

## Airway Humidification Guideline to Prevent ETT Biofilm in COVID-19 Patients

### Summary of Key Points:

- **ETT biofilm build-up leading to airway obstruction has been observed in mechanically ventilated COVID patients.**
- **Heated (37°) humidification of the ventilator circuit is an effective prevention strategy and routine accurate assessment of airway resistance is an effective way to monitor for this complication.**
- **All pts. should be placed on humidified circuit. If unable, due to supplies, medical team will immediately be made aware.**

### *A. Initiate Heated Humidification to Prevent Formation of ETT Biofilm:*

1. Set up ventilator circuit using a heated humidifier (set to invasive mode @ 37 degrees) with a heated-wire circuit, however:
  - a. If a humidifier is unavailable, place an HME with a heated-wire circuit. When humidifier becomes available, switch out the HME for heated (37°) humidification.
    - i. Until then change the HME q24 hrs. and PRN
      1. Evaluate need to change HME every ventilator check, i.e. soiled, saturated, bloody, etc.
      2. To change HME, first clamp ETT tube to prevent aerosolization then change
  - b. If heated-wire circuit is unavailable, use humidifier (set to noninvasive mode @33°) with a passive ventilator circuit. When a heated wire circuit becomes available, switch out the passive ventilator circuit to enable heated (37°) humidification.

### *B. Monitor for ETT Narrowing /Obstruction, when Heated Humidification (37 degrees) is Unavailable:*

1. To detect ETT narrowing, the RT/Medical Team should monitor for difficulty passing a suction catheter as well as patient respiratory mechanics (see tip sheet below for details). Since inspiratory airway resistance ( $R_i$ ) can only be calculated using a single value for flow rate (i.e. using Ohms law:  $\Delta V = I \times R$ ; applied to air flow: **PIP - P<sub>plateau</sub> = Inspiratory Flow x R<sub>i</sub>**), always use a square wave flow profile (Servo-U use “closed” square profile), to maintain flow constant:
  - a. Any difficulty passing a suction catheter (if patient not biting tube) should be evaluated.
  - b. An  $R_i > 12$  is abnormal; values  $R_i > 15$  or if trending upward should raise concerns.
    - i. Using VC mode (w/ square wave flow), measure, document, and monitor airway resistance ( $R_i$ ) q shift, as well as PIP, P<sub>plateau</sub>, and RR.  
**Note:** By using square wave flow,  $\uparrow$  PIP is a sensitive way to detect ETT narrowing, since PIP will  $\uparrow$  in direct proportion to  $\uparrow$  in  $R_i$ .

- ii. **Note:** *If switching from decelerating waveform to square, I-time will shorten at same flowrate and PIPs will increase. Maintain I-time to prevent this.*
        - iii. If  $R_i \uparrow$  or, if PIP  $\uparrow$  disproportionately to the  $P_{\text{plateau}}$  (on same flow setting) ETT narrowing should be suspected, unless there's an alternative cause e.g. obstructed HME or obstructive airway disease.
- 2. If ETT narrowing/obstruction is suspected (i.e. airway resistance increases, PIP rises > Plateau at same flow rate, or difficulty suctioning), first rule out an obstructed filter.
  - a. Check HME and expiratory filters for dysfunction, i.e. soiled or saturated.
    - i. Note: PB's internal HEPA filter is not affected by humidification.
    - ii. If an additional expiratory bacterial filter is used, monitor q shift and change q 24 hrs and PRN
    - iii. Note: Servo's servo/Dou guard filter should be monitored q shift and changed q 24 hrs and PRN
  - b. If it is not clear whether ETT is obstructed, consider bronchoscopy to evaluate.
- 3. *Important points:*
  - a. DO NOT CHANGE VENTILATOR TUBING ROUTINELY unless severe soiling. (This is an outdated practice, and with COVID infection, it will greatly increase risk of aerosolizing secretions into room). Managing filters and water traps are first priority in protecting the circuit.
  - b. Whenever vent circuit is broken, 2 RTs should perform procedure. First clamp ETT and place ventilator in standby mode (servo). For the PB 840 see (C) below for e.g. when a filter needs to be changed.

*C. To Treat/Reverse ETT obstruction:*

- 1. If patient is stable, consider either:
  - a. Using the in-line Endo clear catheter to strip off secretions/biofilm, or
  - b. Nebulizing Hypertonic Saline with Albuterol using an Inline Aerogen Device to control for aerosolization. Alternatively, can nebulize Mucomyst (acetylcysteine) with Albuterol. After Neb completion perform tracheal aspiration.
  - c. Then reassess airway patency by rechecking ease of suctioning, PIP and/or  $R_i$  measurement.
- 2. If patient is unstable:
  - a. Call anesthesia stat +/- airway rapid response for emergent ETT exchange or reintubation.
  - b. When disconnecting patient from the ventilator:
    - i. If Servo U - Place in standby
    - ii. If PB 840

1. Turn off/on, ventilation will initiate in 10-20 seconds
2. Alternatively, a filter can be placed in line to prevent viral exposure
- iii. 980 - Note: 980 has standby but continues to deliver small amount of flow even in pressure trigger, meant to ensure immediate ventilation with reconnect that may cause aerosolization into room.
  1. A filter can be placed in line to prevent viral exposure
  2. Alternatively, turn off/on ventilation will initiate in 27-32 seconds
- iv. Hamilton - Place into standby
- v. EVO -Place into standby

## Penn Medicine COVID-19 Clinical Guide: Endotracheal Tube Obstruction

Updated 9/15/20 – Recommendations may evolve rapidly – Do not save file – If printed, update frequently – Check for latest version [here](#)

### Signs of Loss of ETT Patency

AC/VC	PSV/PC
↑ Peak inspiratory pressures (PIP) Prolonged exp times	PSV: Prolonged insp/exp times PC: Prolonged exp times
<i>Note: Vt may not fall until near complete occlusion<sup>1</sup></i>	
Mechanics	Patient
↑ Inspiratory airway resistance (Ri) ↓ Compliance Progressive auto-PEEP	Difficulty passing suction catheter Retractions/increased WOB Resp efforts fail to trigger breaths

### Monitoring Resistance

	Normal Lungs	ARDS	COPD
Inspiratory Resistance (cmH2O/L/s)	10 – 15	10 – 15	10 – 30
Compliance (ml/cmH2O)	> 60	10 – 50	> 60
Peak Inspiratory Pressure (cmH2O)	< 20	< 35	20-60

**Ri > 15 is abnormal**

**Measure Q12h & with clinical/ventilator changes warranting reassessment**  
 Place patient on AC/VC square wave flow pattern to measure  
 Patient must be passive for accurate measurement; if high concern for obstruction, consider temporary sedation +/- paralysis to obtain accurate vent mechanics

**On AC/VC Square Wave**

On flow 60L/min:  
 $Ri = PIP - Plat$

Other flow rates:  
 $Ri = (PIP - Plat) / Flow (L/s)$   
*(Vent should calculate & display Ri)*

### ETT Obstruction Overview

↑ Incidence in COVID-19, especially with non-humidified vent circuits

- Small decreases in ETT diameter result in large increases in resistance
- Unexplained asynchrony or difficulty tolerating spont modes warrant evaluation
- Progressive autoPEEP & ↑ PIP/Ri on AC/VC square wave warrant urgent mgmt

**Suction Catheter RED FLAGS:**  
 Difficulty passing → urgent intervention; Inability to pass → emergent intervention

### Treating & Reversing ETT Obstruction

**Clinical Instability and/or Inability to Pass Suction Catheter?**

	NO	YES
Consider bronch if unclear if obstruction in ETT or native airway	<b>Urgent Management</b> Give 2mL 3% saline or 2mL 10% Mucomyst +/- albuterol <sup>®</sup> via Aerogen <sup>®</sup> inline nebulizer After treatment, perform inline suctioning +/- If available, use in-line EndOclear catheter vs. Fogarty balloon to strip secretions/biofilm (Fogarty requires anesthesia or IPulm)	<b>Emergent Management</b> Call Airway Rapid Response overhead for emergent airway intervention ETT exchange or reintubation (exchange catheter preferred, alternatively VL or DL at provider discretion given comfort) Call Anesthesia for consideration of airway intervention (If unable to effectively & rapidly address ETT concerns via consult, can call Airway RR)
	Concern for persistent ETT obstruction ↑	

NOTE: Airway Rapid Response previously used for emergent airway loss  
 Now can be called for unstable airway with risk of impending airway loss

a) To prevent bronchospasm  
 b) If Aerogen not available, directly instill medication into ETT, DO NOT use open nebs

<sup>1</sup>Tung. Anesth Analg. 2002
Created by Jen Ginestra, MD, Pulmonary & Critical Care Medicine; Adapted from UPHS Critical Care Committee Guidelines

Quick Guide is located on COVID19 Sharepoint Site and the COVID Learning Site.