

## AARC Clinical Practice Guideline

### Long-Term Invasive Mechanical Ventilation in the Home —2007 Revision & Update

#### HIMV 1.0 PROCEDURE

The application of invasive mechanical ventilation and care of the patient-ventilator system in the home, as ordered by a physician.

#### HIMV 2.0 DESCRIPTION/DEFINITION

Mechanical ventilation may be defined as a life support system designed to replace or support normal ventilatory lung function. Ventilator dependence is caused by an imbalance between ventilatory capacity and demand. A ventilator-assisted individual (VAI) may require mechanical aid for breathing to augment or replace spontaneous ventilatory efforts to achieve medical stability or to maintain life. The patient eligible for invasive long-term mechanical ventilation in the home (HIMV) requires a tracheostomy tube for ventilatory support, but no longer requires intensive medical and monitoring services.<sup>1-6</sup> This guideline refers to patients ventilated by positive pressure via a tracheostomy tube in the home.

##### 2.1 The goals of HIMV are

- 2.1.1 To sustain and extend life<sup>1-6</sup>
- 2.1.2 To enhance the quality of life<sup>1-11</sup>
- 2.1.3 To reduce morbidity<sup>1-6,12-15</sup>
- 2.1.4 To improve or sustain physical and psychological function of all VAIs and to enhance growth and development in pediatric VAIs<sup>1-11</sup>
- 2.1.5 To provide cost-effective care

#### HIMV 3.0 SETTING

The setting is the home, which for the purposes of this guideline may be the patient's home, a foster home, or a group-living environment<sup>1-6,16-19</sup>

#### HIMV 4.0 INDICATIONS

- 4.1 Patients requiring invasive long-term ventilatory support have demonstrated
  - 4.1.1 An inability to be completely weaned from invasive ventilatory support
  - 4.1.2 A progression of disease etiology that requires increasing ventilatory support.

- 4.2 Conditions that met these criteria may include but are not limited to ventilatory muscle disorders, alveolar hypoventilation syndrome, primary respiratory disorders, obstructive lung diseases, restrictive lung diseases, and cardiac disorders, including congenital anomalies<sup>1-6,16-20</sup>

#### HIMV 5.0 CONTRAINDICATIONS

Contraindications to HIMV include:

- 5.1 The presence of a physiologically unstable medical condition requiring higher level of care or resources than available in the home<sup>1-6</sup> Examples of indicators of a medical condition too unstable for the home and long-term care setting are:
  - 5.1.1  $F_{IO_2}$  requirement  $> 0.40$ <sup>1-6</sup>
  - 5.1.2 PEEP  $> 10$  cm  $H_2O$ <sup>1-6</sup>
  - 5.1.3 Need for continuous invasive monitoring in adult patients<sup>1-6</sup>
  - 5.1.4 Lack of mature tracheostomy
- 5.2 Patient's choice not to receive home mechanical ventilation<sup>1-6,20-24</sup>
- 5.3 Lack of an appropriate discharge plan<sup>1-6</sup>
- 5.4 Unsafe physical environment as determined by the patient's discharge planning team<sup>1-6</sup>
  - 5.4.1 Presence of fire, health or safety hazards including unsanitary conditions<sup>1-6</sup>
  - 5.4.2 Inadequate basic utilities (such as heat, air conditioning, electricity including adequate amperage and grounded outlets)<sup>1-6</sup>
- 5.5 Inadequate resources for care in the home
  - 5.5.1 Financial<sup>1-6,25-28</sup>
  - 5.5.2 Personnel
    - 5.5.2.1 Inadequate medical follow-up<sup>1-6</sup>
    - 5.5.2.2 Inability of VAI to care for self, if no caregiver is available<sup>1-6</sup>

**5.5.2.3** Inadequate respite care for caregivers<sup>21-23,29,30</sup>

**5.5.2.4** Inadequate numbers of competent caregivers<sup>1-6</sup> A minimum of two competent caregivers are required.

## HIMV 6.0 HAZARDS AND COMPLICATIONS

**6.1** Deterioration or acute change in clinical status of VAI. Although ventilator-associated complications in the home are poorly documented, experience in other sites can be extrapolated. The following may cause death or require rehospitalization for acute treatment.

**6.1.1 Medical:** Hypocapnia, respiratory alkalosis hypercapnia, respiratory acidosis, hypoxemia, barotraumas, seizures, hemodynamic instability, airway complications (stomal or tracheal infection, mucus plugging, tracheal erosion, or stenosis), respiratory infection (tracheo-bronchitis, pneumonia, bronchospasm, exacerbation of underlying disease, or natural course of the disease<sup>1-6,14</sup>

**6.1.2 Equipment-related:** Failure of the ventilator, malfunction of equipment, inadequate warming, and humidification of the inspired gases, inadvertent changes in ventilator settings, accidental disconnection from ventilator, accidental decannulation<sup>1-6,31-36</sup>

**6.1.3 Psychosocial:** Depression, anxiety, loss of resources (caregiver or financial), detrimental change in family structure or coping capacity<sup>1-6,21-24,29,30,37,38</sup>

## HIMV 7.0 LIMITATIONS

In the home care setting, making and implementing changes in the plan of care may take longer than in a health care facility.

## HIMV 8.0 ASSESSMENT OF NEED

**8.1** Determination that indications are present and contraindications are absent

**8.2** Determination that the goals listed in 2.1 can be met in the home

**8.3** Determination that no continued need exists for higher level of services

**8.4** Determination that frequent changes in the plan of care will not be needed

## HIMV 9.0 ASSESSMENT OF OUTCOME

At least the following aspects of patient management and condition should be evaluated periodically as long as the patient receives HIMV

**9.1** Implementation and adherence to the plan of care

**9.2** Quality of life

**9.3** Patient satisfaction

**9.4** Resource utilization

**9.5** Growth and development in the pediatric patient

**9.6** Change in prognosis

**9.7** Unanticipated morbidity, including need for higher level site of care

**9.8** Unanticipated mortality

## HIMV 10.0 RESOURCES

### 10.1 Equipment

**10.1.1** Ventilator(s)—Choice should be based on patient's clinical need. Patient's medical needs may dictate that more than one ventilator be provided.<sup>1-6</sup>

**10.1.1.1** Ventilators chosen for home care must be dependable and easy for the intended caregivers to operate; small size and lightweight are desirable.

**10.1.1.2** Mobility is frequently an essential element of the plan of care of the patient. The mechanical ventilator system chosen for such a patient should allow mobility.

**10.1.2** With portable, volume-cycled ventilators, use of the SIMV mode increases work of breathing<sup>1-6</sup>

**10.1.3** Complex and non-portable components are not recommended for HIMV but may be used to meet the needs of certain patients<sup>1-6</sup>

**10.1.3.1** Ventilators powered by external compressed gas sources are less desirable<sup>1-6</sup>

**10.1.3.2** A second ventilator should be provided for

**10.1.3.2.1** Patients who cannot maintain spontaneous ventilation for 4 or more consecutive hours<sup>1-6</sup>

**10.1.3.2.2** Patients who live in an area where a replacement ventilator cannot be provided within 2 hours<sup>1-6</sup>

**10.1.3.2.3** Patients who require mechanical ventilation during mobility as prescribed in their plan of care

**10.1.4** Preventive maintenance should be provided at the frequency recommended under manufacturer guidelines

**10.1.5** An adequate power source must be available to operate the ventilator consistent with patient needs.<sup>1-6</sup> This may be supplied by one or more of the following methods

**10.1.5.1** Alternating current (AC) is the primary power source for most long-term care ventilators. Emergency AC power should be available in the long-term care facility.

**10.1.5.2** Direct current (DC) by external battery may be used to allow mobility and as an emergency power source. The internal battery of the ventilator should be used only for short-term use. It should not be used as a primary source of power.

**10.1.5.3** A portable generator may be recommended for the VAI if frequent power outages occur or if the home is in a remote location

**10.1.6** Alarms

**10.1.6.1** A patient-disconnect (eg, low-pressure or low-exhaled-volume) and a high-pressure alarm are essential.

**10.1.6.2** If patient disconnection is likely to produce a serious adverse effect, a remote alarm and a secondary alarm may be indicated. A secondary alarm may be based on chest-wall impedance and cardiac activity, exhaled volume, end-tidal CO<sub>2</sub>, or pulse oximetry with alarm capabilities<sup>3,5</sup>

**10.1.6.3** Audible alarms must be loud enough to be heard by caregivers in all areas of the home.

**10.1.7** Humidification systems are essential for invasive mechanical ventilation. The type of system used is determined by the patient's medical needs and the patient's need for mobility. It may be appropriate for the patient to use more than one type of system, based on those needs.<sup>1-3,5</sup>

**10.1.7.1** Heated humidifier (temperature probes should be provided)

**10.1.7.2** Heat - moisture exchanger (HME) can be used during transport and to enhance mobility and may be used in lieu of a heated humidifier if the HME is determined to meet the patient's medical needs<sup>1-3,5,6</sup>

**10.1.8** Ventilator circuit and accessories as medically indicated

**10.1.9** Self-inflating resuscitation bag with tracheostomy attachments, oxygen port if oxygen is prescribed, and mask of appropriate size<sup>1-3,5,6</sup>

**10.1.10** Replacement tracheostomy tube of appropriate size, plus a tube one size smaller should be available at all times

**10.1.11** Suction equipment<sup>1-3,5,6</sup> including a battery-powered aspirator for patients who leave the home or when indicated as an alternate source in the event of a power failure

**10.1.12** Supplemental oxygen as medically indicated<sup>1-3,5,6</sup>

**10.1.13** VAI must have an adequate means of communicating their needs/desires and have the means to summon help from their caregivers in the case of emergency<sup>3,5</sup>

**10.1.14** VAI and caregivers must have functioning phone lines so that they can contact and be contacted by medical personnel in the case of emergency

**10.2** Personnel

**10.2.1** Health care professionals capable of providing direct patient care and possessing demonstrated competencies to monitor and assess both the patient and equipment are essential. Health care professionals should be credentialed (RRT, CRT, RN) and/or licensed practitioners with documented knowledge and demonstrated competencies so as to:

**10.2.1.1** Understand the patient's disease, plan of care, goals, and the limitations of invasive mechanical ventilation<sup>2,3,5,6</sup>

**10.2.1.2** Assess patient's response to invasive mechanical ventilation

**10.2.1.3** Make recommendations for changes in respiratory management of patient, including weaning as necessary<sup>2,3,5,6</sup>

**10.2.1.4** Train and monitor lay caregivers

**10.2.1.5** Monitor patient's ongoing ventilatory status

**10.2.1.6** Communicate results of assessment to the health care team<sup>2,3,5,6</sup>

**10.2.2** Lay caregivers (family members, personal care attendants, non-credentialed health care personnel such as nurse's aides) can be taught tasks and techniques of care for a specific VAI. Appropriately trained lay caregivers must demonstrate competency in:

**10.2.2.1** Proper set up, use, troubleshooting, and routine maintenance of the equipment and supplies<sup>2,3,5,6,21,23,24,29,30,37-41</sup>

**10.2.2.2** Identification of adverse patient response to invasive mechanical ventilation<sup>2,3,5,6</sup>

**10.2.2.3** Response to the hazards of invasive mechanical ventilation<sup>2,3,5,6</sup>

**10.2.2.4** Response to emergencies<sup>2,3,5,6</sup> such as

**10.2.2.4.1** Power failure

**10.2.2.4.2** Acute life threatening events such as accidental decannulation or medical deterioration of the patient

**10.2.2.4.3** Failure of the equipment or supplies

**10.2.2.5** Appropriate infection control procedures<sup>2,3,5,6</sup>

**10.2.2.6** Use and application of any additional techniques required for ongoing care of the VAI, such as suctioning and the use of ancillary equipment<sup>2,3,5,6</sup>

**10.3** Finances: HIMV can only be instituted and maintained with adequate financial resources to provide the necessary equipment and personnel to manage the patient's care<sup>2,3,5,6,25-28</sup>

## HIMV 11.0 MONITORING

The frequency of monitoring should be determined by the ongoing individualized care plan and be based upon the patient's current medical condition.

The ventilator settings, proper function of equipment, and the patient's physical condition should be monitored and verified: with each initiation of invasive ventilation to the patient, including altering the source of ventilation, as from one ventilator or resuscitation bag to another ventilator; with each ventilator setting change; after moving the patient (eg, from the bed to a chair); on a regular basis as specified by individualized plan of care.<sup>3</sup> All caregivers, both professional and appropriately trained lay caregivers, should follow the care plan and implement the monitoring that has been prescribed. After being trained and evaluated on their level of knowledge and ability to respond to the VAI clinical response to each intervention, lay caregivers with documented competency may operate, perform routine maintenance tasks, monitor equipment, and perform personal care required by the VAI.

**11.1** After completing training, demonstrating competency and if directed in the VAI's plan of care, the lay caregivers should monitor the following

**11.1.1** Patient's physical condition (may include the following: respiratory rate, heart rate, color changes, chest excursion, diaphoresis and lethargy, blood pressure, body temperature)

**11.1.2** Ventilator settings. The frequency at which alarms and settings are to be checked should be specified in the plan of care.

**11.1.2.1** Peak pressures

**11.1.2.2** Preset tidal volume or preset pressure control

**11.1.2.3** Frequency of ventilator breaths

**11.1.2.4** Verification of oxygen concentration setting or flow rate of oxygen bled into the ventilator system

**11.1.2.5** PEEP level (if applicable)

**11.1.2.6** Appropriate humidification of inspired gases

**11.1.2.7** Temperature of inspired gases (if applicable)

**11.1.2.8** Heat-moisture exchanger (HME) function (if applicable)

**11.1.3** Equipment function<sup>3,5</sup>

**11.1.3.1** Appropriate configuration of ventilator circuit<sup>3,5</sup>

**11.1.3.2** Alarm function

**11.1.3.3** Cleanliness of filter(s)—according to manufacturer’s recommendation

**11.1.3.4** Battery power level(s)—both internal and external

**11.1.3.5** Overall condition of all equipment

**11.1.3.6** Self-inflating manual resuscitator—cleanliness and function

**11.2** Health care professionals should perform a thorough, comprehensive assessment of the patient and the patient-ventilator system on a regular basis as prescribed by the plan of care. In addition to the variables listed in 11.1.1-11.1.3.6, the health care professional should implement, monitor, and assess results of other interventions as indicated by the clinical situation and anticipated in the care plan.

**11.2.1** Pulse oximetry—should be used to assess patients requiring a change in prescribed oxygen levels or in patients with a suspected change in condition<sup>3,5</sup>

**11.2.1.1** A physician’s order for pulse oximetry must be obtained before oximetry testing is performed

**11.2.2** End-tidal CO<sub>2</sub>—may be useful for establishing trends in CO<sub>2</sub> levels<sup>3,20</sup>

**11.2.2.1** A physician’s order for end tidal CO<sub>2</sub> monitoring must be obtained before end tidal CO<sub>2</sub> monitoring is performed

**11.2.3** Ventilator settings

**11.2.4** Exhaled tidal volume

**11.2.5** Analysis of fraction of inspired oxygen

**11.3** Health care professionals are also responsible for maintaining interdisciplinary communication concerning the plan of care

**11.4** Health care professionals should integrate respiratory plan of care into the patient’s total care plan.<sup>2,3,5,6</sup> Plan of care should include

**11.4.1** All aspects of patient’s respiratory care<sup>2,3,5,6</sup>

**11.4.2** Ongoing assessment and education of the caregivers involved

## HIMV 12.0 FREQUENCY:

**12.1** The frequency of ventilation (and the patient’s ventilator-free time) is dictated by the patient’s physiologic needs and is deter-

mined in consultation with the patient’s physician.

**12.2** The frequency of assessment of the VAI and the patient-ventilator system must be noted in the evolving total care plan as determined by the health care team, in conjunction with the VAI and their caregivers.

## HIMV 13.0 INFECTION CONTROL

**13.1** Both professional and lay caregivers should be aware of the potential for transmission of both chronic and acute infection from patient to caregiver and from caregiver to patient and should take the steps necessary to avoid that transmission. Aspects of avoidance include

**13.1.1** Careful hand cleansing and barrier protection when appropriate

**13.1.2** Careful disposal of medical waste

**13.1.3** Maximizing protection of patient, family, and caregivers (eg, influenza immunization) and minimizing exposure to persons with acute infections (eg, limiting visitors with upper respiratory infections)

**13.2** Evidence is lacking to support an optimal plan for changing and processing ventilator circuits and ancillary equipment in the home. The standard of care in the home is that ventilator circuits need not be changed more often than once each week. However, CDC guidelines and studies from institutional settings<sup>42-44</sup> suggest that ventilator circuits need only be changed when visibly soiled.

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