

# Mechanical Ventilation: Long-Term Invasive at Home (Respiratory Therapy)

## ALERT

**A patient who is in immediate need of an acute care setting is not a candidate for in-home ventilatory support. Other contraindications include unstable cardiac and respiratory status or an unstable or inadequate home setting without competent family members who are always available.**

**A patient who requires a positive end-expiratory pressure (PEEP) setting above 10 cm H<sub>2</sub>O or who has a fraction of inspired oxygen (FIO<sub>2</sub>) requirement of more than 0.4 (40%) is not a candidate for long-term invasive mechanical ventilation in the home.<sup>1</sup>**

**Every respiratory therapist (RT) and home health practitioner must be familiar with state, Medicare, and Medicaid guidelines for providing care to a patient receiving home mechanical ventilation because guidelines may vary among states.**

## OVERVIEW

Mechanical ventilation is a life-support system used to support or control ventilatory lung function. Patients who become ventilator dependent exhibit an imbalance of ventilatory capacity and demand. Levels of ventilator support range from assisting the patient's work of breathing to controlling all of the patient's ventilatory effort. Most patients receiving long-term invasive ventilatory support have a tracheostomy tube in place to enable ventilator support, but they no longer require intensive monitoring.<sup>1</sup>

Long-term invasive mechanical ventilation provides mechanical ventilator assistance to patients who have been diagnosed with chronic respiratory illnesses or respiratory insufficiency. Patients who may benefit from a long-term home ventilator are limited to those who cannot be completely weaned from invasive ventilator support and those who have a disease progression that requires increasing ventilator support.

The number of patients requiring long-term invasive mechanical ventilation has increased in recent years because of improved care provided in the critical care setting. This improved care has allowed patients to survive acute respiratory failure, some of whom require long-term invasive mechanical ventilation during recovery.<sup>2</sup>

Home mechanical ventilation for children with chronic respiratory insufficiency is a well-established treatment.

## EDUCATION

- Inform the patient and family of infection control measures and emergency measures that should be in place when using ventilators at home. All family members should attend a basic life support class and possess emergency contact information.
- Inform the patient and family of the importance of the patient remaining in a stable, semi-Fowler, or upright position to avoid increased work of breathing, aspiration, and drainage of secretions into the airway.
- Ensure that the patient and family understand airway care, including tracheostomy care, stoma care, and the suctioning procedure.
- Demonstrate the proper technique for using a manual resuscitation bag.
- Discuss the length of time that the patient may need to be on the ventilator.
- Explain the method of ventilation and the benefits of assisting the patient.

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- Ensure that family members can demonstrate proper setup, use, troubleshooting, and routine maintenance of the equipment and supplies needed to provide care.
- Ensure that the family understands emergency measures and can identify any adverse responses to mechanical ventilation that the patient may experience.
- Ensure that family members understand that the ventilator alarms and settings should be adjusted only by a licensed RT with the authorized practitioner's orders.
- Encourage questions and answer them as they arise.

## 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. Assess the indications for long-term mechanical ventilation in the home.
5. Assess the patient's willingness to receive mechanical ventilation at home.
6. Assess the physical environment to which the patient will be discharged to determine if any health or safety standard problems exist.
7. Assess the patient's ventilator requirements as ordered per the authorized practitioner and determine the appropriate ventilator for the patient. For a child, assess his or her growth and development.
8. Ensure that family members have attended a basic life support class.
9. Assess the patient's quality of life, satisfaction, and use of resources.
10. Periodically assess the patient for changes in prognosis.

### Preparation

1. Verify that the necessary supplies are available, and that equipment is set up properly in the home.

## PROCEDURE

1. Perform hand hygiene and don gloves.
2. Verify the correct patient using two identifiers.
3. Explain the procedure to the patient and ensure that he or she agrees to treatment.
4. Verify the practitioner's prescription orders for home ventilator settings.
5. In collaboration with the authorized practitioner, select the most appropriate mode of volume mechanical ventilation based on the patient's needs (control, synchronized intermittent mandatory ventilation [SIMV], or assist-control [AC]).<sup>1</sup>

Rationale: Mode selection varies depending on the clinical goal and the practitioner's preference. Ventilators chosen for use at home must be dependable and easy for family members to operate and must allow mobility.<sup>1</sup>

- a. AC: Use AC when a guaranteed volume and rate are desired. Ensure the volume and rate by setting the sensitivity or flow trigger. AC ventilation is preferred with portable ventilators.

Rationale: The use of SIMV for portable volume control ventilators increases the work of breathing.<sup>1</sup>

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- b. SIMV: Set a rate and tidal volume ( $V_T$ ) to be delivered in synchrony with the patient's respiratory effort. Between mandatory breaths, the patient may initiate breaths at a self-determined volume and rate.
6. For inspiratory:expiratory (I:E) times, select the inspiratory time ( $T_i$ ), which may be named differently depending on the ventilator's manufacturer. Adjust the flow (if an adjustable flow setting is available on the home ventilator model used) as necessary to attain patient-ventilator synchrony.
  - a.  $T_i$  may also be called percentage of  $T_i$ , flow rate, or peak flow.
  - b. Generally, flow rates are set initially and then adjusted to provide a  $T_i$  that synchronizes with the patient's effort.
7. Select the PEEP level.
8. Provide humidification.
9. Ensure that all ventilator alarms are on and functioning.
10. Remove gloves and perform hand hygiene.
11. Document the procedure in the patient's record.

### MONITORING AND CARE

1. Monitor the patient's airway.
2. Monitor the patient's movement and ambulation.
3. Monitor the patient for improved gas exchange, arterial blood gas values, oxygen saturation, and work of breathing.
4. Assess the patient's cardiorespiratory status.
5. Monitor the patient's vital signs.
6. Check the ventilator's settings and alarms as specified in the patient's care plan. Check the settings for peak pressures, preset  $V_T$  or preset pressure control, frequency of ventilator breaths, PEEP, and the temperature and humidification of inspired gases.
7. Monitor the function of the heat-moisture exchanger, if applicable.
8. Monitor the equipment's functionality.
9. Monitor the cleanliness of the filters according to the manufacturer's specifications.
10. Monitor internal and external battery power levels.
11. Monitor the self-inflating manual resuscitation bag for cleanliness and functionality.
12. Monitor the patient for changes in prognosis.
13. Observe the patient for signs and symptoms of pain. If pain is suspected, report it to the authorized practitioner.

### EXPECTED OUTCOMES

- Respiratory parameters within the limits established for the patient's condition
- Improvement or maintenance of the patient's respiratory status
- Maintenance of an independent lifestyle for the patient in his or her home

### UNEXPECTED OUTCOMES

- Deterioration of the patient's health
- Repeated admissions for the patient

### DOCUMENTATION

- Patient and family education

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- Indication for ventilatory assistance
- Date and time ventilatory assistance was instituted
- Ventilator settings
  - FIO<sub>2</sub>
  - Mode of ventilation
  - VT
  - Respiratory frequency (total and mandatory)
  - PEEP level
  - I:E ratio or Ti
  - Peak inspiratory pressure
  - Dynamic lung compliance
  - Static lung compliance
- Arterial blood gas values
- Arterial oxygen saturation readings
- Patient's responses to positive pressure ventilation
- Hemodynamic values
- Vital signs
- Unexpected outcomes and related interventions

### HOME CARE CONSIDERATIONS

- Mechanical ventilation should be considered for use in the home only if the proper resources are available, such as family members who are always available.
- Two competent family members are required, and adequate respite care for the family members must be considered.
- Work with the patient and family to ensure that they understand infection control measures, airway care, and emergency measures.
- The home should provide a safe and sanitary physical environment with no fire, health, or safety hazards. The home should have air-conditioning, heat, and adequate amperage with grounded outlets.
- Consideration should be made for patients who live in rural communities. A second ventilator should be considered for patients who are unable to maintain spontaneous ventilation for 4 or more consecutive hours or who live in an area where a replacement ventilator cannot be provided within 2 hours.<sup>1</sup>

### REFERENCES

1. American Association for Respiratory Care (AARC). (2007). Clinical practice guideline: Long-term invasive mechanical ventilation in the home—2007 revision and update. *Respiratory Care*, 52(8), 1056-1062. (classic reference)\* ([Level VII](#))
2. Sahetya, S. and others. (2016). Long-term mechanical ventilation. *Clinics in Chest Medicine*, 37(4), 753-763. doi:10.1016/j.ccm.2016.07.014.

### ADDITIONAL READINGS

Heuer, A.J. (2017). Respiratory care in alternative settings. In R.M. Kacmarek, J.K. Stoller, A.J. Heuer (Eds.), *Egan's fundamentals of respiratory care* (11th ed., pp. 1284-1311). St. Louis: Elsevier.

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\*In these skills, a “classic” reference is a widely cited, standard work of established excellence that significantly affects current practice and may also represent the foundational research for practice.

## Elsevier Skills Levels of Evidence

- Level I - Systematic review of all relevant randomized controlled trials
- Level II - At least one well-designed randomized controlled trial
- Level III - Well-designed controlled trials without randomization
- Level IV - Well-designed case-controlled or cohort studies
- Level V - Descriptive or qualitative studies
- Level VI - Single descriptive or qualitative study
- Level VII - Authority opinion or expert committee reports

## Supplies

- A second ventilator, if required
- Adequate utilities, such as air-conditioning, heat, adequate amperage with grounded outlets, and telephone service
- An adequate power source for the ventilator
- Gloves
- Humidification system or heat-moisture exchanger
- Manual self-inflating resuscitation bag with tracheostomy attachments, an oxygen port (if needed), and an appropriate-size mask
- Replacement tracheostomy tube of appropriate size along with a tube one size smaller
- Sphygmomanometer
- Stethoscope
- Suction catheters that do not occlude more than 50% of the artificial airway
- Suction equipment
- Supplemental oxygen as medically indicated
- Appropriate-size syringe for tracheostomy cuff inflation and deflation, if applicable
- Thermometer
- Ventilator backup battery
- Ventilator circuit
- Ventilator filters
- Watch or clock

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