- Manter ventilação protetora em média pelo menos 3 a 5 dias.
- Evitar desconexões para não aumentar a disseminação de aerossóis.
- Caso seja necessário, deve-se realizar com tubo clamped.
- Usar HME. Não usar umidificação ativa.
- Se necessário medicação inalatória, usar spray com espaçador.
- Para o teste de respiração espontânea, no desmane da VM, utilizar a modalidade pressão de suporte com parâmetros mínimos (não utilizar tubo T).
- Maiores informações e orientações sobre Manobra de Recrutamento alveolar, Ajuste da PEEP, Posição Própria e Oxido Nítrico, ver Diretrizes da UTI Geral – Ventilação Mecânica Invasiva e Não Invasiva.

**POSIÇÃO PRÓPRA**
- Considerar para pacientes com SDRA grave (PaO2/FIO2 <150).
- Recomenda-se ventilação prona por 12 a 16 horas por dia.
- Recrutar pessoas o suficiente para garantir a segurança do procedimento.
- Protocolos e vídeos disponíveis no vídeo institucional que encontra-se disponível nos computadores da UTI 1A do Hospital Sírio-Libanês (Unidade Bela Vista) e também no Workplace (Grupo Reabilitação) ou no site: https://www.nejm.org doi/full/10.1056/NEJMoa1214103

Criterios de avaliação da resposta da posição prona:
- Respondedores: aumento de 10 mmHg na PaO2 ou aumento de 20 na relação PaO2/FIO2. Será repetido quando observada uma relação PaO2/FIO2 <150 mmHg após 6 (sete) horas em posição supina.
- Não respondedores: reduções de 20% na relação PaO2/FIO2 em relação a posição supina, após duas tentativas consecutivas de pronação ou instabilidade hemodinâmica.

**OUTRAS ORIENTAÇÕES**
- Não realizar inalações, dar preferência para puff e spray com espádger.
- Pacientes em IOT:
  - Quando o procedimento for necessário deve-se utilizar as EPIs para isolamento de contato e para aerossol (máscara N95), além de face shield.
  - Sempre que possível, esse procedimento deve ser realizado em leitos com pressão negativa e isolamento de aerossóis.
- Pacientes em IOT+VM:
  - Manter sistema de aspiração fechado (trach-care).
  - Utilizar o sistema “stand by” e o não dispositivo de “aspiração assistida” do ventilador mecânico para minimizar a disseminação de aerossóis.
  - Trocar os filtros HME e cada 72h ou se apresentarem sujeidade.

**LIMPEZA DOS EQUIPAMENTOS**
- Recomenda-se que a limpeza dos equipamentos ocorra imediatamente após o uso utilizando-se substância alcoólica à 70% ou a base de cloro.
- Para equipamentos em uso contínuo e que permaneçam dentro do ambiente de isolamento, manter a rotina de limpeza corrente preconizada pela instituição.
ORIENTAÇÕES PARA A EQUIPE ASSISTENCIAL NO MANEJO DO PACIENTE COM INFECÇÃO SUSPEITA OU CONFIRMADA PELA COVID-19

PARADA CARDIORESPIRATÓRIA

- Os planejamentos de escalonamento de tratamento devem ser prioridade
- Pacientes não candidatos à ressuscitação cardiopulmonar devem estar sinalizados e bem documentados em prontuário, além disso deve ser compartilhado com a equipe multiprofissional, acompanhantes e familiares

Para a assistência da parada cardiorespiratória, devemos:
- Checar responsividade
- Reconhecer a parada cardíaca por ausência do pulso carotídeo ou não visualização da respiração. Não tente ouvir a respiração se aproximando do rosto do paciente - risco de contaminação
- Identificada a parada cardiorespiratória, conforme fluxo institucional:
  - [ACIONAR CÓDIGO AZUL (Rama 333) + TIME DE VIA AÉREA DIFÍCIL (Rama 2222 + opção 4) - PA euniidades não críticas]
  - Equipe envolvida:
    Médico + Enfermeiro + Fisioterapeuta + Técnico de enfermagem
  - Para empréstimo com EPIs antes de entrar no leito:
    Gorro + Óculos de proteção + face shield + Avental de isolamento + Luvas + Máscara para aerosol (N95 ou similar)

- Os materiais necessários para o procedimento de intubação devem ser confirmados antecipadamente, incluindo a preparação da bolsa-valva-máscara (Ambu*), seguindo a seguinte ordem:
  - Máscara > filtro HMEF e Ambu* conectado no oxigênio (Figura 1)
  - Monitorização do ritmo cardíaco deve ser iniciada rapidamente
  - Após a IOT, verificar a ventilação com o dispositivo Ambu* + HMEF + Trach-care (Figura 2). A curva de capnografia pode ser utilizada nesse momento para verificar a ventilação.
  - É necessário desfibrilador ritmos chocáveis rapidamente.
  - No momento da desfibrilação, manter o tubo conectado ao HMEF, não clamar e não conectar ao ventilador mecânico
  - A restauração precoce da circulação impede necessidades de vias aéreas artificiais e suporte ventilatório
  - As inserções das vias aéreas supraglóticas (máscara laringea) ou IOT devem ser realizadas por médicos experientes
  - Identifique e trate causas reversíveis (por exemplo, hipoxemia grave) antes de considerar a parada da ressuscitação

- Os materiais utilizados na intubação não devem ser apropriados sem proteção ao leito do paciente e devem ser descartados no lixo apropriado no ambiente do isolamento
- Os equipamentos devem ser descartados e higienizados de acordo com as instruções do fabricante e orientações institucionais
- Ao final do procedimento, deve-se realizar a limpeza de todo o ambiente e equipamentos
- Remova EPIs descartáveis (avental e luvas) e jogue-as no lixo apropriado de acordo com a recomendação institucional e da Comissão de Controle de Infecção Hospitalar (CCH)
  - Óculos de proteção/face shield higienizados com água e sabão ou cloro
  - O gorro deve ser descartado ao final do plantão
  - Máscaras para aerosol devem ser trocadas a cada 14 dias ou se sujeitam a ressuscitação cardiopulmonar

Para pacientes que não estão em intubação orotraqueal evitar a ventilação com o dispositivo bolsa-valva-máscara (Ambu*) e sempre preconizar a máscara com reservatório acoplado à face do paciente durante a sequência rápida de intubação, pois isso pode limitar a propagação do aerosol (OBS: o uso da bolsa-valva-máscara (Ambu*) será evitada devido à técnica de sequência rápida de intubação, mas em determinadas situações pode ser necessária, e a devido conexão deve ser ao menos preparada e testada (evitando surpresas de não funcionamento em eventual necessidade de ventilação)

Ao final da ressuscitação todos os profissionais envolvidos devem registar em prontuário os procedimentos envolvidos na manobra de ressuscitação cardiopulmonar

INTUBAÇÃO OROTARQUEAL

1. FORMAÇÃO DA EQUIPE

- A equipe deve ser formada pelo menor número de pessoas possíveis. Em situações controladas deve ser constituída por um único profissional das seguintes áreas:
  - Médico + Enfermeiro + Fisioterapeuta
  - Nas situações emergenciais, em casos de via aérea sabidamente difícil, ou sempre que o médico julgar necessário, a equipe deverá ser constituída por 2 médicos, um enfermeiro, um técnico de enfermagem e um fisioterapeuta
  - Para o ambiente de pronto-atendimento, das unidades de internação não críticas e semicriticas, o time de via aérea deverá ser chamado sempre que se identificar necessidade de intubação, utilizando-se o Ramal 2222, opção 4
  - A intubação orotraqueal deverá ser realizada pelo médico mais experiente da equipe

2. PARAMETRAÇÃO

- Todos os membros da equipe devem estar parametrados antes de entrar no leito de isolamento com:
  - Avental impermeável + Luvas + Máscara N95 ou similar + Óculos de proteção + Face shield + Gorro

Dispositivos de ventilação

- (A) Máscara facial
- (B) Filtro trocador de calor e umidade (HMEF)
- (C) Dispositivo bolsa-valva-máscara (Ambu*)
- (D) Local de conexão do capnógrafo
- (E) Sistema de aspiração fechado (Trach-Care)
- (F) Local de conexão tubo endotraqueal
3. PREPARAÇÃO DO MATERIAL
- Videolaringoscópio (existe uma mala exclusiva de via aérea difícil disponível na ala I e no Pronto-Atendimento, além dos locais padrão, conforme documento de qualidade NOR-CORP-NOR-014), se disponível
- Câmera orotraqueal/guia
- Aspirador
- Bolsa-valva-máscara (Ambu®), filtro HMEF, sistema de aspiração fechada e máscara facial.
- A ordem de conexão é: Ambu® > filtro HMEF > máscara facial (Figura 1)
  Obs.: Se o paciente estiver com capnógrafo disponível, o seu uso é obrigatório.

4. PROCESSO DE INTUBAÇÃO
- Posicionamento e monitorização adequada do paciente
- Pré-oxigenação com máscara reservatório no menor fluxo de oxigênio necessário para garantir saturação adequada do paciente. Caso o paciente não esteja se sentindo em consequência de oxigênio invasiva (VNI) ou cateter nasal de alto fluxo (CNAF) em ambiente de pressão negativa, pode-se dispensar desses dispositivos para a pré-oxigenação
- Deve-se evitar o máximo possível a ventilação da via aérea com a bolsa-valva-máscara (Ambu®). Caso necessário a ventilação pode ser feita com a máscara facial firmemente calçada à face do paciente, para evitar vazamentos
- Em caso de via aérea difícil (VAD) deve-se utilizar o bougie disponível na mala de via aérea quando o médico julgar necessário
- Deve-se posicionar um saco plástico de descarte ao lado da cabeceira do paciente, para que todo o material utilizado seja descartado
- Após a introdução, o cuff do tubo orotraqueal deve ser insuflado e o tubo conectado pelo sistema de aspiração fechada ao conjunto: Ambu® > capnógrafo, se disponível > filtro HMEF > sistema de aspiração fechada (Figura 2)
- Para confirmação da ventilação: expansibilidade torácica e curva da capnografia
- Após a confirmação da ventilação, campear o tubo com HMEF e conectá-lo ao ventilador mecânico
- Somente iniciar a ventilação após o cuff estar insuflado
- Deixar o ventilador regulado antes do procedimento, conectá-lo em modo de espera e ligar após a conexão com o paciente
- Medir a pressão do cuff assim que possível

TRANSPORTE INTRA-HOSPITALAR
- Transporte do PA para a UI ou UTI
- Transporte para exames de imagem
- Para outros serviços

- Casos graves devem ser transferidos diretamente para UTI
- Evitar tomografias, priorizar ultrassom
- Antecipar transferências antes da piora do quadro clínico

- Pacientes graves: verificar a necessidade de IOT antes do transporte
- Equipe no transporte: médico; enfermeira e fisioterapeuta (conforme fluxo de transporte institucional)
- Monitorar pressão arterial, SpO2 e traçado cardiológico
- Proteção dos profissionais da saúde
- Utilizar EPI: gorro, óculos de proteção, face shield, máscara N95 ou similar e avental de isolamento
- Ventilador de transporte: priorizar SERVO-IA® (com HMEF no tubo e filtro HEPA na saída exalatória). Ventiladores de ramo único, utilize o HMEF entre o tubo e o ventilador
- Pacientes em respiração espontânea devem ser transportados com máscara cirúrgica (mesmo em oxigenoterapia). Não utilizar VNI ou alto fluxo durante o transporte
- Evitar desconexões desnecessárias porque geram aerossóis
- Se for desconectar, deve-se clamar o tubo com a pinça clamp
- Todas as recomendações que constam no transporte intra-hospitalar, acrescidas da abertura das janelas da ambulância

PROFISSIONAL DA SEGURANÇA NO TRAÇO
- A equipe de segurança deve garantir que não ocorra expectorados no trajeto e deve utilizar máscara cirúrgica

Antecipação de intercorrências no transporte
- Pacientes instáveis devem ser intubados antes do transporte e preferencialmente em ambiente de UTI e em sala com pressão negativa
- Todos os materiais e drogas utilizadas na parada cardiorrespiratória, extubação acidental e hipotensão devem ser verificados antecipadamente
- Se necessário o uso da bolsa-valva-máscara conectada ao HMEF

Descontaminação pós-transporte
- Retirada das EPI conforme preconizada pela CCIH
- Limpeza dos equipamentos: álcool 70% ou cloro
- É preconizado que ocorra a limpeza do ambiente (corredores e elevadores) após cada transporte e as limpezas concorrentes mantidas conforme preconizadas pela instituição
- Limpeza de rotas e elevadores preconizados pela CCIH
- Limpeza: álcool a 70% ou cloro
- Descartar luvas e avental de isolamento após acodar o paciente na instituição final
- Colocar novas EPIs no retorno
- Limpeza terminal da ambulância
DESMAE DA VENTILAÇÃO MÉCANICA

- A necessidade do processo de desmae e estabilização pode ocorrer ainda em momentos em que o paciente apresenta infecção ativa pelo vírus. Com isso, torna-se necessária a adoção de algumas condutas e cuidados para que não ocorra aumento da formação de aerossóis no ambiente hospitalar e um prolongamento da permanência em ventilação mecânica invasiva e dias de internação no UTI nestes pacientes.

Critérios de elegibilidade para a realização do teste de respiração espontânea (TRE):
- os pacientes devem ter trazidos diariamente
- Disposâo adequada, Pao2 / FiO2 > 200 com PEEP ≥ 5 a 7 cmH2O
- Estabilidade hemodinâmica: doses baixas estabilizadas ou sem necessidade de vasopressores
- Nível de consciência adequado: acordado ou desperta facilmente
- Manejo da tossa e sacolação: presença de reflexo de tosse durante a aspiração fechada
- Pacientes que atendem aos critérios de elegibilidade são candidatos ao TRE
- Tais os TRE no ventilador mecânico com sistema fechado
- Não fazer a tota com tubo + risco de formação de aerossóis e contaminação ambiental

Caso para reduzir o risco de reintubação, é recomendado que uma margem clínica seja adotada, pois a estabilização de pacientes intensivos aumenta a necessidade de ventilação não invasiva e clônica nasal de alto fluxo após a estabilização, aumentando assim as chances de formação de aerossóis

O uso do teste de vasomotor do balanço não deve ser realizado retinamente antes da estabilização pelo risco de aerossolização. No entanto, seu uso deve ser ponderado pela suspeita clínica de extensão das via aéreas superiores ou pela presença de fatores de risco para estirar pós-intubação.

Exclusão de pacientes cuja suspeita de pneumatite e outros profissionais da saúde presentes no ambiente durante a estabilização devem seguir as precauções de isolamento por aerossóis, incluindo: Atenção de isolamento + Luvas + Gorro + Máscaras N95 ou similar + Proteção para os olhos (óculos de proteção e face shield)

Critérios de sucesso:
- Frentia respiratória <35 ppm
- Risco tolerância ao teste
- Frequência cardíaca <120 bpm ou variabilidade da frequência cardíaca < 20%
- SaO2 ≥ 95% ou Pao2 > 60mmHg com FiO2 < 50% (preferencialmente)
- Pressão arterial sistólica < 160 e < 110 mmHg < 20% de mudança em relação ao basal
- Ausência de desconforto respiratório, caracterizado por ausência dos sinais: uso de musculatura acessória, regiões carotídeas ou com presença de assofrações, sudorese intensa e agitados
- Índice de resistência respiratória e superficial (RVST) < 5mmHg (medida em ventilação com pressão de suporte)

Critérios de falha:
- Retenção do nível de consciência e de deterioração
- Sudorese intensa
- Retenção da via nasal
- Aumento do desconforto respiratório
- Taquipnéia – aumento de 40 mmHg comparado ao basal
- Náuseas cardíacas
- Hipotensão
- Apneia
- Aumento do Pco2 > 30mmHg
- Redução do pO2 arterial > 5,32
- Redução do pO2 arterial < 67,07
- Pao2 < 60 mmHg com FiO2 > 30% (relação Pao2/FiO2 <500)
- Queda de 10% sa Pao2, comparado ao basal

EXTUBAÇÃO
- Sintomas e outros profissionais da saúde presentes no ambiente durante a extubação devem seguir as precauções de isolamento por aerossóis, incluindo: Atenção de isolamento + Luvas + Gorro + Máscaras N95 ou similar + Proteção para os olhos (óculos de proteção e face shield)

Cuidados antes da extubação:
1. Desligar o ventilador mecânico antes da desconexão do paciente
2. Monitorar o HME e o sistema de aspiração fechada (Trash-Care+) conectado ao tubo endotraqueal no momento de desconectar o suporte
3. Se for necessária a aspiração: utilizar o Trash-Care+
4. O tubo endotraqueal deve ser retirado de forma mais suave possível para evitar manipulações inúteis e estimulação da tosse
5. Se for necessário estimular a tosse do paciente, o mesmo deve ser orientado a alimentar as medidas de etiqueta da tosse
6. O tubo deve ser descartado conforme recomendado pela CDC
7. É sempre recomendado que durante a estabilização de pacientes com diagnóstico de COVID-19 tenha um medico com experiência em intervenção de pronto socorro, caso seja necessária uma ventilação mecânica
8. A taxa de respostas descritas a esse procedimento deve ser a mais baixa possível, então é preconizada a que a decisão de extubação do paciente seja discutida entre a equipe multiprofissional

Cuidados após extubação:
1. A aplicação de oxigênio suplementar na menor fração possível de oxigênio inspirado (FiO2), preferencialmente por cânula nasal de baixo fluxo
2. Como os pacientes são frequentemente exibidos enquanto ainda apresentam infecção ativa, aconselham-se a adoção de uma abordagem semelhante ao fornecimento de oxigênio como antes da intubação
3. O uso de cânula nasal de alto fluxo e ventilação não invasiva deve ser ponderado e orientado de acordo com instruções clínicas para o caso de falha de extubação, que são:
- Pacientes obesos
- Diagnóstico de doença pulmonar obstrutiva crônica
- Infectedo cardíaca
- Tóxica recente
- Falta de consciência no ambiente
- Presença de mais de uma comorbidade
- Pacientes com idade ≥ 45 anos
- APACHE > 12 nos de duração da ventilação
- Pacientes com mais de 72 horas de ventilação mecânica invasiva

Caso seja necessário o uso de VNI, deve preferencialmente ser feita em ambiente com pressão negativa e o uso deve ser em ventiladores com rama duplo e a utilização do HME entre a máscara e o circuito do ventilador mecânico e um filtro HEPA adicional na saída do sifão expiratório para evitar a formação de aerossóis

FIGURA 1

Dispositivo montado com HME conectado ao Trash-Care+ para teste de respiração espontânea em pacientes traqueotomizados
- (A) HME
- (B) Trash-Care+
- (C) Local de suavização de O2
- (D) Local de conexão com a traqueostoma

HOSPÍTAL SÍRIO-LIBANES