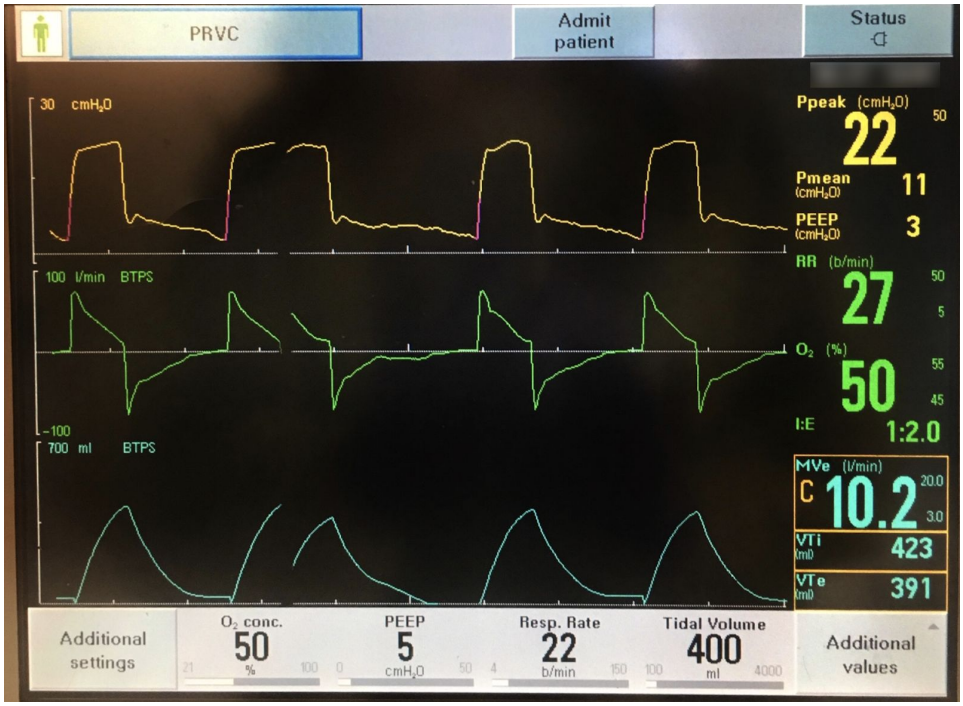
Extubation

Introduction

Just as important as knowing when and how to put a patient on a ventilator, it is important to know when and how to remove them from this support (also known as “weaning”). An adage from Critical Care is that preparation for extubation starts as soon as the patient is intubated. With COVID-19, the patients are generally requiring prolonged periods of intubation, with many reports quoting 10 to 14 days. Regardless, the onus falls on the clinicians caring for any mechanically ventilated patient to assess the patient's daily for signs of stability or improvement. With any signs of improvement, assessment for extubation readiness should begin.

Patients’ conditions should be assessed continually and, once gas exchange and compliance improve, the level of support can be reduced. For most patients, the first step

in moving towards extubation readiness is to move from assist control ventilation to pressure support ventilation. As discussed in previous readings, pressure support ventilation allows for spontaneous ventilation. The patient engages their diaphragm and sets their own respiratory rate, flow, and tidal volume. The following ventilator screen illustrates a patient who is ready to be changed to pressure support. The patient was arousable with lightening sedation, has good pulmonary mechanics as indicated by the low PIP of only 22 with a TV of 400, has a low PEEP requirement, and is only on 50% FiO2. On these settings, the patient's ABG was also reassuring, at 7.37/38/110. (Note: in addition to changing to pressure support, the FiO2 could also be decreased to 40% given the more than adequate PaO2.)



Once the patient has been placed on pressure support, physiological measurements including MIP (maximal inspiratory pressure), f_RV_T (respiratory frequency to tidal volume ratio, or rapid shallow breathing index) and others can be used to assess a patient's readiness to wean.

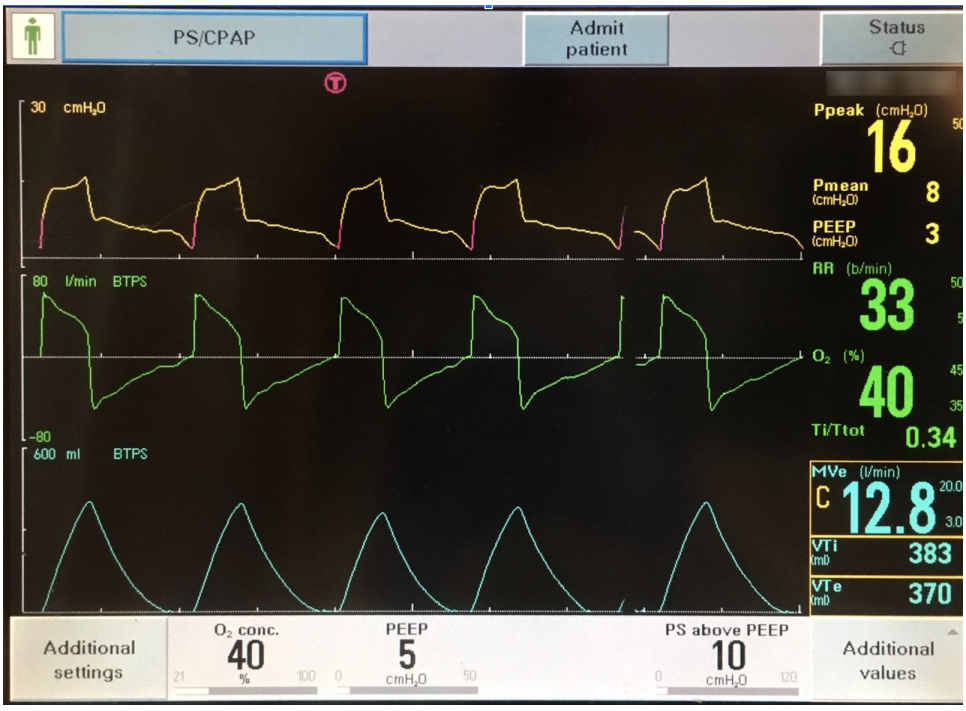
If the following criteria are met, the patient should undergo a spontaneous breathing trial (SBT) to determine if they are ready to attempt extubation.

Criteria for Performing Spontaneous Breathing Trial*

- Improvement of underlying condition that led to intubation
- Relative hemodynamic stability
    - HR < 130
    - Mean arterial pressure (MAP) adequately supported on a stable dose of vasopressors
- Presence of a cough reflex (often elicited by suctioning)
- Burden of secretions that can be handled by cough strength. (Patients with a robust cough will be able to clear more secretions.)
- Adequate oxygenation
    - Usually SpO_2 > 90% on 40% FiO_2 and PEEP ≤ 8
    - Ability to maintain the current oxygenation status once extubated.
- Adequate ventilation
    - pH > 7.3 with a PCO_2 near baseline
    - Minute ventilation that a patient can maintain after extubated, usually < 12 L/min
- Minimal ventilator settings
    - On pressure support ≤ 10 cm H_2O
    - On PEEP ≤ 8 cm H_2O
    - Maintaining tidal volumes ≥ 5 mL/kg PBW
    - Respiratory rate < 35
    - FiO_2 ≤ 50%

**These values are provided for general education purposes. Most institutions have their own specific criteria. Please refer to your institution's protocols for details.*

The following screen shows a patient on pressure support, 10/5 (10 cm H_20 driving pressure over 5 cm H_2O of PEEP). This patient is marginal, as the tidal volume with 10 cm H_2O of driving pressure is 400, which is acceptable, but the respiratory rate is 30. The patient should be assessed for non-pulmonary causes of tachypnea, such as pain, anxiety/agitation, fever, etc. It is reasonable to decrease the pressure support of 10 cm H_2O to 5 cm H_2O and reassess both the tidal volumes and respiratory rate. It is difficult to predict how patients will do; often the best course is to give them a trial and assess.



Spontaneous breathing trials are used to assess a patient's readiness to wean by removing ventilation support for 30 minutes and evaluating the patient's ability to breathe on their own during this time. There are many ways to perform SBTs, including pressure support of 5/5, 0/5, and 0/0, as well as "T-piece trials" in which the patient is taken off the ventilator and supported with blow-by humidified oxygen. Each approach has its proponents, and institutional guidelines vary. The most important concept to consider is the available respiratory support options, and ensure that the patient is able to pass with that level of support.

Criteria for Passing Spontaneous Breathing Trials*

- Clinical Appearance
  - No evidence of respiratory distress
    - Cyanosis, diaphoresis, accessory muscle use, grimacing
- Pulmonary mechanics
  - Ratio of respiratory rate : tidal volume < 105
  - Respiratory rate < 30 breaths per minute
  - Tidal volume < 5 mL/kg PBW
- Oxygenation and ventilation
  - SpO_2 > 90% on FiO_2 ≤ 50%
  - $PaCO_2$ ≤ 50mmHg or a
  - pH ≥ 7.3 or decrease in pH of ≤ 0.07
- Hemodynamics
  - Change in SBP to > 90 or < 180 mmHg
  - HR < 130 beats per minute
  - New dysrhythmias

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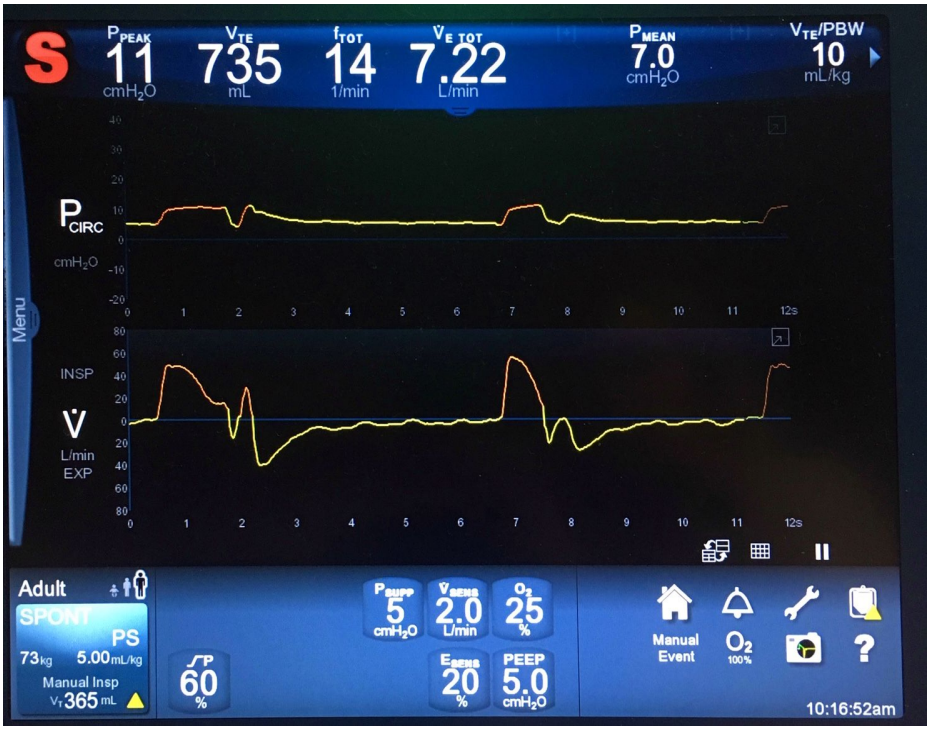
The screen below demonstrates a patient who is doing well on an SBT. They are on pressure support, 5/5, and have large tidal volumes of 735 mL, indicating good compliance. They are breathing at a slow rate of 14, and they are on a low FiO_2 of 25%. This patient would be an excellent candidate for extubation, assuming there are no other barriers.



If a patient's spontaneous breathing trial is successful, the next step is to assess for other barriers to extubation. A helpful approach is to go head to toe:

Assessment for Barriers to Extubation

Head: Is the patient awake, following commands? If not, does the clinician believe s/he will be able to cough and protect the airway? Is the patient calm or agitated? If agitated, does it seem related to the ETT? Is there a plan for agitation management? Is pain adequately controlled without inducing somnolence or apnea?

Face/Neck: Any facial trauma? Tongue or lip swelling? (Note: this may be seen in a patient who was previously proned) Was the patient a difficult intubation? (Note: does not preclude extubation, but all clinicians should be aware) Does the patient have a cuff leak?

Chest: Does the patient have any chest trauma/other pathology (eg, rib fractures, etc) that may preclude adequate breathing?

Abdomen: Any planned procedures or diagnostics that should happen before extubation? What is the nutrition plan after extubation? Should an NG tube be placed for tube feeds before extubation? (Note: most patients with prolonged intubations have oropharyngeal muscle weakness for days after extubation, precluding normal feeding.)

If there are no barriers to extubation, the patient may be extubated. In preparation, gather supplies that would be needed for oxygenation post-extubation (nasal cannula, oxygen mask, CPAP or BPAP, etc.), as well as supplies that would be needed to intubate the patient again if extubation fails:

- Endotrachial tubes (ETTs) of appropriate sizes
- Bag mask with positive end expiratory-pressure (PEEP) valve
- Airway bougies
- Tube exchangers
- Traditional direct laryngoscope
- Video laryngoscope
- Flexible bronchoscope
- Drugs needed for induction
- Suction catheter

For extubation:

1. Put the patient in an upright, seated position.
2. Suction the ETT and oral cavity. Remove all secretions above the ETT cuff using subglottic suction, if available, or insert a small bore catheter on the side of the ETT for removal of secretions above the ETT cuff.
3. Remove the ETT from the holder.
4. Ask the patient to take a deep breath and exhale.
5. During exhalation, deflate the cuff and smoothly remove the ETT.
   Note: If an orogastric tube is present, it will be removed alongside the ETT and may need to be replaced by a nasogastric tube, if the patient is not ready for oral intake of medications and nutrition.
6. Suction the oral cavity.
7. Ask the patient to take a deep breath and cough out all secretions.
8. Provide supplemental oxygen through a nasal cannula, oxygen mask, etc., as appropriate.

After extubation, it is important to monitor the patient carefully. Make sure they have adequate oxygenation and provide supplemental oxygen as appropriate. If necessary, consider CPAP/BPAP if a patient requires additional support. Use bronchodilators as needed, provide secretion management, maintain airway hydration and patent central airway, and encourage patient behaviors that reduce the potential for re-intubation:

- Coughing
- Deep breathing
- Sitting up
- Moving around if appropriate

Risk factors that suggest a patient will need to be re-intubated include:

- Pneumonia
- Weak cough
- Frequent suctioning
- Rapid shallow breathing index >58 breaths per minute per liter
- Positive fluid balance in the 24 hours prior to extubation

Extubation process and post-extubation recommendations modified from Saeed F, Lasrado S. Extubation. [Updated 2019 Jul 21]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2020 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK539804/