UNITED ARAB EMIRATES
MINISTRY OF HEALTH & PREVENTION

GOVERNMENT OF DUBAI

DUBAI HEALTH AUTHORITY

DEPARTMENT OF HEALTH

Clinical Management of the Critically ill COVID-19 Patient

April 15th, 2020

Version 1

Prepared and Reviewed by	**MOHAP ICU team**
Approved by	**National committee for Management of COVID-19 Cases**

Table of Content

Contents	Page No.
Objectives	3
Introduction	3
Definition and Abbreviations	4
Intended users of the guideline and target patient populations	5
Areas covered by this guideline	5
Definitions of SARI and surveillance case definitions for COVID-19	5
Clinical Symptoms	6
Clinical presentations and Complications: associated with COVID-19 • Mild illness • Pneumonia • Severe pneumonia • Acute respiratory distress syndrome (ARDS) • Sepsis • Septic shock	7 8
Screening and triage: early recognition of patients with SARI associated with COVID-19	8
Management of severe COVID-19: oxygen therapy and monitoring	9
Recommendations pertain to patients with ARDS who are treated with non-invasive or high-flow oxygen systems • High-flow nasal oxygen (HFNO) • Non-invasive ventilation (NIV)	11
Management of critical COVID-19: Acute Respiratory Distress Syndrome (ARDS) • Identify high-risk patients with ARDS • Recommendations pertain to mechanically ventilated adults patients with ARDS • Other aspects in ARDS • Recommendations pertain to adult patients with ARDS in whom lung protective ventilation strategy fails	13
Management of critical illness and COVID-19: Septic Shock • Recommendations pertain to resuscitation strategies for adult patients with septic shock	17
Management of critical illness and COVID-19: prevention of complications	18
References	20
Appendix I: How to implement IPC measures for patients with suspected or confirmed COVID-19	21
Appendix II: Movement of patients with confirmed or suspected COVID-19 within the facility	22
Appendix III: Emergency tracheal intubation of COVID 19 patient	22
Appendix IV: Murray's Lung Injury Score	24
Appendix V: : Key strategies in CoViD-19 patients with ARDS	25

1. Objectives

The objectives of this document are to:

- Describe and determine clinical management of the critically ill COVID19 patient
- Indicate procedure and target for the use of oxygen therapy
- Provide a protocol on the practical steps to deal with COVID-19 cases
- Detail the measures necessary to protect ICU staff, patients and visitors
- This guideline is not intended to override the clinical decisions that will be made by clinicians providing individualized patient care.

2. Introduction:

Coronavirus disease 2019 (known as COVID-19) is an illness ranging in severity from the common cold to severe acute respiratory infection (SARI) caused by a newly emergent coronavirus that was first recognized in Wuhan, China, in December 2019. Genetic sequencing of the virus suggests that it is a beta coronavirus closely linked to the SARS virus.

While most people with COVID-19 develop only mild or uncomplicated illness, approximately 15% develop severe disease that requires hospitalization and oxygen support, and 5% require admission to an intensive care unit.

In severe cases, COVID-19 can be complicated by the acute respiratory distress syndrome (ARDS), sepsis and septic shock, Multiorgan failure, including acute kidney injury and cardiac injury. Older age and co-morbid disease have been reported as risk factors for death, and recent multivariable analysis confirmed higher mortality in:

- Older age
- Higher Sequential Organ Failure Assessment (SOFA) score
- D-dimer > 1 µg/L on admission
- Comorbidities like Hypertension, Diabetes mellites, ischemic heart disease, chronic lung disease, chronic kidney disease, chronic liver disease
- Immunocompromised patients

3. Definition and Abbreviations:

SARI: Severe Acute Respiratory Infection

SOFA: Sequential Organ Failure Assessment

FiO2: Fraction of Inspired Oxygen (%).

PaCO2: The Partial Pressure of CO2 in arterial blood. It is used to assess the adequacy of ventilation.

PaO2: The Partial Pressure of oxygen in arterial blood. It is used to assess the adequacy of oxygenation.

SaO2: Arterial Oxygen Saturation measured from blood specimen.

SpO2: Arterial Oxygen Saturation measured via pulse oximeter.

Heat Moisture Exchange (HME) product: are devices that retain heat and moisture minimizing moisture loss to the patient airway.

High Flow Nasal Oxygen (HFNO): High Flow Systems are specific devices that deliver oxygen at high flow rate generating additional CPAP equal 1cmH2o to each 10 L flow rate.

Hypercapnia: Increased amounts of carbon dioxide in the blood → more than 45 mmHg

Hypoxemia: Low arterial oxygen tension in the blood → less than 60 mmHg

Hypoxia: Low oxygen level at the tissues

APACHE II score: Acute Physiology and Chronic Health Evaluation is a general measure of disease severity based on current physiologic measurements, age & previous health conditions.

Low flow: Low flow systems are specific devices that do not provide the patient's entire ventilatory requirements, room air is entrained with the oxygen, diluting the FiO2.

Minute ventilation: The total amount of gas moving into and out of the lungs per minute. The minute ventilation (volume) is calculated by multiplying the tidal volume by the respiration rate, measured in litres per minute.

Tidal Volume: The amount of gas that moves in, and out, of the lungs with each breath, measured in millilitres (6-10 ml/kg).

Ventilation - Perfusion (VQ) mismatch: An imbalance between alveolar ventilation and pulmonary capillary blood flow.

The prone position: is basically achieved when the person is laid straight on the stomach, that is, the chest or the ventral side is downwards while the back or the dorsal side is upwards. It enhance oxygenation in the acute respiratory distress syndrome patients

Plateau pressure: is the pressure that is applied by the mechanical ventilator to the small airways and alveoli. The plateau pressure is measured at end-inspiration with an inspiratory hold maneuver on the mechanical ventilator that is 0.5 to 1 second.

P/F ratio: equals the arterial pO2 divided by the FIO2 (the fraction of inspired oxygen expressed as a decimal) the patient is receiving.

AIIR: Airborne Infection Isolation Room

4. Intended users of the guideline and target patient populations:

It is intended for clinicians involved in the care of adult, and pregnant patients with or at risk for severe acute respiratory infection (SARI) when infection with the COVID-19 virus is suspected. Considerations pregnant women are highlighted throughout the guideline. It is not meant to replace clinical judgment or specialist consultation but rather to strengthen clinical management of these patients and to provide up-to-date guidance.

Best are included.

5. Areas covered by this guideline:

The guideline addresses and encourage clinicians to be adherent with infection prevention and control (IPC) measures, while triaging and provide optimized supportive care to critically ill suspected or confirmed COVID19 patient in hospital setting:

- Emergency Department
- Intensive Care Units

6. Definitions of SARI and surveillance case definitions for COVID-19:

Please follow updated definitions as per the national UAE guidelines

7. Clinical Symptoms:

Signs and symptoms include:

Clinical Symptoms: Signs and symptoms include:

- Fever
- Cough
- Myalgia or fatigue
- Shortness of breath
- Sore throat
- Runny nose
- Diarrhea and nausea
- Muscle ache
- Headache
- Pneumonia and ARDS
- Loss of sense of smell
- Renal failure, pericarditis and Disseminated Intravascular Coagulation

Complications:

- Severe Pneumonia
- Acute Respiratory Failure and ARDS
- Acute Renal failure
- Disseminated intravascular coagulation
- Sepsis or septic shock

High-risk group

- Age above 60 years old
- Smoker
- Cardiovascular disease
- Diabetes
- Hypertension
- Immune deficiency and or suppression (HIV/AIDS, long-term steroid therapy, post-transplant cases, chemotherapy, immune modulator therapy)
- Pre-existing pulmonary disease (uncontrolled Asthma, COPD, bronchiectasis)
- Other chronic disease such as chronic kidney disease, Chronic Respiratory disease, Sickle cell…etc.

8. Types of Clinical Presentation and Complications: associated with COVID-19:

Mild illness:

- Patients uncomplicated upper respiratory tract viral infection may have non-specific symptoms such as fever, fatigue, cough (with or without sputum production), anorexia, malaise, muscle pain, sore throat, dyspnea, nasal congestion, or headache.
- Rarely, patients may also present with diarrhea, nausea, and vomiting
- The elderly and immunosuppressed may present with atypical symptoms. Symptoms due to physiologic adaptations of pregnancy or adverse pregnancy events, such as dyspnea, fever, GI-symptoms or fatigue, may overlap with COVID19 symptoms.

Pneumonia:

- Adult with pneumonia but no signs of severe pneumonia and no need for supplemental oxygen.

Severe pneumonia:

- Fever or suspected respiratory infection, plus one of the following:
    1. respiratory rate > 30 breaths/min
    2. severe respiratory distress
    3. SpO2 ≤ 93% on room air

Acute respiratory distress syndrome (ARDS): (as per Berlin definition)

- **Onset:** within 1 week of a known clinical insult or new or worsening respiratory symptoms.
- **Chest imaging** (radiograph, CT scan, or lung ultrasound): bilateral opacities, not fully explained by volume overload, lobar or lung collapse, or nodules.
- **Origin of pulmonary infiltrates**: respiratory failure not fully explained by cardiac failure or fluid overload. Need objective assessment (e.g. echocardiography) to exclude hydrostatic cause of infiltrates/edema if no risk factor present.
- **Oxygenation impairment in adults:**
    1. Mild ARDS: 200 mmHg < PaO2/FiO2 a ≤ 300 mmHg (with PEEP or CPAP ≥ 5 cmH2O, or non-ventilated)
    2. Moderate ARDS: 100 mmHg < PaO2/FiO2 ≤ 200 mmHg (with PEEP ≥ 5 cmH2O, or non-ventilate)
    3. Severe ARDS: PaO2/FiO2 ≤ 100 mmHg (with PEEP ≥ 5 cmH2O, or non-ventilated)

NB: When PaO2 is not available, SpO2/FiO2 ≤ 315 suggests ARDS (including in non-ventilated patients).

Sepsis: (Sepsis III definition)

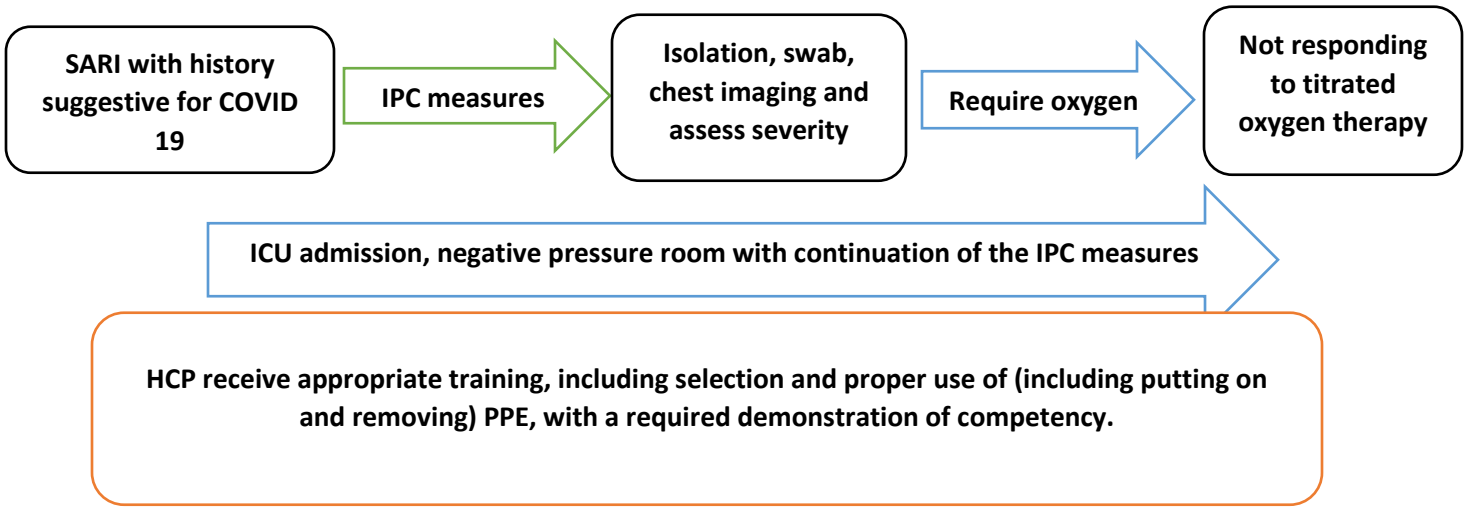
- Life-threatening organ dysfunction caused by a desregulated host response to suspected or proven infection.
- Signs of organ dysfunction include: altered mental status, difficult or fast breathing, low oxygen saturation, reduced urine output , fast heart rate, weak pulse, cold extremities or low blood pressure, skin mottling, or laboratory evidence of coagulopathy, thrombocytopenia, acidosis, high lactate, or hyperbilirubinemia.

Septic shock:

- Persisting hypotension despite volume resuscitation requiring vasopressors to maintain MAP ≥ 65 mmHg and serum lactate level > 2 mmol/L.

9. Screening and triage: early recognition of patients with SARI associated with COVID-19

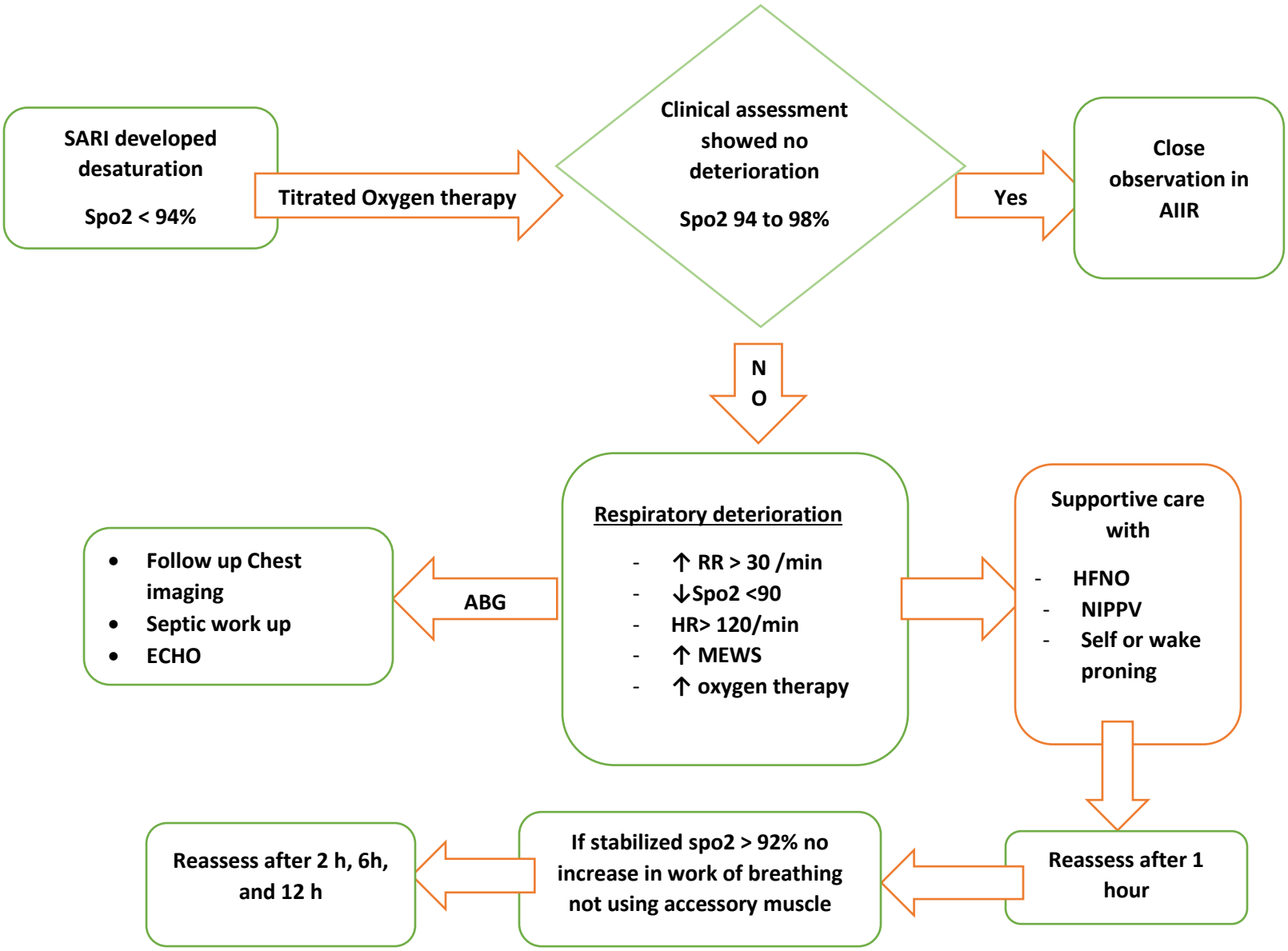
- Screen and isolate all patients with suspected COVID-19 at the first point of contact with the health care system (such as the emergency department or outpatient department/clinic). Consider COVID-19 as a possible etiology of patients with acute respiratory illness.
- Triage patients using standardized triage tools and start first-line treatments.
- Patients developing severe illness requiring oxygen therapy and not responding to titrated oxygen therapy will require intensive care unit treatment.
- The most common diagnosis in severe COVID-19 patients is severe pneumonia.



10. Management of severe COVID-19: oxygen therapy and monitoring:

- Supplemental oxygen therapy should be started immediately to patients with SARI in the following condition with target SpO2 ≥ 94%:
  - ✓ Emergency signs (obstructed or absent breathing, severe respiratory distress, central cyanosis, shock, coma, or convulsions) → airway management and oxygen therapy during resuscitation may be required.

- The staff should use appropriate devices and flow rates in order to achieve the target saturation range
- Patients hospitalized with COVID-19 require regular monitoring of vital signs and, where possible, utilization of medical early warning scores (e.g. MEWS score) that facilitate early recognition and escalation of treatment of the deteriorating patient.
- Prompt clinical assessment is required if oxygen therapy needs to be initiated or increased due to a falling saturation level.
- Initiate oxygen therapy by oxygen cannula, titrate flow rates to reach target SpO2 ≥ 93% during resuscitation; or use face mask with reservoir bag (at 10–15 L/min) if patient in critical condition. Once patient is stable, the target SpO2 is 90-92% in non-pregnant adults.
- Closely monitor patients with COVID-19 for signs of clinical deterioration, such as:
  1. Respiratory rate (RR),
  2. Heart rate (HR),
  3. SpO2 (room air/ Reservoir bag mask).
  4. Rapidly progressive respiratory failure (↓po2 less than 60 mmHg or ↑pco2 more than 50 mmHg with acidosis PH less than 7.25)
  5. Sepsis and septic shock


SARI developed desaturation
Spo2 < 94%
Titrated Oxygen therapy
Clinical assessment showed no deterioration
Spo2 94 to 98%
Yes
Close observation in AIIR
NO
Respiratory deterioration
- ↑ RR > 30 /min
- ↓Spo2 <90
- HR> 120/min
- ↑ MEWS
- ↑ oxygen therapy
ABG
Follow up Chest imaging
Septic work up
ECHO
Supportive care with
- HFNO
- NIPPV
- Self or wake proning
Reassess after 1 hour
If stabilized spo2 > 92% no increase in work of breathing not using accessory muscle
Reassess after 2 h, 6h, and 12 h

11. Recommendations pertain to patients with ARDS who are treated with non-invasive or high-flow oxygen systems:

- Both HFNO and NIV should not be used in severe form of ARDS i.e. Po2: Fio2 Less than 100

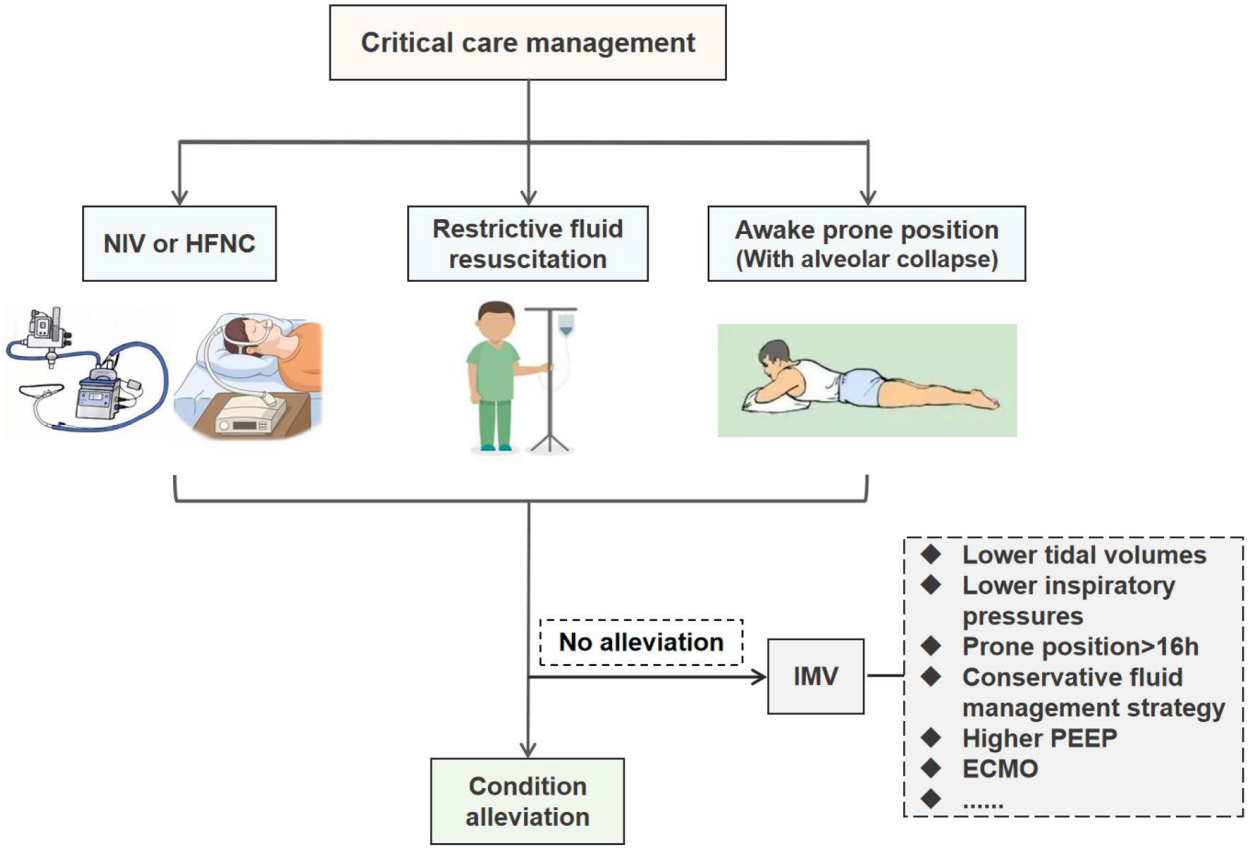
- **High-flow nasal oxygen (HFNO)**

  - Should be used only in selected patients with hypoxemic respiratory failure.
  - Although HFNO systems can deliver 60 L/min of gas flow and FiO2 up to 1.0, in COVID19 patients, we recommend avoiding flow of more than 30L/min to minimize aerosolization.
  - Compared with standard oxygen therapy, HFNO reduces the need for intubation.
  - Patients receiving HFNO should be in a monitored setting and cared for by experienced personnel capable of performing endotracheal intubation in case the patient acutely deteriorates or does not improve after a short trial.
  - After initiation of high flow, evaluate at 2 hours, if patient improved and meeting safe ventilation criteria by ROX score ((Spo2/Fio1)/RR ≥ 4.88 at 2, 6 and 12 hrs.) no need for intubation but if <3.85 is high risk then consider need for intubation
  - Encourage the patient for a wake prone (self-prone) position at least 10 hours

- **Non-invasive ventilation (NIV)**

  - Should be used only in selected patients with hypoxemic respiratory failure.
  - Patients treated with either NIV should be closely monitored for clinical deterioration.
  - NIV guidelines make no recommendation on use in hypoxemic respiratory failure (apart from cardiogenic pulmonary edema and postoperative respiratory failure) or pandemic viral illness (referring to studies of SARS and pandemic influenza).
  - Risks include delayed intubation, large tidal volumes, and injurious transpulmonary pressures.
  - Limited data suggest a high failure rate in patients with other viral infections such as MERS-CoV who receive NIV
  - After initiation of NIV, evaluate at 2 hours, if patient improved and meeting safe ventilation criteria (Criteria: VT <8 mL/kg/IBW, no overt symptoms of respiratory failure or escalating FiO2/PEEP) then continue and reassess in 2 hrs.
  - Consider using mechanical ventilator to provide the NIV (rather than BIPAP device to limit aerosolization).
  - Do not delay intubation if no signs of early improvement.

- **NIV through the helmet** can be used as first-line intervention for early mild and moderate ARDS
- NIV, including CPAP, should be used with **airborne precautions** until further evaluation of safety can be completed.
- **Prompt clinical assessment is required** if Spo2 remain Low (less than 60mmHg) or PO2/FIO2 less than 150 or the patient exhausted with increased work of breathing.



12. Management of critical COVID-19: Acute Respiratory Distress Syndrome (ARDS):

- Adult respiratory distress syndrome (ARDS) characteristically develops after a latent period of hours or days since the initiating or provoking insult. The progressive respiratory failure is associated with pathological features caused by the breakdown of alveolar capillary integrity within the lung and leakage of protein rich fluid into the alveolar space.
- HCP need to recognize severe hypoxemic respiratory failure when a patient with respiratory distress is failing to respond to standard oxygen therapy or NIV and prepare to provide advanced oxygen/ventilator support.

Identify high-risk patients with ARDS.

- age more than 60 years old
- Comorbid diseases such as diabetes, CKD, COPD, BA, and hypertension
- High APACHE II score
- Severe hypoxemia (PaO2:FiO2 less than 100)
- Shock (hypotension with hypoperfusion)

- Endotracheal intubation should be performed by a trained and experienced provider using airborne precautions.

The following recommendations pertain to mechanically ventilated adult patients with ARDS:

- Implement mechanical ventilation using lower tidal volumes (4 to 8 ml/kg predicted body weight, PBW) and lower inspiratory pressures (plateau pressure < 30 cmH2O).
- Bronchoscopy should not be done for sole purpose of ruling COVID-19 in or out. Bronchoscopy should only be done if it will change clinical management (outside of COVID disease). If needed, perform tracheal aspirates or mini BAL before a bronchoscopy.
- Permissive hypercapnia is permitted.
- All patients with moderate to severe ARDS should receive a central venous catheter and an arterial line.
- The use of deep sedation is required to control respiratory drive and achieve tidal volume targets and avoid ventilator desynchrony.
- Conservative fluid management strategy for ARDS patients is preferred without tissue hypoperfusion.

- Once intubated and on mechanical ventilation, some authors suggested that there are two phenotypes of acute respiratory failure in COVID-19 patients:

• Phenotype "**L**" (atypical ARDS) characterized by **L**ow elastance (high respiratory compliance), **L**ow ventilation perfusion ratio (explaining the hypoxemia), **L**ow lung weight (only ground-glass densities on Chest CT), and Low recruitability (low amount of non-aerated tissues).

• Phenotype "**H"** (ARDS like) characterized by **H**igh elastance (low compliance), **H**igh right-to-left shunt (fraction of cardiac output perfusing the non-aerated tissues), **H**igh lung weight (bilateral infiltrates), **H**igh lung recruitability (increased amount of non-aerated tissue).

• Ventilator settings should be different for each phenotype as high PEEP in patients with normal compliance may have detrimental effects on hemodynamics and increase lung hyperinflation and lung stress.

- In cases of moderate to severe ARDS and with presence of ventilation dyssynchrony despite adequate sedation, infusion of neuromuscular blockade agents, like cisatracurium or rocuronium should be started as early as possible. This may often be required for 48 to 72hrs. Intermittent boluses can be given while waiting for infusion to start.
- Inhaled pulmonary vasodilators like inhaled Nitric oxide (up to 20ppm) may be started in patient with moderate to severe ARDS with worsening hypoxia. If no response is noted within 4-hours, it may be weaned and discontinued to allow use by other patients who may potentially benefit from it. Even in patients who respond to it, attempt to wean should be performed at 24-48 hours.
- If patient continues to deteriorate despite above treatment with P/F ratio below 150, prone ventilation is recommended within 24-48 hours of ARDS onset. Proning should be maintained for 12–16 hours per day. Proning requires sufficient human resources and expertise to be performed safely.
- Once into prone position, an arterial blood gas should be done 30 minutes, 2-hours and 4-hour post proning. If there is clear improvement, then patient should remain in prone position for at least 16-18 hours.
- If no clinical improvement in gas exchange or if there is further deterioration, patient should be maintained in supine position again
- Systemic corticosteroids for treatment of severe acute respiratory illness or ARDS secondary to COVID-19 should be avoided, unless indicated for another reason such as refractory septic shock.

Other aspects in ARDS:

- Use in-line catheters for airway suctioning and clamp endotracheal tube when disconnection is required (for example, transfer to a transport ventilator).
- Target Goal:
  - ✓ PaO2 55-80 mmHg or SpO2 90-94% or sometimes 88-92%
  - ✓ pH 7.25-7.35

- ✓ Negative balance UOP 0.5 ml /kg /min in case of AKI use CRRT.
- ✓ Plateau pressure ≤ 30 cm H2O

NB: Avoid disconnecting the patient from the ventilator, which results in loss of PEEP and atelectasis.

- The following recommendations pertain to adult patients with ARDS in whom lung protective ventilation strategy fails:
  - In settings with access to expertise in extracorporeal membrane oxygenation (ECMO), consider referral of patients who have refractory hypoxemia despite lung protective ventilation.

- **Veno-venous extracorporeal membranous oxygenation (VV ECMO)** can be considered in patients with severe ARDS who despite all of the above measures develop the following:

a. Refractory Hypoxemia
b. Refractory Hypercapnia

-P/F Ratio of <50 for >3-hours OR P/F Ratio <80 for >6-hours, regardless of the PEEP used.

-Severe hypercapnia which results in pH <7.25

Patients who end up needing ECMO are most likely to have a Murray's Lung Injury Score of 3.5-4.0 (Appendix A). Please consider the following contraindications while evaluating the patient's suitability for ECMO. If in doubt, discuss the case with ICU ECMO team.

Contraindications for ECMO

- Advanced age (70 and above) – not absolute.
- Irreversible and advanced organ dysfunction prior to ARDS onset e.g. chronic lung disease, chronic heart failure, chronic liver or kidney dysfunction.
- Acute or chronic irreversible neurologic dysfunction e.g. anoxic brain injury, debilitating strokes, dementia, etc.

-Mechanical Ventilation of more than 7 days.

-Advanced malignancy with life expectancy of less than 5-years.

- Onset of advanced multi-organ failure (evaluate on a case-by-case basis)
- Immune compromised status
- Contraindication for anticoagulation e.g. major hemorrhage (evaluate on a case-by-case basis)
- Lack of optimization of non-ECMO medical therapy for ARDS OR disease not severe enough to warrant ECMO.


ARDS – Intubated
(PF Ratio <200)
Targets
SpO2 92-95%
PaO2 8-10kPa
pH≥7.30 (PaCO2 <8kPa)
Pplat ≤30 cmH2O
Vt 4-6 mL/kg PBW
PEEP 8-10 cmH2O
RR initially 20-30
Static compliance ≥ 40 cmH2O
Yes
No
Keep PEEP 8-10 cmH2O
Increase FiO2 to achieve oxygenation targets
Increase Vt to 8 mL/kg and/or RR up to 30 if pH < 7.30 with PaCO2 >6kPa
Targets
SpO2 92-95%
PaO2 8-10kPa
pH≥7.30 (PaCO2< 8kPa)
Pplat ≤30 cmH2O
Driving Pressure ≤ 15 cmH2O
if paO2 <8kPa: Increase PEEP in 2 cmH2O increments up to 15-18 cmH2O (if hemodynamically tolerated, and within and pressures limit targets)
If pH < 7.30 with PaCO2 >6kpa: Increase RR up to 35 (monitor for auto-PEEP).
Keep Vt ≤6 mL/kg PBW
Targets
SpO2 92-95%
PaO2 8-10kPa
pH≥7.30 (PaCO2< 8kPa)
Pplat ≤30 cmH2O
Driving Pressure ≤ 15 cmH2O
PF Ratio < 150
Neuromuscular Blockade (pref. continuous)
iNO Trial for 12-24 hours
Prone Positioning for 16-20 hours
PF Ratio < 80 mmHg for > 6-hours OR < 50 mmHg for > 3-hours AND/OR
pH <7.25 with paCO2 >8kPa for >6-hours
Discuss with ECMO team

13. Management of critical illness and COVID-19: septic shock:

Recognize septic shock when infection is suspected or confirmed and vasopressors are needed to maintain mean arterial pressure (MAP) ≥ 65 mmHg and lactate is ≥ 2 mmol/L, in absence of hypovolemia.

Standard care includes early recognition and the following treatments within 1 hour of recognition:

1. Antimicrobial therapy,
2. Initiation of fluid bolus and vasopressors for hypotension.
3. The use of central venous and arterial catheters should be based on resource availability and individual patient needs.
4. If possible, use bed side tools for assessment of fluid responsiveness to avoid volume overload.

Antiviral therapy as per the national guidelines

- The following recommendations pertain to resuscitation strategies for adult patients with septic shock.

i. In resuscitation for septic shock in adults, give 250–500 mL crystalloid fluid as rapid bolus in first 15–30 minutes and **reassess for signs of fluid overload** after each bolus.
ii. Fluid resuscitation may lead to volume overload, including respiratory failure, particularly with ARDS. If there is no response to fluid loading or signs of volume overload appear (e.g. jugular venous distension, crackles on lung auscultation, pulmonary edema on imaging, then reduce or discontinue fluid administration. This step is particularly important in patients with hypoxemic respiratory failure.
iii. Crystalloids include normal saline and Ringer's lactate.
iv. Determine need for additional fluid boluses (250–500 mL in adults) based on clinical response and improvement of perfusion targets. Perfusion targets include MAP (> 65 mmHg urine output (> 0.5 mL/kg/hr in adults), and improvement of skin mottling and extremity perfusion, capillary refill, heart rate, level of consciousness, and lactate.
v. Consider dynamic indices of volume responsiveness to guide volume administration beyond initial resuscitation based on local resources and experience. These indices include **passive leg raises**, **fluid challenges with serial stroke volume measurements**, or **variations in systolic pressure**, **pulse pressure**, **inferior vena cava size**, or **stroke volume in response to changes in intrathoracic pressure** during mechanical ventilation.

vi. Do not use hypotonic crystalloids, starches, or gelatins for resuscitation.
vii. Administer vasopressors when shock persists during or after fluid resuscitation. The initial blood pressure target is MAP ≥ 65 mmHg in adults and improvement of markers of perfusion.
viii. If central venous catheters are not available, vasopressors (i.e. norepinephrine, epinephrine, and vasopressin) can be given through a peripheral IV but use a large vein and closely monitor for signs of extravasation and local tissue necrosis. If extravasation occurs, stop infusion, or through intraosseous needles.
ix. If signs of poor perfusion and cardiac dysfunction persist despite achieving MAP target with fluids and vasopressors, consider an inotrope such as dobutamine.
x. Norepinephrine is considered first-line treatment in adult patients; epinephrine or vasopressin can be added to achieve the MAP target. Because of the risk of tachyarrhythmia, reserve dopamine for selected patients with low risk of tachyarrhythmia or those with bradycardia.

14.Management of critical illness and COVID-19: prevention of complications:

- Implementation of the following interventions to prevent complications associated with critical illness. These interventions are based on Surviving Sepsis and other guidelines and are generally limited to feasible recommendations based on high- quality evidence

Anticipated outcome	Interventions
Reduce days of invasive mechanical ventilation	•Use weaning protocols that include daily assessment for readiness to breathe spontaneously •Minimize continuous or intermittent sedation, targeting specific titration endpoints (light sedation unless contraindicated) or with daily interruption of continuous sedative infusions
Reduce incidence of ventilator- associated pneumonia	•Oral intubation is preferable to nasal intubation in adolescents and adults •Keep patient in semi-recumbent position (head of bed elevation 30–45º) •Use a closed suctioning system; periodically drain and discard condensate in tubing •Use a new ventilator circuit for each patient; once patient is ventilated, change circuit if it is soiled or damaged, but not routinely

	•Change heat moisture exchanger when it malfunctions, when soiled, or every 5–7 days
Reduce incidence of venous thromboembolism	•Use pharmacological prophylaxis (low molecular-weight heparin [preferred if available] or heparin 5000 units subcutaneously twice daily) in adolescents and adults without contraindications. For those with contraindications, use mechanical prophylaxis (intermittent pneumatic compression devices)
Reduce incidence of catheter-related bloodstream infection	•Use a checklist with completion verified by a real-time observer as reminder of each step needed for sterile insertion and as a daily reminder to remove catheter if no longer needed
Reduce incidence of pressure ulcers	•Turn patient every 2 hours
Reduce incidence of stress ulcers and gastrointestinal (GI) bleeding	•Give early enteral nutrition (within 24–48 hours of admission) •Administer histamine-2 receptor blockers or proton-pump inhibitors in patients with risk factors for GI bleeding. Risk factors for GI bleeding include mechanical ventilation for ≥ 48 hours, coagulopathy, renal replacement therapy, liver disease, multiple comorbidities, and higher organ failure score
Reduce incidence of ICU-related weakness	•Actively mobilize the patient early in the course of illness when safe to do so

15.References

1. Team NCPERE. Vital surveillances: the epidemiological characteristics of an outbreak of 2019novel coronavirus diseases (COVID-19) – China. China CDC Weekly. 2020;2(8):113-22

2. Yang X, Yu Y, Xu J, Shu H, Xia J, Liu H et al. Clinical course and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: a single-centered, retrospective, observational study. Lancet Respir Med. 2020. Epub 2020/02/28. doi: 10.1016/S2213-2600(20)30079-5. PubMed PMID: 32105632.

3. 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(10223):497-506. Epub 2020/01/28. doi: 10.1016/S0140-6736(20)30183-5. PubMed PMID: 31986264.

4. 32. NHLBI ARDS Network Tools [website]. (http://www.ardsnet.org/tools.shtml, accessed 4 March 2020)

5. WHO. Volume 2 IMAI District Clinician Manual. Hospital care for adolescents and adults. Geneva: World Health Organization; 2011 (https://apps.who.int/iris/bitstream/handle/10665/77751/9789241548290_Vol2_eng.pdf?sequence=3, accessed 4 March 2020)

6. Guerin C, Reignier J, Richard JC, Beuret P, Gacouin A, Boulain T et al. Prone positioning in severe acute respiratory distress syndrome. N Engl J Med. 2013;368(23):2159-68. Epub 2013/05/22. doi: 10.1056/NEJMoa1214103. PubMed PMID: 23688302

7. National Heart, Lung, and Blood Institute Acute Respiratory Distress Syndrome (ARDS) Clinical Trials Network, Wiedemann HP, Wheeler AP, Bernard GR, Thompson BT, Hayden D et al. Comparison of two fluidmanagement strategies in acute lung injury. N Engl J Med. 2006;354(24):2564-75. Epub 2006/05/23. doi: 10.1056/NEJMoa062200. PubMed PMID: 16714767

8. National Heart, Lung, and Blood Institute PCTN, Moss M, Huang DT, Brower RG, Ferguson ND, Ginde AA et al. Early neuromuscular blockade in the acute respiratory distress syndrome. N Engl J Med. 2019;380(21):1997-2008. Epub 2019/05/22. doi: 10.1056/NEJMoa1901686. PubMed PMID: 31112383; PMCID: PMC6741345.

9. Riviello ED, Kiviri W, Twagirumugabe T, Mueller A, Banner-Goodspeed VM, Officer L et al. Hospital incidence and outcomes of the acute respiratory distress syndrome using the Kigali modification of the Berlin Definition. Am J Respir Crit Care Med. 2016;193(1):52-9. Epub 2015/09/10. doi: 10.1164/rccm.201503-0584OC.PubMed PMID: 26352116.

10. Combes A, Hajage D, Capellier G, Demoule A, Lavoue S, Guervilly C et al. Extracorporeal membrane oxygenation for severe acute respiratory distress syndrome. N Engl J Med.2018;378(21):1965-75. Epub 2018/05/24. doi: 10.1056/NEJMoa1800385. PubMed PMID: 29791822.

11. Writing Group for the Alveolar Recruitment for Acute Respiratory Distress Syndrome Trial (ART) Investigators, Cavalcanti AB, Suzumura EA, Laranjeira LN, Paisani DM, Damiani LP et al. Effect of lung recruitment and titrated positive end-expiratory pressure (PEEP) vs low PEEP on mortality in patients with acute respiratory distress syndrome: a randomized clinical trial. JAMA. 2017;318(14):1335-45. Epub 2017/10/04. doi: 10.1001/jama.2017.14171. PubMed PMID: 28973363; PMCID: PMC5710484

A. Appendix 1:

How to implement IPC measures for patients with suspected or confirmed COVID-19
Instructions for patients
Give suspect patient a medical mask and direct patient to separate area; an isolation room if available. Keep at least 1 m distance between suspected patients and other patients. Instruct all patients to cover nose and mouth during coughing or sneezing with tissue or flexed elbow and perform hand hygiene after contact with respiratory secretions.
Apply droplet precautions
Droplet precautions prevent large droplet transmission of respiratory viruses. Use a medical mask if working within 1 m of the patient. Place patients in single rooms, or group together those with the same etiological diagnosis. If an etiological diagnosis is not possible, group patients with similar clinical diagnosis and based on epidemiological risk factors, with a spatial separation. When providing care in close contact with a patient with respiratory symptoms (e.g. coughing or sneezing), use eye protection (face mask or goggles), because sprays of secretions may occur. Limit patient movement within the institution and ensure that patients wear medical masks when outside their rooms.
Apply contact precautions
Contact precautions prevent direct or indirect transmission from contact with contaminated surfaces or equipment (i.e. contact with contaminated oxygen tubing/interfaces). Use PPE (medical mask, eye protection, gloves and gown) when entering room and remove PPE when leaving and practice hand hygiene after PPE removal. If possible, use either disposable or dedicated equipment (e.g. stethoscopes, blood pressure cuffs, pulse oximeters, and thermometers). If equipment needs to be shared among patients, clean and disinfect between each patient use. Ensure that health care workers refrain from touching their eyes, nose, and mouth with potentially contaminated gloved or ungloved hands. Avoid contaminating environmental surfaces that are not directly related to patient care (e.g. door handles and light switches). Avoid medically unnecessary movement of patients or transport. Perform hand hygiene.
Apply airborne precautions when performing an aerosol-generating procedure
Ensure that health care workers performing aerosol-generating procedures (e.g. open suctioning of respiratory tract, intubation, bronchoscopy, cardiopulmonary resuscitation) use the appropriate PPE, including gloves, long-sleeved gowns, eye protection, and fit-tested particulate respirators (N95 or equivalent, or higher level of protection). A scheduled fit test should not be confused with a user's seal check before each use. Whenever possible, use adequately ventilated single rooms when performing aerosol-generating procedures, meaning negative pressure rooms with a minimum of 12 air changes per hour or at least 160 L/second/patient in facilities with natural ventilation. Avoid the presence of unnecessary individuals in the room. Care for the patient in the same type of room after mechanical ventilation begins.
Abbreviations: ARI Acute Respiratory Infection; PPE Personal Protective Equipment.

B. Appendix II: Movement of patients with confirmed or suspected COVID-19 within the facility:

- Patient movement outside of the Airborne Infection Isolation Room (AIIR) will be limited to medically-essential purposes.
- A protocol of movement is in place to ensure that, if the patient is being transported outside of the room, HCP in the receiving area are notified in advance.
- Patients transported outside of their AIIR will be asked to wear a facemask and be covered with a clean sheet during transport.
- Patient receiving NIPPV or HFNO not allowed to move outside the AIIR
- Ventilated patient can be moved to Radiology department or operative theater with appropriate Precautions

C. Appendix III: Emergency tracheal intubation of COVID 19 patient:

Tracheal intubation of the patient with COVID-19 is a high-risk procedure for staff, irrespective of the clinical severity of disease.

- In severe COVID-19 it is also a high-risk procedure for the patient
- Limit staff present at tracheal intubation: one intubator, one assistant and one to administer drugs/monitor the patient.
- Create a COVID-19 tracheal intubation trolley that can be used in ICU or elsewhere.
- PPE is effective and must be worn. Wear full PPE at all times **including N95 respirator**. Consider double gloving. Defog goggles and/or eye wear if possible. Touch as little as possible in the room to avoid fomites.
- Intubate in a negative pressure room with >12 air changes per minute whenever possible.
- Everyone should know the plan before entering the room – use a checklist to achieve this Plan.
- The algorithm/cognitive aid you plan to use should be displayed in or taken into the room.
- All preparations of airway equipment and drugs that can take place outside the room should do.
- Use a kit mat if available.
- The best skilled airway manager present should manage the airway to maximize the first pass success.
- Focus on safety, promptness and reliability. Aim to succeed at the first attempt because multiple attempts increase risk to sick patients and staff. Do not rush but make each attempt the best it can be.
- Use reliable techniques that work, including when difficulty is encountered. The chosen technique may differ according to local practices and equipment. With prior training and availability this is likely to include:
    - preoxygenation with a well-fitting mask and a Mapleson C (‘Waters’) or anaesthetic circuit, for 3-5 minutes.
    - video laryngoscopy for tracheal intubation;
    - 2-person, 2-handed mask ventilation with a VE-grip to improve seal;
    - A second-generation supraglottic airway device (SAD) for airway rescue, also to improve seal.

- Place an HME filter between the catheter mount and the circuit at all times. Keep it dry to avoid blocking.
- Avoid aerosol-generating procedure, including:
    - high-flow nasal oxygen,
    - non-invasive ventilation,
    - bronchoscopy and
    - Tracheal suction unless an in-line suction system is in place.
- Full monitoring, including working continuous waveform capnography before, during and after tracheal intubation.
- Use RSI with cricoid force where a trained assistant can apply it. Take it off if it causes difficulty.
- To avoid cardiovascular collapse use ketamine 1–2 mg.kg-1 rocuronium 1.2 mg.kg-1 or suxamethonium 1.5 mg.kg-1
- Have a vasopressor for bolus or infusion immediately available for managing hypotension.
- Ensure full neuromuscular blockade before attempting tracheal intubation.
- Avoid face mask ventilation unless needed and use a 2- person, low flow, low pressure technique if needed.
- Intubate with a 7.0-8.0 mm ID (females) or 8.0-9.0 mm ID (males) tracheal tube with a subglottic suction port.
- Pass the cuff 1-2 cm below the cords to avoid bronchial placement. Confirming position is difficult wearing PPE.
- Inflate the tracheal tube cuff to seal the airway before starting ventilation. Note and record depth.
- Confirm tracheal intubation with continuous waveform capnography – which is present even during cardiac arrest.
- Use a standard failed tracheal intubation algorithm with a cognitive aid if difficulty arises.
- Communicate clearly: simple instructions, closed loop communication (repeat instructions back), adequate volume without shouting.
- Place a nasogastric tube after tracheal intubation is completed and ventilation established safely.
- If COVID-19 status not already confirmed take a deep tracheal aspirate for virology using closed suction.
- Discard disposable equipment safely after use. Decontaminate reusable equipment fully and according to manufacturer's instructions.
- After leaving the room ensure doffing of PPE is meticulous.
- Clean room 20 minutes after tracheal intubation (or last aerosol generating procedure).
- A visual record of tracheal intubation should be prominently visible on the patient's room.
- If airway difficulty occurs the subsequent plan should be displayed in the room and communicated between shifts.

D. Appendix IV: Murray's Lung Injury Score

	Score
Chest radiograph	
No alveolar consolidation	0
Alveolar consolidation confined to 1 quadrant	1
Alveolar consolidation confined to 2 quadrants	2
Alveolar consolidation confined to 3 quadrants	3
Alveolar consolidation confined to 4 quadrants	4
Hypoxaemia score	
$PaO_2/FiO_2 \geqslant 300$	0
PAO_2/FiO_2 225–299	1
PaO_2/FiO_2 175–224	2
PaO_2/FiO_2 100–174	3
$PaO_2/FiO_2 < 100$	4
PEEP score (when mechanically ventilated)	
$\leqslant 5$ cm H_2O	0
6–8 cm H_2O	1
9–11 cm H_2O	2
12–14 cm H_2O	3
$\geqslant 15$ cm H_2O	4
Respiratory system compliance score (when available)	
$\geqslant 80$ ml/cm H_2O	0
60–79 ml/cm H_2O	1
40–59 ml/cm H_2O	2
20–39 ml/cm H_2O	3
$\leqslant 19$ ml/cm H_2O	4
The score is calculated by adding the sum of each component and dividing by the number of components used.	
No lung injury	0
Mild to moderate lung injury	0.1–2.5
Severe lung injury (ARDS)	>2.5

The score is calculated by adding the individual scores and then dividing by 4.

E. Appendix V: Key Strategies in CoViD-19 patients with ARDS

SEDATION/PARALYSIS
Midazolam 0-10mg/hour
Fentanyl 0-200mcg/hour
Rocuronium 50mg IV as needed or
Cisatracurium Infusion 0.5-5mcg/kg/min

PRONE POSITIONING (PP)
Consider if PF Ratio <150
Avoid airway disconnections
Prone for 16-20 hours
Stop when PF >150, >4-6hours while Supine

SHOCK

Target MAP >60mmHg, Hb >70
Norepinephrine 0.01 – 1mcg/kg/min
Vasopressin 0.01-0.04U/min
Hydrocortisone 50mg Q6hr in refractory shock
Consider TTE in all cases to r/o Myocarditis

REFRACTORY SHOCK

Consider VA ECMO if:
<50-years old who are otherwise healthy
AND
Refractory Shock (Lactate >5 and/or other end organ failure) despite optimal medical management. OR Refractory Cardiac Arrest.

ANTIBIOTICS
Early empiric antimicrobials in all cases
Full Septic Screen prior to Antibiotics
De-escalate if CoViD confirmed & MRSA -ve
Use Paracetamol but avoid Ibuprofen

REFRACTORY HYPOXAEMIA
Consider VV ECMO if:
PF <80 for >6-hours OR <50 for >3-hours despite Prone Positioning, iNO, diuresis, and Metabolic Modulation (Paralysis, Temp., HR) OR
Hypercapnoea with pH <7.25
AND
Age <50 with no significant comorbidities

FLUID MANAGEMENT
Target Negative Fluid Balance
Use 20% Albumin 100-200ml if needed
Consider CRRT if severe AKI

NUTRITION
Early EN is advisable but monitor the GRV
Risk of aspiration due to gut dysfunction
Reduce rate during Prone Positioning
Sit up 20-30 degrees when supine

CoViD TREATMENT (Options) ID protocol**

Options:
Lopinavir/Ritonavir 400/100mg PO BID or
Hydroxychloroquine 400mg PO BID (1-day), then OD or
Favipiravir 1600mg BID (x1 day), then 600mg TID or
Remdesivir 200mg IV (1-day), then 100mg IV OD or
Tocilizumab 4-8mg/kg IV (x1 dose)