



# Ventilator Team Based Learning

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Submitted: November 10, 2016; Accepted: December 6, 2016; Electronically Published: January 28, 2017; <https://doi.org/10.21980/J8H01M>

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## ABSTRACT:

**Audience:** This modified team-based learning (TBL) is appropriate for senior medical students, interns, junior and senior emergency medicine residents.

**Introduction:** Ventilator management can be very complex and difficult to understand, much less master. Often, emergency medicine residents and physicians rely on the respiratory therapist to help guide ventilator settings; however, it is important for physicians to understand ventilator settings and management for acute lung protective and obstructive care.

**Objectives:** At completion of this TBL the learner should be able to: 1) choose appropriate ventilator settings and adjustments for a patient with lung injury or obstructive lung pattern, 2) troubleshoot an alarming ventilator, 3) set up the most common ventilator in their ED, 4) set up the equipment needed for transtracheal jet ventilation.

**Methods:** This is a combination of a modified TBL with small group hands-on ventilator and transtracheal jet ventilation set up and instruction.

**Topics:** Pulmonary, critical care, ventilator, airway, respiratory.





# USER GUIDE

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## Learner Audience:

Medical students, interns, junior residents, senior residents, faculty.

## Time Required for Implementation:

Instructor Preparation: 30 minutes

Learner Responsible Content: 30 minutes

In Class Time: 90 minutes

## Recommended Number of Learners per Instructor:

15-30 learners per instructor

## Topics:

Pulmonary, critical care, ventilator, airway, respiratory.

## Objectives:

By the end of this educational session the learner will be able to:

1. Choose appropriate ventilator settings and adjustments for a patient with lung injury.
2. Choose appropriate ventilator settings and adjustments for a patient with obstructive lung pattern.
3. Trouble shoot an alarming ventilator
4. Set up the most common ventilator in their ED.
5. Set up the equipment needed for transtracheal jet ventilation.

## Linked objectives and methods:

The learner responsible content articles provide in-depth discussion on ventilator management for lung injury and obstructive lung disease. The article discusses not only which ventilator settings to use for each but also how to trouble shoot the ventilator. The mTBL consists of an iRAT and gRAT which cover the basics of ventilator settings. The associated group application exercise dives deeper with the goal of having

learners work through ventilator settings and trouble shooting how to adjust the ventilator. By implementing the iRAT, gRAT and GAE you can ensure learner understanding and ensure that objectives are met.

The associated ventilator check list small group activity provides an outline for important knowledge physicians should have about their departments ventilators and the transtracheal jet ventilation small group discusses setting up a transtracheal jet ventilator from common ED supplies and is intended for hands on application.

The mTBL can be completed in approximately 45 minutes, allowing 45 minutes for hands on ventilator and transtracheal jet ventilation teaching which can be facilitated by an attending physician or a respiratory therapist.

## Recommended pre-reading for instructor:

The instructor should read:

1. Weingart SD. Spinning dials: how to dominate the ventilator. *EMCrit*. <http://emcrit.org/podcasts/vent-handout/>. Published 2010. Accessed November 1, 2016.
2. Weingart SD. Managing Initial Mechanical Ventilation in the Emergency Department. *Ann Emerg Med*. 68(5):614-617. doi: 10.1016/j.annemergmed.2016.04.059

Additionally, the instructor could watch the EMCrit podcasts on Ventilator Management by Scott D Weingart, MD

1. Weingart SD. Dominating the vent: part 1. *EMCrit*. <http://emcrit.org/archive-podcasts/vent-part-1/>. Published May 24, 2010. Accessed November 1, 2016.
2. Weingart SD. Dominating the vent: part 2. *EMCrit*. <http://emcrit.org/podcasts/vent-part-2/>. Published June 1, 2010. Accessed November 1, 2016.

## Learner responsible content (LRC):

The learner should read:

1. Weingart SD. Managing Initial Mechanical Ventilation in the Emergency Department. *Ann Emerg Med*. 68(5):614-617. doi: 10.1016/j.annemergmed.2016.04.059

Alternatively, the learner could watch the EMCrit podcasts on Ventilator Management by Scott D Weingart, MD

1. Weingart SD. Dominating the vent: part 1. *EMCrit*. <http://emcrit.org/archive-podcasts/vent-part-1/>. Published May 24, 2010. Accessed November 1, 2016.
2. Weingart SD. Dominating the vent: part 2. *EMCrit*. <http://emcrit.org/podcasts/vent-part-2/>. Published June 1, 2010. Accessed November 1, 2016.



# USER GUIDE

During the TBL the Learner should have access to:

1. Weingart SD. Spinning dials: how to dominate the ventilator. EMCrit. <http://emcrit.org/podcasts/vent-handout/>. Published 2010. Accessed November 1, 2016.

## Results and tips for successful implementation:

This is a combination modified TBL and small group activity.

Prior to the session learners should be given access to the LRC, either the “Managing Initial Mechanical Ventilation in the Emergency Department” by Scott Weingart or the podcasts “Dominating the Vent Part 1 and 2” available on EMCrit.org, as well as the handout “Spinning Dials How to Dominate the Ventilator” by Scott Weingart.

The instructor should review the LRC, and prior to the session print 1 iRAT per person and 1 gRAT and 1 GAE per group.

Prepare the gRATs by making it an immediate feedback/assessment technique (IF/AT) form, see attached gRAT photographs). You can purchase scratch off label stickers at [www.amazon.com](http://www.amazon.com). This will allow the learners to receive immediate feedback as to whether they got the answers correct.

We recommend separating your learners in to groups of 3-5. Each group will complete the iRAT, gRAT, GAE at their own pace (this takes approximately 45 minutes), additionally each group will rotate through the hands-on Ventilator and Transtracheal Jet Ventilation activities (approximately 20 minutes per station or 40 minutes total).

For the hands on portion we recommend allowing 20 minutes per group, and having a Respiratory Therapist (RT) available to help facilitate the session. Our RT brought a ventilator (our common ED ventilator) to the session. We collaborated with our RT to develop a checklist of important ventilator skills the residents needed to master (see Ventilator Hands-On Session Checklist). Our RT also facilitated the transtracheal jet ventilation station. We recommend having materials available so that residents can practice assembling the transtracheal jet ventilation materials—if available we recommend having a SIM man or similar cricothyrotomy simulator so that residents can practice inserting a transtracheal jet ventilator as well.

## Content:

- iRAT
- gRAT
- GAE
- Hands-On Checklist
- Percutaneous Transtracheal Jet Ventilation Handout

- RAT Key
- GAE Key

## References/suggestions for further reading:

1. Weingart SD. Spinning dials: how to dominate the ventilator. EMCrit. <http://emcrit.org/podcasts/vent-handout/>. Published 2010. Accessed November 1, 2016.
2. Weingart SD. Managing Initial Mechanical Ventilation in the Emergency Department. *Ann Emerg Med*. 68(5):614-617. doi: 10.1016/j.annemergmed.2016.04.059
3. Weingart SD. Dominating the vent: part 1. EMCrit. <http://emcrit.org/archive-podcasts/vent-part-1/>. Published May 24, 2010. Accessed November 1, 2016.
4. Weingart SD. Dominating the vent: part 2. EMCrit. <http://emcrit.org/podcasts/vent-part-2/>. Published June 1, 2010. Accessed November 1, 2016.



# LEARNER MATERIALS

## Ventilator TBL

### Individual Readiness Assessment Test (iRAT)

Based on Weingart, Scott D *“Managing Initial Mechanical Ventilation in the Emergency Department”* and *Ventilator Handout*

1. Which study is one of the few ventilator trials to demonstrate mortality benefit?  

---
2. Based on this study, any patient who does not have an obstructive disease should be ventilated with which strategy?
  - a) Lung protective
  - b) High I:E ratio
  - c) Obstructive strategy
  - d) Volume overload strategy
3. According to the article, which mode is considered preferable for critically ill ED patients?
  - a) Synchronized Intermittent-Mandatory Ventilation (SIMV)
  - b) Pressure-Controlled Ventilation
  - c) Volume-Assist Control
  - d) Pressure Support Ventilation
4. What is the recommended initial tidal volume for patients in the ED without obstructive lung disease?
  - a) 6mL/kg
  - b) 8mL/kg
  - c) 10mL/kg
  - d) 12mL/kg
5. What is the minimum acceptable tidal volume?
  - a) 2mL/kg
  - b) 4mL/kg
  - c) 6mL/kg
  - d) 8mL/kg



## LEARNER MATERIALS

6. What is the appropriate initial setting for an inspiratory flow rate?
  - a) 20L/minute
  - b) 40L/minute
  - c) 60L/minute
  - d) 80L/minute
  
7. What setting should be used for titrating ventilation?
  - a) Tidal Volume
  - b) Inspiratory Flow Rate
  - c) PEEP
  - d) Respiratory Rate
  
8. Respiratory rate can be started at \_\_\_\_\_ breaths/min, and titrated up to \_\_\_\_\_ breaths/min in order to achieve the goal \_\_\_\_\_
  
9. What is the goal SpO<sub>2</sub> in a patient requiring protective strategy for ventilation?
  - a) 80-85%
  - b) 82-87%
  - c) 88-95%
  - d) 95-100%
  
10. What is the recommended starting point for FiO<sub>2</sub> and PEEP in a patient without obstructive lung disease?
  - a) FiO<sub>2</sub> 30-40%; PEEP 0
  - b) FiO<sub>2</sub> 30-40%; PEEP 5
  - c) FiO<sub>2</sub> 50-60%; PEEP 0
  - d) FiO<sub>2</sub> 50-60%; PEEP 5
  
11. If a patient is hypoxic, despite an FiO<sub>2</sub> > 50%, the continued hypoxia is due to:
  - a) Excess pressure
  - b) Hyperoxia
  - c) Inadequate ventilation
  - d) Physiologic shunt



## LEARNER MATERIALS

12. How do you measure the plateau pressure?

---

13. What is the goal plateau pressure?

- a) <10 cm H<sub>2</sub>O
- b) <20 cm H<sub>2</sub>O
- c) <30 cm H<sub>2</sub>O
- d) <40 cm H<sub>2</sub>O

14. If plateau pressures are too high, you should decrease the \_\_\_\_\_ by \_\_\_\_\_ until the goal plateau pressure is achieved.

15. Why are patients with COPD and asthma different than most other patients?

- a) They require high tidal volumes to ensure appropriate ventilation
- b) They are difficult to oxygenate due to physiologic shunting
- c) They are at high risk for severe acute lung injury
- d) They experience air trapping and barotrauma because they cannot fully exhale

16. The best ventilation strategy in obstructive patients is:

- a) Titrating FiO<sub>2</sub> and PEEP
- b) Avoiding intubation all together
- c) Titrating to higher respiratory rates
- d) Utilizing low inspiratory flow rates

17. What is the starting respiratory rate for intubated patients with an obstructive lung disease?

- a) 8-10 breaths/min
- b) 10-12 breaths/min
- c) 12-14 breaths/min
- d) 14-16 breaths/min



## LEARNER MATERIALS

18. What is the recommended starting point for PEEP in a patient with obstructive lung disease?
- a) PEEP 0
  - b) PEEP 2
  - c) PEEP 5
  - d) PEEP 8
19. What is the goal I:E ratio in a patient with obstructive lung disease?
- a) 1:2
  - b) 1:3
  - c) 1:4
  - d) 1:5
20. If the plateau pressure is  $>30$  cm H<sub>2</sub>O in a patient with obstructive lung disease, the appropriate change is:
- a) Increased RR and decreased inspiratory time
  - b) Decreased RR and decreased inspiratory time
  - c) Increased RR and increased inspiratory time
  - d) Decreased RR and increased inspiratory time



# LEARNER MATERIALS

*The subsequent gRAT is intended to be an IF/AT. Ideally, you will purchase “scratch-off label stickers” (available at amazon.com) and place the stickers over the index letters as shown below. If you do not want to create an IF/AT form, you can print the iRAT instead for your gRAT*

**Ventilator gRAT**

Based on Weingart, Scott D "Managing Initial Mechanical Ventilation in the Emergency Department" and Ventilator Handout

1. Which study is one of the few ventilator trials to demonstrate mortality benefit?  
\_\_\_\_\_
2. Based on this study, any patient who does not have an obstructive disease should be ventilated with which strategy?  
Lung protective  
High I:E ratio  
Obstructive strategy  
Volume overload strategy
3. According to the article, which mode is considered preferable for critically ill ED patients?  
Synchronized Intermittent-Mandatory Ventilation (SIMV)  
Pressure-Controlled Ventilation  
Volume-Assist Control  
Pressure Support Ventilation
4. What is the recommended initial tidal volume for patients in the ED without obstructive lung disease?  
6mL/kg  
8mL/kg  
10mL/kg  
12mL/kg
5. What is the minimum acceptable tidal volume?  
2mL/kg  
4mL/kg  
6mL/kg  
8mL/kg
6. What is the appropriate initial setting for an inspiratory flow rate?  
20L/minute  
40L/minute  
60L/minute  
80L/minute
7. What setting should be used for titrating ventilation?  
Tidal Volume

Inspiratory Flow Rate  
PEEP  
Respiratory Rate

8. Respiratory rate can be started at \_\_\_\_\_ breaths/min, and titrated up to \_\_\_\_\_ breaths/min in order to achieve the goal \_\_\_\_\_ PaCO<sub>2</sub>
9. What is the goal SpO<sub>2</sub> in a patient requiring protective strategy for ventilation?  
80-85%  
82-87%  
88-95%  
95-100%
10. What is the recommended starting point for FIO<sub>2</sub> and PEEP in a patient without obstructive lung disease?  
FIO<sub>2</sub> 30-40%; PEEP 0  
FIO<sub>2</sub> 30-40%; PEEP 5  
FIO<sub>2</sub> 50-60%; PEEP 0  
FIO<sub>2</sub> 50-60%; PEEP 5
11. If a patient is hypoxic, despite an FIO<sub>2</sub> > 50%, the continued hypoxia is due to:  
Excess pressure  
Hyperoxia  
Inadequate ventilation  
Physiologic shunt
12. How do you measure the plateau pressure?  
\_\_\_\_\_
13. What is the goal plateau pressure?  
<10 cm H<sub>2</sub>O  
<20 cm H<sub>2</sub>O  
<30 cm H<sub>2</sub>O  
<40 cm H<sub>2</sub>O
14. If plateau pressures are too high, you should decrease the \_\_\_\_\_ by \_\_\_\_\_ until the goal plateau pressure is achieved.
15. Why are patients with COPD and asthma different than most other patients?  
They require high tidal volumes to ensure appropriate ventilation  
They are difficult to oxygenate due to physiologic shunting  
They are at high risk for severe acute lung injury



# LEARNER MATERIALS

## Ventilator TBL

### Group Readiness Assessment Test (gRAT)

Based on Weingart, Scott D “*Managing Initial Mechanical Ventilation in the Emergency Department*” and *Ventilator Handout*

1. Which study is one of the few ventilator trials to demonstrate mortality benefit?

\_\_\_\_\_ **ARDSNet ARMA study** \_\_\_\_\_

2. Based on this study, any patient who does not have an obstructive disease should be ventilated with which strategy?

★ Lung protective

b) High I:E ratio

c) Obstructive strategy

d) Volume overload strategy

3. According to the article, which mode is considered preferable for critically ill ED patients?

a) Synchronized Intermittent-Mandatory Ventilation (SIMV)

b) Pressure-Controlled Ventilation

★ Volume-Assist Control

d) Pressure Support Ventilation

4. What is the recommended initial tidal volume for patients in the ED without obstructive lung disease?

a) 6mL/kg

★ 8mL/kg

c) 10mL/kg

d) 12mL/kg

5. What is the minimum acceptable tidal volume?

a) 2mL/kg

★ 4mL/kg

c) 6mL/kg

d) 8mL/kg



## LEARNER MATERIALS

6. What is the appropriate initial setting for an inspiratory flow rate?
  - a) 20L/minute
  - b) 40L/minute
  - ★ 60L/minute
  - d) 80L/minute
  
7. What setting should be used for titrating ventilation?
  - a) Tidal Volume
  - b) Inspiratory Flow Rate
  - c) PEEP
  - ★ Respiratory Rate
  
8. Respiratory rate can be started at \_\_\_\_\_ 15-16 \_\_\_\_\_ breaths/min, and titrated up to \_\_\_\_\_ 30-40 \_\_\_\_\_ breaths/min in order to achieve the goal \_\_\_ PaCO<sub>2</sub> \_\_\_\_\_
  
9. What is the goal SpO<sub>2</sub> in a patient requiring protective strategy for ventilation?
  - a) 80-85%
  - b) 82-87%
  - ★ 88-95%
  - d) 95-100%
  
10. What is the recommended starting point for FiO<sub>2</sub> and PEEP in a patient without obstructive lung disease?
  - a) FiO<sub>2</sub> 30-40%; PEEP 0
  - ★ FiO<sub>2</sub> 30-40%; PEEP 5
  - c) FiO<sub>2</sub> 50-60%; PEEP 0
  - d) FiO<sub>2</sub> 50-60%; PEEP 5
  
11. If a patient is hypoxic, despite an FiO<sub>2</sub> > 50%, the continued hypoxia is due to:
  - a) Excess pressure
  - b) Hyperoxia
  - c) Inadequate ventilation
  - ★ Physiologic shunt



## LEARNER MATERIALS

12. How do you measure the plateau pressure?

\_\_\_\_\_ **Pressing the inspiratory hold button at the end of the breath** \_\_\_\_\_

13. What is the goal plateau pressure?

- a) <10 cm H<sub>2</sub>O
- b) <20 cm H<sub>2</sub>O
- ★ <30 cm H<sub>2</sub>O
- d) <40 cm H<sub>2</sub>O

14. If plateau pressures are too high, you should decrease the **tidal volume** by **1mL/kg** until the goal plateau pressure is achieved.

15. Why are patients with COPD and asthma different than most other patients?

- a) They require high tidal volumes to ensure appropriate ventilation
- b) They are difficult to oxygenate due to physiologic shunting
- c) They are at high risk for severe acute lung injury
- ★ They experience air trapping and barotrauma because they cannot fully exhale

16. The best ventilation strategy in obstructive patients is:

- a) Titrating FiO<sub>2</sub> and PEEP
- ★ Avoiding intubation all together
- c) Titrating to higher respiratory rates
- d) Utilizing low inspiratory flow rates

17. What is the starting respiratory rate for intubated patients with an obstructive lung disease?

- ★ 8-10 breaths/min
- b) 10-12 breaths/min
- c) 12-14 breaths/min
- d) 14-16 breaths/min



## LEARNER MATERIALS

18. What is the recommended starting point for PEEP in a patient with obstructive lung disease?
- ★ PEEP 0
  - b) PEEP 2
  - c) PEEP 5
  - d) PEEP 8
19. What is the goal I:E ratio in a patient with obstructive lung disease?
- a) 1:2
  - b) 1:3
  - ★ 1:4
  - ★ 1:5
20. If the plateau pressure is  $>30$  cm H<sub>2</sub>O in a patient with obstructive lung disease, the appropriate change is:
- a) Increased RR and decreased inspiratory time
  - ★ Decreased RR and decreased inspiratory time
  - c) Increased RR and increased inspiratory time
  - d) Decreased RR and increased inspiratory time



## Ventilator TBL

### Group Application Exercise

Based on Weingart, Scott D *“Managing Initial Mechanical Ventilation in the Emergency Department”* and *Ventilator Handout*

1. A 70 kg F is intubated for worsening respiratory status in the setting of severe sepsis. Her chest radiograph shows diffuse opacities and is consistent with ARDS. Her preintubation respiratory rate is 26, SpO<sub>2</sub> 80%. After intubation you tell the respiratory therapist to adjust the PEEP and FiO<sub>2</sub> per ARDSnet protocol. The RT asks you for an initial Tidal Volume, Respiratory Rate and goal SpO<sub>2</sub>, what do you choose?
  
2. A 70 kg F with severe sepsis is intubated for respiratory distress, her chest radiograph is consistent with ARDS. Initially she required high PEEP and high FiO<sub>2</sub>, however her SpO<sub>2</sub> has been consistently 99 to 100% for the last several hours. Your intern suggests decreasing the PEEP from 14 to 8 and the FiO<sub>2</sub> from 0.7 to 0.6. You disagree because:
  
3. A 80kg M with a history of COPD is intubated for AMS secondary to COPD exacerbation. The intern suggests the following vent settings:

Volume Assist Control

Tidal Volume 640

Respiratory Rate 16

Inspiratory Flow Rate of 100 L/min

PEEP of 5

FiO<sub>2</sub> 40%



## LEARNER MATERIALS

You tell the intern they are close, but would adjust the vent by:

4. As you are walking through the ICU you hear the ventilator beeping, upon further inspection you note that the ventilator keeps reading “Plateau Pressure HIGH”. In order to decrease the plateau pressure on a patient with lung protective strategy ventilation you adjust the vent by:
  
  
  
  
  
  
  
  
  
  
5. As you are walking through the ICU you hear the ventilator beeping, upon further inspection you note that the ventilator keeps reading “Plateau Pressure HIGH”. In order to decrease the plateau pressure on a patient with obstructive strategy ventilation you adjust the vent by:
  
  
  
  
  
  
  
  
  
  
6. What ventilator settings would you choose for a 50 kg M with asthma.

Setting	_____
Tidal volume	_____
Inspiratory flow rate	_____
Respiratory rate of	_____
PEEP	_____
FiO2	_____
Goal SPO2 of	_____



# LEARNER MATERIALS

## Ventilator Small Groups Hands-On Session Checklist

### Ventilator

- 1) How to turn the machine on
- 2) Pressure control vs Assist control- indications and adjustments
- 3) Machine parameters
  - a) Respiratory rate
  - b) Oxygen saturation
  - c) Volume
- 4) Trouble shooting
  - a) Peak pressure management
  - b) Hypoxia management
- 5) Connection to O2 tank or wall O2

### Percutaneous Jet ventilation

Indications

Equipment

14 gauge angiocath

6.5 endotracheal tube

3mL syringe

Equipment assembly (see Percutaneous Transtracheal Jet Ventilation Handout)



# LEARNER MATERIALS

## Percutaneous Transtracheal Jet Ventilation Handout

### INTRODUCTION:

- Used in “can’t intubate, can’t oxygenate” situations
- Allows for trans-tracheal oxygenation (but poor ventilation)
- Rescue procedure!
  - Allows for “ok” oxygenation, but poor ventilation.
- Surgical airway of choice for pediatric patients who are 10-years-old and under.
  - Small trachea and small cricothyroid membrane are too small to insert a tracheostomy tube and doing so is likely to injure surrounding structures
- NOT a definitive airway
  - There is no cuff, so it does not protect the airway

### INDICATIONS:

- Failed upper airway / contraindications to intubation
- No definitive airway and inadequate oxygenation
- Surgical Airway for pediatric patients <10 years old

### CONTRAINDICATIONS:

There really aren’t any. But you might want to think about:

- Distorted anatomy due to trauma, masses, obesity, etc.
- Infection overlying the neck
- Coagulopathy
- Awake, uncooperative patient (it will be hard to keep the airway in)

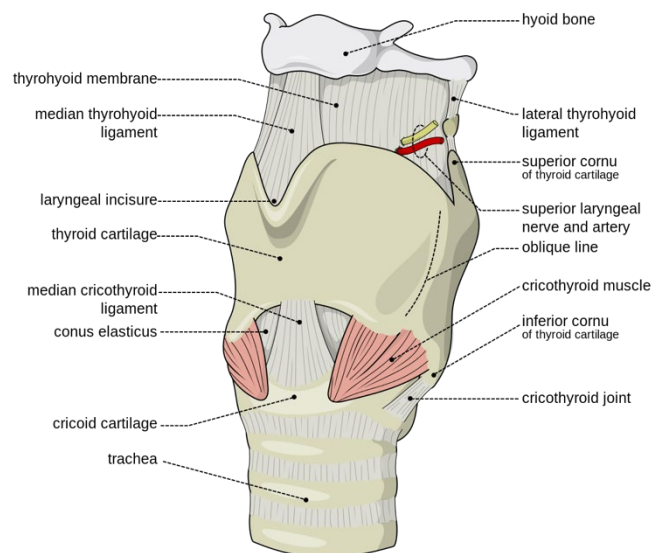
### COMPLICATIONS:

- Bleeding, Infection
- Can cause a pneumothorax
- Not a definitive airway → aspiration
- Subcutaneous emphysema
- Catheter is small in diameter, can get obstructed or kinked or displaced
- Posterior tracheal wall perforation
- Injury to the superior laryngeal nerve and thyroid artery and vein

### ANATOMY:

Compliments of:

[Wikipedia Commons](#)





# LEARNER MATERIALS

## EQUIPMENT:

- Sterile PPE—Gown-Up, Glove-Up!
- 14 gauge angio cath
- 3 cc plastic syringe, luer lock tip
- 7.5 ETT adapter
- BVM
- Oxygen Tubing
- 6.5 ETT cut just below the BVM connector
- 3 way stopcock

## STEPS:

1. Patient Supine
2. Attach a 3mL syringe to the 14 gauge angiocath, fill with 1 cc of water
3. Stabilize the larynx with the non-dominant hand between the thumb and middle finger, use the pointer finger to located the cricothyroid membrane
4. Using the dominant hand, insert the needle through the skin and cricothyroid membrane into the larynx while aspirating the syringe, you will get a release and aspirate air when you are in the trachea
5. Advance the cannula into the larynx and trachea, remove the needle
6. Secure the cannula by sutures or tape/tie
7. Connect to Oxygen Source
8. Method 1
  - a. Connect a 3ml syringe to the angiocath
  - b. Insert a 6.5, 7 or 7.5 ETT connector in to the 3ml syringe
  - c. Connect to BVM
9. Method 2
  - a. Connect a 3-way stopcock to the angiocath, leave open to all ports
  - b. Cut a 6.5 ETT and connect cut tubing of ETT directly to stopcock
  - c. Connect to BVM to ETT connector
10. Method 3
  - a. Connect a 3-way stopcock to the angiocath, leave open to all ports
  - b. Connect oxygen tubing to one other port
  - c. The last port will be covered with a finger to oxygenate the patient



## OXYGENATE THE PATIENT

11. Using 100% oxygen, <50 psi for adults, <30 psi for children
12. Alternatively, you can use 1L/min per year of age, and titrate up 1L/min depending on chest wall movement
13. Inspiratory phase should be 1 second, followed by 3 seconds for exhalation
14. If age <5 use a BVM for lower tidal volumes to avoid barotrauma

## TROUBLE SHOOTING:

- Patient awake/choking → inject 2-3 ml of lidocaine into the larynx
- Kinking of catheter? → nick the skin before inserting angiocath
- Hit a blood vessel? → back out, one small puncture to an artery is unlikely to cause harm



# INSTRUCTOR MATERIALS

Answer keys to all exercises with explanations, are on the following pages.

Learners: please do not proceed.



# INSTRUCTOR MATERIALS

## Ventilator TBL

### Readiness Assessment Test Answer Key

Based on Weingart, Scott D *“Managing Initial Mechanical Ventilation in the Emergency Department”* and *Ventilator Handout*

1. Which study is one of the few ventilator trials to demonstrate mortality benefit?

\_\_\_\_\_ **ARDSNet ARMA study** \_\_\_\_\_

2. Based on this study, any patient who does not have an obstructive disease should be ventilated with which strategy?

**a) Lung protective**

b) High I:E ratio

e) Obstructive strategy

f) Volume overload strategy

3. According to the article, which mode is considered preferable for critically ill ED patients?

c) Synchronized Intermittent-Mandatory Ventilation (SIMV)

d) Pressure-Controlled Ventilation

**e) Volume-Assist Control**

d) Pressure Support Ventilation

4. What is the recommended initial tidal volume for patients in the ED without obstructive lung disease?

b) 6mL/kg

**c) 8mL/kg**

c) 10mL/kg

d) 12mL/kg

5. What is the minimum acceptable tidal volume?

b) 2mL/kg

**c) 4mL/kg**

c) 6mL/kg

d) 8mL/kg



## INSTRUCTOR MATERIALS

6. What is the appropriate initial setting for an inspiratory flow rate?
  - c) 20L/minute
  - d) 40L/minute
  - e) 60L/minute**
  - d) 80L/minute
  
7. What setting should be used for titrating ventilation?
  - d) Tidal Volume
  - e) Inspiratory Flow Rate
  - f) PEEP
  - g) Respiratory Rate**
  
8. Respiratory rate can be started at \_\_\_\_\_15-16\_\_\_\_\_breaths/min, and titrated up to \_\_\_\_\_30-40\_\_\_\_\_breaths/min in order to achieve the goal \_\_\_PaCO<sub>2</sub>\_\_\_\_\_
  
9. What is the goal SpO<sub>2</sub> in a patient requiring protective strategy for ventilation?
  - c) 80-85%
  - d) 82-87%
  - e) 88-95%**
  - d) 95-100%
  
10. What is the recommended starting point for FiO<sub>2</sub> and PEEP in a patient without obstructive lung disease?
  - b) FiO<sub>2</sub> 30-40%; PEEP 0
  - c) FiO<sub>2</sub> 30-40%; PEEP 5**
  - c) FiO<sub>2</sub> 50-60%; PEEP 0
  - d) FiO<sub>2</sub> 50-60%; PEEP 5
  
11. If a patient is hypoxic, despite an FiO<sub>2</sub> > 50%, the continued hypoxia is due to:
  - d) Excess pressure
  - e) Hyperoxia
  - f) Inadequate ventilation
  - g) Physiologic shunt**



## INSTRUCTOR MATERIALS

12. How do you measure the plateau pressure?

\_\_\_\_\_ **Pressing the inspiratory hold button at the end of the breath** \_\_\_\_\_

13. What is the goal plateau pressure?

- c) <10 cm H<sub>2</sub>O
- d) <20 cm H<sub>2</sub>O
- e) <30 cm H<sub>2</sub>O**
- d) <40 cm H<sub>2</sub>O

14. If plateau pressures are too high, you should decrease the **tidal volume** by **1mL/kg** until the goal plateau pressure is achieved.

15. Why are patients with COPD and asthma different than most other patients?

- d) They require high tidal volumes to ensure appropriate ventilation
- e) They are difficult to oxygenate due to physiologic shunting
- f) They are at high risk for severe acute lung injury
- g) They experience air trapping and barotrauma because they cannot fully exhale**

16. The best ventilation strategy in obstructive patients is:

- e) Titrating FiO<sub>2</sub> and PEEP
- f) Avoiding intubation all together**
- c) Titrating to higher respiratory rates
- d) Utilizing low inspiratory flow rates

17. What is the starting respiratory rate for intubated patients with an obstructive lung disease?

- a) 8-10 breaths/min**
- g) 10-12 breaths/min
- h) 12-14 breaths/min
- i) 14-16 breaths/min



## INSTRUCTOR MATERIALS

18. What is the recommended starting point for PEEP in a patient with obstructive lung disease?
- a) **PEEP 0**
  - b) PEEP 2
  - c) PEEP 5
  - d) PEEP 8
19. What is the goal I:E ratio in a patient with obstructive lung disease?
- e) 1:2
  - f) 1:3
  - g) **1:4**
  - h) 1:5
20. If the plateau pressure is  $>30$  cm H<sub>2</sub>O in a patient with obstructive lung disease, the appropriate change is:
- b) Increased RR and decreased inspiratory time
  - c) **Decreased RR and decreased inspiratory time**
  - d) Increased RR and increased inspiratory time
  - e) Decreased RR and increased inspiratory time



# INSTRUCTOR MATERIALS

## Ventilator TBL

### Group Application Exercise Answer Key

Based on Weingart, Scott D *“Managing Initial Mechanical Ventilation in the Emergency Department”* and *Ventilator Handout*

1. A 70 kg F is intubated for worsening respiratory status in the setting of severe sepsis. Her chest radiograph shows diffuse opacities and is consistent with ARDS. Her preintubation respiratory rate is 26, SpO<sub>2</sub> 80%. After intubation you tell the respiratory therapist to adjust the PEEP and FiO<sub>2</sub> per ARDSnet protocol. The RT asks you for an initial Tidal Volume, Respiratory Rate and goal SpO<sub>2</sub>, you choose:

Possible answer: Tidal Volume 560, RR 16, SpO<sub>2</sub> 88-95%

Patients with sepsis should be ventilated for lung protection. This means starting with a tidal volume of 8 mL/kg, a starting respiratory rate of 16, and then adjusting as needed for the patients CO<sub>2</sub> goal, and a goal SpO<sub>2</sub> of 88 to 95%.

2. A 70 kg F with severe sepsis is intubated for respiratory distress, her chest radiograph is consistent with ARDS. Initially she required high PEEP and high FiO<sub>2</sub>, however her SpO<sub>2</sub> has been consistently 99 to 100% for the last several hours. Your intern suggests decreasing the PEEP from 14 to 8 and the FiO<sub>2</sub> from 0.7 to 0.6. You disagree because:

ANSWER: Downward titration should be done at a slower pace to avoid losing alveolar recruitment.

Patients with sepsis should be ventilated for lung protection. PEEP and FiO<sub>2</sub> should be adjusted per the ARDSnet protocol as this is the ventilator trials to demonstrate mortality benefit. Decreasing PEEP and FiO<sub>2</sub> should be done at a slower pace to avoid losing “hard won” alveolar recruitment. Thus the PEEP should be decreased from 14 to 12 and the physician/RT should consider leaving the FiO<sub>2</sub> at 0.7 and monitoring the patients respiratory status before decreasing the PEEP and FiO<sub>2</sub> further.

3. A 80kg M with a history of COPD is intubated for AMS secondary to COPD exacerbation. The intern suggests the following vent settings:

Volume Assist Control



## INSTRUCTOR MATERIALS

Tidal Volume 640  
Respiratory Rate 16  
Inspiratory Flow Rate of 100 L/min  
PEEP of 5  
FiO<sub>2</sub> 40%

You tell the intern they are close, but would adjust the vent by:

ANSWER:

Decrease the RR as patients who are obstructive need more time to exhale

Decrease the inspiratory flow rate to 70 L/minute as higher IFR do little to increase exhalation, and only cause increase ventilator machine alarming

The intern could also lower the PEEP to 0 as this is thought to help, however there is little evidence to support a PEEP of <5.

4. As you are walking through the ICU you hear the ventilator beeping, upon further inspection you note that the ventilator keeps reading “Plateau Pressure HIGH”. In order to decrease the plateau pressure on a patient with lung protective strategy ventilation you adjust the vent by:

ANSWER: Decreasing the patients’ tidal volume by 1mL/kg until the plateau pressure is less than 30

The plateau pressure approximates the pressure on and in the alveoli. In order to decrease the plateau pressure for a lung protective strategy ventilation the physician/RT can decrease the tidal volume by 1 mL/kg until the plateau pressure is <30 cm H<sub>2</sub>O. Tidal volumes can go as low as 4 mL/kg in order to protect the lungs.

5. As you are walking through the ICU you hear the ventilator beeping, upon further inspection you note that the ventilator keeps reading “Plateau Pressure HIGH”. In order to decrease the plateau pressure on a patient with obstructive strategy ventilation you adjust the vent by:



## INSTRUCTOR MATERIALS

ANSWER: Decrease the respiratory rate to allow for full exhalation

The plateau pressure approximates the pressure on and in the alveoli. In order to decrease the plateau pressure for obstructive strategy ventilation the physician/RT can decrease the respiratory rate to allow for full exhalation, thus decreasing breath stacking and plateau pressure.

6. What ventilator settings would you choose for a 50 kg M with asthma.

ANSWER:

Setting Volume Assist Control

Tidal volume of 8 mL/kg = 400 mL

Inspiratory flow rate of 60-80 L/min

Respiratory rate of 10

PEEP 0

FiO<sub>2</sub> 0.4

Goal SPO<sub>2</sub> of 88%