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.

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. When Heated (37 degrees), Humidification is Unavailable, Monitor for ETT Narrowing /Obstruction:
   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: \(PIP - P_{plateau} = \text{Inspiratory Flow} \times R_i\)), always use a square wave flow profile (Servo-U use “closed” square profile):
      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_{plateau}, 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_{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 airway resistance increases, 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 by 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. Use the in-line Endo clear catheter to strip off secretions/biofilm.
      b. Or nebulize Hypertonic Saline with Albuterol using an Inline Aerogen Device to control for aerosolization. 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 840/980 - Note: 980 has standby but continues to deliver small amount of flow even in pressure trigger, meant to ensure immediate ventilation with reconnect but if circuit is bumped etc. ventilation may initiate causing aerosolization into room.
            1. If patient can tolerate, do the following:
               a. Change to pressure trigger with no bias flow
               b. Turn PEEP/PSV off
               c. Decrease VT to 25ml
               d. Decrease Peak Flow to 3 lpm
               e. Decrease resp rate to 1
            2. OR, if 840 turned Off/On ventilation will initiate quickly
               iii. Hamilton - Place into standby
               iv. EVO -Place into standby
               v. Trilogy 202 - Turn off, then on
                  1. Similar to standby
                     a. Begin to ventilate quickly
Tip Sheet: Located on COVID19 Sharepoint Site and the COVID Learning Site.
Assessment and Mitigation of ETT Obstruction Quick Guide