Society of Critical Care Medicine
The Intensive Care Professionals

FCCS Fundamental Critical Care Support

Fundamental Critical Care Support Skill Station
Mechanical Ventilation Station II
Participant Guide

Estimated completion time: 45-60 minutes

The mechanical ventilation skill stations review information presented in the textbook chapters, Diagnosis and Management of Acute Respiratory Failure and Mechanical Ventilation. The cases presented here are intended to represent common problems encountered when caring for critically ill patients.

Station Goals

The goals for this station are to:

- Provide a foundation for correlating pathophysiology and appropriate ventilator interactions.
- Develop strategic evaluation of secondary lung parameters and the methods of ventilator modification required to address them.
- Expand both the didactic and practical understanding of mechanical ventilation strategies.

Participant Objectives

After completing this skill station, the student should be able to:

- Discuss the initiation of the ARDSnet ventilation strategies in the care of a patient with acute respiratory distress syndrome (ARDS).
- Describe alternatives focused on the improvement of oxygenation in response to the patient with hypoxemia despite administration of high fraction of inspired oxygen (FIO_2).
- Explain the concept of permissive hypercapnia, as well as relative contraindications to its use.
- Adjust ventilator settings to minimize auto-positive end-expiratory pressure (auto-PEEP) [or intrinsic PEEP] in the management of the patient with severe bronchospasm and air trapping.
- Relate indications for and complications of pharmacologic paralysis.

Case Scenario 1	
You are called to the unit because a patient appears to be “bucking the ventilator.” The patient is visibly coughing and recoiling against each delivered machine breath. The high pressure alarm is sounding, and the staff is requesting a propofol infusion to calm the patient. You correctly identify that the patient is experiencing patient-ventilator dyssynchrony and start considering your options for correcting this.	**Notes of Concern**
Detection	
Q. Beyond the discomfort of the endotracheal tube, how might ventilator breath delivery modes cause air hunger or discomfort?	
Intervention	
Q. In addition to or instead of sedation, what ventilator adjustments could be made?	

Case Scenario 2	
A 62-year-old, 5 feet 10 inches tall, 70-kg man admitted for a small bowel obstruction was transferred to the ICU after aspirating a large volume of gastric contents. He is severely tachypneic and hypoxemic despite supplemental oxygen delivered via a non-rebreather face mask. You decide to intubate and initiate mechanical ventilation. The following initial ventilator settings are selected: mode: assist-control rate 12, V_T 650 mL, pressure support 10 cm H_2O, PEEP 5 cm H_2O, F_{IO_2} 100%. A postintubation chest radiograph demonstrates diffuse alveolar infiltrates. His initial peak airway pressure is 45 cm H_2O and plateau pressure is 40 cm H_2O. His initial arterial blood gas measurement (ABG) reveals pH 7.35, Pa_{CO_2} 45 mm Hg (6.0 kPa), Pa_{O_2} 80 mm Hg (10.7 kPa), HCO_3 24 mmol/L.	**Notes of Concern**
Detection	
Q. What would be the most likely cause of the patient's diffuse infiltrates and hypoxemia (shunt)?	
Intervention	
Q. What would be the most appropriate change to the current ventilator settings in light of this diagnosis?	
Reassessment	

The patient continues to demonstrate worsening oxygenation with oxygen saturation of 86% on pulse oximetry and on an F_{IO_2} 100%.	
Intervention	
Q. What simple adjustment to one ventilator setting would likely improve oxygenation (decrease shunt)?	
Reassessment	
Q. What other modification to the ventilator strategy might improve oxygenation (decrease shunt)?	

Case Scenario 3	
JT is an 18-year-old man with severe asthma. He remains poorly controlled despite the use of multiple asthma medications. He presents to the emergency department with a severe asthma exacerbation. Despite bronchodilator treatments and intravenous corticosteroids, he becomes minimally responsive and his ABG measurement demonstrates a severe respiratory acidosis with a $PaCO_2$ >100 mm Hg (13.3 kPa). He is intubated by emergency department staff and is transferred to the ICU. His vital signs on arrival to the ICU are as follows: pulse 160 beats/min, blood pressure 70/55 mm Hg, respiratory rate 30 breaths/min, oxygen saturation on pulse oximetry 88%. Auscultation of his chest reveals minimal air movement. His ventilator alarm is sounding with high respiratory rate, low V_T, and high peak airway pressure.	**Notes of Concern**
Detection	
Q. What is the physiology underlying the patient's cardiac and respiratory instability?	
Intervention	
Q. What immediate intervention is needed to stabilize his hemodynamic and respiratory status?	
Reassessment	
Q. How is the patient's spontaneous respiratory rate contributing (if at all) to this problem?	
Intervention	

Q. What pharmacotherapy and ventilator interventions should be considered?	

JT's hemodynamics improve, as well as his oxygenation. You note better air movement with the interventions noted. ABG results reveal the following: pH 7.20, $PaCO_2$ 70 mm Hg (9.3 kPa), PaO_2 155 mm Hg (20.7 kPa), HCO_3 26 mmol/L.	**Notes of Concern**
Q. With regard to the ABG, what are the findings of note? What, if anything, needs to be done to the ventilator settings?	
Q. How often is pharmacologic paralysis necessary to facilitate patient tolerance of ventilator settings?	
Q. What are the risks associated with the use of non-depolarizing neuromuscular blockers?	

Discuss the effects of changes in physiology or ventilator methods on measured parameters.

Change in Mechanical Parameters*	Effect Upon†			
	Peak Airway Pressure	Mean Airway Pressure	Inspiratory Time	Expiratory Time
Increase V_T	↑	↑	↑	↓‡
Decrease flow rate	↓	↓ or ↑¶	↑	↓‡
Increase PEEP	↑	↑	---	---
Decrease compliance	↑	↑	---	---
Increase airway resistance§	↑	↑	---	---
Increase rate	Same or ↑‡	↑‡	---	↓‡

* Assume all other settings remain the same.
† Remind participants that secondary hemodynamic changes and barotrauma are possible.
‡ Consider effect of auto-PEEP.
¶ Depends upon prolongation of inspiratory time.
§ Auto-PEEP may occur as a result of the new resistance if it presents in exhalation (eg, bronchospasm).