


<b>Name of Policy:</b> <u>Ventilator Management Protocol</u> <b>Policy Number:</b> 3364-136-07-09 <b>Department:</b> Respiratory Care <b>Approving Officer:</b> Chief Nursing Officer  <b>Responsible Agent:</b> Director, Respiratory Care  <b>Scope:</b> The University of Toledo Medical Center Respiratory Care Department	
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## Policy Statement

Initiating mechanical ventilator settings, ventilator assessments, and establishing ventilator alarm settings, shall be in accordance to the following procedure.

## Purpose of Policy

To provide guidelines for the assembly and function testing of mechanical ventilators, and to establish guide lines for initial ventilation, ongoing management and weaning. The Respiratory Care Practitioner (RCP) will utilize the following Therapist Driven Protocol (TDP) to assess the patient on mechanical ventilation for “Readiness to Wean” with a daily Spontaneous Breathing Trial (SBT) to be performed daily as appropriate, for the purpose of expediting weaning and extubation from mechanical ventilation. A physician must order “Ventilator Management, Weaning & Extubation Protocol” or simply “Ventilator Protocol”. Upon the physician’s order for the Ventilator Protocol, the RCP will follow the procedure described and outlined in this document to facilitate a safe and timely removal of the endotracheal tube (ETT) at the earliest possible and appropriate time.

## Procedure

### A. Mechanical Ventilator Initiation

1. Physician will order “Ventilator Management, Weaning & Extubation Protocol” or simply “Ventilator Protocol” and “Ventilator Sedation Protocol”.
2. Patient will be on ETCO<sub>2</sub> monitoring along with the mechanical ventilator, a cardiac monitor and continuous pulse oximetry.
3. The RCP will document all initial ventilator parameters and parameter changes in the electronic medical record.
4. The RCP will set the initial ventilator settings as follows for adults:
  - Mode: PRVC A/C
  - RR: 8-20 breaths per minute as clinical condition mandates
  - FiO<sub>2</sub>: 100%
  - PEEP: 8 cmH<sub>2</sub>O (unless neurologically contraindicated)
  - Tidal Volume: 5-8 ml/kg/PBW
    - PBW Females (kg): 45.5 + 2.3 (height in inches - 60)
    - PBW Males (kg): 50 + 2.3 (height in inches - 60)

5. The RCP will set the sensitivity, flow rate, inspiratory time, I:E ratio, flow cycle, inspiratory rise and bias flow to meet the needs of the patient, prevent air-trapping and to maximize ventilator-patient synchrony.
6. Place Heat Moisture Exchanger (HME) inline to humidify ventilator gases. If the patient has thick mucus present at any time, use active humidification instead of an HME.
7. Set alarm limits appropriately:
  - Apnea:  $\leq 20$  seconds
  - High/low minute volume: set at 2-5 L/min above/below total minute volume
  - High/low tidal volume: 10-15% above/below set tidal volume
  - High/low pressure limit: 10 cmH<sub>2</sub>O above/below average PIP
  - High/low PEEP: 3-5 cmH<sub>2</sub>O above/below set PEEP
  - High/low respiratory rate: 10-15 breaths/minute above/below total respiratory rate
  - High/low ETCO<sub>2</sub>: 10 mmHg above/below average ETCO<sub>2</sub>

## B. Mechanical Ventilator Management:

1. The RCP will draw an arterial blood gas (ABG) approximately 30 minutes after placing the patient on the initial ventilator settings. The patient must be on the same ventilator settings without interruption in order for the blood gases to be an accurate reflection of the patient-ventilator relationship.
2. If a high PaO<sub>2</sub> is noted with the initial ABG then decrease the FiO<sub>2</sub> to maintain target SpO<sub>2</sub>.
3. The target arterial pH is between 7.35 – 7.45. Adjust tidal volume and/or respiratory rate to meet the target arterial pH.
4. The target PaCO<sub>2</sub> is between 35 – 45 mmHg **or** the patient's baseline if they are in chronic respiratory failure. Adjust tidal volume and/or respiratory rate to meet the target arterial PaCO<sub>2</sub> as clinically indicated.
5. The target peak inspiratory pressure (PIP) is < 40 cmH<sub>2</sub>O. Adjust tidal volume if applicable.
6. The target plateau pressure (Pplat) is < 30 cmH<sub>2</sub>O. Adjust tidal volume if applicable.
7. The target SpO<sub>2</sub> is  $\geq 92\%$ . If the FiO<sub>2</sub> requirement reaches .60 then adjust PEEP.
8. Adjust PEEP in increments of 1-2 cmH<sub>2</sub>O to meet the target SpO<sub>2</sub>. Monitor hemodynamics with every change in PEEP. If a negative change in hemodynamics is noted with a change in PEEP then decrease the PEEP to the previous setting.
9. If a negative change in hemodynamics is noted, increase FiO<sub>2</sub> up to 100% (in increments of 10-15%) to reach target SpO<sub>2</sub>. If the target SpO<sub>2</sub> is not met, the physician managing the ventilator will be contacted.
10. Once the patient stabilizes, decrease FiO<sub>2</sub> to .60 as tolerated.

11. Once the FiO<sub>2</sub> reaches .60, decrease PEEP in increments of 1-2 cmH<sub>2</sub>O to maintain target SpO<sub>2</sub>. Do not wean PEEP below 8 cmH<sub>2</sub>O.
12. Arterial blood gases will be drawn approximately 30 minutes after ventilator parameter changes until the patient's baseline PaCO<sub>2</sub> is met or until the target arterial pH and/or PaCO<sub>2</sub> is met.
13. Arterial blood gases will be drawn every morning at 05:00 and PRN for respiratory distress.
14. The RCP will suction the endotracheal tube and oropharynx as needed.
15. The RCP will collect sputum for C & S upon intubation and PRN if an increase in mucus purulence is noted.
16. Portable chest x-ray initially for endotracheal tube placement and then as necessary.
17. The RCP can switch to a different mode of mechanical ventilation if needed to improve ventilator/patient synchrony and to maintain target airway pressures.
18. If ARDS is suspected, the physician managing the ventilator will be contacted and the ARDSnet ventilator protocol will be implemented (see page 4).

### **Other RCP Options**

The RCP may alter the ventilator settings by increasing/decreasing the respiratory rate and/or tidal volume to maintain the following parameters:

- pH 7.30 – 7.45
- PaCO<sub>2</sub> 35 – 50 mmHg
- Titrate FiO<sub>2</sub> to keep SpO<sub>2</sub> ≥ 92%
- RR ≤ 25bpm

Parameters may be adjusted as needed by the physician based on clinical presentation and expectations. Desired parameter changes must be documented on the physician's order sheet.

At any time that the TV is adjusted, correcting the respiratory rate is essential to maintain the previously set minute ventilation (MV). Plateau pressures should not exceed 30 cmH<sub>2</sub>O.

Airway Pressure Release Ventilation (APRV) may be considered if plateau pressure (P<sub>plat</sub>) > 30 cmH<sub>2</sub>O.

### **Oxygenation**

The RCP may alter the FiO<sub>2</sub> to assure adequate oxygenation by increasing/decreasing the FiO<sub>2</sub> (in 10-15% increments) to insure maintenance of the following parameters unless specifically ordered otherwise:

- PaO<sub>2</sub> ≥ 70 torr **or**
- SaO<sub>2</sub> ≥ 92% **or**
- SpO<sub>2</sub> ≥ 92%

**Inclusion Criteria: Acute onset of:**

1. PaO<sub>2</sub>/FiO<sub>2</sub> ≤ 300
2. Bilateral (patchy, diffuse, or homogeneous) infiltrates consistent with pulmonary edema
3. No clinical evidence of left atrial hypertension

**Ventilator Setup and Adjustment**

1. TV = 8 mL/kg (initial)
2. Plateau pressure (Pplat) as low as possible or ≤ 30 cmH<sub>2</sub>O
3. Reduce TV by 1 ml/kg at intervals ≤ 2 hours until TV = 6 ml/kg PBW
4. Set initial rate to approximate baseline minute ventilation (not > 35 bpm)
5. Adjust TV and RR to achieve pH and plateau pressure goals below

**Oxygenation Goal:** PaO<sub>2</sub> 55-80 mmHg or SpO<sub>2</sub> 88-95%. Use a minimum PEEP of 5 cmH<sub>2</sub>O. Consider use of incremental FiO<sub>2</sub>/PEEP combination such as shown below to achieve goal.

Lower PEEP/higher FiO<sub>2</sub> Strategy

FiO <sub>2</sub>	30	40	50	60	70	80	90	100
PEEP	5	5-8	8-10	10	10-14	14	14-18	18-24

Higher PEEP/lower FiO<sub>2</sub> Strategy

FiO <sub>2</sub>	30	40	50	50-80	80	90	100
PEEP	10-14	14-16	16-18	20	22	22	22-24

**Plateau Pressure Goal:** ≤ 30 cmH<sub>2</sub>O

1. Check Pplat (0.5 second inspiratory pause), at least q4 hour and after each change in PEEP or TV.
2. If Pplat > 30 cmH<sub>2</sub>O: decrease TV by 1 ml/kg steps (minimum = 4 ml/kg).
3. If Pplat < 25 cmH<sub>2</sub>O and TV < 6 ml/kg, increase TV by 1 ml/kg until Pplat > 25 cmH<sub>2</sub>O or TV = 6 ml/kg.
4. If Pplat < 30 and breath stacking or dys-synchrony occurs: may increase TV in 1 ml/kg increments to 7 or 8 ml/kg if Pplat remains ≤ 30 cmH<sub>2</sub>O.

**pH Goal:** 7.30 – 7.45

Acidosis Management: (pH < 7.30)

- If pH 7.15 – 7.30: Increase RR until pH > 7.30 or PaCO<sub>2</sub> < 25 mmHg (maximum set RR = 35)
- If pH < 7.15: Increase RR to 35.
  - If pH remains < 7.15, TV may be increased in 1 ml/kg steps until pH > 7.15 (Pplat target of 30 may be exceeded)
  - May give NaHCO<sub>3</sub>

Alkalosis Management: (pH > 7.45) Decrease ventilator rate if possible.

**I:E Ratio Goal:**

Recommend that duration of inspiration be ≤ duration of expiration

### C. Mechanical Ventilator Weaning

1. An assessment of the readiness to wean the patient from mechanical ventilation will be performed once daily.
2. Patient will be on a cardiac monitor, ETCO<sub>2</sub> and continuous pulse oximetry.
3. Patient must exhibit signs of readiness to be weaned from mechanical ventilation as outlined by the following criteria. These criteria do not automatically exclude the patient from a weaning readiness trial. Discussion with physician managing the ventilator must take place prior to initiating the weaning readiness trial.
  - Diaphoresis, agitation or dyspnea
  - Fever > 101F
  - Pulse <50 or > 120 bpm
  - Systolic Blood Pressure < 90mmHg
  - Blood pressure requiring vasopressor support
  - PaO<sub>2</sub>/FIO<sub>2</sub> <200
  - SpO<sub>2</sub> <90% and/or FiO<sub>2</sub> > .50 and/or PEEP >8cmH<sub>2</sub>O
  - Pt is unable to follow simple commands on a continuous infusion of Midazolam, Ativan, Diprivan or other hypnotics with the exception of PCA Morphine, Fentanyl and Dilaudid with a basal rate
  - Pt. currently on dialysis
  - Surgery planned in next 24 hours
  - History of OSA
4. The RN and RCP will coordinate patient's schedule
  - a. The RN and RCP will determine the best time for the SBT
  - b. No activities such as baths and physical therapy will be performed during SBT
  - c. No trial will begin between 20:00 and 06:00
  - d. A sign should be placed on the door to alert staff to minimize interruptions (PT, Radiology, etc.)
  - e. The RN will stop sedation and the RCP will determine neurological readiness to wean and pulmonary mechanics will be performed
5. Pulmonary mechanics must be completed prior to initiation of SBT and documented in EMR. Mechanics must be within limits:
  - a. Respiratory Rate < 30 breaths per minute
  - b. Spontaneous Tidal Volume of 5 – 8 ml/kg of PBW
  - c. Minute Volume < 15 l/m
  - d. Vital Capacity > 10 ml/kg of PBW
  - e. Negative Inspiratory Force > - 20 cmH<sub>2</sub>O
  - f. Rapid Shallow Breathing Index < 105
6. If patient does not meet above criteria then the RCP will document the reason for weaning failure.

7. If patient meets above criteria then patient may be placed in Pressure Support. If patient is already on PEEP then leave them on the same amount for the SBT. The patient will also remain on the same FiO<sub>2</sub> setting. Pressure Support Ventilation will be titrated to keep TV at 5-8 ml/kg PBW.
8. Prior to the SBT initiation, confirm the HOB is at least 30 degrees, provide oral care and hold tube feedings.
9. SBT should last 30 to 90 minutes at which time ABG's will be drawn and called to the physician managing the ventilator. Be ready to report the patient's mechanics, SBT toleration, any signs of distress, or any pertinent information.
10. SBT will terminate and patient will be returned to previous ventilator settings and sedation restarted if any of the following occur:
  - a. Respiratory rate > 35 breaths per minute > 5 minutes
  - b. Spo<sub>2</sub> < 92% and FiO<sub>2</sub> increased > 10%
  - c. Heart rate > 120 or an increase or decrease of pre-SBT HR > 20%
  - d. Systolic blood pressure > 180 mmHg or < 90 mmHg
  - e. Agitation, diaphoresis, anxiety
  - f. Paradoxical chest movement
  - g. Chest pain
11. Increased monitoring is indicated to avoid the possible complications of increased oxygen consumption and excessive workload on the respiratory muscles that occurs as soon as a failure criterion is met.
12. SBT will be done once per day per above criteria.
13. If the patient shows any signs of intolerance to the weaning trial at any time, discontinue the SBT and place the patient back on previous settings and notify physician.
14. Readiness to extubate is exhibited by answering "yes" to each of the following criteria regarding the patient's current status:
  - Awake or easily arousable
  - Effective cough
  - Vital capacity of >10 ml/kg PBW
  - MIP > -30 cmH<sub>2</sub>O
  - Requires suctioning less frequent than every 2 hours
  - Adequate cuff leak
15. When extubation orders have been received by the physician managing the ventilator, the SBT will terminate and the extubation procedure will be followed. Post-extubation assessment will be documented in the patient's EMR. After extubation, place patient on a cool aerosol mask at FIO<sub>2</sub> patient was on during mechanical ventilation or enough FiO<sub>2</sub> to keep oxyhemoglobin saturations  $\geq 92\%$ .

16. If post-extubation stridor develops, a nebulizer treatment containing Racemic Epinephrine 0.5 ml and 3 ml normal saline may be given immediately. This medication order will be documented in the EMR.
17. The physician will be immediately notified if stridor, complications or untoward effects occur.

#### D. Difficult to Wean

May be utilized with patients who have been unable to liberate from mechanical ventilation utilizing traditional methods and have failed SBT for > 7 days.

Goal: Interval cycles of work and rest modes to build respiratory muscle strength and endurance, leading to liberation from the ventilator.

Objective: 2 hours in a “work mode”, 4 hours in a “rest mode” to prevent fatigue. This cycle should be repeated 2-3 times during the day/evening. Patient will have full support and minimal stimulation at night to encourage rest and healing.

##### Work Mode

2 hour PSV strengthening:

PSV should be set so patient is working but not exhausted at end of wean.

Respiratory rate should be 25-35bpm with slightly decreased TV.

PSV level should be adjusted as tolerated during the work mode to assure an adequate but not exhaustive level of work.

If patient suddenly develops failure criteria, place on rest mode and notify RN and physician.

Communication with the ICU team is needed to avoid extra activities during work mode times (i.e. transports, baths, PT/OT).

##### Rest Mode

Place patient on appropriate ventilator settings to rest as much as possible

Maintain a respiratory rate < 25/min. with adequate MV and easy WOB

Minimum rest time should be 4 hours unless otherwise ordered by physician

Rest period may be extended as clinically indicated

##### Night Mode

Routine care should be avoided when possible between 23:00 – 05:30

If patient is unable to sleep, sleep medication should be considered

#### E. Medical Symbols and Abbreviations

ABG	Arterial Blood Gas
A/C	Assist Control Ventilation
APRV	Airway Pressure Release Ventilation
ARDS	Adult Respiratory Distress Syndrome
BPM	Breaths Per Minute
CMV	Continuous Mandatory Ventilation
CPAP	Continuous Positive Airway Pressure

EMR	Electronic Medical Record
ETCO <sub>2</sub>	End Tidal Carbon Dioxide
ETT	Endotracheal Tube
FiO <sub>2</sub>	Fraction of Inspired Oxygen
HME	Heat Moisture Exchanger
HOB	Head of Bed
HR	Heart Rate
PBW	Predicted Body Weight
MIP	Maximal Inspiratory Pressure
MDI	Metered Dose Inhaler
MV	Minute Ventilation
NaHCO <sub>3</sub>	Sodium Bicarbonate
NIP	Negative Inspiratory Pressure
OSA	Obstructive Sleep Apnea
OT	Occupational Therapy
PaO <sub>2</sub>	Partial pressure of arterial oxygen
PaCO <sub>2</sub>	Partial pressure of arterial carbon dioxide
PC	Pressure Control
PEEP	Positive End Expiratory Pressure
pH	Quantitative measure of the acidity or basicity of aqueous or other liquid solutions
PCA	Patient-Controlled Analgesia
PIP	Peak Inspiratory Pressure
Pplat	Plateau Pressure
PRN	As needed
PRVC	Pressure Regulated Volume Control
PT	Physical Therapist
P0.1	Occlusion Pressure
PS	Pressure Support
RCP	Respiratory Care Practitioner (Respiratory Therapist)
RN	Registered Nurse
RR	Respiratory Rate
RSBI	Rapid Shallow Breathing Index
SIMV	Synchronized Intermittent Mandatory Ventilation
SaO <sub>2</sub>	Oxygen Saturation of arterial blood (obtained invasively by Arterial Blood Gas)
SBT	Spontaneous Breathing Trial
SpO <sub>2</sub>	Oxygen Saturation of arterial blood (obtained non-invasively by pulse oximeter)
TDP	Therapist Driven Protocol
VC	Vital Capacity
TV	Tidal Volume
WOB	Work of Breathing



## F. References

1. Lipes J, et al. Low tidal volume ventilation in patients without acute respiratory distress syndrome: a paradigm shift in mechanical ventilation. *Crit Care Res Pract* 2012; 416862; e-pub
2. Blackwood B, et al. Use of weaning protocols for reducing duration of mechanical ventilation in critically ill adult patients: Cochrane systematic review and meta-analysis. *BMJ* 2011; 342:c7237
3. MacIntyre, NR. Evidence-based ventilator weaning and discontinuation, *Respir Care* 2004; 49(7): 830-836
4. Yilmaz M, et al. Toward the prevention of acute lung injury: protocol-guided limitation of large tidal volume ventilation and inappropriate transfusion. *Crit Care Med* 2007; 35(7): 1660-1666
5. Thille AW, et al. Weaning from the ventilator and extubation in ICU. *Curr Opin Crit Care* 2013; 19(1): 57-64
6. Robertson TE, et al. Improved extubation rates and earlier liberation from mechanical ventilation with implementation of a daily spontaneous-breathing trial protocol. *Journal of the American College of Surgeons*. 2008, August 22; 489-495
7. Haas CF, Loik PS. Ventilator discontinuation protocols. *Respir Care* 2012; 57(10): 1649-1662
8. Hess DR, et al. Care of the ventilator circuit and its relation to ventilator-associated pneumonia (an AARC Evidence-based CPG). *Respir Care* 2003; 48(9):869-879
9. Girard TD, et al. Efficacy and safety of a paired sedation and ventilator weaning protocol for mechanically ventilated patients in intensive care (Awakening and breathing controlled trial): a randomized controlled trial. *Lancet* 2008; 371:126-134
10. Boles JM, et al. Weaning from mechanical ventilation. *Eur Resp J* 2007; 29:1033-1056
11. Deem S. Limited value of the cuff leak test. *Respir Care* 2005; 50(12): 1617-1618 (ed)
12. Han J, Liu Y. Effect of ventilator circuit changes on ventilator-associated pneumonia: a systematic review and meta-analysis. *Respir Care* 2010; 55(4): 467-474
13. Diaz E, et al. Ventilator-associated pneumonia: issues related to the artificial airway. *Respir Care* 2005; 50(7):900-906

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