This document is to be used along with 'National Guidelines for Clinical Management of Coronavirus Disease 2019 (COVID-19)'

CARING FOR CRITICALLY ILL COVID- 19 PATIENT: QUICK GUIDE FOR ICU CARE

The COVID-19 outbreak is a unprecedented challenge for Bangladesh. Its impacts are currently rapidly unfolding. How to provide the best practices for mass medical emergency is a real challenge.

Symptomatic COVID-19 infection can range from mild to severe illness. In the clinical process, ARDS developed in median of eight days after the onset of symptoms.

Clinical process for COVID-19 pneumonitis/ARDS:

Some patients with severe illness were relatively asymptomatic although they have a good degree of hypoxemia for inexplicable reasons (referred to as "silent hypoxemia"). Multiple pathology of severe hypoxemia is desregulation of pulmonary perfusion, pulmonary micro thrombosis, ARDS like pulmonary edema & atelectasis. Some patients deteriorate quickly due to severe & silent hypoxemia because silent hypoxemia gives a false sense of well-being (alternative name is happy hypoxemia) when the oxygen debt has been actually high. Other severe cardiac complications were arrhythmias, acute cardiac injury, and shock states, & cardiomyopathy. Some patients with severe COVID-19 have laboratory evidence of an exuberant inflammatory response, similar to cytokine release syndrome, with persistent fevers, elevated inflammatory markers (eg, D-dimer, ferritin), and elevated proinflammatory cytokines; these laboratory abnormalities have been associated with critical and fatal illnesses.

Clinical features of Coronavirus Disease 2019 (COVID-19) are non-specific and do not easily distinguish it from other causes of severe community-acquired pneumonia. As the pandemic worsens, intensive care unit (ICU) practitioners should increasingly have a high index of suspicion and a low threshold for diagnostic testing for COVID-19

Diagnosis of COVID-19 in ICU: Sensitivity of RT-PCR assays for critically ill patients is unknown. Repeat the sampling may be necessary, preferably from lower respiratory tract

RT-PCR assays might not be available in many ICUs; if available, assays will take time to complete

Recommendations for the admission of patients with COVID-19 to intensive care

Basic Principle:

1. Severe/Critical COVID-19 patients should be admitted in the designated COVID-19 hospitals ICU.
2. In hospitals where both COVID-19 and NON-COVID patients are admitted COVID-19 ICU should be separated from NON-COVID ICU.
3. All medical personnel should take full protective measures in COVID-19 ICU
4. All medical staff should be trained for management of COVID-19 patients in COVID-19 ICU
5. COVID-19 ICU should be equipped with necessary equipments e. g. Oxygen therapy device, all other logistic facilities, Lung USG, Mechanical ventilators, monitors, Portable X-Ray, ABG analyser, Biochemical analyser and all necessary drugs. (Annex)

Categories of patients with COVID-19 infection requiring admission

HDU :

- Patients who require oxygen therapy and continuous monitoring of vital parameters (at least SpO2, ideally blood pressure, heart rate and respiratory rate)
- Oxygen administration via nasal cannula/probe(nasal cannula 2 to 4 litre), in face mask 5 to 10 litre, Venturi mask or non-rebreathing reservoir mask (more than 15 l/min, no nasal highflow device)
- The use of high-flow oxygen therapy and non-invasive ventilation is not recommended in general and outside of an intensive care unit (risk of aerosols and of rapid deterioration in the case of system failure)

ICU:

Patients with increasing organ dysfunction (e.g., increasing respiratory failure)

Criteria to determine inpatient management line

- Individual patient characteristics must always be considered: Frailty and comorbidities (medical history of the patient).
- Patient wishes, advance directive/advance care planning (ACP) or information from the authorized representative.

ICU capacity

During surges in numbers of critically ill patients with COVID-19 -Implement national and regional modeling of needs for intensive care.

Bangladesh has insufficient ICU beds in general: Consider whether increasing intensive care provision is an appropriate use of resources; if so, make plans for an increase in capacity, including **providing intensive care in areas outside ICUs and centralizing intensive care in designated ICUs**

Increasing ICU capacity requires more equipment (eg, ventilators), consumables, and pharmaceuticals, which might be in short supply.
Pay close attention to logistical support and the supply chain; reduce the inflow of patients who do not urgently require intensive care (eg, by postponing elective surgeries).
Ventilators are in short supply, so consider transport, operating theatre, and military ventilators.

Critically ill patients with suspected or confirmed COVID-19 should ideally be admitted to an airborne infection isolation room (AIIR) that is at negative pressure relative to surrounding areas, with accessible sinks and alcohol hand gel dispensers.

If AIIRs are unavailable, patients can be placed in adequately ventilated single rooms with the doors closed (WHO).Where single ICU rooms are unavailable, cohorting of cases in shared rooms with dedicated staff is an alternative, with beds spaced apart.PPE should be considered for patients in shared rooms. Oxygen masks with HEPA filters might provide some protection for non-intubated patients.

Quick Guide for Management with Covid-19: Respiratory Failure (COVID-19 pneumonitis)

Oxygen Therapy:

Oxygen therapy is the administration of oxygen at concentrations greater than that in room air to treat or prevent hypoxia. Hypoxemia is common in COVID-19 infection. Physicians should not make delay to give supplementary oxygen therapy to COVID-19 infection with hypoxemia.

Indications of oxygen therapies:

Patients with oxygen saturation (SPO2) of less than 93% and have respiratory distress. In some patients with COVID-19 infection have hypoxia but surprisingly have no obvious symptom of respiratory distress but require oxygen therapy.

The treatment goal of oxygen therapy:

The aim of oxygen therapy is to maintain the oxygen saturation (SpO2) at 93%-96% for patients without chronic pulmonary disease and at 88%-92% for patients with chronic type II respiratory failure. Particular attention should be given to keep oxygen saturation (SPO2) 92%-95% for patients whose SpO2 drops below 85% frequently during daily activities.

Factors that determine which system to use:

1. Patient comfort / acceptance
2. The level of FiO2 that is needed
3. The requirement that the FiO2 be controlled within a certain range
4. The level of humidification and /or nebulization
5. Minimal resistance to breathing
6. Efficient & economical use of oxygen
7. Availability of support system

Monitoring during oxygen therapy:

Continuous monitoring of oxygen saturation (SpO2) of COVID-19 patients is with pulse oximeter is strongly recommended. Some patients do not necessarily have impaired oxygenation functions at the onset of infection but may manifest rapid deterioration in oxygenation over time. Therefore, continual monitoring of oxygen saturation is vital, before and during oxygen therapy.

Oxygen therapy devices:

In mild to moderate cases, oxygen can be given via nasal cannula and face mask. In nasal cannula 2-6 L/min Oxygen can be given. Advantages of the nasal cannula are inexpensive, well tolerated, can able to eat, drink but disadvantages are dryness in the nasal mucosa, epistaxis, crusting of secretion and pressure sore. Flow higher than 6 L/min results in turbulent flow rather than laminar flow and is not recommended. A simple face mask is a popular device to give oxygen to patients, inexpensive, easy to use and FiO2 can be increased up to 0.5. The flow rate of oxygen must be between 5-10 L/min and flow below 5 L/min causes rebreathing of expired gas and not recommended. If the oxygen demand of the patient is still very high, non-rebreathing mask with reservoir bag with 10-15 L/min is the choice. Exhaled oxygen from anatomical dead space is utilized and FiO2 can be increased > 0.6. Alternatively, if available, High Flow Nasal Cannula (HFNC) is useful in moderate to severe distress and when other methods of oxygen therapy fail to correct the hypoxemia.

The Venturi mask is considered as a high flow oxygen delivery device. It also has the advantage of fixed FiO2 and due to high flow, excess gas flushes out expired CO2 through the holes in the side of the mask. The Venturi mask is cheap, easy to use and very useful in COPD patients.

Noninvasive Ventilation (NIV):

NIV is not strongly recommended in COVID-19 patients. NIV is an aerosol-generating device and can contaminate room environment. But the NIV can be useful in COPD patientswith COVID-19with CO2 retention. A short-term (less than 2 hours) use of NIV can be closely monitored if the patient has chronic obstructive pulmonary disease and COVID-19. Intubation should be performed as early as possible if improvement of respiratory distress symptoms or PaO2/FiO2 is not observed.

NIV with a double circuit is recommended. A virus filter should be installed between the mask and the exhalation valve when applying NIV with a single tube. Suitable masks should be chosen to reduce the risk of virus spread through air leakage.

Steps of Oxygen Therapy:

1. Goal: SpO2 92-96% PaO2 >75
2. Nasal canula (NC) 1-5L/min to maintain SpO2 goal, consider early prone, if patient able to do.

Even self proning the ones on nasal cannula helps.

Fig 1: Patient getting nasal canula oxygen with a surgical facemask for prevention of droplet.

3. NC 6L/min to maintain SpO2 goal, consider venturi mask or non-rebreather mask
4. Plan elective intubation **EARLY** (when Venturi mask @ 60%FiO2) or endotracheal intubation if FiO2≥ 60% to avoid emergent scenario.

Note: Do not use BiPAP- it does not work well and is a significant exposure risk with high levels of aerosolized virus to you and your staff. AVOID CPAP or BiPAP for ARDS, but can consider in reversible cases (e.g. flash pulmonary edema, mild COPD exacerbation) with **non-vented mask with virus filter (HME filter).**

Fig 2: Non-vented mask (left) & Vented NIV mask (right)

UPFRONT VENTILATOR SETTINGS: Immediately upon intubation.

Mechanical ventilation, though vital in supporting respiratory function in patients with acute hypoxemic respiratory failure or ARDS, may promote lung damage, a phenomenon known as ventilator-induced lung injury.

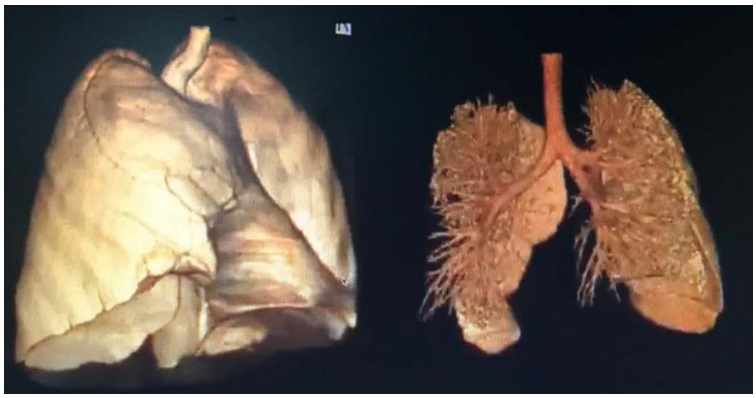


Fig 3: Normal lungs vs ARDS

So **Lung Protective Ventilation** strategy should be implemented:

Volume control with Vt 6cc/kg IBW + RR 16-24 + FiO2 1.0 + PEEP based on BMI as below

If BMI<35 PEEP 5; if BMI ≥35 PEEP 10

Note: Use Virus/ HME filter (check for virus filtering) in every ventilator circuit.

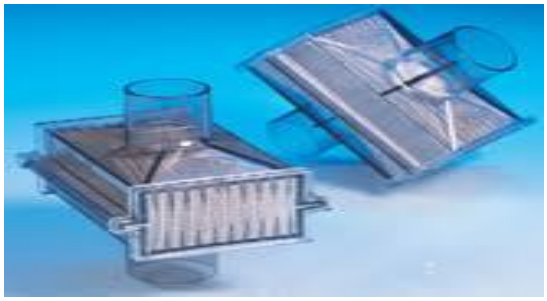


Fig 4: Virus filter (in replacement pure HME filter)

INITIAL VENT ADJUSTMENTS (How to ventilate CIVID-19 patients): (do this before bedside procedures)

1. **Titrate peep:** Best PEEP protocol according to ARDSNET table.

   Be very judicious for adjusting peep in early stage of COVID-19 pneumonitis.

   Disconnecting the patient from the ventilator results in loss of PEEP and atelectasis, and it should be avoided. In-line catheters for airway suctioning and endotracheal tube clamping are recommended before disconnecting breathing circuits.

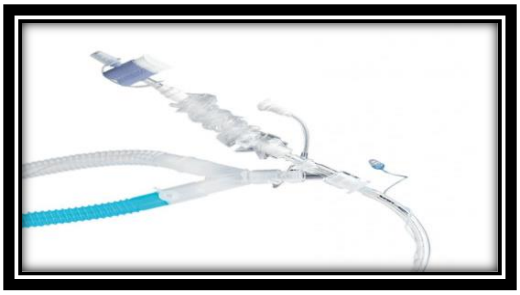


Fig 5: Closed suction catheter.

2. **Titrate down FiO2** for goal SpO2 92-96% or PaO2 >75
3. **Measure resistance + Compliance**
4. **Measure plateau pressure**: if >30, decrease Vt to 4cc/kg IBW (tolerate increase PCO_2 as a result- permissive hypercapnia)
5. **Measure driving pressure: Target**<15, if >15, readjust Vt & PEEP.

Calculation of driving pressure

Platue pressure minus Total PEEP

(Platue pressure can be measured by pressing inspiratory hold button for 4 seconds)

WHAT TO DO FOR DIFFICULTY WITH OXYGENATION

1. PEEP titration (as above for initial settings)

FiO_2	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.7	0.7	0.8	0.9	0.9	0.9	1.0	1.0	1.0
PEEP	5	5	8	8	10	10	10	12	14	14	14	16	18	20	22	24

2. Increase sedation to goal RAAS (**Richmond Agitation-Sedation Scale**)-5
3. Initiate continuous paralysis
4. Monitor PaO2 & FiO2 (P/F) ratio every 8 hourly or if condition deteriorate to identify degree of hypoxemia & ARDS for advanced planning.
5. Prone positioning **if P: F <150 or FiO2 >0.75 & do prone 12- 16 hours daily.**

Every hourly post-prone check mechanics + adjust PEEP as above.

Discontinue proning when, P:F>200 or if O2 @ goal with FiO2 <0.5

Caution: Monitor ET displacement or $ETCO_2$ monitoring & CVC in place.

Contraindication to proning: is spinal cord injury or open

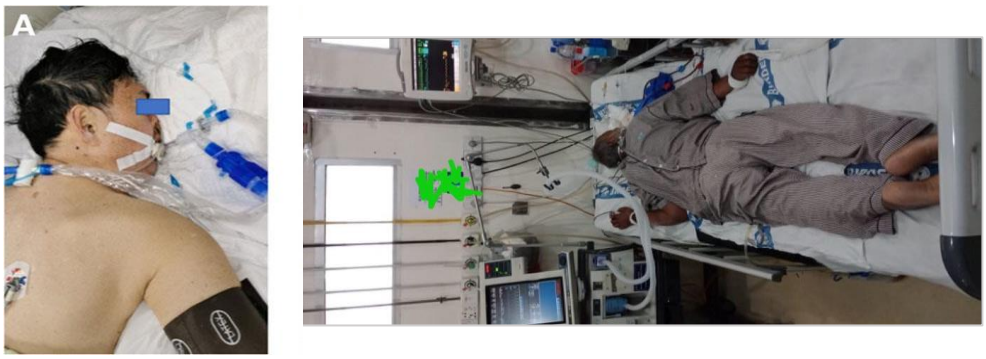


Fig 6: Prone for recruitment maneuver in COVID-19 pneumonitis.

6. Inhaled Epoprostenol - titrate to 0.05mcg/kg/min by continuous neb, x4 hrs if P:F no improvement, better wean off per protocol
7. Inhaled Nitric Oxide: 40-80ppm into vent circuit trial x4 hrs if P:F no better wean off over 2 hrs.
8. ECMO consultation

VENT TITRATION for ACID/BASE ISSUES: target pH 7.25-7.45

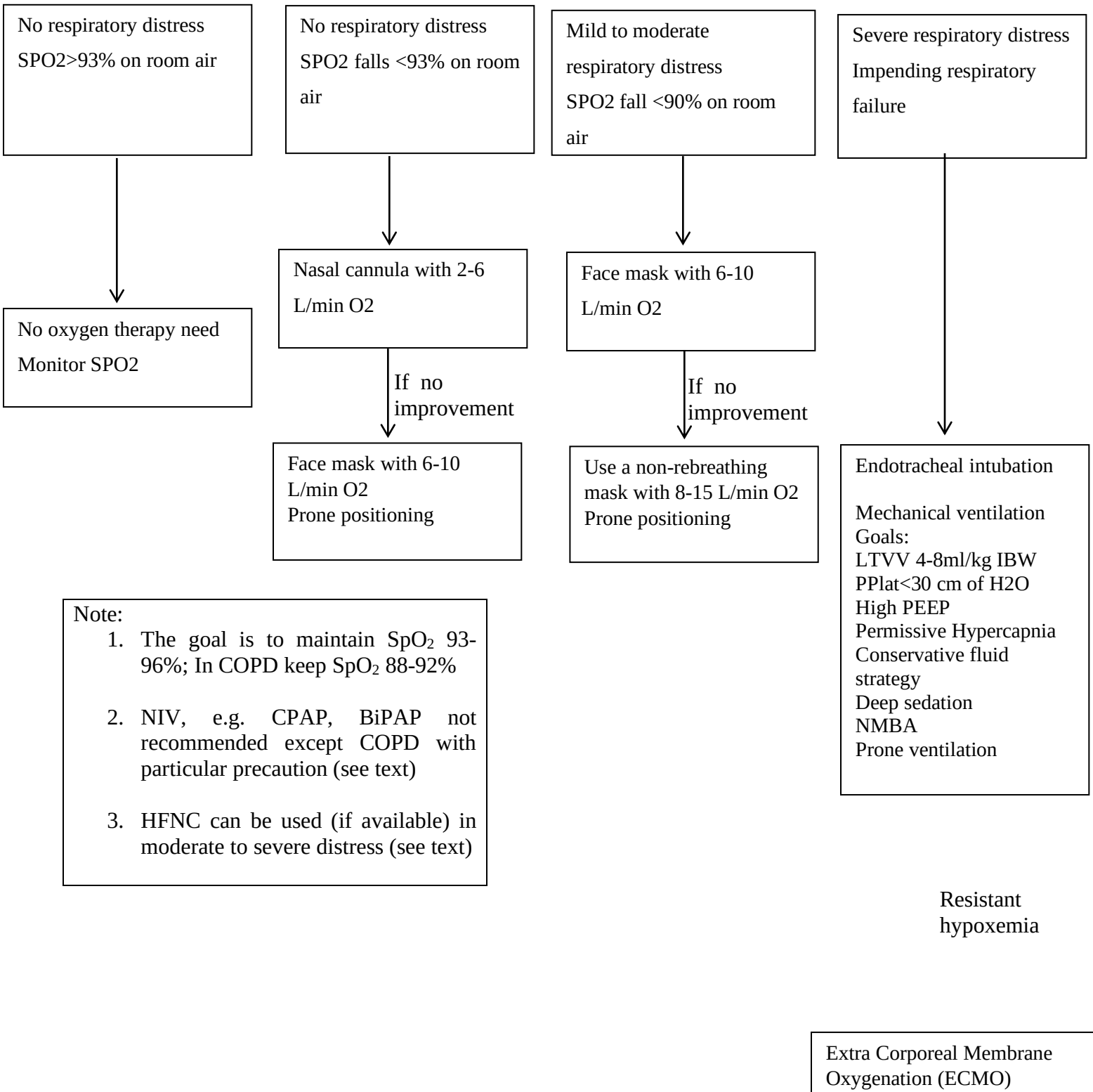
if pH <7.25 increase RR towards 35

if pH <7.15 and RR is 35 then increase Vt to 8cc/kg IBW (as long as plateau pressure <30) AND do (sedation to RASS -5 + paralysis + prone).

A. If available, check arterial blood gas (ABG) 15 minutes after connecting patient to ventilator.

B. If available, check portable x-ray to confirm endotracheal tube placement & barotrauma.

AN ALGORITHM FOR COVID-19- RESPIRATORY FAILURE



Respiratory Failure Algorithm: What to do in each situation

Note: Airway devices providing 6 L/min or more of oxygen are considered high flow and discourage their use if an airborne infection isolation room is unavailable. To reduce the risk, place a surgical mask over the device.

How to intubate safely:

Intubation is an 'aerosol generating' procedure with an increased risk of transmitting COVID-19, as described in section .Staff will need to wear an N95 mask and take extra precautions to decrease the risks. When hospitals are caring for many COVID-19 patients, some have created a dedicated 'intubation team' who gets called when a patient requires intubating.

Before intubation:

Staff protection

Full personal protective equipment (N95 mask with extra medical mask, eye protection, double gloves, gown and overlying apron).

Minimize the number of staff present for the intubation – maximum of 3 for most situations.

Where possible, intubation should be carried out in a side room with the windows open.

Where not possible, it should be carried out in a room where only COVID-19 patients are being cared for.

Prepare the drugs and equipment and discuss the airway plan before putting on PPE and going into the patient's room.

Equipment:

- Endotracheal tubes (have 2 sizes available)
- Bag-valve mask ventilator (Ambu bag)
- Laryngoscope (check light is working)
- Stylet or bougie
- Tape to secure tube
- Aqueous lubricant
- 10ml syringe
- Oropharyngeal airway (2 sizes)
- One heat and moisture exchange filter (HMEF) and one bacterial / viral filter
- Suction machine and suction catheter

- Pillow or folded towel to help with patient positioning
- Will need 2 oxygen sources, one preconnected to the ventilator, the other to the reservoir mask then the AMBU.
- Clean ventilator tubing and closed-circuit suction device
- NG tube to insert post intubation

Intubation drugs

- Sedative: pick ONE
  - Midazolam (dormicum) 0.1 – 0.3 mg/kg
  - Propofol 1.5 mg/kg
  - Ketamine 2mg/kg
- Opiate:
  - Fentanyl 2 – 10 mcg/kg
- Muscle relaxant at the intubator's discretion:
  - Succinylcholine (suxamethonium) 1.5 mg / kg (avoid if hyperkalaemia)
- Noradrenaline infusion if patient haemodynamically unstable

The choice of intubation drugs is up to the intubator and what they are most comfortable and familiar with. However, it is important to bear in mind the following:

i) Try to decrease the period during which the patient is apnoeic (not breathing) so as to minimise the need for bag-valve mask (Ambu) ventilation.

ii) If the intubator is familiar with using succinylcholine, this will decrease the risk of the patient coughing during intubation and potentially increase the speed and ease of the intubation. However, if the intubator is not comfortable with using succinylcholine safely then it is not advised.

During intubation:

Non-technical skills

Allocate clear roles to the team

- Communicate the airway plan clearly
- 'Closed loop' communication throughout*
- All team members should check each other for potential contamination

Technical aspects

- Connect a viral / bacterial filter to AMBU bag and then move it to the expiratory limb of the ventilator once the patient is intubated.
- Connect an HMEF filter to the patient end of the ventilator tubing.
- Pre-oxygenate with 15L O_2 via a reservoir mask for at least 5 minutes beforehand
- Intubation by the most experienced practitioner
- Use a two person AMBU technique – one person to hold the mask, one to squeeze the bag
- 'Thumbs down' facemask grip to achieve a tight seal
- Minimise patient coughing where possible
- After intubation, only squeeze the AMBU bag after the cuff has been inflated.

¶**If you want someone to carry out a task:**

1) Pick a specific person and address them by name
2) Tell them what you would like them to do in a clear manner without ambiguity
3) That person should repeat back the instruction to check that they have understood it correctly.
4) Confirm that they have understood correctly or correct them.
5) Ask them to come and tell you when they have completed the task.

After intubation:

Avoid unnecessary circuit disconnection

The bag valve mask bag and any other airway equipment used (stylet/bougie) will need to be carefully disinfected.

Extubation Plan:

Average ventilator days (10days) in china.

Plan for careful extubation because reintubation rate was very high.

Don't extubate, if secretion is thick & unable to expectorate.

High-Flow Nasal Cannula (HFNC):

Why it might be okay

- Typical cough is 300-400 L/min, High flow is typically 60 L/min or less, thought to be minimal exposure when prongs are appropriately sized and placed
- Why it might not be okay: Concern for risk of exposure with a high flow "blower" dispersing virus throughout the environment

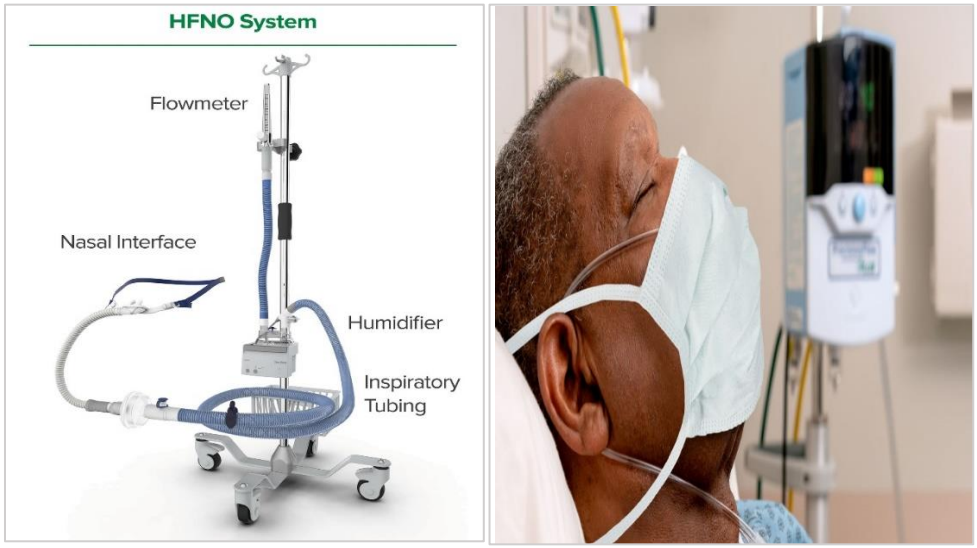


Fig 7: High flow nasal Oxygen(HFNO) & patient with HFNO with mask to prevent aerosolization.

- Limiting flows to 40 L per minute to limit viral aerosolization (without literature support)
- Evidence: Limited, but SCCM recommends (if supplemental O2 not working, prefers over NPPV), WHO recommends, CP advises against. AHA recommends at lower flowrates over CPAP/NPPV.

- Modifications to prevent aerosolization:
    1. Consider lower rates of flow (15-30 L/min versus 30-60 L/min, should still equal minute ventilation).
    2. Consider surgical mask on patient over patient-interface
    3. Strongly consider negative-pressure room (or closed door, minimally) and airborne precautions.
    4. Stop flow before removing device

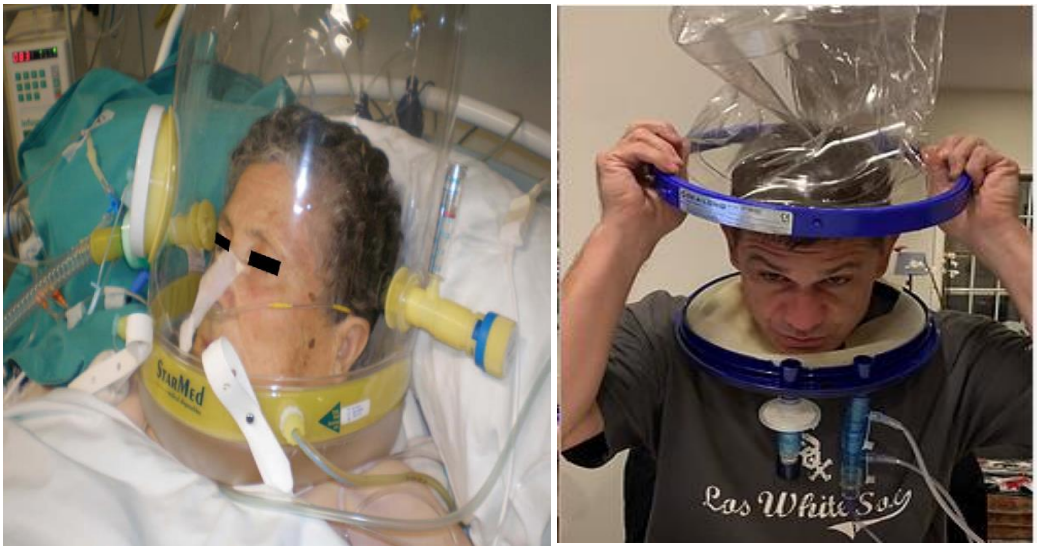
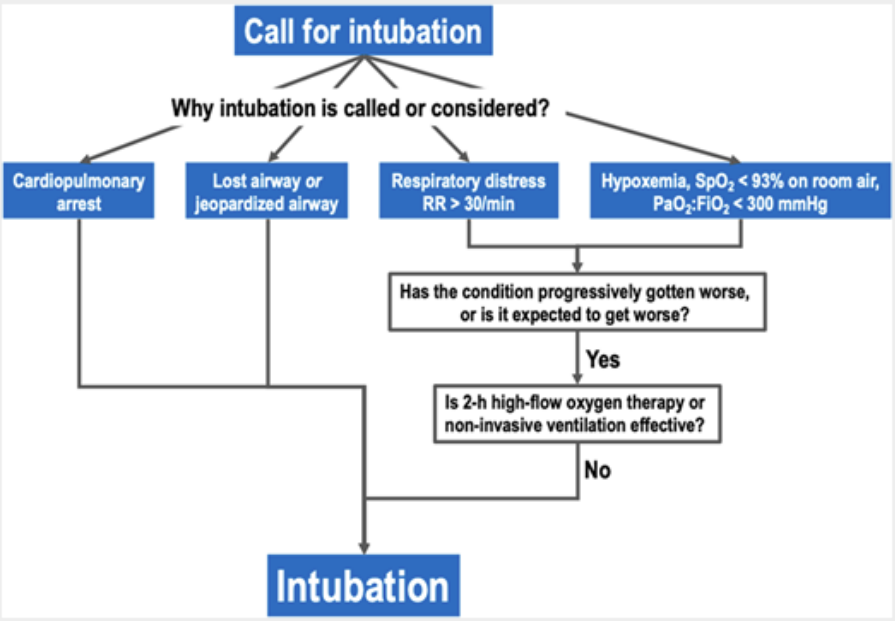


Fig 8: NIPPV with Helmet interface with expiratory limb virus filter.

Criteria for nonoperating room intubation amid the COVID-19 outbreak. FIO_2, fraction of inspired oxygen; PaO_2, partial pressure of arterial oxygen; RR, respiratory rate.



LABS in the ICU:

At admission	CBC with Differential, B. Urea, S, Creatinine, S. Electrolytes, Magnesium, Urine RE, S. Bilirubin, SGPT, PT, INR, APTT, S. Fribinogen, CXR, ECG, Troponin I, D Dimer, CPK, NT-proBNP, Ferritin, CRP, Procalcitonin, LDH, Lactate
Daily	CBC, BMP (Basic Metabolic Panel)
Every other day	LFT, LDH, CRP, D-Dimer, Ferritin, (if Propofol also Triglyceride)
If clinical condition worsening	LFT, CPK, troponin, CRP, procalcitonin, LDH, ferritin, d-dimer, fibrinogen, PT, INR
Others	CT scan of chest, Lung Ultrasound and portableECHO

Lab Results to Expect:

Potential marker of disease severity

Lymphopenia and ratio of neutrophil :Lymphocyte> 3.5

Thrombocytopenia

BMP with elevated Cr

Normal procalcitonin

Elevated AST/ALT

Elevated CRP

Elevated LDH

Elevated d-dimer

Elevated troponin

Initial Management Considerations:

CXR: The hypoxia may not correlate with the CXR findings.

POCUS: LUNG USG & ECHO: on admission if suspected cardiac involvement, fluid responsiveness.

CT chest: recommend minimizing use of CT given challenges with isolation and transport.

IV fluids: Conservative fluid management is important to mitigate risk of progression of respiratory failure.

Conservative fluids, "dry lungs = happy lungs"

Assess fluid responsiveness, +/- bedside ultrasound (POCUS), only small boluses (250-500 cc)

Do not give these patients standard sepsis fluid resuscitation. Be very judicious with the fluids as it hastens their respiratory decompensation. Outside the DKA and renal failure dehydration, leave them dry.

Sedation for ARDS: Fentanyl/morphine + propofol +/- midazolam (adjunct)

Steroids: Avoid using empirically, only use if other indication, then use lowest dose possible.

Thick secretion Management: **Syrup carbocysteine,** 750mg TDS through NGT (prevent chance of ET tube block).

Antibiotics: Follow guidelines for empiric antibiosis based on patient risk factors& consider de-escalation. (Specially check for MRSA & pseudomonas risk).

Neuraminidase inhibitor: Oseltamivir 75 mg twice daily(unless conformed case)

DVT prophylaxis: High rate of microvascular thrombosis in pulmonary circulation if no contraindications.

Shock: Patient may develop distributive (DS) vs. Cardiogenic Shock (CS)

Distributive shock: Work-up as per sepsis guidelines

CS suggested by high NT-proBNP, CVO2 <60% +/- bedside ultrasound with decreased LV function.

Cardiogenic shock: Management:

a. Norepinephrine upfront for MAP 65-75
b. Diuretics if CVP>14 for goal CVP 6-14
c. Dobutamine (inotropy) if MAP>65 for goal CVO2 >60 (start at 2mcg/kg/min, up by 1-2 q30-60 min, to max dose 10)
d. Do serum Lactate and SCVO2 (from ABG) every 4-6hrs.(if possible, point of care)
e. Mechanical support if SCVO2 <60 and lactate >4 @ dobutamine 5mcg/kg/min
f. Avoid dopamine: dopamine causes arrhythmias. China reported 15% cardiac involvement (i.e. myocarditis, pericarditis, new onset CHF and new onset atrial fibrillation & elevated troponin).

Nebulizer treatments: Use MDI. You can give 8-10 puffs at one time of an albuterol MDI. Use only if wheezing which isn't often with COVID-19. If you have to give a nebulizer must be in a negative pressure room; and if you can, instruct the patient on how to start it after you leave the room.

Anti-Viral therapy (See the National Treatment Guidelines for COVID-19):

No recommendation from FDA and WHO

Consider in all patients with Spo2 <94% on room air.

1. Hydroxychlorquine 400 mg PO, BID on day 1 followed by 200mg TID for next 9 days And Azithromycin 500mg Day 1 and then 250 mg daily for next 4days (if $QT_c \leq 450ms$).(the national guideline)
2. Remdesivir (on trial)-(preferred if eligible; include age ≥ 18, infiltrates/req. suppl. oxygen; exclude AST/ALT > 5x ULN, CKD4(cyclin-dependent kinase 4).Day 1 200 mg IV followed by 100mg IV from day 2 to Day 10.
3. Lopinavir/ritonavir 400mg/100mg Po BID for 7 days (if QT_c ->450ms)
4. Flavipiravir: 1600 mg day 1 followed by 600 mg TID from Day 2 to day 10

Anti-inflammatory therapies: immunosuppression for Cytokine storm(on trial but not easily available in Bangladesh).Insufficient evidence.

Consider for hyper inflammatory state, especially early.

Defined as rapid deterioration (including worsening hypoxemia), multi-organ failure, grade 3-4 cytokine release syndrome, elevated IL-6 level; exclude patients with suspected infection.

1. Tocilizumab
2. Sarilumab
3. Clazakizumab

Convalescent plasma:

Although there is lack of convincing evidence from RCTs and the uncertainty surrounding the optimal preparation of convalescent plasma and its safety, it can be an option used in treating patients with severe and critical COVID-19.

Human convalescent serum is an option for prevention and treatment of COVID-19 disease that could be rapidly available when there are sufficient numbers of people who have recovered and can donate immunoglobulin-containing serum. Passive antibody therapy has a storied history going back to the 1890s and was the only means of treating certain infectious diseases prior to the development of antimicrobial therapy. (COVID-19 is such states of pandemic)

Clinical worsening: Consider MI, myocarditis or stress cardiomyopathy, Secondary infection, HLH.

Secondary hemophagocytic lymphohistiocytosis (SHLH) is an under-recognized, hyperinflammatory syndrome characterized by a fulminant and fatal hypertyrosinemia with multiorgan failure. In adults, SHLH is most commonly triggered by viral infections) The H-score generates a probability for the presence of secondary HLH. HScores can be calculated using an online H Score calculator.

PROGNOSIS: From evolving data,

- Worse outcomes if >65 yrs
- Lab markers of severe disease: lymphopenia, increased troponin, LDH, d-dimer, CRP,LDH
- A ratio of absolute neutrophil count to absolute lymphocyte count greater than 3.5 may be the highest predictor of poor outcome.
- Thrombocytopenia and LFTs 5x upper limit of normal.
- An elevated Interleukin-6 (IL6) is an indicator of their cytokine storm
- Calculate SOFA score to assess organ dysfunction.

When to discharge from ICU

De-isolate patients only after clinical recovery and two negative RT-PCR assays performed 24 h apart.

Code Blue:

For COVID-19 + or COVID-19 rule-out, tell page operator this is COVID-19 patient; use normal protocol for donning of PPE prior to entering room, even if this delays CPR.

End-of-life care:

Not all patients will survive COVID-19 and is it important that these patients receive high quality end-of-life care. The focus should be on alleviating a patient's symptoms and providing emotional support for them and their families. Where possible, patients should be offered a choice between hospital or community-based care (either in home isolation if they meet the criteria to do it safely or in an isolation facility). If they choose hospital-based care, provide a single room where possible or screens for privacy. Try to facilitate telephone contact with family and friends.

Further reading:

1. Alhazzani W, Moller M H, Arabi Y M, Loeb M et al (2020). Surviving Sepsis Campaign: Guidelines on the Management of Critically Ill Adults with Coronavirus Disease 2019 (COVID-19). European Society of Intensive Care Medicine and the Society of Critical Care Medicine.
2. Phua J, Weng L, Ling L, Egi M, Lim C-M et al (2020). Intensive care management of coronavirus disease 2019 (COVID-19): challenges and recommendations. Lancet Respir Med, Published online. https://doi.org/10.1016/ S2213-2600(20)30161-2
3. Inglis R, Ayebale E, and Schultz M J (2019). Optimizing respiratory management in resourcelimited settings. Curr Opin Crit Care 2019, 25:45–53.
4. Ismail S, Baker T, Baker P, Chalkidou K, ChiY-L and Sullivan R (2020). Strengthening the Basics: Approaches to COVID-19 Care in Low-Resource Settings. https://www.cgdev.org/blog/strengthening-basics-approaches-covid-19-care-low-resource-settings

Annex I: For hospital-based care, the patient should be assessed every four hours to evaluate and treat their symptoms according to the table:

Symptom	Suggested treatment
Breathlessness	Morphine 0.5 – 2.5mg IV, every 30 minutes as required. Alternatives if morphine not available: Fentanyl 12.5 – 25 micrograms, every 15 minutes as required. Midazolam 0.5 – 1mg, every 30 minutes as required.
Nausea	Ondansetron 4mg every 4 – 6 hours as required.
Pain	Morphine 1 – 2.5 mg every 2 hours as required.
Agitation	Midazolam 0.5 – 1mg, every 30 minutes as required.

All patients should receive regular mouth care and repositioning.

Cardiopulmonary resuscitation is considered to be an aerosol-generating procedure and so should be avoided unless everyone in the room is wearing the appropriate PPE including an N95 mask.

Annex II: Management of Moderate to severe COVID-19 Pneumonia with Other Respiratory Illness: It's very important to identify co-existing lung diseases in a patient with COVID-19 Infection. More comorbidity is associated with increased mortality and morbidity.

1. **COPD/Post PT Pulmonary Fibrosis**

i. Oxygen to maintain SpO2 >90%
ii. Repeated doses of Salbutamol-Inpratropium Combination Via VSD(??): try to avoid Nebulization as it might spread infection
iii. LABA-LAMA Inhale vis VSD
iv. Steroid- In Low dose for shorter period, Clinicians judgement
v. Doxophyllin
vi. Parenteral Antibiotics: Empirical initiallyand then according to sensitivity
vii. NIV- In increased work of Breathing or hypercarbia or acidosis
viii. Frusemide- Low dose shorted duration
ix. Ionotropes- If needed
x. Bosentan/ambrisan, ih PH present
xi. Anti-Platelets : if CAD or raised D-dimer
xii. Anti-Coagulants;

2. **Bronchial Asthma ± allergic Rhinitis**

i. Oxygen to maintain SpO2 >92%
ii. Repeated doses of Sabultamol with/without SAMA via VSD
iii. LABA-LAMA inhalers via VSD
iv. Steroid- If Asthmatic Problem predominats
v. Doxophyllin- If no arrhythmia or Past CAD
vi. Montelukast + fexofenadine
vii. Cromones Nasal spray
viii. NIV: If Pneumonia Predominates (CXR could help) or morbid Obese os OSA

3. Pulmonary TB or Any Tuberculosis

i. Oxygen to maintain SpO2>90%
ii. Anti-TB treatment should be continues according to guideline
iii. Salbutamil-Ipratropium inhalers via VSD
iv. Rehydrat with Nutritional suppliments

4. Bronchial Carcinoma

i. Oxygen to maintain SpO2 >94%
ii. Avoid Chemo or Radiotherapy in COVID-19 Infected period
iii. Rehydrat
iv. Nutritional suppliments
v. Doxophylline
vi. Steroid- In case of Compelling indication
vii. Antibiotics- if Coexisting infection

5. DPLD (IPF/NSAIP/HP)

i. Oxygen to maintain SpO2 >90%
ii. Steroid – In HP or NSAIP; Avoid in IPF
iii. Salbutamol-Ipratropium Inhale via VSD
iv. Perfenidion- If Already started in IPF

Annex III: Consumables required for any patient with confirmed COVID-19 on a mechanical ventilator.

ICU for adult patient	Comments, including estimated requirement per intubated patient
Ambu mask (+/- Ambu bag)*	Essential
Single use suction catheter	Essential (for use during intubation, approx. 2 per intubated patient)
Closed circuit suction	Essential (approx. 2 per intubated patient)
Oropharyngeal airway	Essential (1 per patient)
N95 mask	Essential
Stylet OR Bougie*	Essential (1 per patient, but can reuse)
Endotracheal tube with cuff (6.0, 6.5, 7.0, 7.5)	Essential (minimum 2 sizes)
Heat and Moisture Exchange Filter (HMEF)	Essential (likely 10 per patient)
Bacterial and viral filter	Essential (1 per patient)
Tape for ET tube	Essential (7 rolls of neopore per patient)
NG tube	Essential (1 per patient)
Urine catheter	Essential (1 per patient)
Urine bag	Essential (1 per patient)
IV giving set	Essential (7 per patient)
IV cannulas (16G, 18G, 20G, 22G)	Essential (7 per patient)
Tape to secure cannulas	Essential
Needles 19G, 21G, 23G	Essential
Syringes 5ml, 10ml	Essential
Syringes 50ml	Desirable (2 per patient)
Syringe driver compatible giving set	Desirable
TED anti-embolism stockings	Desirable (1 pair per patient)
Aqua gel lubricant	Desirable (1 x 3ml sachet per patient)
Bandages / arm ties for patient restraint	Desirable
Non-sterile gauze	Desirable
Sputum trap (to attach to closed circuit suction)	Desirable (3 per patient)
Heparinised syringe for arterial or venous blood gas analysis	Desirable

*Can reuse if washed according to instructions in annex A.

Annex IV: Reusable items required for any patient with confirmed COVID-19 on a mechanical ventilator.

ICU	Comments
Oxygen hose adaptor for top of oxygen cylinder	Essential (one per ventilated patient)
Oxygen hose	Essential (one per ventilated patient)
Suction machine	Essential (minimum one per ventilated patient if in single room, minimum two per ward if patient in cohort)
Mechanical ventilator + spare parts	Essential (one per ventilated patient)
Laryngoscope + Mac 3 blade	Essential (minimum one per mechanical ventilator)
Reusable ventilator tubing and water trap	Essential (two per ventilator)
Patient monitor (or individual patient oxygen saturation probe)	Essential (one per ventilated patient)
Electric syringe	Desirable (one per ventilated patient)
Pillow + pillowcase	Desirable (one per ventilated patient)
Portable X-ray machine	Desirable (one per hospital)

Annex V: Intensive care Medicine

Guideline:

Table 1 Implication of different recommendation to key stakeholders

Recommendation	**Meaning**	Implication to patients	**Implication to clinicians**	**Implication to policymakers**
Strong recommendation or Best practice	Must do or must avoid	Almost all individuals in this situation would want to recommended intervention, and only a small proportion would not want it	Most individuals shouldreceived the recommended course of action,	Can be adopted as policy in most situations, including the use as performance indicators
Weak recommendations	Consider doing or consider avoiding	The majority of the individuals in this situation would want the recommended intervention, but may would not	Different choice are likely to be appropriate for different patients and the recommendation should be tailored to the individuals patient's circumstances such as patients family or substitute decision makers value and preferences	Policies will likely be variable

Table: 2 Recommendation and statements

Sl no	Recommendation	Strength
	Infection control & testing	
1.	For health care workers performing **aerosol generating procedures** on patient with COVID-19 in the ICU, we **recommend** using **fitted respiratory Mask (N95 respirators FFP-2, or equivalent),** as opposed to surgical /medical mask, in addition to other personal protective equipments (i.e. gloves, gown, and eye protection, such as a face shield or safety goggles).	Best practice statement
2.	We **recommend** performing **aerosol generating procedures** on ICU patient with COVID-19 in a negative pressure room.	Best practice statement
3.	For health care workers proving usual care for non-ventilated COVID-19 patients, we **suggest** using surgical/medical Mask, as opposed to respiratory mask, in addition to other personal protective equipment's (i.e. gloves, gown, and eye protection, such as a face shield or safety goggles).	Weak
4.	For health care workers who are performing **non-aerosol generating procedures** on mechanically ventilated (close circuit) patient with COVID-19, we **suggest** using surgical/medical Mask, as opposed to respiratory mask, in addition to other personal protective equipment (i.e. gloves, gown, and eye protection, such as a face shield or safety goggles)	Weak
5.	For health care workers performing **endotracheal intubation** on patients with COVID-19, we **suggest** using video guided laryngoscopy, over direct laryngoscopy if available.	Best practice statement
6.	For COVID-19 patients requiring **endotracheal intubation,** we **recommend** that endotracheal intubation be performed by the health care workers who is most experienced with airway management in order to minimize the number of attempt and risk of transmission.	Best practice statement
7.1	For intubated and mechanically ventilated adults with suspicion of COVID-19: For diagnostic testing, we **suggest** obtaining lower respiratory tract samples in preference to upper respiratory tract (nasopharyngeal or oropharyngeal) samples.	Weak

Sl no	Recommendation	Strength
7.2	For intubated and mechanically ventilated adults with suspicion of COVID-19: With regard to lower respiratory samples, we suggest obtaining endotracheal aspirates in preference to bronchial wash or bronchoalveolar samples.	Weak
	Hemodynamics	
8	In adult with **COVID-19 & shock**, we **suggest** using dynamic parameter skin temperature, capillary refilling time, and /or serum lactate measurement over static parameter in order to assess fluid responsiveness.	Weak
9	For acute **resuscitation** of adults with **COVID-19 and shock,** we **suggest** using a conservative over a liberal fluid strategy.	Weak
10	For the acute **resuscitation** of adults with **COVID-19 & shock,** we **recommend** using crystalloid over colloids.	Weak
11.	For the **acute resuscitation** of adults **with COVID-19 & shock,** we **suggest** using buffered/ balanced crystalloids over unbalanced crystalloids	Weak
12	For the **acute resuscitation** of adults with **COVID-19 & shock,** we recommend against using hydroxylethylstarches	Weak
13.	For the **acute resuscitation** of adults with **COVID-19 and shock,** we suggest against using gelatins.	Weak
14.	For the **acute resuscitation** of adults with **COVID-19 and shock,** we suggest against using dextrans.	Weak
15.	For the **acute resuscitation** of adults &**COVID-19 and shock,** we suggest against the routine use of albumin for initial resuscitation.	Weak
16.	For adults with **COVID-19 and shock,** we **suggest** using norepinephrine at the first line vasoactive agent, over other agents.	Weak
17.	If norepinephrine is not available, we **suggest** using either vasopressin or epinephrine as the first line vasoactive agents, For adults with **COVID-19 & shock**.	Weak

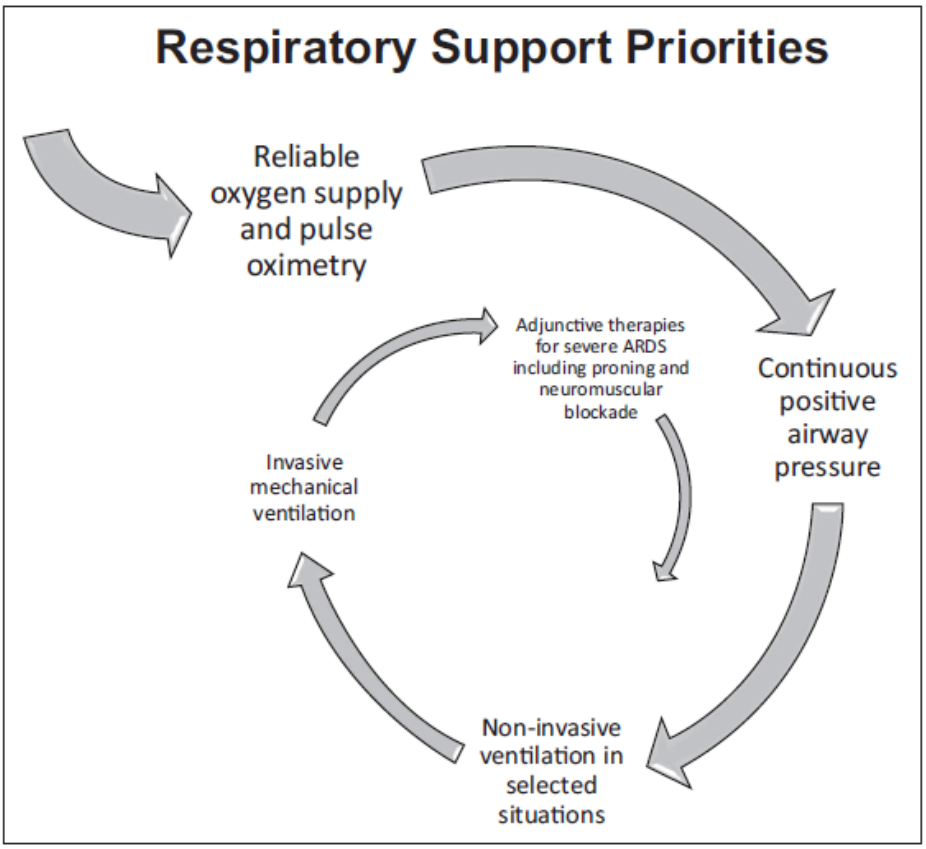
Sl no	Recommendation	Strength
18.	For adults with **COVID-19 and shock**, we **recommend against using** dopamine if norepinephrine is available.	Strong
19.	For adults with **COVID-19 and shock**, we **suggest** adding vasopressin as a second line agent, over titrating norepinephrine dose, if target mean arterial pressure (MAP) cannot be achieved by norepinephrine alone.	Weak
20.	For adult with **COVID-19 and shock,** we **suggest** titrating vasoactive agents to target a MAP of 60-65 mmHg, rather than higher MAP target.	Weak
21.	For adult with **COVID-19 and Shock, with evidence of cardiac dysfunction and persistent hypoperfusion despite fluid resuscitation and norepinephrine**, we suggest adding dobutamine, over increasing norepinephrine dose.	Weak
22.	For adults with **COVID-19 and refractory shock,** we **suggest** using low dose corticosteroid therapy("shock reversal"), over no corticosteroid. Remarks: A typical corticosteroid regimen in septic shock is intravenous hydrocortisone 200 mg per day administered either as an infusion or intermittent dose.	Weak
	Ventilation	
23	In adults with COVID-19, we **suggest** starting supplemental oxygen if the peripheral oxygen saturation (Spo2) is <92%, and **recommend** starting supplemental oxygen if SPO2 is <90%	Weak Stronge
24.	In adult with COVID-19 **and acute hypoxemic respiratory failure on oxygen, we recommend** that SPO2 maintained not higher than 96%.	Strong
25.	For adult with **COVID-19and acute hypoxemic respiratory failure** despite conventional oxygen therapy, we **suggest using** HFNX over conventional oxygen therapy.	Weak
26.	In adult with COVID-19 and **acute hypoxemic respiratory failure,** we **suggest** using HFNC over NIPPV.	Weak
27.	In adult with COVID-19 and **acute hypoxemic respiratory failure,** if HFNC is not available and there is no urgent indication for endotracheal intubation, we **suggest** a trial of NIPPV with close monitoring and short interval assessment for worsening of respiratory failure.	Weak

Sl no	Recommendation	Strength
28.	**We were not able to make recommendation regarding the use of helmet NIPPV** compared with mask NIPPV. It is an option, but we were not certain about its safety or efficacy in COVID-19.	No recommendation
29.	In adult with C**OVID-19 receiving NIPPV or HFNC, we recommend** close monitoring for worsening of respiratory status, and early intubation in a controlled setting if worsening occurs.	Beat practice statement
30.	In mechanically ventilated adults with COVID-19 and ARDS, we **recommend** using low tidal volume (Vt) ventilation (Vt 4-8 mL/kg of predicted body weight), over higher tidal volume(Vt>8 mL/kg).	Strong
31.	For mechanically ventilated adults with COVID-19 and **ARDS**, we **recommend**targeting plateau pressure (Pplat) of <30 cm H_2O.	Strong
32.	For mechanically ventilated adult with COVID-19 and moderate to severe ARDS, we **suggest** using a higher PEEP strategy, over a lower PEEP strategy. **Remarks:** if using higher PEEP strategy (i.e. PEEP>10 cm H_2O) clinician should monitor patients for barotrauma.	Strong
33.	For mechanically ventilated adult with COVID-19 and ARDS, we **suggest** using a conservative fluid strategy over a liberal fluid strategy.	Weak
34.	For mechanically ventilated adult with COVID-19 and **moderate to severe ARDS**, we **suggest** prone ventilationfor **12-16 hours**, over no prone ventilation.	Weak
35.1	For mechanically ventilated adult with COVID-19 and **moderate to severe ARDS**: We **suggest** using, as needed, intermittent boluses of neuromuscular blocking agent (NBMA), over continuous NMBA infusion, to facilitate protective lung ventilation	Weak
35.2	In the event of persistent ventilator dyssynchrony, the need for ongoing sedation, prone ventilation, or persistently high plateau pressure, we **suggest** using continuous NMBA infusion for upto 48 hours.	Weak

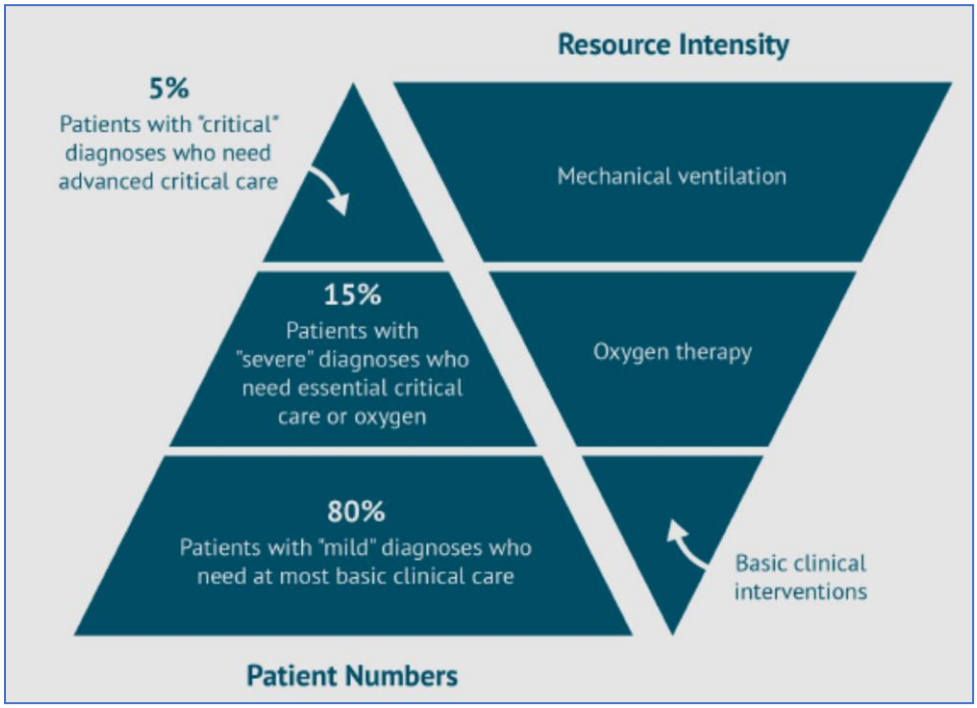
Sl no	Recommendation	Strength
36	In mechanically ventilated adult with COVID-19 ARDS, we **recommend against** the routine use of inhaled nitric oxide.	Weak
37	In mechanically ventilated adults with COVID-19, severe ARDS and hypoxemic despite optimizing ventilation and other rescue strategies, we **suggest** a trial of inhaled pulmonary vasodialtors as a recue therapy; if no rapid improvement in oxygenation is observed, the treatment should be tapered off.	Weak
38.	For mechanically ventilated adult with COVID-19 and hypoxemia despite optimizing ventilation, we **suggest**using recruitment maneuvers, over not using recruitment maneuvers.	Weak
39.	If recruitment maneuvers are used, we **recommend** against using staircase (incremental PEEP) recruitment maneuvers.	Strong
40.	In mechanically ventilated adults with COVID-19and refractory hypoxemia despite optimizing ventilation, use of rescue therapies, and proning, we **suggest** using venovenous (VV) ECMO if available, or referring the patient to ECMO center.. **Remarks:** Due to the resource intensive nature of ECMO, and the need for experienced centers and health care workers, and infrastructure, ECMO should be considered in carefully selected patients with COVID-19 and severe ARDS.	Weak
	Therapy	
41.	In mechanically ventilated adults with COVID-19 and respiratory failure (**without ARDS**), we **suggest against** the use of systemic corticosteroids.	Weak
42.	In mechanically ventilated adult with COVID-19 **and ARDS,** we suggest using systemic corticosteroid, over not using corticosteroids. Remarks: The majority of our panel support a weak recommendation (i.e. suggestion) to use steroids in the sickest patients with COVID-19 and ARDS. However, because of the very low- quality evidence, some experts on the panel preferred not to issue a recommendation until higher quality direct evidence is available.	Weak

Sl no	Recommendation	Strength
43.	In mechanically ventilated with COVID-19 and respiratory failure, we suggest using empiric antimicrobials/antibacterial agents, over no antibactrials. **Remark:** if the treating team initiates empiric antimicrobials, they should assess for de-escalation daily, and re-evaluate the duration of therapy and spectrum of coverage based on the microbiology results and the patient's clinical status.	Weak
44.	For critically adults with COVID-19 who develop fever, we **suggest**using acetaminophen/paracetamol for temperature control, over no treatment	Weak
45.	In critically adult with COVID-19, we **suggest against** the routine use of standard intravenous immunoglobulin (IVIgG).	Weak
46.	In critically adult with COVID-19, we **suggest against** the routine use of convalescent plasma	Weak
47.1	In critically adult COVID-19, we **suggest against** the routine use of lopinavir/ritonavir	Weak
47.2	There **is insufficient evidence to issue a recommendation** on the use of other antiviral agents in critically ill adults with COVID-19.	No recommendation
48.	There **is insufficient evidence to issue a recommendation** on the use of recombinant rIFNs, alone or in combination with antivirals, in critically adult with COVID-19.	No recommendation
49.	There is **insufficient evidence to issue a recommendation** on the use of chloroquine or hydroxychloroquine in critically ill adult with COVID-19	No recommendation
50.	There **is insufficient evidence to issue a recommendation** on the use of tocilizumab in critically ill adult with COVID-19	No recommendation

Annex (A): Proposed order of priority for respiratory support interventions.



Annex (B): Breakdown of patients with identified COVID-19 (left) and the spectrum of clinical intervention options focusing on breathing support (right).



Some Perals:

1. The interaction between these factors leads to development of a time related disease spectrum within two primary phenotypes

a) Type L characterized by	Low elastance (high compliance)
	Low ventilation perfusion ratio
	Low lung weight
	Low Recruitability.
b) Type H Characterized by	High elastance
	Hight right to left shunt
	High lung weight
	High recruitability.

COVID-19 pneumonia, Type L

At the beginning, COVID-19 pneumonia presents with the following characteristics:

- Low elastance: the nearly normal compliance indicates that the amount of gas in the lung is nearly normal.
- Low ventilation to perfusion (VA/Q) ratio: since the gas volume is nearly normal, hypoxemia may be best explained by the loss of regulation of perfusion and by loss of hypoxic vasoconstriction. Accordingly, at this stage, the pulmonary artery pressure, should be near normal.
- Low lung weight: Only ground-glass densities are present on CT scan, primarily located subpleurally and along the lung fissures. Consequently, lung weight is only moderately increased.
- Low lung recruitability: the amount of non-aerated tissue is very low, consequently the recruitability is low.

The evolution of the disease: Transitioning between phenotypes

The Type L patients may remain unchanging for a period and then improve or worsen the possible key feature which determines the evolution of the disease - other than the severity of the disease itself, is the depth of the negative intrathoracic pressure associated with the increased tidal volume in spontaneous breathing. Indeed, the combination of a negative inspiratory intrathoracic pressure and increased lung permeability due to inflammation, results in interstitial lung edema. This phenomenon, initially described by Barach in 1938 and Mascheroni in 1988 both in an experimental setting, has been recently recognized as the leading cause of Patient - Self Inflicted Lung Injury (P-

SILI). Over time, the increased edema increases lung weight, superimposed pressure, and dependent atelectasis. When lung edema reaches a certain magnitude, the gas volume in the lung decreases, and the tidal volumes generated for a given inspiratory pressure decrease. At this stage, dyspnea develops, which in turn leads to worsening P-SILI. The transition from Type L to Type H may be due to the evolution of the COVID-19 pneumonia on one hand and the injury attributable to high-stress ventilation on the other.

COVID-19 pneumonia, Type H

The Type H patient

- High elastance: The decrease of gas volume due to increased edema accounts for the increased lung elastance.
- High right-to-left shunt: This is due to the fraction of cardiac output perfusing the non-aerated tissue which develops in the dependent lung regions due to the increased edema and superimposed pressure.
- High lung weight: Quantitative analysis of the CT scan shows a remarkable increase in lung weight (> 1.5 kg), on the order of magnitude of severe ARDS.
- High lung recruitability: The increased amount of non-aerated tissue is associated, as in severe ARDS, with increased recruitability.

In conclusion, Type L and Type H patients are best identified by CT scan and are affected by different pathophysiological mechanisms. If not available, signs which are implicit in Type L and Type H definition could be used as surrogates: respiratory system elastance and recruitability. Understanding the correct pathophysiology is crucial to establishing the basis for appropriate treatment.

By lung USG we can differentiate type L and Type H

In type H there will be multiple B and C line with low PF ratio

But in L type there will be normal lung with A line with low to moderate PF ratio.

Contributors:

1. Professor Mozaffar Hussain, Dhaka Medical College, Email:mozaffer1963@gmail.com, Phone: 01713015380.
2. Dr. Fatema Ahmed. Associate Professor, Dept. of Critical Care Medicine, BIRDEM general Hospital.
3. Dr. Mohammad Asaduzzaman, Assistant Professor, Critical Care Medicine, Dhaka Medical College, Email: drasadccm@gmail.com Phone 01711736692
4. Dr. Ranjan Kumar Nath Professor& Head Dept. of Anaesthesiology & ICUChattogram Medical College Chattogram; Email: rknkazal@gmail.com, Phone: 01819315112
5. Dr. Ariful Basher. Resident, Critical care medicine, E-mail: ariful.dr@gmail.com; Phone: 01711-078752, BSSMU
6. Dr. Mohammed Abdur Rahaman Chowdhury, Anaesthesiologist ICU and Resident, Critical Care Medicine, CMCH, Emailmarahmanchy@gmail.com, Phone: 01558434300
7. Dr. Mamunur Rashid, Assistant Professor, Respiratory Medicine, NIDCH
8. Professor Md. Robed Amin, Professor of Medicine, Dhaka Medical College, Email: robedamin@yahoo.com, Phone: 01711-725787

Note: This is an ongoing document will be updated when new evidence are available. Comments are welcome.