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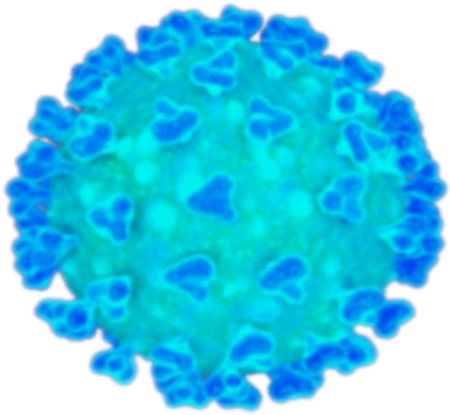

الإرشادات والتوصيات الخاصة بمرض كورونا المستجد-19 لممارسي الرعاية التنفسية في الجمهورية اليمنية

RCSA of COVID19 Guidelines for Respiratory Care Practitioners in Yemen

Respiratory Care Services Administration (RCSA)

Republic of Yemen

Disclaimer: *This guideline is subject to change as more evidence accumulates about the best practices in caring for patients with confirmed or suspected COVID-19. Please make sure to follow the most updated version of this guideline. This guidance is developed to assist healthcare practitioners according to the best available evidence and is not intended to replace clinical judgment.*

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Contents :

Preface :

These guidelines are adopted from many international resources aiming to providing recommendations for our frontlines **Respiratory Therapists in Yemen** on how to manage critically ill patients with **COVID19** , requiring invasive and non-invasive mechanical ventilation and other respiratory Therapy procedures .

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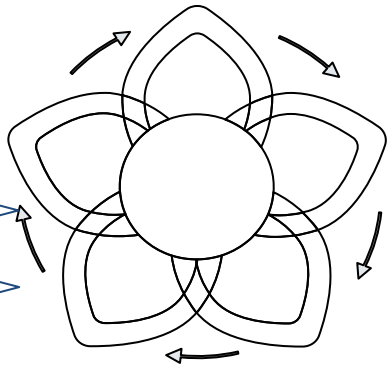

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What is a Respiratory Care ? :

Respiratory care, also known as **respiratory therapy**, has been defined as the health care discipline that specializes in the promotion of optimal cardiopulmonary function and health. **Respiratory therapists (RTs)** apply scientific principles to prevent, identify, and treat acute or chronic dysfunction of the **cardiopulmonary** system. Respiratory care includes the assessment, treatment, management, control, diagnostic evaluation, education, and care of patients with deficiencies and abnormalities of the cardiopulmonary system. **Respiratory care** is increasingly involved in the prevention of respiratory disease, the management of patients with chronic respiratory disease, and the promotion of health and wellness.

Who are Respiratory Therapists :

Respiratory therapists (RTs) are highly skilled health care professionals. They have specialized medical expertise and use their knowledge and skills to provide safe, high-quality care. If you have medical problems that may be caused by cardiorespiratory or respiratory-related issues, respiratory therapists are the experts who will work with you to diagnose, treat and manage your condition.

Where do respiratory therapists work?

Respiratory therapists work within and outside of the hospital setting and with all patient/client age groups. They work in many areas of the health care sector, including:

- Intensive care units
- Emergency departments
- Operating rooms
- Neonatal nurseries
- General wards
- Outpatient clinics
- Pulmonary function labs, sleep labs and other diagnostic clinics
- Patient/client homes
- Community health centers
- Educational institutions

What does a respiratory therapist do?

Respiratory therapists perform a number of vital roles throughout the health care system. They:

- are members of interprofessional health care teams
- are members of resuscitation and rapid response teams
- assess and treat patients who have breathing difficulties
- perform a variety of interventions to support the cardiopulmonary system
- administer various medical gases (e.g. oxygen) and medications
- conduct cardiopulmonary function testing to diagnose, track and manage cases of respiratory disease
- provide and maintain mechanical ventilators for patients suffering from respiratory failure
- assist in the delivery of anesthesia
- provide respiratory care for both the mother and baby in high risk deliveries
- keep patients stable and breathing during transitions within and between health care facilities
- visit and educate patients who require home oxygen and other respiratory care in their homes
- assist patients who require long-term ventilation to return to their homes
- perform or assist with the insertion of artificial airways and invasive lines (e.g. IVs)
- provide education to patients/clients, students and other members of the health care team
- advance the practice of respiratory therapy by doing research and creating practice guidelines
- fulfill managerial and administrative positions
- work in private industry (e.g. sales and clinical support)

Background:

The first cases of coronavirus disease 2019 (COVID-19) were reported from Wuhan, China in early December 2019 **[1],** now known to be caused by a novel beta-coronavirus, named as Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Within a span of months COVID 19 has become pandemic due to its transmissibility, spreading across continents with the number of cases and deaths rising daily **[2].** Although most infected individuals exhibit a mild illness (80%+), 14% have serious and 5% have critical illness. Approximately 10% will require hospital admission due to COVID-19 pneumonia, of which approximately 10% will require ICU care, including invasive ventilation due to acute respiratory distress syndrome (ARDS) **[3].** While mortality appears to be more common in older individuals and those with comorbidities, such as chronic lung disease, cardiovascular disease, and diabetes, young people with no comorbidities also appear to be at risk for critical illness including multi-organ failure and death.

There has been an expanding number of studies rapidly published online and in academic journals; however, some of these may be of limited quality and are pre-published without sufficient peer-review. Critical appraisal of the existing studies is needed to determine if the existing evidence is sufficient to support currently proposed management strategies.

Given the rapid global spread of SARS CoV-2 and the difficulty for the overburdened front-line providers and policymakers to stay up to date on emerging literature, IDSA has recognized the necessity of developing a rapid guideline for the treatment of COVID-19. The guideline panel used a methodologically rigorous process for evaluating the best available evidence and providing treatment recommendations. Two additional guidelines on diagnostic testing and infection prevention are also under development. These guidelines will be frequently updated as substantive literature becomes available and will be accessible on an easy to navigate web and device interface at http://www.idsociety.org/covid19guidelines .

These recommendations are intended to inform patients, clinicians, and other health professionals by providing the latest available evidence.

The **Republic of Yemen reported its' first confirmed case on the 10th** of April 2020, and currently had a total **only 1 confirmed case**. The most recently discovered coronavirus causes coronavirus disease COVID-19.

Definition of COVID-19 :

COVID-19 is a pandemic with a rapidly increasing incidence of infections and deaths. Many pharmacologic therapies are being used or considered for treatment. Given the rapidity of emerging literature, IDSA identified the need to develop living, frequently updated evidence-based guidelines to support patients, clinicians and other health-care professionals in their decisions about treatment and management of patients with COVID-19 infection.

Mode of transmission:

Early reports suggest person-to-person transmission most commonly happens during close exposure to a person infected with COVID-19, primarily via respiratory droplets produced when the infected person coughs or sneezes. However, airborne transmission from person-to-person over long distances is unlikely.

Droplet transmission:

The virus is released in the respiratory secretions when an infected person coughs, sneezes or talks. These droplets can infect others if they make direct contact with the mucous membranes. Infection can also occur by touching an infected surface and followed by eyes, nose or mouth. Droplets typically do not travel more than six feet (about two meters) and do not linger in the air. However, given the current uncertainty regarding transmission mechanisms, **airborne precautions are recommended** routinely in some countries and in the setting of specific high risk procedures. Patients are thought to be most contagious when they are symptomatic. Some spread might be possible before symptoms appear, but this is not thought to be a common occurrence.

Basic Information :

- Caused by a virus thought to be **Droplet** Transmission but also uncertainty as to whether it is **Airborne**. (JAMA, WHO)
- Incubation is thought to be 2-14 days after exposure (average is 5 days) (WHO)
- Current evidence supports a patient having immunity once recovered - presence of antibodies (CDC)

- One estimate suggests 3% of all COVID-19 pts require intubation, with about a 50% survival chance on the ventilator (Meng, et. al), some report mortality as high as 81% (Weis, et. al)
- Severe (dyspnea, hypoxia, > 50% lung involvement) occurs around 14% of cases, Critical (resp failure, shock, multi-system organ failure) occurs around 5% of cases (CDC)
  Overall case fatality is around 2.3%, but closer to 50% in those with severe COVID-19. ICU mortality ranges from 39%-72% (CDC)

- CT scan is more helpful than CXR, but either may indicate bilateral, peripheral ground-glass opacities (CDC, Pan et. al)
- While more rare in children, often presents initially as a mild flu-like illness, more likely to be mild symptoms (Guo, et. al, Wei, et. al)
- Avoid PFTs unless critical for immediate treatment, then use only absolutely necessary tests (IPC, ATS)

Clinical Progression :

Some have suggested multiple phenotypes for the virus (no data to support - purely theoretical), each with a different clinical progression. Easy way to differentiate? Check the Lung Compliance. (Gattinoni, et. al; ESICM)
Take-Home Message: pay attention to the "story" your assessment is telling you. Most major consensus supports ARDSnet strategies currently (lung protection), but information is changing quickly, too:

- **Phenotype L:** focus is on hypoxia-driven disregulation of pulmonary perfusion (Low elastance, Low V/Q, Low recruitability, Low PEEP response)
  Note that these patients often have normal lung compliances, good plateau pressure, lower driving pressures. Consider not using high PEEP - this is not ARDS (high PEEP may worsen V/Q matching in this case, may affect cardiac function, especially the right ventricle/cor-pulmonale). May be more responsive to inhaled pulmonary vasodilators.
- **Phenotype H:** focus is on pulmonary edema/collapse - ARDS-like (High lung elastance, Higher recruitability, High Right-to-Left shunt, Higher PEEP response)
  These patients have lower lung compliance, higher driving pressures.
  High PEEP and proning is likely a critical aspect of management
- In addition, patients may transition from Phenotype L to Phenotype H, an important observation during care due to the change in strategy.

Watch for signs of deterioration:

Note that while onset of symptoms, such as dyspnea, is relatively late (around 6-7 days after symptoms start), the progression to distress/need for vent is quick. (Wang, et. al; Zhou, et al.). Many reports of patients going from stable to crashing within hours, not days.

- Increased O2 needs, especially if supplemental O2 doesn't increase SpO2/PaO2 (suggesting V/Q imbalance)
    - Increased A-a gradient with ABG, decreased P/F ratio
    - Consider intubation once SpO2 < 90-92% with FIO2 0.60 or higher (CP; ESICM)
- Tachypnea (RR > 30) is quite common with distress,
    - so may present as respiratory alkalosis initially (usually with significant hypoxia)
- Indications of shortness-of-breath (speaking in shorter sentences, for example), Dyspnea
- Diaphoresis is concerning sign (indicates potential for near-respiratory-arrest)
- Lack of improvement on noninvasive strategies (HFNC, noninvasive CPAP or NPPV), hemodynamic instability should be seen as a concerning sign (consider intubation) **Strongly consider Intubation**

Personal Protective Equipment (PPE):

Remember: Protect yourself and others from potential exposures. Equipment must be worn correctly to be effective (See CDC 3 Keys for Respiratory Effectiveness, See CDC Mask Seal Self-Check)

Our Summary:

- Evidence is consistently emerging to support aerosolized transmission risks at all times. This is supported also by rate of transmission.
- It is important to recognize that while we use the term *airborne* to refer to a certain diameter size (MMAD), indeed droplets can still become aerosolized and travel beyond 6-feet (encapsulated, avoiding evaporation) (JAMA)
- There is absolute evidence to support certain activities guaranteeing airborne transmission (see list below in this section), and these should be performed using airborne precautions (including N95 or higher mask), without exception. It is our belief that if adequate PPE is not available, those so-called aerosol-producing procedures simply cannot be performed in a safe manner.
- Studies of "viral load" support that greatest risk is closest to the patient, and when performing aerosol-generating-procedures. Because of diffiusion, that viral load decreases the further from the patient you are.
- In our thinking: if there is any increased risk, and certianly there seems to be, the higher level of protection should be strictly followed (N95 or above). While we understand PPE shortages are driving difficult decisions, for adequate healthcare provider protection, this is a necessity.

Current Published Guidelines

- **Direct Care**: Surgical mask, Gown, Gloves, Eye Protection (shield or goggles) for direct-care (WHO; CDC; SCCM)
- **Aerosol-Producing Procedures**: N-95 or above mask, Gown, Gloves, Eye Protection (shield or goggles) (WHO; CDC; SCCM)
- **Some are recommending** consideration for both airborne and droplet precautions, deferring to local standards (AHA)
- **Healthcare workers exposed to coronavirus** are now permitted to stay at work as long as they are asymptomatic, take daily temp, and wear a face mask (CDC)

For ANY aerosol-producing procedure, including much of what respiratory does, only perform absolutely necessary procedures, and then airborne precautions are recommended (including N-95 or above mask), as well as eye protection, gloves, gown, Negative Pressure room is ideal (CDC; WHO; SCCM). Includes from the sources:

- Manual Resuscitation (bagging)
- Noninvasive Ventilation
- Intubation/Tracheostomy
- Bronchoscopies
- CPR efforts (compressions + bagging)
- Bronchial Hygiene, including Suctioning
- Aerosolized Medications (including Nebulizer Treatments)
- Proning a patient
- Sputum Induction

Note: In the studies reported (see the sources in blue in this section), there is an indication that N-95 masks are safer in all situations, but were not found to be "statistically" so. We recommend protecting yourself from exposure when in doubt, with a consideration for equipment availability in higher-risk situations.

- **Clinicians who are reusing N95 masks report placing a surgical mask over the N95 to protect it some**

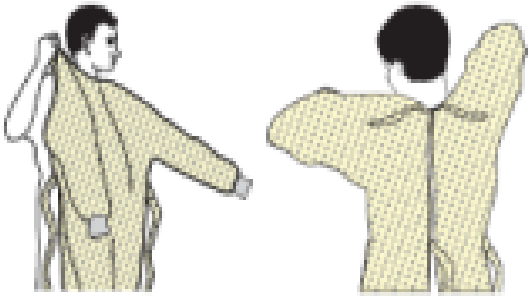
SEQUENCE FOR PUTTING ON or DONNING PERSONAL PROTECTIVE EQUIPMENT (PPE)

Isolation Precautions for Patients with Aerosol Generating Procedure with N-95 and Face Shield

1. Perform HAND HYGIENE

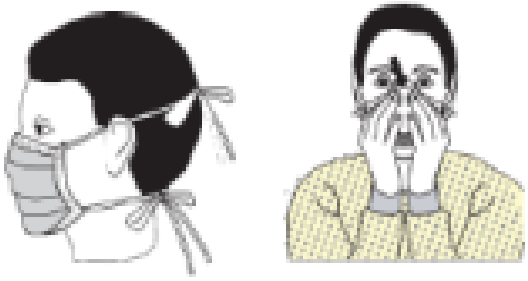
2. GOWN

- Fully cover torso from neck to knees, arms to end of wrists, and wrap around the back
- Fasten in back of neck and waist



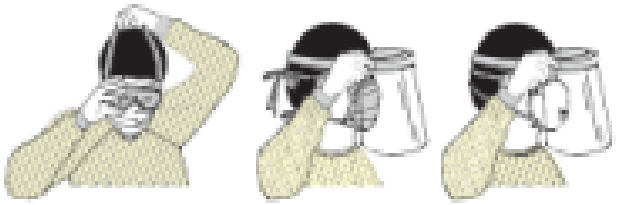
3. N-95

- Secure elastic bands at middle of head and neck
- Fit flexible band to nose bridge
- Fit snug to face and below chin
- Fit-check respirator (see manufacturer directions)



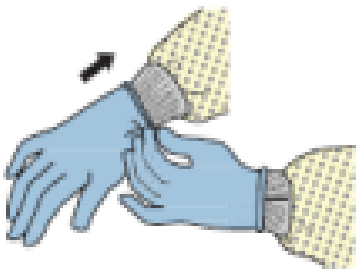
4. FACE SHIELD

- Place over face and eyes and adjust to fit



5. GLOVES

- Extend to cover wrist of isolation gown



USE SAFE WORK PRACTICES TO PROTECT YOURSELF AND LIMIT THE SPREAD OF CONTAMINATION

- Keep hands away from face
- Limit surfaces touched
- Change gloves when torn or contaminated
- Perform hand hygiene

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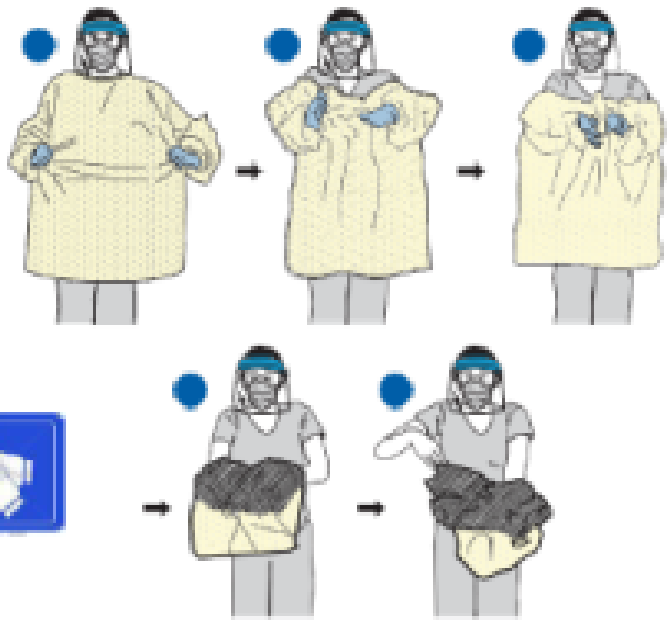
HOW TO SAFELY REMOVE or DOFF PERSONAL PROTECTIVE EQUIPMENT (PPE)

Isolation Precautions for Patients with Aerosol Generating Procedure with N-95 and Face Shield

1. GOWN AND GLOVES

- Gown front and sleeves and the outside of gloves are contaminated!
- Untie the gown ties, then grasp the front of the gown and pull away from your body, touching only the outside of gown with gloved hands
- While removing the gown, roll the gown inside-out into a bundle
- Peel off your gloves at the same time, only touching the inside of the gloves and gown with your bare hands. Discard the gown and gloves into a waste container.



Perform HAND HYGIENE

2. EXIT ROOM & CLOSE DOOR

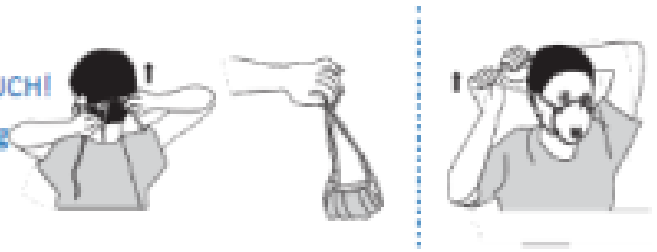
3. FACE SHIELD

- Outside of face shield is contaminated!
- Remove face shield from the back by lifting head band and without touching the front
- Wipe with a disinfectant wipe and allow to dry.
- Store in a plastic bag and label with name

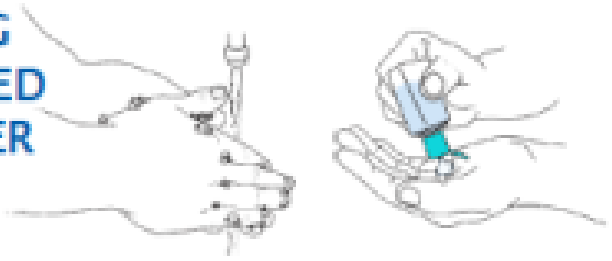
Perform HAND HYGIENE

4. MASK OR RESPIRATOR

- Front of the N 95 respirator is contaminated — DO NOT TOUCH!
- Grasp the bottom strap and pull over head without touching the front of the mask
- Grasp the top strap, and pull away from face completely.
- Discard in a waste container



5. Perform HAND HYGIENE by WASHING HANDS OR USING AN ALCOHOL-BASED HAND SANITIZER IMMEDIATELY AFTER REMOVING ALL PPE



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Airway Management :

The most appropriate airway manager:

We recommend that the 'most appropriate' clinician manages the airway. This is to enable successful airway management that is safe, accurate and swift. Deciding who is the most appropriate airway manager requires consideration of factors such as the available clinicians' airway experience and expertise, whether they fall into any of the groups of clinicians who would be wise to avoid tracheal intubation, the predicted difficulty of airway management, its urgency and whether an tracheal intubation team is available. On occasion this may necessitate senior anaesthetists managing airways in lieu of junior anaesthetists or intensivists who do not have an anaesthesia background. However, it is unlikely and unnecessary that tracheal intubation will be the exclusive preserve of one specialty. Judgement will be required.

A- Briefly Points :

1- Intubation:

- **Do not delay intubation if the patient is worsening or is pre-code (unstable) - Proactive Intubation is Preferred** (APSF)
- **If trialing HFNC or BiPAP/CPAP: if no improvement within 1-2 hours (distress, RR, P/F<150), intubation is recommended** (Meng, et. al)
- **Intubation is high-risk for exposure to COVID19 - take every precaution possible.**

COVID-19 airway management: SAS	
Safe	for staff and patient
Accurate	avoiding unreliable, unfamiliar, or repeated techniques
Swift	timely, without rush or delay

2- Preparation of Intubation :

- **Personal Protective Equipment:** Airborne (a must!) + Contact = N95 or higher, gown, gloves, goggles/face shield
- Least # people possible in room, close door during intubation and for a period after (AHA, WHO)
- Consider use of a covering over patient's head during intubation - large clear trash bag, O2 tent, etc., to decrease aerosolization risks SEE 1 Video Demo , see NEJM correspondence. Citzens-Against-COVID-19 lists sources for purchasing these supplies
- Use of (preferably dedicated or disposable) fiber-optic equipment is highly recommended. It prevents exposure (looking directly into the airway) and improves chances of intubating successfully (see video demo from ATS) (APSF)
- Oxygenating
  - Either NO bagging (use NRB to minimize aerosolization) OR Hepa/Viral filter in between Resuscitator Bag and Mask with GENTLE breaths only (AHA, ASPF; CTS, Wax & Christian; Sorbello, et. al, Cheung, Tran, et. al)
  - Consider passive supplemental oxygen with NC during intubation attempts (6 L/min) - do not use HFNC due to exposure risk (Sorbello, et. al)

- Team should have a discussed plan, all know part, closed-loop communication at all times. Consider Mock Intubations to practice (APSF)
- Because the goal is to minimize all exposures (and disconnections), the ventilator should be ready, in stand-by, Resuscitation bag should be ready with filter
- **There is no "Emergency" intubation** - all PPE must be donned appropriately to minimize risk.

3- During Intubation

- Prioritize using the person who has the most experience/skill with intubating to avoid multiple attempts.
- When possible, oxygenate for 5 minutes before RSI (using NRB if not bagging) (APSF)
- **Expect no respiratory reserve** (due to hypoxemic respiratory failure): SpO2 may drop quickly during attempt (Meng, et. al)
- Use Rapid Sequence Intubation (RSI) unless difficult airway identified (assess the airway if time) - RSI should decrease time, decrease cough-risk during attempt.
- If possible, **have 2 people confirm ET tube through vocal cords using video laryngoscope** (especially if not using colorimetric ETCO2)
- If unable to obtain airway, may need to provide GENTLE breaths with Resuscitation bag (if using), some recommend Max 2-3 attempts, then place supra-glottic device (such as LMA) (Sorbello, et. al)

4- Post-Intubation :

- **Finger occlude ET tube as soon as it is placed and stylet out, then place on vent (or bag), Clamp ET tube if any delay (Kelly Clamps, 4x4 Gauze)**
- **Reports are that patients are rapidly desaturating right after intubation (derecruitment ?)**
- Some hospitals report intubating, then placing directly on ventilator for tube placement confirmation with ETCO2 (again, this avoids droplet aerosolization) = avoiding colorimetric capnography (EZ-Cap). If in-line ETCO2 not an option, consider using alternative methods of confirming placement - chest rise on vent, breath sounds, depth marking on ET tube, then follow-up CXR.

3- Extubation :

- **Most prefer a protected extubation which means treating as a very high-risk procedure and minimizing exposures at each step**
- Normally many clinicians take an aggressive approach to weaning and extubating. There are some anecdotal reports of patients having early relapses, so keep that in mind before extubating (GIVIT Mtg). Extra caution now due to the exposure risks that would be associated with reintubation.
- Airborne and Contact precautions required - this is a high-risk for aerosolization procedure
- Limit the number in the room (preferably 2) (Tan, et. al)
- **Recommended Procedure** (Tan, et. al)
    - Pre-oxygenate (FIO2 1.0 x 3 minutes)
    - Consider using 2 "chux" pads, one on pt chest (pad side up), one over pt face (pad side down) - pad sides face each other.
    - Gentle oral suction
    - Suction through in-line suction via ET tube
    - Remove ET tube stabilization/tie while holding ET tube in place
    - Turn Ventilator to Stand-by or OFF (especially if it could auto-restart), cap end
    - Deflate cuff and extubate - no further suctioning, do not instruct patient to cough. Used ET tube should end up in between chux pads.

    - Others (not source cited) recommend having in-line suction ON when deflating cuff, leaving suction on through the extubation maneuver to minimize aerosolization.
    - Place O2 mask on patient immediately as tube is removed to minimize cough exposure (most recommend not using NC, consider NRB mask or Venturi mask)
    - Consider transitioning to nasal cannula as patient settles and stops coughing
- Remain cautious about considering NPPV or HFNC as a bridge post-extubation (ANZICS), others recommend avoiding if possible (Tan, et. al)

- **Unplanned Extubation:** Not an emergency - MUST take the time to put Airborne and Contact PPE on correctly. TURN OFF VENTILATOR as soon as safely possible. Place on NRB mask if not using manual resuscitation in hospital, if using consider 2-handed technique with bagging to avoid exposure. Assess patient for need for reintubation. (Tan, et. al)

- **Terminal Wean:** Some facilities report placing patients on Room Air, CPAP +5 instead of extubating with the goal of preventing unnecessary exposure/aerosolization risk.

- **Post-Mortem Extubation**: If patient dies prior to extubation, airborne and contact precautions still necessary, ENSURE VENTILATOR IS OFF BEFORE DISCONNECTING. Some recommend:

- Turn off ventilator
- Clamp endotracheal tube
- Disconnect the ventilator and immediately cap it
- Leave patient intubated, leave clamped, or consider immediately placing filter and cap on end of endotracheal tube

5- General Airway Management

All tasks should be performed with the goal of minimizing exposures, avoiding aerosolization of secretions

- **Minimize disconnects from vent whenever possible**
- When disconnecting from vent circuit:
    - **consider clamping endotracheal tube** (use flat Kelly Clamp (no teeth with a 4x4 gauze) until reconnected to bag-valve-mask, etc. or cover the end of the vent circuit with a gloved hand while disconnecting to minimize aerosolizing droplets
    - Some report a bolus of sedation if necessary (avoid coughing) (Sorbello, et. al)
    - Some report placing ventilator in stand-by mode prior to disconnecting/clamping (Sorbello, et. al)
- If bagging at your facility, use a **HEPA, viral/bacterial filter** between Resuscitator Bag (BVM) and the artificial airway.
- If possible, avoid procedures that increase exposure-risk, including trach placement/change, bronchoscopies, etc.
- Ensure cuff pressures between 25-30 cmH2O (ensures appropriate seal with airway) - no evidence for over-inflating cuff .

B-Detailed Airway Management with COVID19 Patients :

Fundamentals of airway management for a patient with suspected or confirmed COVID-19:

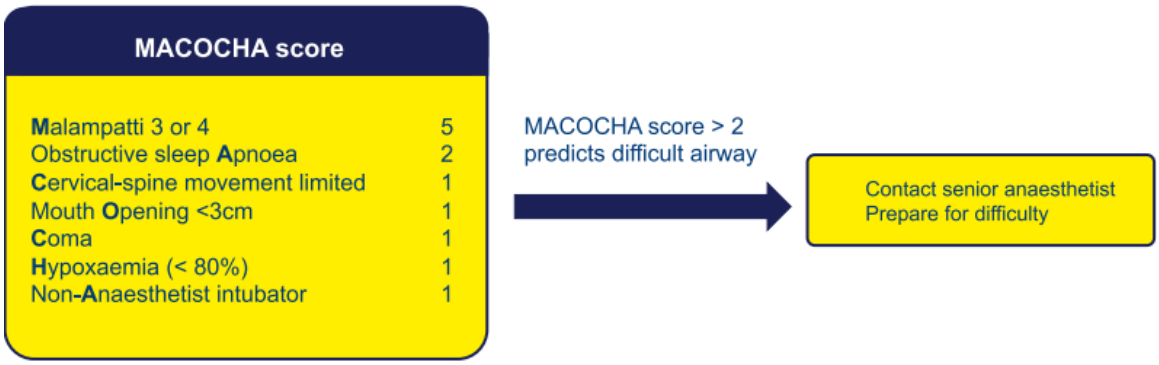
Airway management for patients who are suspected or confirmed to have COVID-19 follows similar principles in both emergency and non-emergency settings

1. **Prepare.**

A- Institutional preparation (equipment for routine management and for managing difficulty; adequate numbers of appropriately trained staff; availability of tracheal intubation checklists; PPE etc.) should be in place well before airway management occurs. If this does not already exist, it is strongly recommended it is put in place urgently. Resources from this guideline may form part of that preparation.

B- Team and individual preparation require knowledge of the institutional preparation, the skills required, how to use PPE correctly and assessment of the patient's airway to predict difficulty and prepare the airway strategy

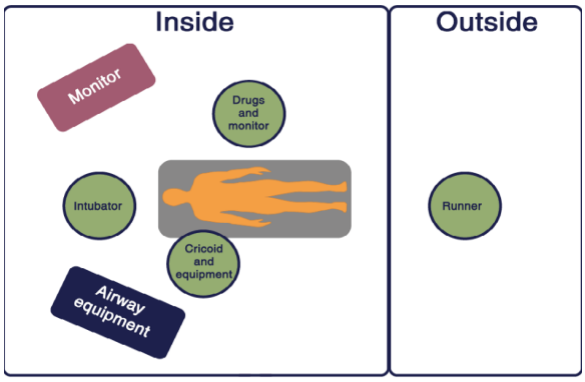
It is accepted that **MACOCHA** (**M**alampatti, obstructive sleep **A**pnoea, **C**-spine movement , mouth **O**pening, **C**oma, **H**ypoxaemia, non-**A**naesthetist intubator) is not widely used but it is validated and recommended.



2. **Create a COVID-19 tracheal intubation trolley or pack.** Critically ill patients may need to be intubated in a location other than ICU. On ICU, tracheal intubation will likely take place in single rooms. Prepare a tracheal intubation trolley or pack that can be taken to the patient and decontaminated after use.

3. **Have a strategy**. The airway strategy (the primary plan and the rescue plans, and when they are transitioned to) should be in place and the airway team briefed before any part of airway management takes place.

4. **Involve the smallest number of staff necessary**: This is not an argument for solo operators but staff who have no direct role in the airway procedure should not unnecessarily be in the room where airway management is taking pace. Three individuals are likely required:



- **An intubator.**
- **An assistant**
- **Third person to give drugs and watch monitors.**
- **A runner should be watching from outside** and be able to summon help rapidly if needed .

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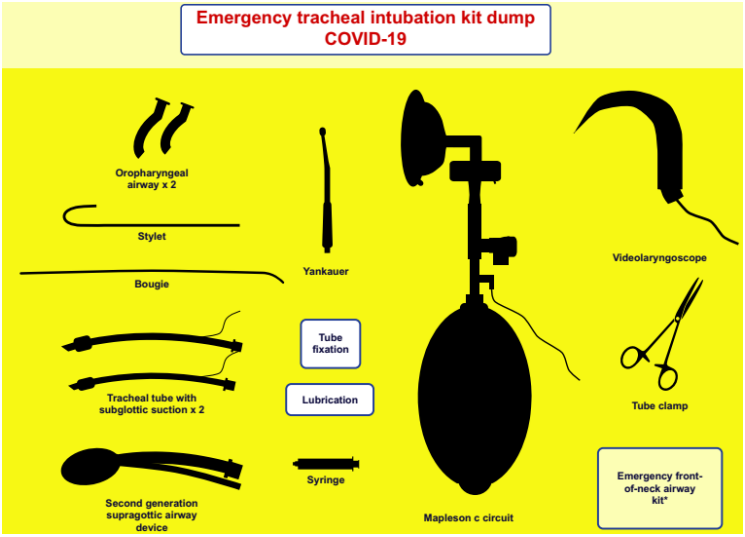
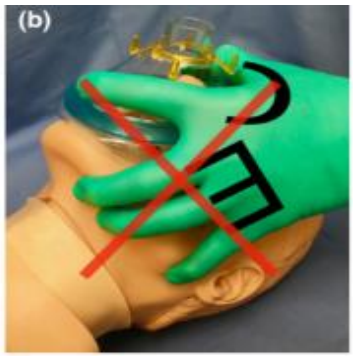
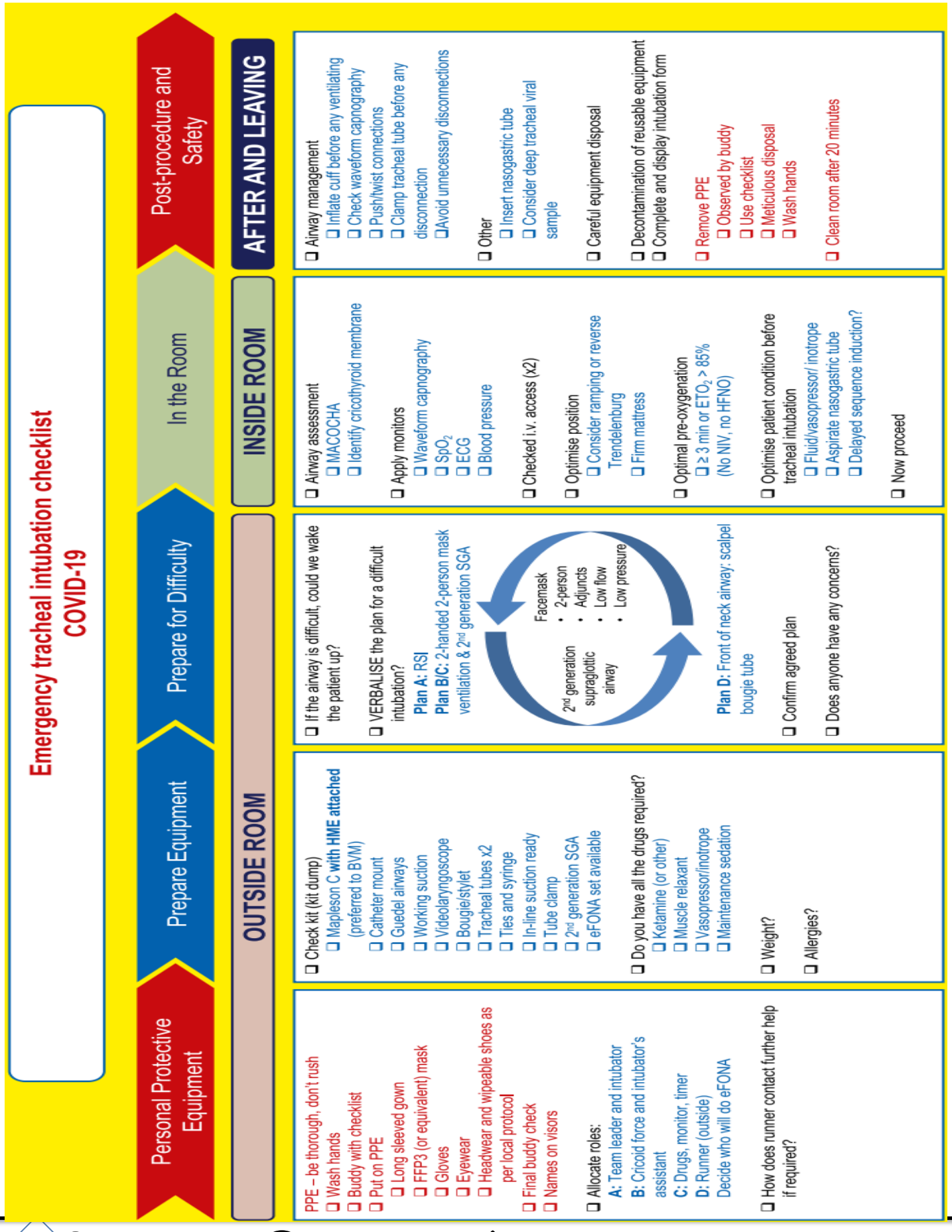
5. **Wear appropriate, checked PPE** . Even in an emergency and including cardiac arrest, PPE should be in worn and checked before all airway management and staff should not expose themselves to risk in any circumstance.
6. **Avoid aerosol-generating procedures wherever possible**. If a suitable alternative is available, use it. If aerosol generation takes place, the room is considered contaminated, airborne precaution PPE should be used and the room should be deep cleaned after 20 min [24].
7. **Focus on promptness and reliability.** The aim is to achieve airway management successfully at the first attempt. Do not rush but make each attempt the best it can be. Multiple attempts are likely to increase risk to multiple staff and to patients.

8. **Use techniques that are known to work reliably across a range of patients**, including when difficulty is encountered. The actual technique may differ according to local practices and equipment. Where training and availability is in place this is likely to include:
   a. **Use of a kit dump mat.**
   b. Video laryngoscopy for tracheal intubation;
   c. A 2-person 2-handed mask ventilation with a VE-grip.
   d. A second-generation supraglottic airway device (SGA) for airway rescue (e.g. i-gel, Ambu Aura Gain, LMA ProSeal, LMA Protector).
9. **The most appropriate airway manager should manage the airway**.
10. **Do not use techniques you have not used before** or are not trained in. Again, for the reasons stated above, this is not a time to test new techniques.
11. **Ensure all necessary airway kit is present in the room** before tracheal intubation takes place. This includes the airway trolley and a cognitive aid consistent with the rescue strategy.
    a. Monitoring including working continuous waveform capnography
    b. Working suction
    c. Ventilator set up
    d. Working, checked intravenous (i.v.) access
12. **Use a tracheal intubation checklist** and also see Supporting Information, Appendix S2). This is designed to aid preparedness and should be checked before entering the patient's room as part of preparation.
13. **Use a cognitive aid if difficulty arises** . Airway difficulty leads to cognitive overload and failure to perform optimally. A cognitive aid will help focus the team and enhance transitioning through the algorithm. Two algorithms are provided: that derived from the Difficult Airway Society (DAS) 2018 guidelines for tracheal intubation of the critically ill [20] has intentionally been reduced in scope and choices removed to accommodate the current setting and encourage reliable and prompt decision-making and actions.

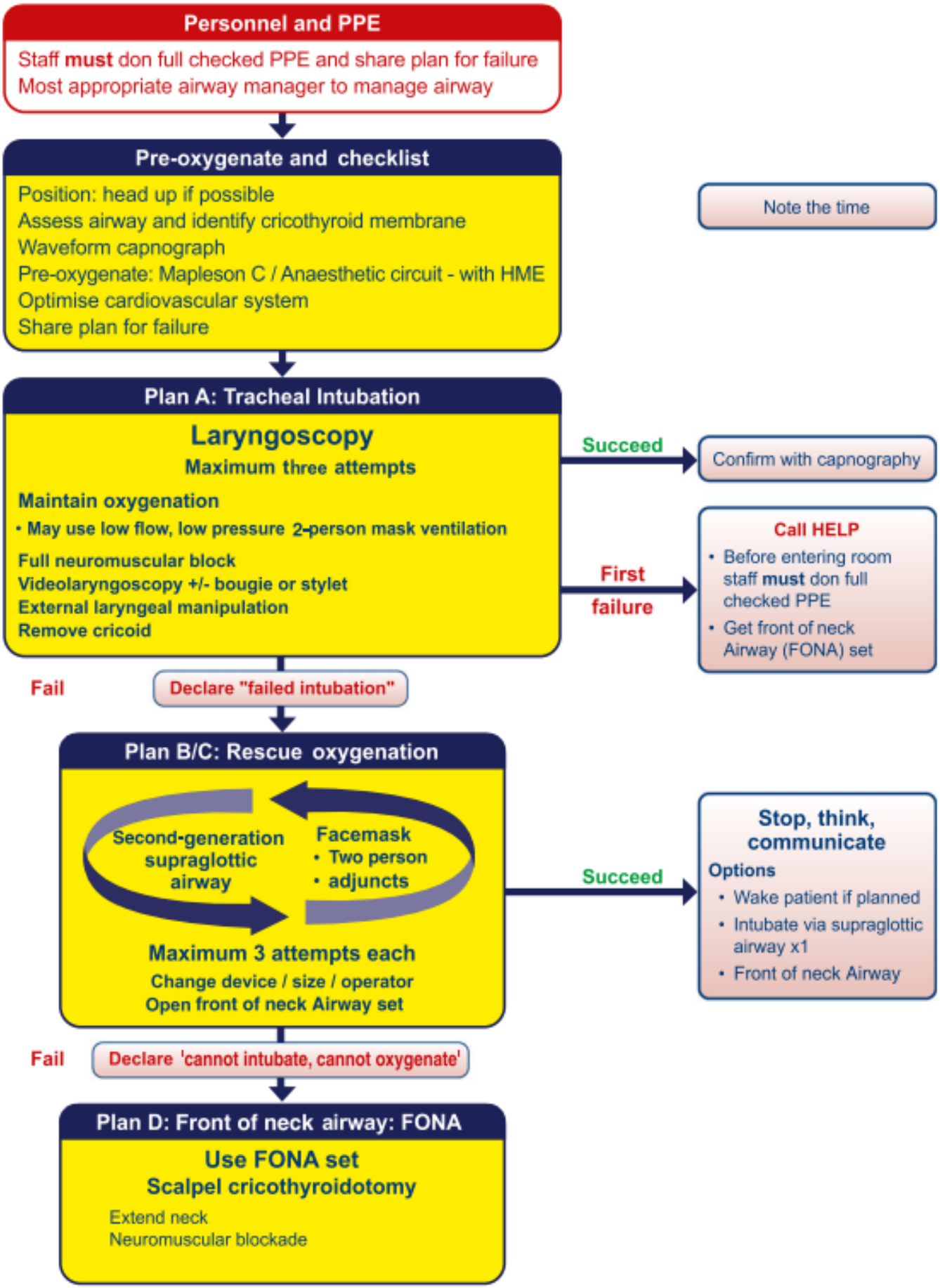




14. **Use clear language and closed loop communication**. It may be hard to communicate when wearing PPE and staff may be working outside normal areas of practice. Give simple instructions. Speak clearly and loudly, without shouting. When receiving instructions repeat what you have understood to the person speaking. If team members do not know each other.



Tracheal intubation of critically ill adults
Adapted for COVID-19



This flowchart forms part of the 2020 COVID-19 Airway Guideline for tracheal intubation. Refer to the full document for further details.

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Cannot Intubate,Cannot Oxygenate (CICO) in critically ill adults

Adapted for COVID-19

Call for help

↓ **Declare 'cannot intubate, cannot oxygenate'**

Plan D: Front of neck Airway: FONA

Extend neck

Ensure neuromuscular blockade

Exclude oxygen failure and blocked circuit

Personnel and PPE

New staff **must** don full checked PPE

Most appropriate airway manager to perform FONA

Scalpel cricothyroidotomy

Equipment:
1. Scalpel (wide blade e.g. number 10 or 20)
2. Bougie (≤ 14 French gauge)
3. Tube (cuffed 5.0-6.0 mm ID)

Laryngeal handshake to identify cricothyroid membrane

Palpable cricothyroid membrane

Transverse stab incision through cricothyroid membrane

Turn blade through 90° (sharp edge towards the feet)

Slide Coudé tip of bougie along blade into trachea

Railroad lubricated cuffed tube into trachea

Inflate cuff, ventilate and confirm position with capnography

Secure tube

Impalpable cricothyroid membrane

Make a large midline vertical incision

Blunt dissection with fingers to separate tissues

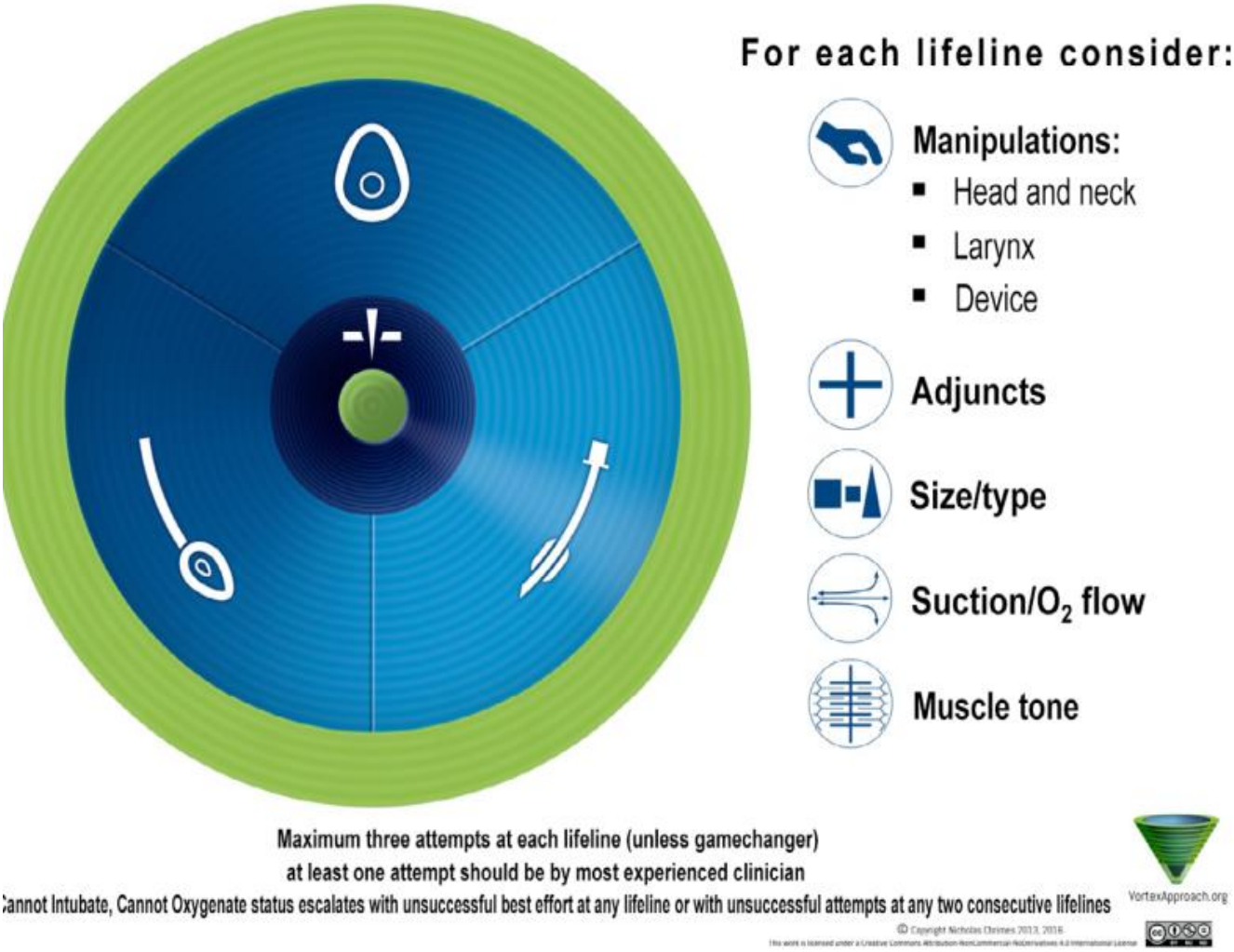
Identify and stabilise the larynx

Proceed with technique for palpable cricothyroid membrane as above

Post-FONA care and follow up

- Closed tracheal suction
- Recruitment manoeuvre (if haemodynamically stable)
- Chest X-ray
- Monitor for complications
- Surgical review of FONA site
- Agree airway plan with senior clinicians
- Document and complete airway alert

This flowchart forms part of the 2020 COVID-19 Airway Guideline for tracheal intubation. Refer to the full document for further details.



Cognitive aids for use when managing unexpected difficulty when intubating a patient with coronavirus disease 2019

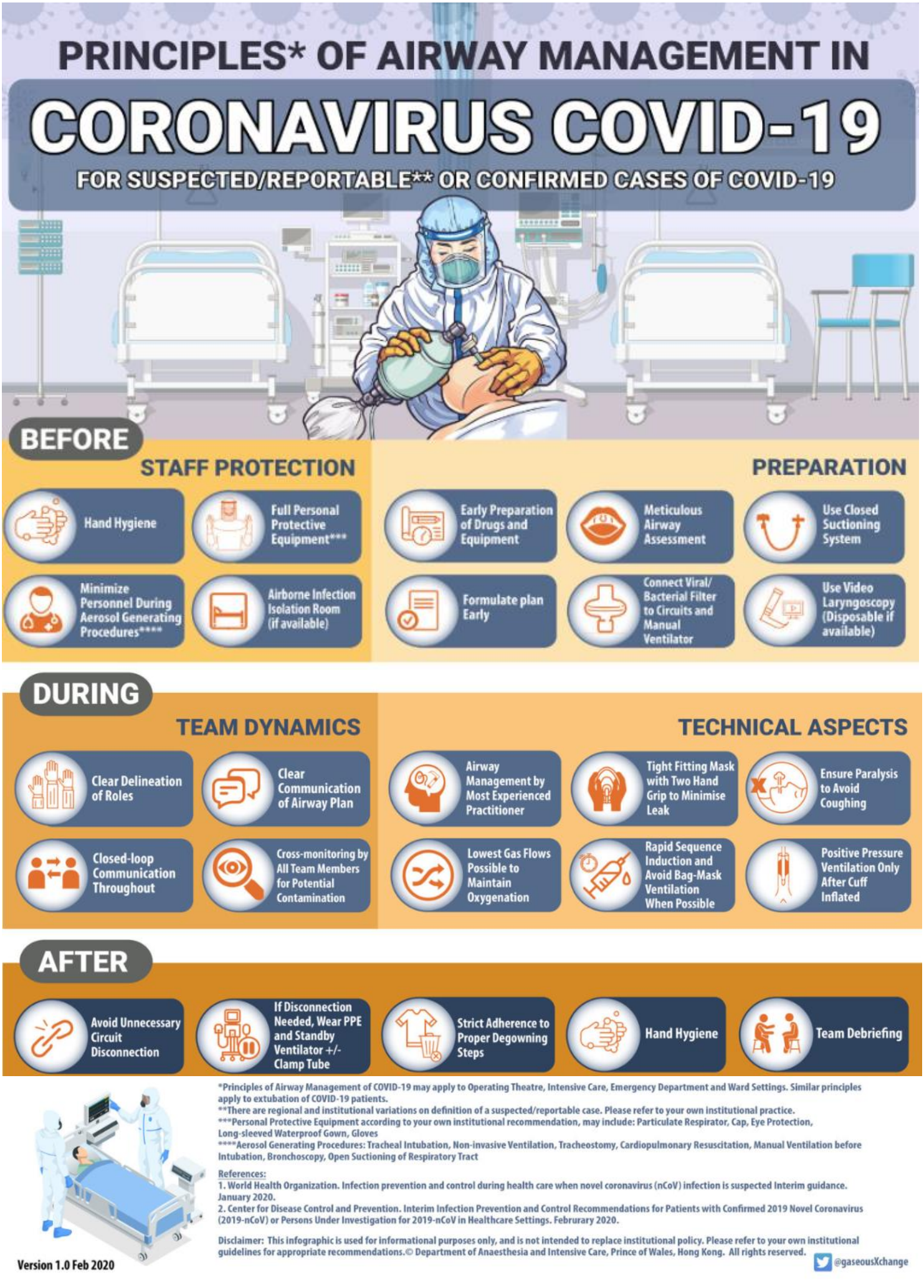


Figure 5 Checklists (b) from [26] reproduced with permission of Dr A Chan. Department of anaesthesia and Intensive Care, Chinese University Hong Kong

15. Bronchoscopy :

General Precautions for performing non-urgent bronchoscopy among patients WITHOUT suspected COVID-19 infection:

- Postponing non-urgent bronchoscopy procedures.
- High-Risk due to potential exposures: priority use of PPE (N-95, Face shield, gown, gloves)
- Bronchoscopy should not be done only for the purpose of ruling COVID-19, but consider for mucous plugs or to specifically r/o alternative diagnoses (TB, other pneumonias)
- Negative pressure room if available
- Minimize disconnections, use of bronchoscopy adapter on ET tube is recommended
- Standard disinfection protocols should be followed for cleaning your flexible bronchoscopes and video monitors.

16. Pulmonary Function Tests (PFTs):

- All kinds of pulmonary function tests should be avoided among patients with a strong suspicion of upper or lower Respiratory tract infection.
- In COVID 19 endemic zones it would be wise to avoid PFTs for a major proportion of patient to avoid spread of infection and usage of PFT should be limited for time being for only pre-operative assessment.
- All patients who are enrolled to perform a PFT should be segregated, since this helps in preventing the spread of infection.
- Contact in waiting room with potentially infectious patients should be minimized.
- All connections between the patient and the PFT machine (tubing's & valves) should be cleaned and disinfected before re-use.
- Disposable items in PFT lab like mouth pieces and filter can be a reservoir of microorganisms and hence should be disposed carefully.
- Usage of personal protective equipment helps in reducing the risk of cross contamination.

17. Pulmonary Hygiene Therapy PHT:

- Avoid Bronchial Hygiene Therapies that may increase risk of cough when possible (chest physiotherapy, IPV, etc.)
- Avoid drugs that induce cough whenever possible (mucokinetics such as acetylcysteine, hypertonic saline)
- Avoid open suction techniques, including naso-tracheal suctioning, open suction of the tracheostomy/stoma
- If absolutely necessary, treat as a critical activity with priority on PPE (N-95 mask, face shield, gown/gloves)

-Aerosolized Therapies (Aerosol-generating procedures):

Severe acute respiratory syndrome-corona virus-2 is spread by inhalation of infected matter containing live virus (which can travel up to 2 m) or by exposure from contaminated surfaces. Aerosol-generating procedures create an increased risk of transmission of infection.
A systematic review of infection risk to HCWs , based on limited literature, ranked airway procedures in descending order of risk as:

(1), tracheal intubation.
(2), tracheostomy (and presumed for emergency front-of-neck airway (FONA)).
(3), non-invasive ventilation (NIV).
(4), mask ventilation.

Other potentially aerosol-generating procedures include:

18. Disconnection of ventilatory circuits during use
19. Tracheal extubation.
20. Cardiopulmonary resuscitation (before tracheal intubation).
21. Bronchoscopy
22. Tracheal suction without a 'closed in-line system.'

Transmission of infection is also likely to be possible from faeces and blood although detection of virus in the blood is relatively infrequent .

Aerosol-Generating Procedures, a common term in literature now, is covered in PPE section. Bottom line: Avoid whenever possible, but wear max PPE (airborne + Contact + Negative Pressure Room) if necessary.

Use MDI with spacer over Nebulizer. One study showed active virus 3-hours in air sample after a nebulizer treatment (assuming not in a negative pressure room) (Munster, et. al)

Aerosolizing drugs/treatments should be considered HIGH RISK *treat as Airborne with N-95 or higher mask CMAJ, CP

Use HEPA filters if possible when needed **AHA**

All aerosol-generating procedures should be done in negative pressure room if possible. Second best is a portable HEPA-filter in room (SCCM)

Choosing a Drug-Delivery Therapy (in recommended order of preference, based on exposure risk, not drug deposition, etc.)**:**

1. **Use an MDI (with spacer) when possible.** Consider shared cannister protocol to preserve aerosolized drug availability. Use MDI adaptor/HME on vent circuit.

2. **Consider breath-actuated neb (BAN) with filter, or a breath-actuated vibrating-mesh neb to minimize number of breaths required (for example, if MDI unavailable)**
Specific to: 2.5 mg (0.5 mL) of Albuterol, with no saline and no additional drugs

3. **Use a filtered nebulizer (such as those used with pentamidine, or with HEPA/viral filter placed)**

4. **On Vent, consider vibrating mesh neb in-line with extra filter at the expiratory port during treatment (CTS)**

Oxygenation :

Oxygenation Progression of Care, may deteriorate quickly SpO2 Goals (WHO, GOLD, SCCM)

Adults with severe COVID (distress, hypoxemia, shock)	Evidence Varies, with lower limits as low as 88% reported (Wax & Christian) **92-96%** SCCM (SCCM suggests low threshold of 92%, but recommends that threshold be no lower than 90%) 90-96% WHO. 88-94% AHA
once stable	> 90%
once stable, pregnant	92-96%
Pediatrics initially (severe distress, cyanosis)	≥ 94%
once stable	≥ 90%
Adults with COPD	DO NOT WITHHOLD OXYGEN Goal per normal (no less than 88%)

Many clinicians are reporting a consensus in progression of care:

1. Initiate with Nasal Cannula (WHO recommends starting at 5 L/min)
2. Progress to 6 L/min (some avoid humidifying)
3. Switch either to nonrebreather mask (15+ L/min) or going directly to intubation. Proactive intubation is advised.
   *If increased WOB after O2, V/Q mismatch may exist and intubation is indicated

COVID-19 Resources

Summary of recommendations on the management of patients with COVID-19 and ARDS

COVID-19 with mild ARDS

- DO: Vt 4-8 ml/kg and P_{plat} <30 cm H_2O
- DO: Investigate for bacterial infection
- DO: Target SpO2 92% - 96%
- CONSIDER: Conservative fluid strategy
- CONSIDER: Empiric antibiotics
- UNCERTAIN: Systemic corticosteroids

COVID-19 with mod to severe ARDS

- CONSIDER: Higher PEEP
- CONSIDER: NMBA boluses to facilitate ventilation targets
- CONSIDER: if PEEP responsive — Traditional recruitment maneuvers
- CONSIDER: Prone ventilation 12 -16 h
- CONSIDER: if proning, high P_{pl} asynchrony — NMBA infusion for 24 h
- DON'T DO: Staircase recruitment maneuvers
- CONSIDER: Short course of systemic corticosteroids
- UNCERTAIN: Antivirals, chloroquine, anti-IL6

Rescue/adjunctive therapy

- UNCERTAIN: Antivirals, chloroquine, anti-IL6
- CONSIDER: if proning, high P_{pl} asynchrony — NMBA infusion for 24 h
- CONSIDER: Prone ventilation 12 -16 h
- CONSIDER: STOP if no quick response — A trial of inhaled nitric oxide
- CONSIDER: follow local criteria for ECMO — V-V ECMO or referral to ECMO center

Mod = moderate
ARDS = adult respiratory distress syndrome
P_{plat} = plateau pressure
SpO2 = peripheral capillary oxygen saturation
PEEP = positive end-expiratory pressure
NMBA = neuromuscular blocking agents
ECMO = extracorporeal membrane oxygenation

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COVID-19 Resources

Summary of recommendations on the initial management of hypoxic COVID-19 patients

COVID-19 with hypoxia

Indication for endotracheal intubation?

- Yes → DO IT: Endotracheal intubation
- DO IT: Expert in airway to intubate
- DO IT: Use N-95/FFP-2 or equivalent and other PPE/infection control precautions
- DO IT: Minimize staff in the room
- CONSIDER: if available — Video-laryngoscope

No

Tolerating supplemental oxygen?

- Yes → DO IT: Monitor closely for worsening
- DO IT: Target SpO2 92% to 96%
- DO IT: Appropriate infection control precautions
- DO NOT: Delay intubation if worsening

No

CONSIDER: HFNC

- Tolerating HFNC → (same as Yes branch)

Not tolerating HFNC or HFNC is not available

Indication for endotracheal intubation?

- Yes → (same as first Yes branch)
- (same as Yes branch)

No

- CONSIDER: a trial of NIPPV
- DO IT: Monitor closely short intervals
- DO NOT: Delay intubation if worsening

Note: N-95/FFP-2 are facial masks

HFNC = high-flow nasal cannula
NIPPV = noninvasive positive-pressure ventilation
PPE = personal protective equipment
SpO2 = peripheral capillary oxygen saturation

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Mechanical Ventilation with COVID19 patients :

A- Noninvasive Ventilation:

It is difficult to assess consensus on noninvasive applications (HFNC, CPAP, NPPV), as many are unsure how to balance risk of exposure/aerosolization with the need for bridge therapies, especially when they don't use needed critical care ventilators, as is particularly true of HFNC. We advise caution, with an emphasis on healthcare professional safety (anyone in room with patient) overriding all concerns.

Remember: Consider Intubation while it is proactive/routine - don't wait for an emergent situation

Considerations

- Most people agree that due to exposure risks, **airborne precautions** should be used with either, and a negative-pressure room is preferred
- Either modality is probably more likely to fail than succeed, so consider a **short trial if using (1 hour)**
- Must monitor closely: **if any indication of failure or instability, especially WOB: discontinue and intubate** (Gattioni, et. al)
    - GCS < 10
    - Increased vasopressor support
    - P/F < 200
    - O2 should improve (not stay the same!) within about an hour
- **Less clear is the use of CPAP/NPPV for patients with OSA or malacias.** Minimally, it may be worth considering transition to NC at night, if possible, or from nasal pillows or nasal mask to a face mask with a dual-limb circuit (and HEPA/viral filter)

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. Note that the source for this is a manufacturer, but suggests that high-flow nasal cannula, when properly fitted and applied, and with a surgical mask placed over nose/mouth, that the risk is similar to a pateint breathing with no HFNC (Vapotherm)
- Why it might not be okay: Concern for risk of exposure with a high flow "blower" dispersing virus throughout the environment
- 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. One study prefers over NPPV (Bouadma et. al), but another suggests most people fail on HFNC (Zuo, et. al)
- Modifications:
    - Consider lower rates of flow (15-30 L/min versus 30-60 L/min, should still equal minute ventilation)
    - Consider surgical mask on patient over patient-interface (CTS)

- Strongly consider negative-pressure room (or closed door, minimally) and airborne precautions
- Stop flow before removing device (Tan, et. al)

Noninvasive CPAP

- Why it might be okay: Increased mean airway pressure - while not using ventilators, doesn't augment breaths (supports lung protection)
- Why it might not be okay: Achieving an adequate seal on mask can be a challenge, any leak increases risk of aerosolization/risk to healthcare providers, higher CPAP level may increase risk of leak, CPAP assumes minimal WOB - pH acceptable (as a reflection of PaCO2)
- Evidence: See this excellent article on CPAP for COVID (Josh Farkas). AHA strongly recommends against.
- Modifications:
  - Extra care with mask-fitting and adjustments (high-risk)
  - Use HEPA/viral filter (expiratory side)
  - If possible, avoid using a mask with an exhalation port, consider dual limb circuit (requires critical care vent which may use critical resources)
  - Titrate CPAP to SpO2 goals - but do not exceed 20 cmH2O (gastric insufflation) - also remember, the higher the pressures, the greater the risk of leaks, and the tighter the mask the greater risk for skin breakdown issues
  - Stop flow before removing device (Tan, et. al)

Noninvasive BiPAP (Noninvasive Positive Pressure Ventilation or NPPV)

- Why it might not be okay:
  - Hypoxemia and thus respiratory arrest can progress rapidly
  - Significant increase in risk of transmission to Therapist, others (Wax & Christian).
  - Poor mask fit, leaks around mask, taking mask off - all common and increase risk
  - Very high failure rates (76% failure in Chinese study)
  - High respiratory drive: self-injurious breathing. This occurs when rapid number of breaths, large breaths, with large pleural pressure swings can accelerate ARDS pathways (MGH)
- Evidence: Consider use of NPPV or nothing (so, avoid HFNC) - (CP), SCCM recommends if HFNC not available and no urgent indication of need for intubation. AHA strongly recommends against.
- Modifications/Strategies:
  - Use a dual-limb circuit if possible, filters placed at equipment outlets
  - If single-limb circuit, consider HME between exhalation port and mask (CTS) **SEE IMAGE of SETUP**
  - If possible, avoid using a mask with an exhalation port
  - Use a higher EPAP if tolerated (much above 12 is difficult, but do not exceed 20 cmH2O due to high risk of gastric insufflation).
  - Maintain ΔP (IPAP-EPAP) for tidal volume around 6 mL/kg (Vimeo - Dr. Clum)
  - Stop flow before removing device (Tan, et. al)

Other Considerations

- Some hospitals even recommend transitioning from NPPV to NRB Mask if change to suspected/confirmed COVID (CP)
- DNI: Most report using NRB mask instead of HFNC or NPPV in these patients (CP)

- Bubble CPAP may be needed for newborns/children with severe hypoxemia when other equipment is unavailable (WHO)

- **Experience from China has reported very high failure rates for noninvasive techniques. Keep this in mind as you consider intubation vs. noninvasive**
- **Any indications of ARDS (V/Q mismatching through P/F ratio, for example) should push towards intubation over noninvasive (you are otherwise delaying the inevitable)**

B- Invasive Ventilation :

The primary goal is to support the lungs (Supportive Care) until the virus has passed. Lung Protective Strategies prioritize protecting lungs during an active infection and we often adopt a mentality of "Minimum Acceptable" standards, such as minimally acceptable oxygenation, instead of normalizing.

Primary Goals are consistent with ARDSnet with variations noted below :

- **Lung Protection (Plateau Pressure ≤ 30) - note Pplat may be higher with severe obesity or abdominal compartment syndrome**
- **Support Minimum Oxygenation Goals (PaO2 = 55-80) to prevent hypoxia / SpO2 88-93%**
- **Support Minimum Ventilation Goals (pH > 7.20) to maintain lung protection**

Strategies:

There is some debate on appropriate vent strategies with the following all coming from reputable references:

- The majority of resources still recommend ARDSnet, lung-protective strategies with higher PEEP (assuming the patient is PEEP-responsive)
- **There is evidence to support maintaining the driving pressure (Pplat - PEEP) to under 12-15.** Driving pressure is a reflection of the functional size of lung and may be a predictor of mortality - above 15 is worrisome. Maintaining a lower driving pressure may help by minimizing over-distention and other complications. The bedside take-home? We should optimize PEEP and then titrate/drop our VT not necessarily to a mL/kg but by monitoring driving pressures (Amato, et. al; Loring, et. al, Brower)
  TO CALCULATE: obtain Plateau Pressure, then subtract PEEP.
- Some reports indicate that while some patients fit criteria for ARDS, some (maybe most) do not. These patients are more consistent with a hypoxic vasoconstriction, with near-normal lung compliance but significantly low P/F ratios. (ATS, ESICM). In these patients higher PEEP may actually worsen V/Q matching and is thus relatively contraindicated. Prone positioning also may be of only limited benefit.
- Consider need to prevent spontaneous breathing due to high respiratory drive, large pleural pressure swings, which may worsen lung injury and worsen compliance. Place patient on controlled mode of ventilation (see below), consider use of deep sedation and/or paralytics to prevent injury. (MGH)
- Sedation Note: Sedation should be deep enough to ensure ventilator synchrony (to prevent potential lung damage), and if deep sedation (RASS -5), but still dyssynchrony, may need to consider paralytics. (CP)
- Most reported prolonged periods of mechanical ventilation being required with extubation coming 8+ days after vent initiation (NEJM)

Ventilators Equipment

- For specific ventilator advice, consider PSRC (Pennsylvania Society) - including stockpile ventilators. Also see our resources at bottom of page.
- Equipment should be as closed-circuit as possible, HEPA or viral filters placed on any exhalation ports. Dual-limb circuits are preferred over single-limb. Some hospitals have come up with scavenger-system add-ons to minimize exposures.

Mode

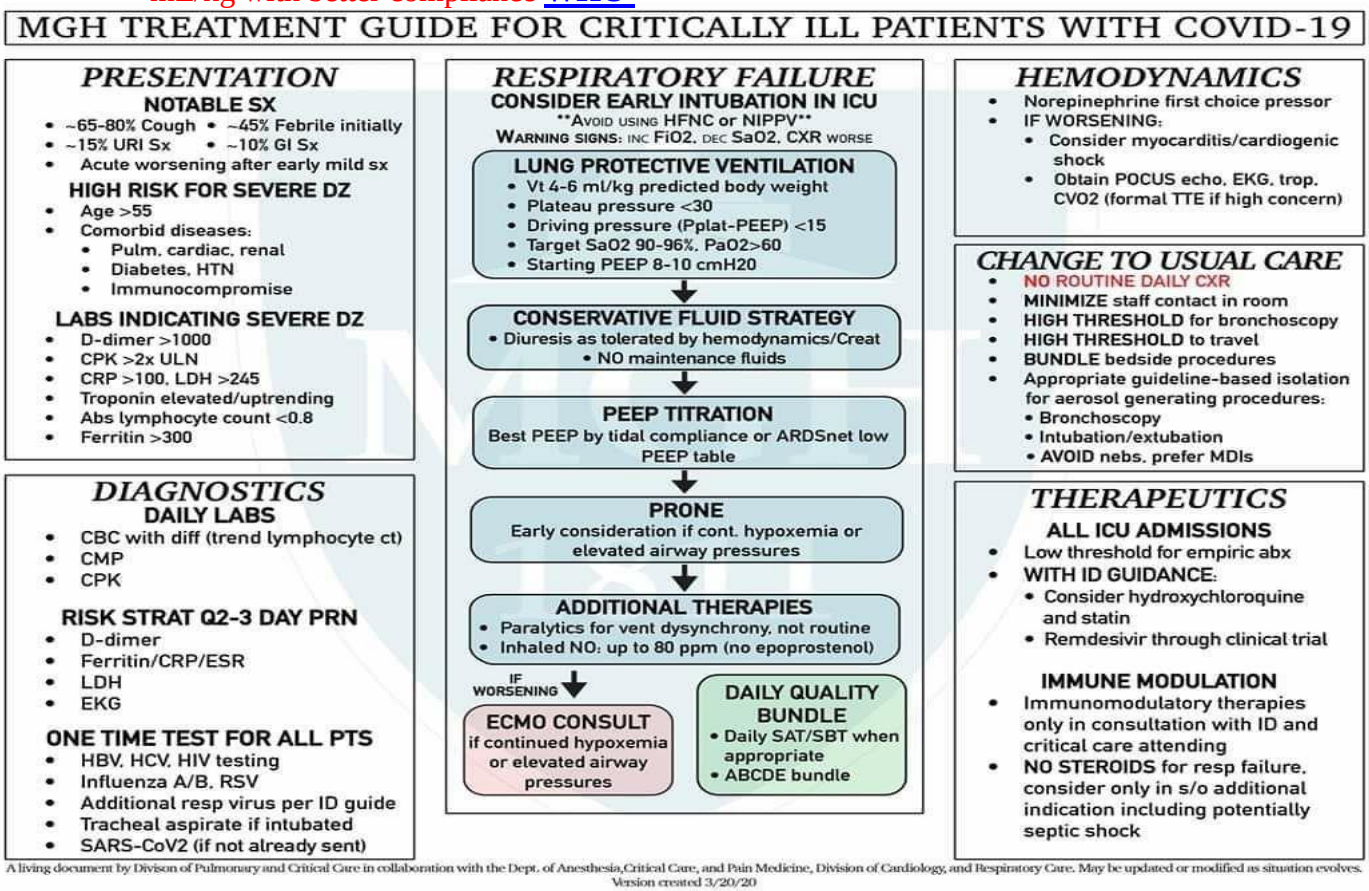
There is no evidence to support any one mode over another, although there is anecdotal evidence that we should avoid spontaneous breathing (due to risk of self-injurious breathing).

Special Note on APRV: For those using APRV, here is a great resource on APRV-TCAV Method

Tidal Volume

Start at around 6 mL/kg Ideal Body Weight (IBW) (IPC; WHO). 4-8 mL/kg (SCCM)
If Compliance is normal, consider starting at 8 mL/kg IBW (ESICM)

- **If Plateau is 30 or greater, drop tidal volume by 1 mL/kg IBW at a time until Pplat under 30 or at 4 mL/kg IBW (ARDSnet)**
  (do not go under 4 mL/kg IBW as this will approach dead space ventilation)
- **As you decrease VT, you will likely need to increase RR.** Consider increasing 5/min for each 1 mL/kg drop in tidal volume. For the most part we don't exceed a RR of 30-35/min due to air-trapping (not enough time to exhale)
- May need to actually **INCREASE VT** up to 8 mL/kg IBW (ARDSnet usually starts here) **only if significant dyssynchrony or pH < 7.15 (WHO)**
  Deep Sedation may also be required
- **Pediatric**: use target Pplat < 28, pH 7.15-7.30, VT 3-6 mL/kg with poor compliance, 5-8 mL/kg with better compliance **WHO**



Rate:

Preferably start at whatever rate needed to match baseline MINUTE VENTILATION, but if initiating consider around **20/min** to start, then titrate per ABG (see ABGs, below. See Inspiratory Time)
Avoid rates above 35/min (remember, do not normalize pH)

Inspiratory Time
Typically around 0.9-1.0 second, may need to consider shorter TI especially at 6 mL/kg IBW and below (0.7 or 0.6 sec).
Either way, ensure adequate exhalation (flow scalar should return to baseline) unless APRV where "therapeutic air-trapping" is employed.

PEEP
Use higher PEEP strategies if PEEP responsive (oxygenation improves with increase in PEEP level) (**IPC, SCCM).** Please see notes on phenotypes in disease section above. PEEP in non-ARDS may transmit to pleural pressures and have an exponential impact on (decreasing) cardiac output. There is evidence to support use of PEEP in patients with poor lung compliance, but the opposite is true if pateints have good compliance (normal plateau pressure)

- Higher PEEP is suggested to be > 10 (SCCM). If PEEP is too high: P/V Loop with beaking; cardiac output will decrease; BP will drop - this indicates overdistension of alveoli, DECREASE PEEP
- Perform an optimal PEEP maneuver if knowledgeable in how to do so

*Some evidence for maintaining a driving pressure (Pplat-PEEP) of under 12-15 by adjusting VT and PEEP) if no spontaneous breaths (Meng, et. al)

FIO2
Prioritize use of PEEP over FIO2 when possible. Increasing FIO2 without adequately recruiting alveoli (PEEP) will result in only minimal increases in PaO2. High FIO2s (1.0 or 100%) may result in further atelectasis from nitrogen washout

Humidity

There is no current consensus on HME vs. Heated Wire. More evidence is supporting HME placement to minimize aerosolization risks.

- HME:
  - may result in more mucous plugging (be aware of need to instill saline and in-line suction)
  - Consider over heated-wire particularly with single-limb ventilators (Zhonghua, et. al)
  - Note that some HMEs may claim to be viral filters as well, but most do not

- Heated Wire:
  - may result in more condensate in tubing, AVOID breaking circuit to empty condensate (exposure risk), used closed-system trap if available.
  - may increase risk of aerosolization (heat + humidity)

WHO recommends changing HME every 5-7 days or when soiled/not functioning

Acid-Base with mechanically ventilated COVID19 patients :

Use a lung protective strategy with ABG management (permissive hypercapnia via pH management, lower PaO2 than normal)

Monitoring trends by ETCO2, SpO2 is helpful. SpO2, in particular, may be a later sign of distress in patients with cardiac muscle dysfunction secondary to COVID.

pH: Keep pH above somewhere **> 7.15, though > 7.25 if possible**- no need to normalize (normal is 7.35-7.45)
if pH under 7.15 after vent changes, consider 1) Deep Sedation, then 2) Paralytics **CP** Either way, consider proning

PaCO2: less important than pH - treat pH not PaCO2 in patients with significant lung disease

PaO2: Keep minimum acceptable PaO2 goals (60 or higher is reasonable, normal is 80-100)
*Consider increasing PEEP if PaO2 is below the goal

Oxygenation: A-a Gradient, P/F ratio, Oxygenation Index may be better indicators of oxygenation when there is a V/Q mismatch as is likely with these patients

Weaning / Discontinuation :

Expect extended time on ventilator - weaning is often slow

- Reports are that some wean off around 8-10 days, but that many require **15-20 days of ventilation** before being ready to discontinue from vent (NEJM, MGH) - patience!
- Ventilator Criteria to Consider
  - Meeting oxygenation goals with FIO2 < 0.4, PEEP < 8-10 on PSV < 10 (Tan, et. al)
  - Secretions should be minimal/manageable (some reports are lots of secretions for COVID pts, others report minimal)
- Consider less-aggressive weaning/extubation (with goal of avoiding need for HFNC/NPPV post-extubation, often difficult wean initially), (MGH)
- Avoid use of T-Piece trials, including with trach patients (as well as trach mask). Use pressure support weaning instead (CTS)
- There is debate on when and if to trach patients at some point (due to exposure risks)

Critical Care Strategies:

PRONING

There is a strong consensus that proning a patient is a critical step in management.
(Proning may improve ventilation-perfusion matching which can increase oxygenation)

Proning is considered an aerosol-generating procedure due to the risk of coughing/disconnect. Use Airborne PPE if possible

Proning Guidance/Consensus

- Emphasis is on early proning (Ding, et. al; Sun, et. al; Agrawal, et. al; Kallet, et. al)
- Some recommend proning if refractory hypoxemia (SpO2 < 90%) despite maximizing vent settings (ATS)
- Deep Sedation (RASS -4 to -5) should be considered while proning
- After proning, wait about an hour, then recheck ventilator parameters (Pplat, PEEP, VT) - make changes as necessary (CP)
- **Prone for no less than 6-hours at a time** (multiple sessions per day), but preferably 12-20 hours/day (JAMA, WHO, SCCM)
- Some recommend d/c prone once patient is sustained in stable state (FIO2 needs, Pplat, ABG, P/F)

- **Airway in Prone**: Reports of lost airways (gravity, secretions), skin breakdown (facial edema). Consider:
  - Secure with cloth tape - video demo of that here (use 2 people to tape, change when patient supine)
  - Reinforce with "pink tape" (such as Hy-Tape), esp if issues with oral secretions
  - Some also recommend successful use of "Stabilock tube holder" and "COMFIT"
  - In one report, Hollister in prone was linked with breakdown requiring treatment (Gomaa and Branson)
  - Use an "omniflex" adaptor, if needed
  - No matter the method used (or device used), skin integrity should be monitored closely due to facial edema in prone (Gomaa and Branson)

- **CPR IN PRONE: If no airway, turn supine. If airway, CPR in prone (unless no risk of exposure in flipping to supine). SEE CPR TOPIC, BELOW**

- **Pregnant**: recommend use of lateral decubitis position (off-load inferior vena cava), not proning (WHO)
- **Pediatrics**: consider proning with indications of severe ARDS (WHO)

Proning Resources

- **More Information/Instruction on Proning: Uptodate, NEJM, RespiratoryCare**
- Helpful Instruction for teams not used to proning: **Rush University**
- Learning module on Proning from Osler

Other Feedback/Information

- **Airway: RT should always be present to prone or supine a patient - securing the airway and avoiding disconnect is absolutely critical**
- Most people report performing the "swimming" method of proning - turn head side-to-side every 2 hrs (See Oliveira, et. al for photos/description of this)

- Some clinicians recommend proning higher-risk, nonintubated patients on a nasal cannula if indication of V/Q mismatch (such as low P/F ratio) - (Sun, et. al.)

Recruitment Maneuvers

Use with caution (watch slosely for any desaturation, hypotension, barotrauma. STOP maneuver if any of these occur) but some recommend use of a recruitment maneuver. (SCCM)

Suggested: Place patient on CPAP 35-40 cmH2O for 40 seconds (SCCM), some recommend less time for safety - like 15 seconds (ESICM)

Do NOT: Perform Incremental PEEP recruitment (increasing PEEP from 25 to 35 to 45, each level for 1-2 minutes) (SCCM)

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iNO or inhaled prostaglandins

- There is limited evidence to support use of iNO (SCCM says no, MGH suggests is viable)
- Some recommend short trial of inhaled pulmonary vasodilators- taper off if no effect (SCCM)

NMBA
to manage ventilation of COVID patients, some combination of deep sedation and possibly paralytics might be necessary, especially if:

- Dyssynchrony with ventilator
- Plateau Pressures over 30 despite other attempts (such as PEEP, low VT) to lower

If needed, consider boluses vs. continuous initially. If persistently high plateau pressures, consider 48-hours of continuous SCCM

ECMO
Consider long-term (> 6 hours) ECMO for either respiratory failure or cardiopulmonary failure, especially when other options have all been trialed (FDA, ATS, WHO, SCCM)

Multiple Patients on a Single Ventilator

Our official position is in line with the majority of respiratory and medical professionals: **Multiple Patients should not be put on a single ventilator.** The risks (including causing damage to all lungs being ventilated, increased cross-contamination, exposure risks due to more frequent disconnects) outweighs the benefits (stretching limited equipment/resources). MAJOR considerations include the need for both sets of lungs to have very similar lung mechanics (compliances, resistance, respiratory quotient, BMI, etc.), the driving pressure (Pplat-PEEP) needs to be identical, and the needs the same (acid-base, including metabolic component to a degree, PEEP, inspiratory time, total rate). If hypothetically able to match and maintain match (nearly impossible), these variables would need to stay the same in both patients the entire time (impossible). At best this would require a Respiratory Therapist be very close to bedside, constantly monitoring, all the time.

A major joint statement has been published on the matter:

See the Joint Statement on Multiple Patients per Ventilator (SCCM, AARC, ASA, ASPF, AACN, and CHEST)

Last-Resort Alternative to Multiple Ventilators:

Manual resuscitation (bag the patient) with a viral filter. Preferred use with an O2 blender, possibly a PEEP valve. While healthcare resources would be unlikely to allow for this, consider use of a family member to provide manual ventilation. Again, this is all "last-resort" thinking.

These reasons of never use Multiple Patients per Ventilator include:

- Volumes would go to the most compliant lung segments.
- Positive end-expiratory pressure, which is of critical importance in these patients, would be impossible to manage.
- Monitoring patients and measuring pulmonary mechanics would be challenging, if not impossible.
- Alarm monitoring and management would not be feasible.
- Individualized management for clinical improvement or deterioration would be impossible.
- In the case of a cardiac arrest, ventilation to all patients would need to be stopped to allow the change to bag ventilation without aerosolizing the virus and exposing healthcare workers. This circumstance also would alter breath delivery dynamics to the other patients.
- The added circuit volume defeats the operational self-test (the test fails). The clinician would be required to operate the ventilator without a successful test, adding to errors in the measurement.
- Additional external monitoring would be required. The ventilator monitors the average pressures and volumes.
- Even if all patients connected to a single ventilator have the same clinical features at initiation, they could deteriorate and recover at different rates, and distribution of gas to each patient would be unequal and unmonitored. The sickest patient would get the smallest tidal volume and the improving patient would get the largest tidal volume.
- The greatest risks occur with sudden deterioration of a single patient (e.g., pneumothorax, kinked endotracheal tube), with the balance of ventilation distributed to the other patients.
- Finally, there are ethical issues. If the ventilator can be lifesaving for a single individual, using it on more than one patient at a time risks life-threatening treatment failure for all of them.

Troubleshooting's :

- **Sudden Deterioration**
  - Consider pneumothorax, more common with SARS. Consider use of ultrasound to r/o if portable CXR delayed. (Wax & Christian)

- **If O2 is below goal**
  - Prone patient
  - Optimize PEEP (is patient PEEP-responsive?) - if over-distension, PEEP may decrease oxygenation
  - Recruitment Maneuver
  - Deep Sedation or Paralytics (with sedation) if signs of vent-patient dyssynchrony
  - Inhaled Pulmonary Vasodilators (avoid iNO)
  - V/V ECMO

- **Pplat over 30**
  - Drop VT by 1 mL/kg IBW until at 4 mL/kg (do not go below 4)
  - Prone patient

- **Evidence of air-trapping** (flow not returning to baseline on graphics, measured auto-PEEP)
  - Check inspiratory time and I:E ratio, especially if using higher rates.
  - Consider dropping the set rate (which may actually improve pH/PaCO2 if air-trapping)
  - Signs of bronchospasm? Consider SABA

- **Risk Minimization Strategies**
  - Some recommend placing ventilator monitoring screen outside of room, requires 2 people to make changes while assessing patient, but may assist with basic monitoring
  - Some recommend positioning vent monitoring screen to be clearly visible from outside room, use of binoculars, zoomed phone screen, to avoid unnecessary risk in between scheduled room-time
  - Ventilator should be wiped down with approved chemicals at regular intervals

Airway Clearance:

Bronchoscopy

High-Risk due to potential exposures: priority use of PPE (N-95, Face shield, gown, gloves) - avoid use if possible!

- Do not use to r/o COVID -19, but consider for mucous plugs or to specifically r/o alternative diagnoses (TB, other pneumonias) IPC
- Sputum specimens should be obtained by closed suction with endotracheal tube with COVID sampling preference for lower respiratory tract (SCCM)
- Limit to therapeutic indications such as hemoptysis
- Minimize disconnections, use of bronchoscopy adapter on ET tube is recommended
- Consider placing mask on patient during bronch if not intubated (minimizes exposure)
- Use of disposable bronchoscope, if possible

Suctioning and Bronchial Hygiene

Strong preference for closed suctioning only (in-line suction) when intubated (WHO, CTS)
minimizes aerosolization exposure, decreases derecruitment of lungs (alveoli collapse)

Avoid open suction techniques, including nasotracheal suctioning, open suction of the tracheostomy/stoma
If absolutely necessary, treat as a critical activity with priority on PPE (N-95 mask or higher level, face shield, gown/gloves).

Avoid Bronchial Hygiene Therapies that may increase risk of cough when possible (chest physiotherapy, IPV, etc.) (CTS)
(Exception: diseases that produce abnormal secretions such as Cystic Fibrosis, Bronchiectasis, etc.)

Protected Code Blue:

Direct Link to the COVID-19 AHA new Algorithms

All CPR activities should be performed using Airborne Precautions and should limit the number of people present (AHA)

Protected Code Blue

- **Take the time to put all appropriate PPE on (Airborne + Contact, check PPE)** (AHA)
- Attempt to minimize number of people in room (3 is seen as ideal)
- To minimize exposure risks, some hospitals are performing a single round of CPR, then discontinuing further efforts
- Use mechanical CPR device if available, if pt meets height + weight criteria

CPR for Non-Intubated Patients
(may result in aerosolizing the virus, increasing risk)

- Initially, assess rhythm and defibrillate if ventricular dysrhythmia (AHA)
- Many (or most?) are not using bag-valve-mask ventilation to minimize exposure-risk.
    - Consider Intubating more Quickly, some practice compression-only CPR until airway is established (CP)
    - Consider use of a nonrebreather mask , covered also with a surgical mask (AHA)
- If decision to use BVM: consider use of a HEPA or Bacterial/Viral Filter in-between bag/mask and ensure a TIGHT seal against face - may require 2-people to do so
- Pause chest compressions to intubate - allow for more accurate intubation (less particle spread) (AHA)

CPR for Intubated Patients (or with artificial airway)

- **Consider leaving on ventilator during code to keep a closed circuit** and make the following changes (per AHA guidelines):
    - **Mode: PC, A/C with target of 6 mL/kg IBW**
    - **FIO2: 1.0**
    - **Trigger: OFF**
    - **Set Rate: 10/min (adults, peds) or 30/min (neo)**
    - **Consider PEEP to optimize for venous return to heart**
    - *If/when ROSC is established, place on appropriate clinical settings*

- **Defibrillating on Ventilator**
    - Risk: while extremely rare, reports of fires/arcing in the presence of an oxygen-enriched environment
    - Reason to Consider: any disconnect of the airway/vent circuit increases aerosolization risk to those in room
    - **Modifications to Consider if Leaving on Vent:**
        - Drop O2 below 50% and ensure any exhalation is 30 cm (12 in) away (APSF)

- Consider pausing the ventilator during defibrillation - extra measure of safety despite closed circuit (APSF)
- DO NOT disconnect the vent circuit and leave on patient - increases risk (AHA, ECRI)

CPR for Patients who are in Prone Position (AHA)

- **No Airway**: attempt to place in supine position for resuscitation
- **Artificial Airway**: avoid turning the patient to supine uness able to do so without risk of equipment disconnection
  - Place defibrillator pads in the A-P position
  - Provide CPR with pt remaining prone - over T7 and T10 vertebral bodies

Respiratory/ Critical Drugs:

Evidence is mixed on use of systemic steroids and probably should be limited to treating other indications, such as Asthma and COPD (WHO)**. Inhaled steroids should be continued, MDI when possible**

Avoid corticosteroids (may prolong illness) unless using for underlying disease. This is primarily true of SYSTEMIC steroids. (CDC, WHO)

COPD: use caution with systemic steroids, but there's no evidence that inhaled/oral steroids should be avoided (GOLD)

Asthma: Continue all inhaled drugs, as ordered (GINA)

For severe Asthma, lowest-effective-dose of inhaled steroids as possible (GINA)

as indicated but with more caution than normal (especially systemic, less so for inhaled)

For shock, low-dose steroids should be considered (over giving none) (SCCM)

Avoid drugs that induce cough whenever possible (mucokinetics such as acetylcysteine, hypertonic salines)

Consider careful use with patients with abnormal secretions related to diseases - Cystic Fibrosis, Bronchiectasis, as needed when appropriate PPE is available, negative pressure rooms are preferred

iNO not preferred, but inhaled prostaglandins can be trialed briefly as a rescue therapy

Asthma Exacerbation: Consider use of Albuterol by MDI with spacer initially for exacerbation, every 20 mins x 3 doses. Consider IV mag if needed. Avoid continuous albuterol due to aerosolization risk unless absolutely necessary. Be aware of need for early intubation (CHOP). Systemic steroids should still be considered in severe asthma exacerbations (benefits may outweigh risks) (WHO)

COVID19 Patient Transport Considerations:

Avoid transport when possible, including limiting away-from-room imaging/procedures to absolutely essential for treatment only

- Consider early transfer of deteriorating patients to ICU (Liew, et al.)
- Medically-essential transport only (CDC)
- Inform receiving department of COVID+ patient beforehand (CDC)
- Transporting Team should wear PPE (some recommend all everything (Liew, et al.), CDC recommends full PPE while handling the patient, but then only wearing a face mask during transport (CDC)
- Patient should wear surgical mask if not intubated (CDC), do not transfer on HFNC, NPPV, etc. (Liew, et al.). Cover patient with a clean sheet (CDC)
- Clean and disinfect all high-touch surfaces, including side rails, headboard, footboard, etc. (NebraskaMed)
- Routes should be designated (and dedicated, if possible) between departments to minimize contact with others. If team MUST pass through bystander area, it is advised to have security or someone who can safely clear the area prior to arriving. Any accompanying security should wear masks. (Liew, et al.)
- If intubated: use transport ventilator, if available. If no transport vent available, consider bagging (filters!) with PEEP valve

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