Mechanical Ventilation: Troubleshooting (Respiratory Therapy)

ALERT
If the cause of an alarm cannot be identified and corrected quickly, remove the patient from the ventilator and begin manual ventilation with a manual resuscitation bag (MRB).

To maintain patient safety, never disable alarms.

OVERVIEW
Mechanical ventilator alarms are used to warn of changes in a patient’s status. All alarms should be set according to the patient’s condition and per the organization’s practice. For patient safety, alarms should never be disabled.

Some essential alarms on the ventilator include ventilator inoperative (Vent INOP), power failure, no gas delivery to the patient, low peak inspiratory pressure (PIP), low tidal volume (Vt), low or high minute volume (MV), low positive end-expiratory pressure and continuous positive airway pressure (PEEP/CPAP), apnea, inspiratory:expiratory (I:E) ratio, high-pressure limit, high respiratory rate, and low or high fraction of inspired oxygen (FIO₂).

EDUCATION
• Explain the meanings of the alarms to the patient and family.
• Explain the corrective measures needed or taken to address alarms as soon as possible.
• Assure the patient and family that staff members do respond appropriately to all alarms.

ASSESSMENT AND PREPARATION
Assessment
1. Perform hand hygiene before patient contact.
2. Introduce yourself to the patient.
3. Verify the correct patient using two identifiers.
4. When an alarm sounds, quickly assess the patient’s vital signs, including heart rate, respiratory rate, breath sounds, and peripheral oxygen saturation (SpO₂).

Preparation
1. Conduct a performance evaluation, or bench test, before patient connection.1
2. Ensure that a self-inflating resuscitation bag with an appropriate-size face mask is available, functional, and attached to a supplemental oxygen source. Attach a PEEP valve, if necessary.

PROCEDURE
Ventilator Inoperative (Vent INOP)
1. Perform hand hygiene and don gloves.
2. Explain the procedure to the patient.
3. Immediately remove the patient from the ventilator and begin manual ventilation with an MRB.
4. Turn the ventilator off and restart it.2
5. Follow the message instructions on the ventilator, if available.
6. If the ventilator fails to operate properly, tag it for a maintenance check and replace it with another ventilator.
7. Ensure that the alarms are set properly.
Mechanical Ventilation: Troubleshooting (Respiratory Therapy)

8. Verify that the alarm has been corrected and the patient is stable.
9. Remove gloves and perform hand hygiene.

**Power Failure**
1. Perform hand hygiene and don gloves.
2. Explain the procedure to the patient.
3. If the reason for the power failure cannot be identified, begin manual ventilation with a self-inflating resuscitation bag and replace the ventilator.
4. Assess the ventilator to make sure its power cord is plugged into an electric outlet that is connected to an emergency power source, such as a generator.²
5. If the external or internal battery is low, reconnect the ventilator’s power cord to an electric outlet.
6. If applicable, check the fuse or circuit breaker by replacing the fuse or pressing the reset button next to the circuit breaker.
7. Ensure that the alarms are set properly.
8. Verify that the alarm has been corrected and the patient is stable.
9. Remove gloves and perform hand hygiene.

**No Gas Delivery to the Patient**
1. Perform hand hygiene and don gloves.
2. Explain the procedure to the patient.
3. If the reason for the failure of gas delivery to the patient cannot be identified, begin manual ventilation with a self-inflating resuscitation bag and replace the ventilator.²
4. Ensure that all high-pressure gas hoses are tightly connected to the appropriate gas sources.
5. Check oxygen and air pressure.
   a. The gas pressure gauge is located at the gas shut-off valve for the unit.
   b. Check the cylinder tank gauges if using freestanding gas cylinders.
6. Ensure that the alarms are set properly.
7. Verify that the alarm has been corrected and the patient is stable.
8. Remove gloves and perform hand hygiene.

**Low Peak Inspiratory Pressure (PIP)²**
1. Perform hand hygiene and don gloves.
2. Verify the correct patient using two identifiers, if time permits.
3. Explain the procedure to the patient.
4. Check the circuit for leaks or disconnections. Tighten or reconnect the connections.
5. Check the patient’s artificial airway cuff for leaks or deflation.
6. Check the humidifier for leaks or disconnections and tighten or reconnect the connections.
7. Check the inline suction system for leaks or disconnections. Tighten or reconnect the connections. Replace the inline suction system if a leak persists.
Mechanical Ventilation: Troubleshooting (Respiratory Therapy)

8. Check inline adapters for a metered-dose inhaler (MDI) or a small volume nebulizer (SVN). Check them for leaks or disconnections and tighten or reconnect the adapter connections.
9. Check for chest tube leaks. If one is found, consult the practitioner for further interventions.
10. Ensure that the proximal pressure line is connected and unobstructed.
11. Ensure that alarms are set properly.
12. Verify that the alarm has been corrected and the patient is stable.
13. Remove gloves and perform hand hygiene.

Low Tidal Volume ($V_T$)²
1. Perform hand hygiene and don gloves.
2. Verify the correct patient using two identifiers, if time permits.
3. Explain the procedure to the patient.
4. Check the circuit for leaks or disconnections. Tighten or reconnect the connections.
5. Check the artificial airway cuff for leaks or deflation.
   a. Check cuff pressure and listen for an air leak in the patient’s trachea.
   b. Identify and correct the cause of the leak.

6. Check the humidifier for leaks or disconnections and tighten or reconnect the connections.
7. Check the inline suction system for leaks or disconnections. Tighten or reconnect the connections. Replace the inline suction system if a leak persists.
8. Check inline adapters for an MDI or an SVN. Check them for leaks or disconnections and tighten or reconnect the adapter connections.
9. Check for chest tube leaks. If one is found, consult the practitioner for further interventions.
10. Ensure that alarms are set properly.
11. Verify that the alarm has been corrected and the patient is stable.
12. Remove gloves and perform hand hygiene.

Low Minute Volume ($MV$)²
1. Perform hand hygiene and don gloves.
2. Verify the correct patient using two identifiers, if time permits.
3. Explain the procedure to the patient.
4. Assess the patient’s respiratory rate and clinical condition for apnea, low respiratory rate, or low exhaled $V_T$.
   a. If necessary, contact the practitioner and correct the clinical problem.
   b. Begin manual ventilation with an MRB if the patient is apneic.

5. Check the circuit for leaks or disconnections. Tighten or reconnect the connections.
6. Check the patient’s artificial airway cuff for leaks or deflation.
   a. Check cuff pressure and listen for an air leak in the patient’s trachea.
   b. Identify and correct the cause of the leak.
Mechanical Ventilation: Troubleshooting (Respiratory Therapy)

7. Check the humidifier for leaks or disconnections and tighten or reconnect the connections.
8. Check the inline suction system for leaks or disconnections. Tighten or reconnect the connections. Replace the inline suction system if a leak persists.
9. Check inline adapters for an MDI or an SVN. Check them for leaks or disconnections and tighten or reconnect the adapter connections.
10. Check for chest tube leaks. If one is found, consult the practitioner for further interventions.
11. Ensure that alarms are set properly.
12. Verify that the alarm has been corrected and the patient is stable.
13. Remove gloves and perform hand hygiene.

Low Positive End-Expiratory Pressure/Continuous Positive Airway Pressure (PEEP/CPAP)²
1. Perform hand hygiene and don gloves.
2. Verify the correct patient using two identifiers, if time permits.
3. Explain the procedure to the patient.
4. Check the circuit for leaks or disconnections. Tighten or reconnect the connections.
5. Check the patient’s artificial airway cuff for leaks or deflation.

a. Check cuff pressure and listen for an air leak in the patient’s trachea.
b. Identify and correct the cause of the leak.

6. Check the humidifier for leaks or disconnections and tighten or reconnect the connections.
7. Check the inline suction system for leaks or disconnections. Tighten or reconnect the connections. Replace the inline suction system if a leak persists.
8. Check inline adapters for an MDI or an SVN. Check them for leaks or disconnections and tighten or reconnect the adapter connections.
9. Check for chest tube leaks. If one is found, consult the practitioner for further interventions.
10. Ensure that the proximal pressure line is connected and unobstructed.
11. Check the exhalation valve for leaks. If a leak is found and an external exhalation valve is in place, replace the circuit and the ventilator.
12. Ensure that alarms are set properly.
13. Verify that the alarm has been corrected and the patient is stable.
14. Remove gloves and perform hand hygiene.
15. Document the procedure in the patient’s record.

Apnea²
1. Perform hand hygiene and don gloves.
2. Verify the correct patient using two identifiers, if time permits.
3. Explain the procedure to the patient.
4. Assess the patient’s breathing.

a. If the patient is apneic, begin manual ventilation with an MRB.
b. Assess the patient’s clinical condition for causes of apnea and contact the patient’s practitioner, if necessary, to correct the clinical problem.

5. Check the ventilator’s sensitivity setting to ensure that it detects the patient’s inspiratory efforts.
6. Check the circuit for leaks or disconnections. Tighten or reconnect the connections.
7. Ensure that alarms are set properly.
8. Verify that the alarm has been corrected and the patient is stable.
9. Remove gloves and perform hand hygiene.

**Inspiratory:Expiratory (I:E) ratio**
1. Perform hand hygiene and don gloves.
2. Verify the correct patient using two identifiers, if time permits.
3. Explain the procedure to the patient.
4. Ensure that the inspiratory time is set appropriately. An I:E alarm usually indicates an inverse I:E ratio.2
5. Ensure that the flow rate is set appropriately.
6. Check the patient’s respiratory rate.
7. Ensure that alarms are set properly.
8. Verify that the alarm has been corrected and the patient is stable.
9. Remove gloves and perform hand hygiene.

**High Minute Volume (MV)**2
1. Perform hand hygiene and don gloves.
2. Verify the correct patient using two identifiers, if time permits.
3. Explain the procedure to the patient.
4. Assess the patient for signs of respiratory distress.
   a. If distress is found, take appropriate action to correct the cause.
   b. If necessary, contact the practitioner.
5. Ensure that alarms are set properly.
6. Verify that the alarm has been corrected and the patient is stable.
7. Remove gloves and perform hand hygiene.

**High-Pressure Limit**2
1. Perform hand hygiene and don gloves.
2. Verify the correct patient using two identifiers, if time permits.
3. Explain the procedure to the patient.
4. Assess the patient for signs of respiratory distress.
5. Attempt to pass a suction catheter through the patient’s artificial airway to check for an obstruction.
   a. If the tube is kinked, reposition it to straighten it.
   b. If the patient bites the tube, consider placing an oral airway or bite block.
Mechanical Ventilation: Troubleshooting (Respiratory Therapy)

c. If the tip of the artificial airway has impinged on the tracheal wall, reposition the tube to free the obstruction.
d. For all other obstructions, attempt to clear the tube with a suction catheter.
e. If unable to clear the tube with a suction catheter, attempt the following steps.
   i. Remove and replace the inner cannula of the tracheostomy tube.
   ii. Remove the artificial airway and begin manual ventilation.
   iii. Contact the practitioner for further interventions.

6. Check the ventilator circuit for water. Drain condensation away from the patient and toward the expiratory limb.
7. Check the ventilator circuit for kinking or obstructions.
8. Check breath sounds to determine if any of the following are present:
   a. Bronchospasm: Consult the practitioner and consider bronchodilator therapy.
   b. Secretions: Suction the secretions to clear the patient’s airway.
   c. Pneumothorax: Immediately contact the practitioner for further interventions.

9. Check the exhalation valve for failure; if it has failed, immediately remove the patient from the ventilator and begin manual ventilation with an MRB.

10. Ensure that alarms are set properly.
11. Verify that the alarm has been corrected and the patient is stable.
12. Remove gloves and perform hand hygiene.

High Respiratory Rate
1. Perform hand hygiene and don gloves.
2. Verify the correct patient using two identifiers, if time permits.
3. Explain the procedure to the patient.
4. Assess the patient for signs of respiratory distress.
   a. If distress is found, take appropriate action to correct the cause.
   b. If necessary, contact the practitioner.

5. Ensure that alarms are set properly.
6. Verify that the alarm has been corrected and the patient is stable.
7. Remove gloves and perform hand hygiene.

Low or High Fraction of Inspired Oxygen (FIO₂)
1. Perform hand hygiene and don gloves.
2. Verify the correct patient using two identifiers, if time permits.
3. Explain the procedure to the patient.
4. Check the gas source to ensure that the ventilator is connected to a high-pressure oxygen source.
5. Ensure that the FIO₂ is set properly.
6. Recalibrate the internal oxygen analyzer.
7. Check the FIO₂ with the calibrated external oxygen analyzer. If the correct FIO₂ is not being delivered, replace the ventilator.
Mechanical Ventilation: Troubleshooting (Respiratory Therapy)

8. Ensure that alarms are set properly.
9. Verify that the alarm has been corrected and the patient is stable.
10. Remove gloves and perform hand hygiene.

MONITORING AND CARE
1. Ensure secure stabilization of the patient’s artificial airway.
2. Ensure that alarms are on and set appropriately.
3. Keep the ventilator tubing free from condensation. Drain tubing away from the patient and toward the expiratory limb.
4. Check the alarm settings at regular intervals during a ventilator system check.
5. Observe the patient for signs and symptoms of pain. If pain is suspected, report it to the authorized practitioner.

EXPECTED OUTCOMES
- Resolution of alarms
- Return of heart rate, respiratory rate, breath sounds, and SpO₂ to baseline
- Maintenance of functioning ventilator

UNEXPECTED OUTCOMES
- Patient death or harm
- Pulmonary barotrauma or volutrauma
- Discrepancy between set and measured values

DOCUMENTATION
- Patient and family education
- Alarm parameters
- Adverse patient response
- Patient’s vital signs
- Hemodynamic values
- SpO₂ readings
- Respiratory interventions in response to alarms
- Unexpected outcomes and related interventions

HOME CARE CONSIDERATIONS
- Alarms must be set loud enough to be heard in other rooms.
- Alarms should never be disabled.

REFERENCES
Mechanical Ventilation: Troubleshooting
(Respiratory Therapy)

ADDITIONAL READINGS


Supplies
- Gloves
- Cuff pressure manometer
- Self-inflating resuscitation bag with face mask
- Oxygen analyzer
- Pulse oximeter
- Stethoscope
- MRB
- SVN

Clinical Review: Aimee D. Green, MPH, MA, BHA, RRT-RCP

Published: August 2019