AARC Clinical Practice Guideline

Humidification during Mechanical Ventilation

HMV 1.0 PROCEDURE:
The addition of heat and moisture to inspired gases delivered to the patient during mechanical ventilatory support via an artificial airway

HMV 2.0 DESCRIPTION/DEFINITION:
When the upper airway is bypassed, humidification during mechanical ventilation is necessary to prevent hypothermia, inspissation of airway secretions, destruction of airway epithelium, and atelectasis.(1-7) This may be accomplished using either a heated humidifier or a heat and moisture exchanger (HME). (HMEs are also known as hygroscopic condenser humidifiers, or artificial noses). The chosen device should provide a minimum of 30 mg H2O/L of delivered gas at 30°C.(8,29) Heated humidifiers operate actively to increase the heat and water vapor content of inspired gas.(11-14) HMEs operate passively by storing heat and moisture from the patient's exhaled gas and releasing it to the inhaled gas.(15-25)

HMV 3.0 SETTINGS:
3.1 Critical care
3.2 Acute care inpatient
3.3 Extended care and skilled nursing facility
3.4 Home care
3.5 Prolonged transport

HMV 4.0 INDICATIONS:
Humidification of inspired gas during mechanical ventilation is mandatory when an endotracheal or tracheostomy tube is present.(1-7)

HMV 5.0 CONTRAINDICATIONS:
There are no contraindications to providing physiologic conditioning of inspired gas during mechanical ventilation. An HME is contraindicated under some circumstances.

5.1 Use of an HME is contraindicated for patients with thick, copious, or bloody secretions.(8,26-28)
5.2 Use of an HME is contraindicated for patients with an expired tidal volume less than 70% of the delivered tidal volume (eg, those with large bronchopleurocutaneous fistulas or incompetent or absent endotracheal tube cuffs).(15-25)
5.3 Use of an HME is contraindicated for patients with body temperatures less than 32°C.(8,29)
5.4 Use of an HME may be contraindicated for patients with high spontaneous minute volumes (> 10L/min).(8,26,29)
5.5 An HME must be removed from the patient circuit during aerosol treatments when the
nebulizer is placed in the patient circuit.(8-29)

**HMV 6.0 HAZARDS/COMPLICATIONS:**

Hazards and complications associated with the use of humidification devices include

6.1 potential for electrical shock--heated humidifiers;(11-14)
6.2 hypothermia--HME or heated humidifiers; hyperthermia--heated humidifiers;(11-14)
6.3 thermal injury to the airway from heated humidifiers;(30) burns to the patient and tubing meltdown if heated-wire circuits are covered or circuits and humidifiers are incompatible;
6.4 underhydration and impaction of mucus secretions--HME or heated humidifiers;(1-7)
6.5 hypoventilation and/or alveolar gas trapping due to mucus plugging of airways--HME or heated humidifier;(1-7)
6.6 possible increased resistive work of breathing due to mucus plugging of airways--HME or heated humidifiers;(1-7)
6.7 possible increased resistive work of breathing through the humidifier--HME or heated humidifiers;(31-34)
6.8 possible hypoventilation due to increased dead space--HME;(8,15-25,26-30)
6.9 inadvertent overfilling resulting in unintentional tracheal lavage--heated reservoir humidifiers;(35)
6.10 the fact that when disconnected from the patient, some ventilators generate a high flow through the patient circuit that may aerosolize contaminated condensate, putting both the patient and clinician at risk for nosocomial infection--heated humidifiers;(35)
6.11 potential for burns to caregivers from hot metal--heated humidifiers;
6.12 inadvertent tracheal lavage from pooled condensate in patient circuit--heated humidifiers;(35)
6.13 elevated airway pressures due to pooled condensation--heated humidifiers;
6.14 patient-ventilator dysynchrony and improper ventilator performance due to pooled condensation in the circuit--heated humidifiers;
6.15 ineffective low-pressure alarm during disconnection due to resistance through HME.(36)

**HMV 7.0 LIMITATIONS OF METHODS:**

7.1 Insufficient heat and humidification can occur with some HME devices, resulting in complications noted in HMV 6.0.(8,15-28)
7.2 Insufficient heat and humidification can occur with heated humidifiers and result in complications noted in HMV 6.0 when
   7.2.1 improper temperature settings are selected.
   7.2.2 water level in the humidifier falls below manufacturer's suggested level.(37)
7.3 The HME selected should be appropriate to the patient's size and tidal volume.

**HMV 8.0 ASSESSMENT OF NEED:**

Humidification is needed by all patients requiring mechanical ventilation via an artificial airway. Conditioning of inspired gases should be instituted using either an HME or a heated humidifier.

8.1 HMEs are better suited for short-term use (< or = 96 hours) and during transport.(8,29)
8.2 Heated humidifiers should be used for patients requiring longterm mechanical ventilation (> 96 hours) or for patients who exhibit contraindications for HME use. (8,29)

HMV 9.0 ASSESSMENT OF OUTCOME:
Humidification is assumed to be appropriate if, on regular careful inspection, the patient exhibits none of the hazards or complications listed in HMV 6.0.

HMV 10.0 RESOURCES:

10.1 Equipment: Appropriate equipment should be available to provide for adequate humidification of the inspired gas. Such equipment may include but is not limited to

10.1.1 humidification device;
10.1.2 a system to monitor inspired gas temperature and to alarm when the temperature falls outside a preset range (for heated humidifier);
10.1.3 sterile water for heated humidifiers;
10.1.4 equipment necessary to comply with Universal Precautions.

10.2 Humidifier performance specifications should be checked to assure adequate heating and humidification during expected peak inspiratory flowrate and minute ventilation delivered by the mechanical ventilator. Heated humidifiers selected for use should meet specifications of the American National Standards Institute. (9)

10.3 Personnel:

10.3.1 Level-I personnel should possess

10.3.1.1 a complete understanding of the operation, maintenance, and troubleshooting of the ventilator, circuit, and humidifying device;
10.3.1.2 knowledge of and ability to implement Universal Precautions.

10.3.2 Level-II personnel should possess the abilities described in 10.3.1.1 and 10.3.1.2 and should also have

10.3.2.1 the ability to assess patient response to humidification;
10.3.2.2 the ability to recognize an adverse response to humidification;
10.3.2.3 the ability to appropriately respond to adverse events;
10.3.2.4 the ability to recommend modifications in humidification techniques as

HMV 11.0 MONITORING:
The humidification device should be inspected visually during the patient-ventilator system check and condensate should be removed from the patient circuit as necessary. HMEs should be inspected and replaced if secretions have contaminated the insert or filter. The following variables should be recorded during equipment inspection:

11.1 Humidifier setting (temperature setting or numeric dial setting or both). During routine use on an intubated patient, a heated humidifier should be set to deliver an inspired gas temperature of 33 ± 2°C and should provide a minimum of 30 mg/L of water vapor. (8-10)

11.2 Inspired gas temperature. Temperature should be monitored as near the patient's airway opening as possible, if a heated humidifier is used.

11.2.1 Specific temperatures may vary with patient condition, but the inspiratory gas should
not exceed 37°C at the airway threshold.

11.2.2 When a heated-wire patient circuit is used (to prevent condensation) on an infant, the 
temperature probe should be located outside of the incubator or away from the direct heat of 
the radiant warmer. (12)

**11.3 Alarm settings** (if applicable). High temperature alarm should be set no higher than 37°C, 
and the low temperature alarm should be set no lower than 30°C. (8,10)

**11.4 Water level and function of automatic feed system** (if applicable).

**11.5 Quantity and consistency of secretions.** Characteristics should be noted and recorded. When 
using an HME, if secretions become copious or appear increasingly tenacious, a heated humidifier 
should replace the HME.

**HMV 12.0 FREQUENCY:**

All patients with an artificial airway requiring mechanical ventilation should receive continuous 
humidification of inspired gases.

**HMV 13.0 INFECTION CONTROL:**

13.1 Reusable heated humidifiers should be subjected to high-level disinfection between 
patients. (35) Clean technique should be observed when manually filling the water reservoir. Sterile 
water should be used.

13.2 When using a closed, automatic feed system, the unused portion of water in the water feed 
reservoir remains sterile and need not be discarded when the patient circuit is changed. However, 
the water feed system should be designated for single patient use only.

13.3 Condensation from the patient circuit should be considered infectious waste and disposed of 
according to hospital policy using strict Universal Precautions. (35,38,39)

13.4 Because condensate is infectious waste, it should never be drained back into the humidifier 
reservoir. (35,38,39)

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**REFERENCES**

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