Penn Medicine

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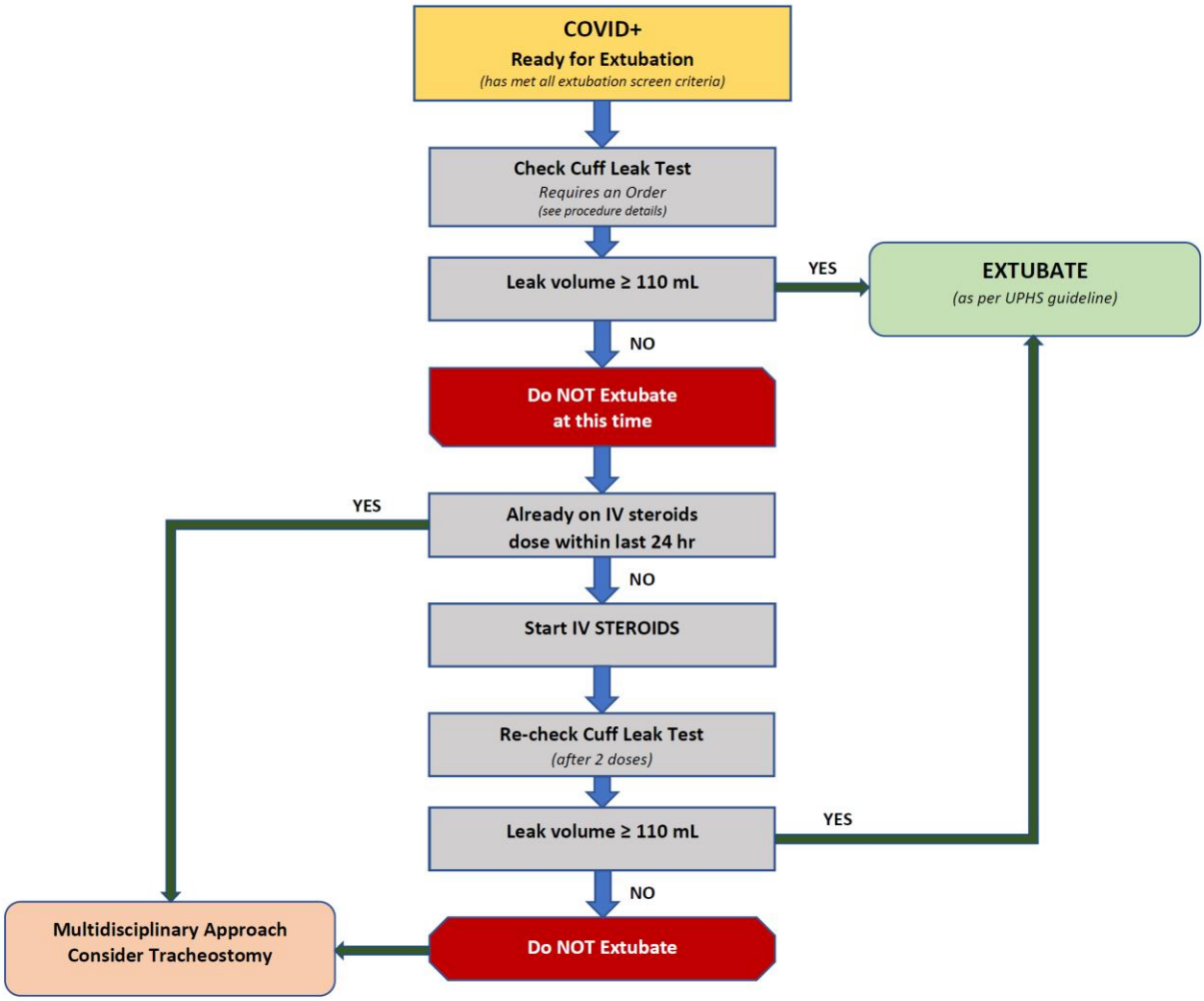
Ventilator Liberation, Extubation, and Cuff Leak-Test for COVID+ patients:

Algorithm Showing Key Points:



1. When placing initial vent order, select AC/VC mode and then "Yes" to Lung Protective Ventilation (LPV) protocol for ARDS management. Also select Ventilator Liberation Protocol (VLP) so RT can screen daily for earliest time to start weaning (embedded links have protocol details).
    a. Maintain on LPV protocol and RT will still perform a spontaneous breathing trial (SBT) when patient meets criteria. Switching to PS mode prior to SBT eligibility may be considered providing patient maintains V_E spontaneously with acceptable TV (c/w LPV) and RR (< 25) but, to minimize room entry, PS should not be titrated more than once daily.

   b. SBT should be performed on PS 0-5 with PEEP of 5 for 2 hours.
   c. When the patient has passed their SBT and either passed their extubation screen (ES), or is anticipated to do so within 24 hours, perform cuff leak test (CLT) and document result with leak volume in the Vent doc flowsheet. A provider order to check CLT is required in EMR prior to test. See procedure details below (section on CLT).
      i. If CLT passed (≥110 mL), proceed with extubation (follow steps 2-19 below)
      ii. If CLT failed (<110 mL), do NOT extubate.
         1. If IV steroids have been given (for COVID-19 ARDS or septic shock) within last 24 hours, consider multi-disciplinary approach and/or tracheostomy
         2. If IV steroids have not been given (for COVID-19 ARDS or septic shock) within last 24 hours, start methylprednisolone 40 mg IV q12h x 2 doses (or dexamethasone 8 mg IV q12h x2 doses). Administer first dose approximately 12 hours prior to extubation, and second dose before extubation.
            a. After 2 doses of IV steroids repeat CLT (as above)
               i. If CLT passed, extubate.
               ii. If CLT fails again, consider multi-disciplinary approach and/or tracheostomy.

2. Review extubation plan, if patient was screened as a high risk extubation. The high-risk extubation workflow in place at each UPHS entity should be followed.
3. Hold gastric feeds at least 1 hour prior to extubation.
4. Gather supplies: drape (surgical or clear plastic), clean towel or plastic bag for endotracheal tube (ETT), supplemental oxygen device (nasal cannula, HFNC, or NRB mask).
5. Prepare to extubate in Airborne Infection Isolation Room (AIIR), if available.
6. RT and RN staff must don PPE for airborne, droplet, and contact isolation.
   a. Limit to 2 personnel in room.
   b. RN outside of the room should be available to gather additional supplies, as needed.
7. Consider using medications to decrease coughing (e.g. lidocaine via ETT, low-dose opioid bolus, dexmedetomidine).
8. Drape the patient to cover chest and face prior to extubation (to provide barrier between patient and RT/RN).
9. Remove oral enteral access prior to extubation. Replace with NGT if continued enteral access necessary.
   a. Note: NGT placement in a native airway is an aerosol generating procedure.
10. Suction the ETT and oro-pharyngeal secretions well.
11. Avoid positive pressure during extubation. Turn off ventilator (PB 840/980), or place in "standby" mode (Servo, Hamilton), depending on safest mode available per ventilator specifications.
12. Deflate endotracheal cuff.
13. Instruct the patient to inspire, and remove ETT into clean towel or plastic bag. If plastic bag available, grab open end of ETT into plastic bag, sleeve remaining bag over ETT during removal, and seal closed with entire length of ETT inside.

14. Immediately upon extubation, place patient on supplemental oxygen at prescribed settings and observe for 20-30 minutes.
    a. Extubation to HFNC up to 60 LPM flow and FiO2 up to 100%, should be considered as COVID+ patients are at risk of extubation failure.
    b. Alternatively, can use NC at 2-6 LPM, NRB at 10-15 LPM, or CPAP Helmet.
    c. NPPV may be considered in patients at risk of hypercapnic respiratory failure (use a well-fitted, non-vented mask, and ventilation circuit with exhalation filter).
15. Cover patient with surgical mask over oxygen delivery device.
16. Keep SaO2 at goal 92-96%.
17. If increased work of breathing or SaO2 <92%, follow separate UPHS COVID guidelines for Respiratory Escalation, Non-invasive ventilation, and ICU Management, and if unstable for more than 1 hour consider reintubation. In patients with post-extubation stridor, consider trial of nebulized racemic epinephrine.
18. In patients intubated for 48 hours or more, consult speech therapy before allowing oral intake. If less than 48 hours, initially nothing by mouth for 4 hours; thereafter RN should assess patient at bedside for aspiration risk.
19. RT and RN assess patient for signs of acute respiratory failure, as per ICU guidelines.

Recommended procedure for unplanned extubation (or self-extubation):

1. If the patient had concerns for airway edema (e.g. failed CLT), Anesthesia Stat and Airway Rapid Response should be called immediately.
2. Responding staff must don appropriate PPE for airborne, droplet, and contact isolation.
3. Consider using Ambu bag with filter, to quickly obtain closure of the airway with a mask, and minimize HCW exposure.
    a. Bag must be kept partially squeezed to maintain oxygen to the patient, as the flutter valve is closed due to the high resistance of the viral filters.
4. If patient appears stable, place on either a non-rebreather (NRB) mask at 10-15 LPM, or HFNC up to 60 LPM and FiO2 up to 100%, and wean FiO2 to goal SaO2 of 92-96%. CPAP Helmet may be considered. Observe for hypoxia or signs of acute respiratory distress.
5. If patient improves, wean oxygen to NC 2-6 LPM.
6. If increased work of breathing or SaO2 <92%, consider re-intubation.

Cuff Leak Test in COVID+Patients: (see Video simulation: Performing Cuff Leak Test)

1. Check Cuff Leak Test (CLT) as required in the UPHS Extubation Guideline. This requires a provider order.
2. CLT can predict the risk of post-extubation stridor (PES) due to upper airway obstruction.
3. A *failed CLT* is defined as a *leak volume of <110 mL*.
4. Failed CLT has a high specificity of 92% and sensitivity of 56% for PES. Also, a failed CLT has a specificity of 86% and sensitivity of 63% for predicting reintubation.
5. Caution should be maintained while performing this test in intubated COVID+ patients, as there is risk of aerosolization while performing the test. Therefore, necessary PPE and precautions should be used as for any aerosol-generating procedure (AGP).
    a. Use a plastic sheet or towel over the mouth/face area to create a barrier between the patient and RT.
6. Procedure for performing CLT:
    a. Suction the ETT and oro-pharyngeal secretions well.
    b. Place patient in volume-control mode with VT set at 10 mL/kg.
        i. If VT at 10 mL/kg is not tolerated by patient, decrease VT by 1 mL/kg increments to enable highest tolerable VT to perform the CLT.
            a. Note: regardless of the size of VT used, leak volume of ≥110 mL is considered a passed CLT. However, use of lower VT may increase the likelihood of a false negative test (see below).
        ii. For patients completely intolerant of being placed on VC, consider testing for a robust audible leak on PS/CPAP of 5. However, evidence for this is not well established.
    c. Record inhaled and exhaled tidal volumes (VT) with cuff inflated. Confirm there is less than 20 mL difference between the two volumes. Record the inhaled VT.
    d. Deflate the ETT cuff.
    e. Record exhaled VT for next 6 consecutive breath cycles, with cuff deflated.
    f. Take the average of the 3 lowest VT values. Record this as exhaled VT.
    g. Determine the volume of leak around deflated ETT: this is the difference between inhaled VT (cuff inflated) and the average of 3 lowest exhaled VTs (cuff deflated).
        i. Document volume, and test result (Pass/Fail; see below) in PENN Chart.
    h. If the leak volume is **<110 mL**, the test is considered **failed CLT**. Do NOT extubate patient.
        i. Note: test can be falsely negative (despite patent airway) due to use of lower VT during the CLT, crusted secretions around ETT, or large caliber ETT.
    i. If the leaked volume is **≥110 mL**, the test is considered **passed CLT**. This means there is adequate patency of patient's native airway.

i. Note: do not use >10% of the inhaled VT, or audible leak as criteria for positive leak. The only exception for audible leak is when CLT is done on PS/CPAP mode.

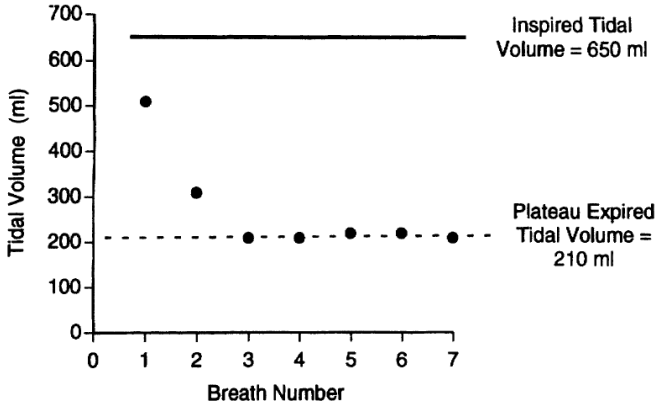


FIGURE 1. Sequential expired tidal volumes after balloon cuff deflation. Data obtained from a representative patient are shown.

Figure 1 Adapted from Miller and Cole, CHEST 1996; 110:1035-40
Six cycles were recorded because it was found that the exhaled tidal volume decreased decrementally over the first few breaths before reaching a plateau value; the lowest three values were averaged.