UTSW Department of Emergency Medicine
Acute Airway and Resuscitation Goals and Recommendations
COVID-19 (SARS-nCoV-2)
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Introduction

The Severe Acute Respiratory Syndrome Novel Coronavirus (SARS-nCoV-2) is the cause of COVID-19, a pandemic which started in late 2019, first identified in Wuhan, China [1]. As of this writing, the disease COVID-19 has affected more than 330,000 persons in the United States alone, resulting in over 41,000 hospitalizations and 9,498 fatalities [2]. Best estimates for Intensive Care Unit (ICU) need and mechanical ventilation range from 5-10% [1]. The clinical severity ranges from asymptomatic to catastrophic multisystem organ failure resulting in death. The presenting symptoms to Emergency Departments (ED), in living patients, range from mild upper respiratory complaints akin to the common cold to bilateral pneumonia and decompensating severe Acute Respiratory Distress Syndrome (ARDS) [1]. We anticipate that the major proportion of patients requiring hospitalization and higher level care will present through the ED with respiratory symptoms [1]. In a surge-condition, virtually 100% of patients requiring in-patient services will present to the ED.

Purpose

The purpose of this writing is to define the key terms, highlight departmental goals, and provide practice recommendations regarding the management of critically ill COVID-19 patients (both known and suspected) presenting to the ED at WP Clements University Hospital and Parkland Memorial Hospital. We recognize that these goals and recommendations are just that; meaning that the recommendations will not be applicable in every situation, and further, that our response to this evolving pandemic viral illness will require critical re-analysis at frequent intervals and need to be flexible in order to meet the needs of our physicians, learners, institution, and foremost, our patients. This will, at times, necessitate a change in the way we have previously practiced medicine. It may require us to consider unconventional and novel approaches in our care. It will require the practice of exemplary communication amongst a broad spectrum of providers and specialties.

Terms:

- Hypoxia and Hypoxemia in COVID-19
- Early Warning System
- Aerosol Generation (AG)
- Aerosol Generating Medical Procedure (AGMP)
- Personal Protective Equipment (PPE)
- Negative Pressure Room
- Oxygen Adjuncts

- High-Flow Nasal Cannula (HFNC)
- Continuous Positive Airway Pressure (CPAP)
- Non-Invasive Ventilation (NIV) or Non-Invasive Positive Pressure Ventilation (NIPPV)
- Awake Prone Positioning (aPP)
- Respiratory Decompensation in COVID-19
- Crash Airway in COVID-19
- Protected Endotracheal Intubation (ETI) in COVID-19
- Invasive Mechanical Ventilation (IMV)
- Cardiopulmonary Arrest and Cardiopulmonary Resuscitation (CPR) in COVID-19

Goals:

- Provide optimal care to all patients presenting to our EDs.
- Limit transmission exposure to ourselves and other healthcare workers (HCW)
- Limit spread of COVID-19 into the community

Recommendations:

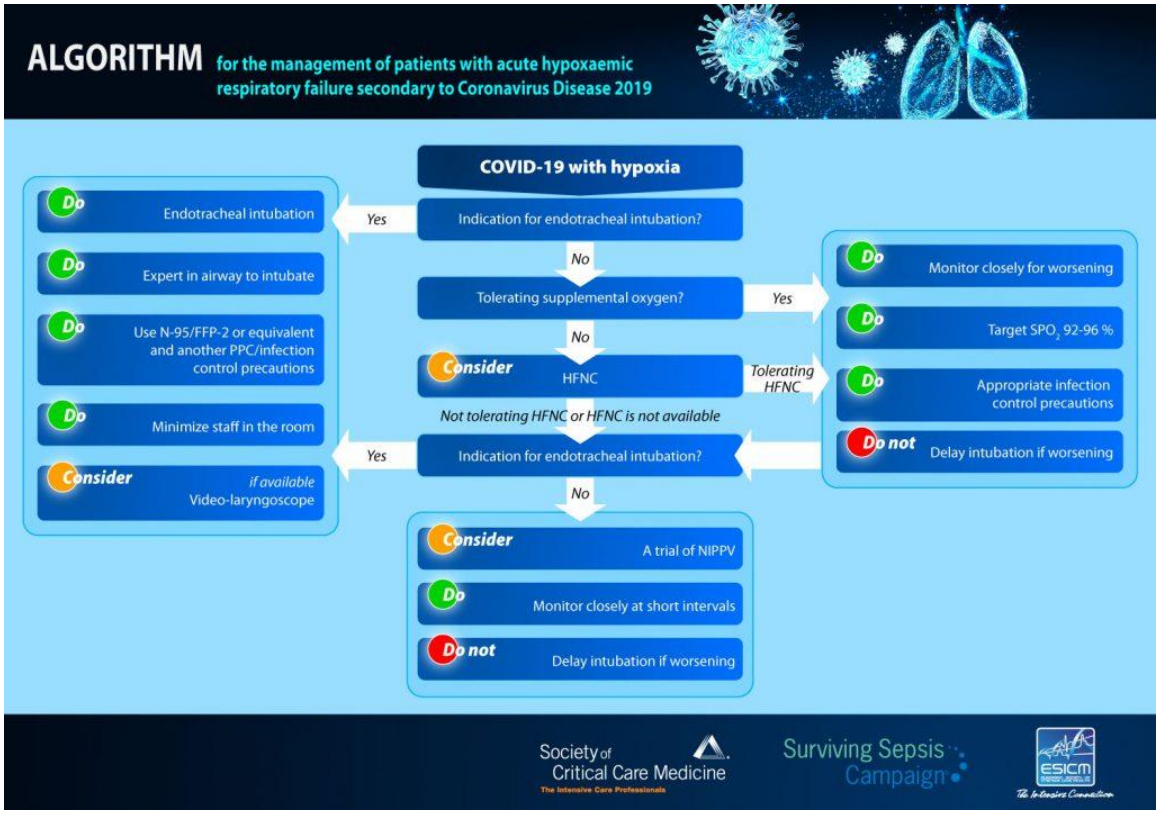

Figure 1. Algorithm to address decisions in the hypoxic COVID-19 patient.

Hypoxia and Hypoxemia

- Hypoxia, as measured by peripheral pulse saturation oximetry (SpO2), may be an isolated finding, with or without associated respiratory distress or a patient complaint of dyspnea.
- Hypoxemia, as measured by arterial blood gas (ABG), with a PaO2 < 60 mm Hg, may be identified in a patient with COVID-19 symptomatology.
    - ABG is *not* recommended on every hypoxic (SpO2 low) patient. Use clinical judgement.
    - Obtaining an ABG does require Airborne PPE when a patient is coughing, or on advanced oxygen adjunct.
- *Increasingly, the most serious COVID-19 insult appears to be one of overwhelming hypoxia and hypoxemia* [3, 12].
- Hypoxia in COVID-19 patients is *often out of proportion* to work of breathing; many patients do not have respiratory distress despite significant hypoxia.
- Hypoxic and hypoxemic COVID-19 patients are at an elevated risk for deterioration, however the progression to respiratory failure is not absolute.
- Hypoxic COVID-19 patients will broadly respond to supplemental oxygen.
- Hypoxic/hypoxemic COVID-19 pathway patients require immediate monitoring given the risk for deterioration, in addition to isolation commensurate with the patient's degree of illness.

Early Warning System and Risk Stratification

- There are no validated methods to definitively identify known or suspected COVID-19 patients at-risk for respiratory decompensation.
- Sun et al have utilized the following pathway to determine a binary risk (high versus low). [7]

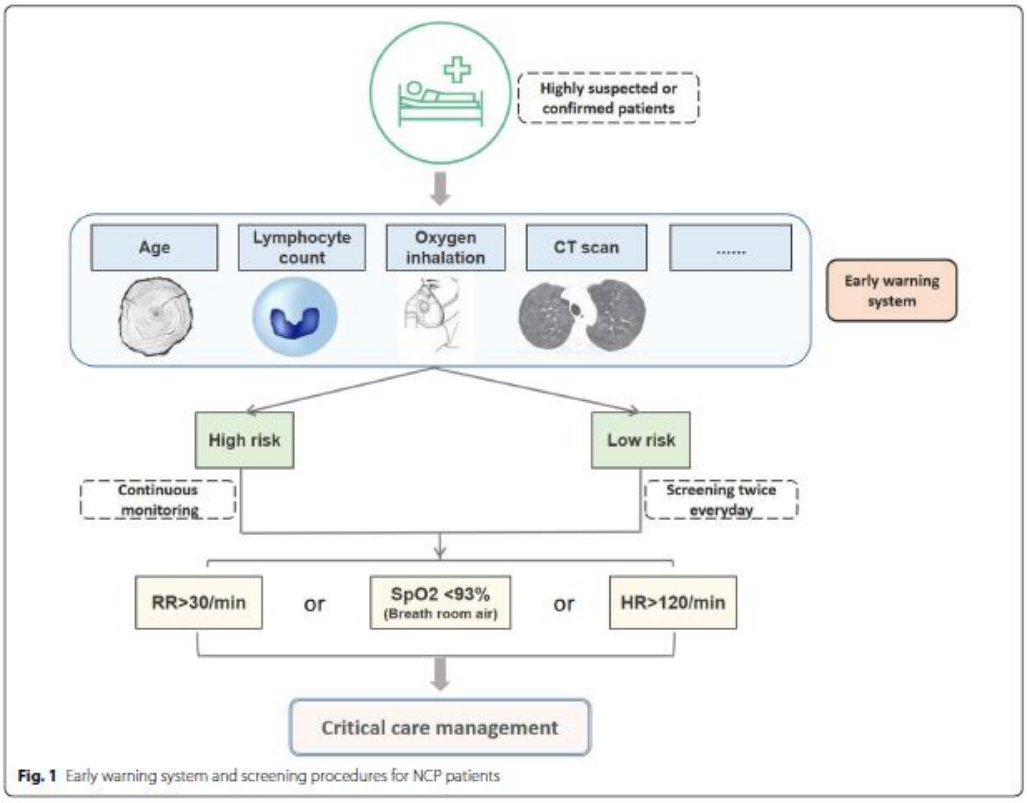

Fig. 1 Early warning system and screening procedures for NCP patients

- As we are urging restraint on the use of CT Chest at present, this limits the utility of Sun's screening method.
- The ellipses in Sun et al's diagram are not described in the writing.
- Additional risk stratification tools may be found on the MDCalc.com bundle:

    - The MuLTBSA score has been validated for viral pneumonia, but has not been externally validated for COVID-19 pneumonia
        - https://www.mdcalc.com/mulbsta-score-viral-pneumonia-mortality
    - The COVID-Brescia Score has been developed in Italy specifically for the COVID-19 pandemic. This scale is also not externally validated for COVID-19 pneumonia.
        - https://www.mdcalc.com/brescia-covid-respiratory-severity-scale-bcrss-algorithm

Aerosol Generating Medical Procedure (AGMP)

- Although the predominant route of infection with SARS-nCoV-2 appears to be surface-droplet fomite based, certain interventions significantly raise the risk of infected particles becoming airborne, increasing the risk of transmission to HCW during care at bedside.

- These AGMP include nasopharyngeal swabbing, HFNC, NIV, Intubation in an awake patient, and use of the Bag-Valve Mask (BVM).
- Airborne PPE precautions will decrease the risk of HCW becoming infected when used appropriately in the setting of AGMP.

Negative Pressure Room

- Air exchanges above the regulatory threshold, 10-12 cycles per hour
- Optimal for patients at risk for AG and who may undergo AGMP.

Personal Protective Equipment

- Consider PPE in all patients according to facility recommendations.
- For patients at risk for AG and who may undergo AGMP consider the following *Airborne Precautions*:
    - Powered Air Purifying Respirator (PAPR) with double cape (available in Pod L/M).
        - Training on-site is available
        - Each PAPR hood may be used 25 times. Track use accordingly.
        - Each filter (2 per respirator motor) has a ceiling of 25 hours.
            - Each 30 minutes *must* be tracked.
            - Mark the PURPLE strip with a marker for each 30 minutes.
            - A single use is considered 30 minutes, regardless of length within that period of time.
    - N95 respirator mask may be substituted for PAPR with face shield and bonnet
    - Eye protection with goggles and full-face shield
    - Hair cover, e.g. bonnet
    - Plastic gown
    - Gloves with wrist covered
- Doffing: observer is recommended to assure proper order

Oxygen Adjuncts

- Efforts to supplement the hypoxic COVID-19 patient with an augmented or high FiO2 should be administered early in the ED course.
    - Nasal Cannula is the preferred initial method, given its availability and ease of administration.
        - May be initiated and managed by a physician (MD or DO), mid-level provider (APP or PA), respiratory therapist (RT), or a registered nurse (RN)
        - Titration of the liter flow of oxygen up to 6 liters per minute (LPM) is an acceptable initial step to correct hypoxia.
        - Goal SpO2 88-92%

        - 6 LPM is equivalent to a Fraction of Inspired Oxygen (FiO2) of 0.45 or 45%.
        - Nasal Cannula may be insufficient to meet FiO2 demand in severe or critical hypoxia and hypoxemia.
            - This does not represent impending respiratory failure *per se.*
            - Clinical evaluation of the patient's perfusion status is appropriate.
    - Step-up adjuncts including simple masks, partial non-rebreather masks (NRB), and the venturi mask *should* be considered early.
        - May be initiated and managed by a physician (MD or DO), mid-level provider (APP or PA), respiratory therapist (RT), or a registered nurse (RN)
        - NRB may achieve an FiO2 approaching 95% if the reservoir is filled appropriately.
    - Cautions
        - Caution is appropriate: All of these adjuncts have the potential to substantially increase Aerosol Generation (AG).
        - It is our recommendation to administer therapies of this type in a negative-pressure room to minimize AG exposure to the staff.
        - Placement of a surgical mask (rectangular type) over the patient's face and oxygen adjunct may decrease AG transmission.

Continuous Positive Airway Pressure (CPAP) [4]

- CPAP is the preferred form of NIV in the hypoxic/hypoxemic suspected/known COVID-19 Patient.
    - Recommend initial settings of 10 cm H2O and 60% FiO2.
    - Titration of CPAP to 12-15 cm H20 and up to 100% FiO2 may be considered.
    - The Phillips Respironics V60 used in the Parkland ED is a single limb circuit with an expiratory port which may be fitted with a viral filter.
        - RT has been advised against the use of the V60 due to its expiratory port.
        - If inventory is low, this may be a choice made to limited availability of other ventilation machines.
    - The Puritan Bennet 840 Ventilator may be converted to CPAP/NIV mode.
        - Dual-limb circuit with in-line expiratory limb viral filter.
        - RT has been advised to choose this ventilator first, but may be in short supply if existing inventory is in use for other patients.
- Cautions and Planning
    - CPAP does not replace Invasive Mechanical Ventilation (IMV).
    - CPAP applied early may serve as a bridge to IMV.
    - CPAP benefits hypoxic patients by increasing the Mean Airway Pressure (MAP).

        - Increased MAP improves oxygenation
        - Increased MAP aids recruitment of under-ventilated regions of the lung.
- CPAP Tolerance
    - High tidal volumes (V_T)and high respiratory rates (*f*) will lead to lung injury
    - CPAP masks and hoods (where available) may be poorly tolerated and lead to highV_T and high *f*.
    - Patients on CPAP may benefit from administration of low dose IV narcotics to decrease their work of breathing and sense of anxiety.
    - Patients on CPAP may benefit from administration of low dose IV benzodiazepines to decrease anxiety and improve tolerance.
    - Patients on CPAP may benefit from administration of dexmedetomidine as a drip.
    - Patients on CPAP may benefit from ketamine as a drip.
- CPAP Intolerance
    - No response on 30-60 minute reevaluation
        - Limited airway reflexes
        - Altered mental status
    - Clinical decline continues despite physiological response
    - Patient tolerance limits the use
    - Proceed to ETI and IMV.

Non-invasive Ventilation (NIV)

- NIV refers to Bi-Level Positive Airway Pressure (BiPAP) in these recommendations.
- ***BiPAP is not recommended*** for the *hypoxic* suspected/known COVID-19 patient.
- BiPAP is recommended *only* in setting of:
    - known Acute-on-Chronic Congestive Heart Failure
    - or Acute-on-Chronic Hypercapnic Respiratory Failure (COPD or Asthma).
- BiPAP utilizes a high Inspiratory PAP (IPAP) and a low expiratory PAP (EPAP) to assist ventilation, increase MAP, and recruit lungs.
    - The expiratory phase (EPAP) raises the risk of AG.
    - If unavoidable, it will be optimal that a patient on BiPAP be located in a negative pressure room.
- BiPAP use in the setting of CHF exacerbations may be augmented by the use of vasodilator medication.
    - Nitroglycerin
    - Isosorbide Mononitrate
- BiPAP use in the setting of CHF exacerbations may be augmented by the use of diuretic medication.
    - Loop diuretics (e.g. Furosemide)
    - Thiazide diuretics (e.g. Chlorothiazide)
    - Carbonic Anhydrase Inhibitors (e.g. Acetazolamide)

High Flow Nasal Cannula (HFNC)[5]

- Mechanism and Benefit
    - Decreases dead space ventilation to improve oxygenation
    - Avoids discomfort associated with NIV mask
- Features
    - Humidified (100% relative humidity)
    - Heated (to 37 degrees Celsius)
    - Gas flow rate up to 60 LPM
    - Gas blend between 0.21 to 1.00 FiO2
    - LPM and FiO2 may be titrated independently
    - Increased tolerance due to comfort

- Set-up and Administration standardized by RT
    - Recommended initial settings 40 LPM and 40% FiO2.
    - In COVID-19, titrate FiO2 before flow rate.
- Indications
    - COVID-19 patient with hypoxia or hypoxemia with FiO2 requirement in excess of that provided by the above-mentioned oxygen adjuncts not requiring intubation (see flow diagram above).
- Cautions

    - Must be considered an AGMP and will necessitate a negative pressure environment.
    - AGMP risk may be offset by placing a rectangular surgical mask over the patient's face and cannula.
    - Airborne PPE mandatory for all HCW providing care to the patient up to 8 feet [6]

Table: Adult escalation plan following initial assessment and treatment for patients in hospital

Category	Clinical status	Suggested action
Green	RR ≥ 20bpm with SpO_2 ≤94%	Administer O_2 <40% by face mask. If SpO_2 rises to >94%, observe and monitor
Yellow	RR ≥ 20bpm with SpO_2 ≤94% on FiO_2 ≥40%	Start 15L/min O_2 via non-rebreathe mask *Senior clinical review to consider:* If orientated and able to tolerate well-fitted non-vented face mask, trial CPAP 10cmH_2O with FiO_2 0.6 If further escalation appropriate, consider increasing CPAP 12-15 cmH_2O + 60-100% oxygen if needed If not, IMV if in accordance with TEP
Red	RR ≥ 20bpm with SpO_2 ≤94% on 15L/min O_2 via non-rebreathe mask and/or patient unable to tolerate CPAP mask, obtunded/ disorientated, rising FiO_2 needs, significant clinical decline	Urgent critical care review and prepare for intubation if in accordance with TEP

Abbreviations: RR = respiratory rate; SpO_2 = oxygen saturation; CPAP = continuous positive airways pressure; FiO_2 = fraction of inspired oxygen, IMV = invasive mechanical ventilation, TEP = treatment escalation plan

Figure 2. Adopted from UK NHS guidance on clinical respiratory evaluation in the setting of known or suspected COVID-19 patients.

Awake Prone Positioning (aPP)

- aPP was trialed as a component of the bundle used by Sun et al [7] in combination with CPAP and a restrictive volume resuscitation strategy.
- Sun et al did not document proning time values.
- A prior non-COVID-19 ARDS awake proning trial with 20 patients enrolled between Jan 2018 and April 2019 decreased the rate of patients progressing to IMV [8]. No control group in study.
    - Stable SpO2 on NIV at FiO2 0.5
    - Proned on either HFNC or NIV for 30 minutes until fatigue, BID for 3 days.

Respiratory Decompensation

- Advanced Directives
    - Be in communication early with COVID-19 pathway patients regarding their wishes regarding intubation (ETI).
        - Clarify the patient's wishes regarding ETI and prolonged IMV.
        - Clarify the patient's wishes regarding Cardiac Arrest and CPR.
    - Our patients may be media-sensitive, may know other COVID-19 patients, and understand the high-mortality rates associated with respiratory failure in COVID-19 and coronavirus.
    - Honor their wish if they do not want to be intubated.
    - At present, we must advise that the decision to pursue ETI/IMV will be made to improve the patient's chance of living through a critical illness.
    - If the decision to intubate is made, make every effort to help the patient contact family by phone.
    - The patient's will be alone, in contact isolation.
    - If recovery is possible, they will be without familiar bedside contact for the duration of that recovery.
- Assessment
    - Respiratory failure must be distinguished from hypoxia and hypoxemia in COVID-19.
        - Conventional assessment for respiratory failure otherwise applies
            - Inability to protect the airway
            - Altered Mental Status
            - SIRS Criteria with hypotension
    - Sun et al utilized 3 points to determine need for ICU care [7].
        - RR > 30 bpm
        - HR > 120 bpm
        - SpO2 < 93%
        - Once in ICU, the combined strategy of NIV/HFNC, aPP, and restrictive fluid management was employed.
        - If the combination was not effective, the patients were selected for intubation.
        - Limited demographic data included in the paper
        - Of note
            - 10% of COVID-19 patients in the Jiangsu Province were assessed as critically ill
            - 1 % required IMV

- Sun et al compared their fatality rate to the neighboring Hubei (Wuhan) province and found the rate to be lower in Jiangsu.

Management of the "Crash Airway"

- The "Crash" or Emergency Airway is the most high-risk transmission event in the care of the COVID-19 patient[10].
    - Every effort to avoid this situation should be made, including Protected Airway Management (see below).
    - If unavoidable, use every precaution.
- The airway should be managed by the person who will have the best opportunity for "First Pass Success".
- This may be an ED attending or an ED resident or a member of the Department of Anesthesia.
- Parkland ED
    - A discussion of the daily plan should be undertaken at the beginning of a shift between the attending in the L/M pod, the ED residents working on that shift, the nursing staff from the ED in L-pod and the Trauma Nurse Clinicians assigned to Trauma Hall (Pod M).
    - At this time, Anesthesia at Parkland is available to assist in the event we have multiple airways or a difficult airway. Page them via: Anesthesia Consult to reach the Anesthetist-in-Charge (AIC) or through the Airway Disaster pager.
- CUH ED
    - At CUH ED, this discussion should be undertaken at the beginning of the Ice Pod and Red pod shifts with nursing staff and RT (depending on availability).
    - At this time, the Covid-19-ICU team should be called and Anesthesia will assist with all ED Covid-19 ETI as availability allows.
- If a resident will be managing the airway, the attending must be present in the room at the bedside during the procedure.
- The intubating operator must use *Airborne* PPE precautions.
    - Powered Air Purifying Respirators (PAPR) are available and stocked in L-pod.
    - The back up/attending can don the PAPR as well, if equipment inventory allows.
    - Otherwise operators are to use N95/Face shield/goggles/bonnet/gown/double gloves.
- There should be no more than two physicians (e.g. attending and resident) in the room for airway management
- There should be one RT and no more than two Nurses to assist.
- There should be a Nurse outside of the room to pass in medications and chart.
- If possible, open communication via phone is encouraged.

- Rapid Sequence Induction is the preferred means of intubation.
    - Ketamine (1.5-2 mg/kg, 150-200 mg) is the recommended sedative.
    - Etomidate (0.3 mg/kg, 20-30 mg) is second line.
    - Both Rocuronium and Succinylcholine are reasonable choices for paralysis
        - Rocuronium (1.2 mg/kg) has a longer time to onset of action (60-90 seconds) which may precipitate desaturation and increase anxiety for the physician managing the airway, however allowing full paralysis will yield the best first pass success
        - Succinylcholine (1-2mg/kg) has a rapid onset but may cause tissue hypoxia due to fasciculation and consumption.
- Apneic oxygenation is recommended with low flow nasal cannula[10].
- Apneic oxygenation *may* be administered via BVM with flush oxygen rate ≤6 lpm.
    - Tight seal using the "V-E" grip to optimize occlusion of the nose and mouth is recommended.
    - Gentle BVM ventilation may minimally assist with oxygenation.
    - The PEEP valve on the BVM must be turned to lowest setting to prevent release of gas from BVM when the mask is removed.
- We recommend, *however*, that BVM ventilation not be applied following the administration of sedation/paralytics to limit aerosolization.
    - Forced ventilation during the apneic period will likely promote reflex coughing which will expel highly infectious airborne particles.
    - Anecdotally, apneic arrest has been rare during this pandemic.
- ETT is advanced under direct vision through the cords to the black indicator line on the tube.
    - Stop.
    - Inflate Cuff.
    - Connect directly to the ventilator if available with in-line End-Tidal CO2 detector assembled.
        - Avoid BVM
        - Avoid colorimetric capnography.
        - ET-CO2 values 30-60 appropriate early.
        - Secure tube with RT
        - Place OGT under direct vision with video laryngoscopy.

Protected Endotracheal Intubation (ETI)

- COVID-19 pathway patients demonstrating progressive hypoxia or hypoxemia and the development of respiratory decompensation *may* benefit from judicious airway intervention.
    - Both elements must be present along with discussion with COVID-MICU service
        - Progressive hypoxia or hypoxemia
        - Respiratory decompensation

- The Protected ETI decision and process varies in significant ways from the conventional decision to ETI.
    - The decision considers the potential for oxygenation and ventilation unavailable with non-invasive means in a patient with progressive hypoxia needs approaching FiO2 1.0 (100%).
    - The decision recognizes the potential of ETI to exclude transmissible infectious particles to limit risk to HCW.
    - The process utilizes team-based coordination in deliberate execution.
        - Assigned roles
            - Intubating Operator (in-room)
            - Medication Nurse (in-room)
            - Communication Nurse (in-room)
            - Respiratory Therapist (in-room)
            - Doctor #2 (outside-room)
            - Runner Nurse (outside-room)
            - PPE observer (outside-room)
        - Process review outside the room with RT pack, Doc pack, RSI meds, post-intubation sedation meds, OGT, Foley prepared.
            - Review Plan A (RSI + glidescope)
            - Review Plan B
                - operator dependent or different operator
                - secondary preference for position, technique, blade, tube, and approach[10].
            - Review Plan C (FONA)
                - #11 scalpel and 6-0 cuffed ETT included in Covid-pack in Pod L.
        - Room entry and role execution
            - Ask patient to take breaths as allowed while receiving maximum allowable oxygens supplementation prior to RSI.
            - Glidescope prepared with 7.5 ETT with functional cuff and appropriate stylet or gum-elastic bougie
            - RSI, sedative and paralytic, dosing as above in Crash section.
            - Goal of RSI is the suppression of the cough reflex and no more.
            - Apneic period with either no use of BVM or careful BVM mask seal application
                - 2 handed “VE” grip with thenar eminences close to touching
                - Do not use 1 handed “CE” grip
                - Check PEEP valve with RT, maintain 5 cm H20 or lower as higher PEEP setting may reflux gas into field when seal breaks.
            - First pass success is equally important in the Protected ETI pathway

        - The operator must be familiar with the equipment and procedure
        - The operator must be prepared to switch Plan A without haste to Plans B and C to preserve the paralytic and minimize exposure for team members present at bedside.

    - ETT is advanced under direct vision through the cords to the black indicator line on the tube.
        - Stop.
        - Inflate Cuff.
        - Connect directly to the ventilator if available with in-line End-Tidal CO2 detector assembled.
            - Avoid BVM
            - Avoid colorimetric capnography.
            - ET-CO2 values 30-60 appropriate early.
            - Secure tube with RT
            - Place OGT under direct vision with video laryngoscopy.

        - Room clear and doffing
            - Appropriate to wait until NPR has undergone 2 cycles.
            - OGT should be placed by operator while foley placed by RNs.

Invasive Mechanical Ventilation (IMV) [1]

- IMV initial settings should reflect correction of patient's insult
- CPAP is appropriate if oxygenation corrects and the patient is spontaneously breathing.
    - May not be appropriate if patient requiring high rate of sedation
    - Not appropriate if patient ventilation demand too high (respiratory acidosis with uncorrected PaCO2).
- FiO2 should be titrated preferentially over PEEP to achieve oxygenation goals (PaO2 > 60 mm Hg or SaO2 > 85%)
- Conventional modes of Assist Control with Volume or Pressure Cycles are appropriate if the patient is not spontaneously breathing.
- Low Tidal Volume (LTV) settings (4-8 cc/kg) based on the patient's predicted body weight (height estimate) are the appropriate starting V_T.
    - COVID-19 patients may tolerate the higher end of LTV, 8 cc/kg.
    - Target Plateau Pressure of < 30 cm H20
    - The anecdotal reporting on the COVID-19 population describes high Compliance (C_{dyn}), and lower Peak Pressures than would be expected with typical ARDS.

Cardiopulmonary Arrest in COVID-19 (suspected or known) [9]

- CPR is high risk for aerosolizing the virus and exposing HCW.
- Airway Recommendations
    - BVM ventilation should be avoided. CPR only may be used until a SGA can be placed.
    - SGA with BVM and viral filter can be used to administer breaths
    - Patients arriving with EMS-placed SGA (iGel/King/Combi-tube) are to be assessed by the physician and the SGA changed at the physician's discretion.
    - A viral filter should be used with BVM regardless of tube type.
- Chest Compressions should ideally be done with a compression device (Lucas)
- In the absence of the Lucas we recommend that the least number of providers be used to perform compressions.
    - If a field SGA (King, King LT, iGel) is left in place with the viral filter it is our recommendation to perform CPR in a 30:2 Compression:Breath ratio with attention to hand placement, encouragement of an up-down compression to avoid compressing the lungs and promoting reflux of gas.
- ACLS
    - ACLS protocols should be followed
    - Inter-osseous (IO) Placement may be favorable over IV access to avoid HCW exposures and facilitate drug administration
    - Strongly recommend against administering *any* medications via the ETT to avoid exposure.
- Calling the code
    - A reasonable attempt should be made to resuscitate the patient while recognizing that there may be significant HCW exposure and risks
    - Prolonged CPR and ACLS in patients who do not achieve ROSC are likely to be unsuccessful.
    - At this time Family should not be invited back to see the patient after cessation of resuscitation efforts to prevent further transmission of SARS-nCoV-19 to susceptible community members.

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