Society of Critical Care Medicine
The Intensive Care Professionals

FCCS Fundamental Critical Care Support

Fundamental Critical Care Support Skill Station
Mechanical Ventilation I
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 practical foundation for evaluating patients requiring intubation.
- Create a standardized method for therapeutic management immediately following intubation.
- Define the basic parameters of mechanical ventilation.
- Expand both the didactic and practical understanding of mechanical ventilation strategies.
- Review common problems leading to alarm status.

Participant Objectives

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

- Describe the indications for the initiation of mechanical ventilation.
- Select appropriate initial ventilator settings (ventilator prescription).
- Modify the ventilator prescription in response to pressure changes and arterial blood gas analysis.
- Discuss the causes of hypotension after intubation and after initiation of ventilation.
- Describe the differences between mandatory and spontaneous modes of mechanical ventilation.

Introduction to mechanical ventilator. Pay attention to features common to most ventilators.	Participant will discuss and observe the following.
Consider "generic" features of the ventilator control panel: ● Airway pressure gauge/digital display ● Dials, buttons, etc, for entry of settings ● General alarm displays ● Settings usually determined by trained practitioners, such as flow rate, pressure volume curves, flow waveform, inspiratory to expiratory ratio (I:E) display, etc. **Consider** "generic" features of ventilator circuit: ● Oxygen/air source(s) and high pressure lines to ventilator ● Inspiratory circuit to patient ● Expiratory circuit, exhalation valve, and positive end-expiratory pressure (PEEP) device, if visible **Consider** any added features: ● Humidifier/heater ● Treatment nebulizer ● Bacterial filters ● Attached suction devices	● Ventilator controls ● Essential components of the ventilator - controls - displays - alarms ● Elements of the patient/ventilator circuit - inspiratory circuit - expiratory circuit - added features

Review indications for intubation and mechanical ventilation.	List the indications for intubation and ventilation.
Consider: ● Airway control ● Types of respiratory failure ● Work of breathing	

Case Scenario 1	
Mr. Z—a 43-year-old, 60-kg, 170-cm patient—is admitted with a multidrug overdose. He is observed in the intermediate care unit for 2 hours, when the nurses note a worsening of his mental status with a decline in his GCS score to 6. The house physician intubates the patient. After the patient is transferred to the ICU, the staff calls you to confirm the mechanical ventilator parameters ordered by the house physician.	**Notes of Concern**
Detection	
Q. What is the indication for intubation and initiation of mechanical ventilation in this patient?	
Discuss the basic components of mechanical ventilation settings: ● Mode ● Tidal volume ● Respiratory rate (RR) ● Fraction of inspired oxygen (FIO_2) ● PEEP	
Q. What does the term *synchronized intermittent mandatory ventilation* (SIMV) describe, and what advantages does SIMV provide?	

Q. What does the term *assist-control ventilation* (AC) describe, and what advantages does AC provide?	

Intervention	
Q. What are the 5 essential parameters necessary for a ventilator prescription, and what are reasonable starting values for each?	
Q. How do you confirm the appropriate endotracheal tube location?	
Reassessment	
Q. What laboratory tests or studies should you obtain after intubation?	
Mr. Z's blood pressure drops several minutes after initiation of mechanical ventilation. **Q. What are important concerns?**	

Consider a blood gas measure after initiation of mechanical ventilation.

Discuss the appropriate diagnosis and therapies for the following arterial blood gas (ABG) results:

1. pH 7.32, $PaCO_2$ 30 mm Hg, PaO_2 130 mm Hg, HCO_3 15 mmol/L, RR 35 breaths/min

2. pH 7.30, $PaCO_2$ 61 mm Hg, PaO_2 82 mm Hg, HCO_3 31 mmol/L, RR 27 breaths/min

Mr. Z continues to be minimally responsive and is not over-breathing the ventilator. His current ventilator settings are below, and a critical blood gas value is sent to you from the lab.

Ventilator Settings	**ABG**
• AC	• pH 7.2
• RR 12 breaths/min	• $PaCO_2$ 64 mm Hg (8.5 kPa)
• V_T 500 mL	• PaO_2 580 mm Hg (77.3 kPa)
• FIO_2 100%	• HCO_3 26 mmol/L
• PEEP 5 cm H_2O	

Notes of Concern

Intervention	
Q. What are the main findings of note on this ABG report, and what modifications would you make to your ventilator prescription? **Consider:** ● Utility of the ABG: key values pH, $PaCO_2$, PaO_2 ● $PaCO_2$ as a measure of adequacy of minute ventilation ● pH: importance of interpreting $PaCO_2$ values in context of pH and HCO_3 (Henderson equation) ● PaO_2 and hemoglobin saturation as measures of adequacy of oxygen uptake ● $PaCO_2$ and relationship to minute ventilation (MV): CO_2 clearance is a function of MV. MV = (RR) (V_T). To increase MV and reduce $PaCO_2$, rate and/or V_T must be increased.	
Reassessment	
Q. What pressure changes will you see if the airway resistance increases?	
Q. What is the difference between peak and plateau pressure?	

Case Scenario 2	
Ms. S is a 65-year-old woman receiving mechanical ventilation after myocardial infarction complicated by cardiogenic shock. Suddenly her ventilator alarm continuously sounds because of high airway pressures. Ms. S is diaphoretic and visibly uncomfortable on the ventilator.	**Notes of Concern** Potential causes of high pressure alarms
Detection	
Q. What are appropriate initial steps? **Q. How is the patient evaluated?** **Q. What is the differential diagnosis of distress in this patient?**	

Intervention	
Q. What are some of the potential causes of increasing airway pressures?	
Q. What is the difference between peak pressure (PIP or Paw) and plateau pressure (Pplat)? (Paw) – (Pplat): if >10 cm H_2O, suggests increased airway resistance; if ≤5 cm H_2O, decreased compliance	

Q. How do you measure Pplat? Demonstrate the method for obtaining a Pplat value. If a test lung is available to simulate high resistance or decreased lung compliance, demonstrate calculation of peak to plateau difference.	
Q. What is the significance of the Pplat?	
Q. What are some of the methods utilized to reduce Pplat?	
Reassessment	
Q. What are some potential causes of: ● **Decreased lung/chest compliance?** ● **Increased airways resistance?** **Q. How do you address these problems?**	

Case Scenario 3	
You are called to evaluate a patient who has had a lung resection. The patient is making gurgling noises from his mouth during each inspiratory cycle of the ventilator. You notice that the V_T set on the ventilator is 450 mL, but the exhaled volume is approximately 300 mL. You assume "cuff leak."	
Detection	
Q. What is the significance of volume loss? **Q. How is the function and position of the endotracheal tube evaluated?**	
Intervention	
Q. What are the initial steps to consider?	
Reassessment	
Q. What is the significance of the gurgling during the respiratory cycle of the ventilator?	

Q. What are the common causes of a low exhaled V_T?	
Q. What ventilator alarms would sound in the setting of a cuff leak?	
Q. What are the problems with just adding air to the tracheal balloon to correct the assumed leak?	