Humidification on Ventilated Patients: Heated Humidifications or Heat and Moisture Exchangers?

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Abstract: The normal physiology of conditioning of inspired gases is altered when the patient requires an artificial airway access and an invasive mechanical ventilation (IMV). The endotracheal tube (ETT) removes the natural mechanisms of filtration, humidification and warming of inspired air. Despite the noninvasive ventilation (NIMV) in the upper airways, humidification of inspired gas may not be optimal mainly due to the high flow that is being created by the leakage compensation, among other aspects. Any moisture and heating deficit is compensated by the large airways of the tracheobronchial tree, these are poorly suited for this task, which alters mucociliary function, quality of secretions, and homeostasis gas exchange system. To avoid the occurrence of these events, external devices that provide humidification, heating and filtration have been developed, with different degrees of evidence that support their use.

Keywords: Air humidification, Humidification devices, humidification IMV, humidification NIMV.

1. INTRODUCTION

The human airway has an important role in heating and humidification of the inspired gas [1]. During spontaneous breathing, inspiratory gases are usually heated and humidified in the nasal cavity and pharynx [2]. The normal physiology of conditioning gas is altered when the patient requires an artificial airway, intubation eliminates the natural mechanisms of filtration, humidification, and warming of inspired air [3]. The humidification of inspired gas is mandatory for all mechanically ventilated patients, however, the debate about the ideal humidification continues today [4].

NIMV supplies dry and cold gas through the upper airway causing dryness of the mucosa and respiratory dysfunction. Leakage compensation applied by NIMV creates high flow throughout the respiratory cycle, which contributes to the loss of heat and humidity [5]. Although in NIMV the upper airway is preserved, humidification during NIMV might not be optimal due to the greater flow delivered, thus producing an increase in mucous viscosity and secretion retention, these conditions that increase the risk of obstruction of the upper airways [6].

During NIMV, active humidification is recommended to improve patient comfort [7]. But in which patients, it provides better evidence and Is it always necessary in hospitalized patients?

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2. PHYSIOLOGICAL CONCEPTS

2.1. Humidification

Humidity refers to the quantity of water vapor in a gaseous environment [4] and it depends on the temperature of the gas and it can be expressed in two ways, as absolute humidity and relative humidity. The absolute humidity (AH) is the amount of water in a given volume of gas usually expressed in H2O mg/L volume [4, 8]. The relative humidity (RH) is the amount of water vapor in a volume of gas, expressed as a percentage of the amount of water vapor required to fully saturate the same volume of gas at the same temperature and pressure [4].

If atmospheric air is at 20°C, and has an AH H2O of about 10 mg/L water and RH of 55 to 60%. As this air passes through the nose and upper respiratory tract, it humidifies and heats the air [4]. This occurs thanks to the fact that in nasopharynx the inspired gases are exposed to a highly vascularized moist mucous membrane [9]. The respiratory mucosa is lined by ciliated columnar pseudostratified epithelium and numerous goblet cells, these cells and submucosal glands are responsible for maintaining the mucosal layer that serves as a trap for the pathogens and as an interface for the exchange of moisture. At the level of the terminal bronchioles, the epithelium becomes a simple cubic type with minimum goblet cells and few submucosal glands. Therefore, the capacity of these pathways to perform the same level of humidification than the upper airway is limited [8, 10].

The movement of the cilia is called metachronalciliary; the beat frequency is directly proportional to the temperature (t°) and it is normal that at 37°C it is 750 b/min, but at 40°C it increases to 1100 b/min. Excessive moisture affects ciliary

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function, since it increases the volume of secretions due to its low viscosity and risk of atelectasis by plugging the airway [11]. This explains why at a temperature above 37°C and 100% gas saturation produces a condensation of the gas, thus causing a reduction in mucus viscosity and an increase in the thickness of the pericellular liquid, which may be too liquid to be coupled properly to the tips of the cilia, thus affecting mucociliary transport [12, 13].

As the air moves forward through the respiratory tract, it will be thermo-humidified, at the middle of the trachea the temperature and the AH reaches approximately 34°C and 34 to 38 mg H2O/L respectively [14]. The point at which the gas reaches 37°C and a relative humidity of 100% (which corresponds to an absolute humidity of 44mgH2O/L), it is known as the limit of isothermal saturation, which is about 5 cm below the carina during quiet breathing between the third and the fifth generation of the bronchial tree [14, 15]. This provides optimal conditions for gas exchange in the alveolar-capillary membrane [4]. Humidity and temperature are constant below the limit of isothermal saturation [14].

The upper airway delivers 75% of the heat and humidity delivered to the alveoli. If the physiological conditions change, either by having an ETT during the IMV or when changing the flow and pressure conditions during NIMV, there is not an adequate system of humidification for our patients. The point of isothermal saturation could be affected, any moisture and heating deficit is compensated by the large airways of the tracheobronchial tree, which are unsuitable for this task, thus altering the mucociliary function, quality of secretions, and the homeostasis system gas exchange.

2.2. Humidification Devices

Humidifiers are devices that add water molecules, gas and temperature. They are classified as active if they have external sources of heat, water and flow, and passive if they use temperature and hydration from the exhaled gas from patients [16]. See Table **1**.

2.3. Active Humidifiers

These types of humidifiers are divided into several categories: bubble humidifiers, waterfall humidifiers, bypass humidifiers and shirt humidifiers [8]. Of the active humidification systems, the bypass is the most widely used today in the ICU, they are applied in both, in mechanical ventilation and noninvasive ventilation [7]. The gas that goes to the patient passes over the surface of the heated water, which causes the humidification to come close to 100% RH and can deliver up to 44 mg/L of AH [17, 18].

The water is heated *via* heating base, which transmit heat by convection from the metal of the bases. It is self-regulating by a servomechanism and consist of: a heating cable, (which maintains the temperature of gas in the circuit, thus preventing condensation in the piping and the probability of bacterial colonization), a cable with two temperature sensors, which are locked at the output of the humidifier, and a Y-piece (near the patient) to servo-control the temperature of the system [18, 19]. In most modern devices, the temperature is preset at 37°C [20]. This system maintains control of the gas temperature to the patient, regardless of changes in the gas flow or water level in the reservoir, despite having a slow time of reaction [21]. The water that condenses the pipes is considered contaminated, and should not be returned to the humidifier [19]. The main problem with this device is that it does not filter particles [22].

2.4. Passive Humidifiers

Are disposable heat and moisture exchangers (HME), some with a particle filter. They are lightweight, inexpensive and easy to use with standard connectors for IMV [23]. They contain a high contact surface of paper, with compressed metallic elements which capture particles of exhaled water vapor and heat, holding and releasing it in the next inspiration. To fulfill this function, the HME can be Hydrophobic (HMEF, Heat-and-Moisture Exchanger Filter) Hygroscopic (HHME, Hygroscopy Heat-and-Moisture Exchanger) or both with filter (HHMEF, Hygroscopy Heat-and-Moisture Exchanger and filter). This data are shown in

Table 1. Advantages and disadvantages of HH and HME.

Devices	Advantages	Disadvantages
Active	Universal application	Cost
	Reliability	Using water
	Alarms	Condensation
	Wide ranges of temperature and humidity	Risk of contamination
	Temperature monitoring	Low possibility of electrical shock and burns
	Reaches the maximum absolute humidity	no Filter
Passive	Cost	Does not apply to all patients
	Passive operation	Increased dead space
	User friendly	Increased resistance
	Removal of condensation	Potential occlusion
	Portable	Misting problems

Table 2. Types of heat-and-moisture exchanger.

	Function	Absolute Humidity
HME	Hydrophobic	10-14 mgH2O/L
HMEF (*Heat-and-Moisture Exchanger Filter*):	Hydrophobic + Filter	18-28 mgH2O/L
HHME (*Hygroscopy Heat-and-Moisture Exchanger*):	Hydrophobic + Hygroscopic	22-34 mgH2O/L
HHMEF (*Hygroscopy Heat-and-Moisture Exchanger*):	Hydrophobic + Hygroscopic + Filter	23-35 mgH2O/L

Table **2**. Hygroscopic is an adjective of a compound chemical material, which absorbs moisture from the air. The aluminum material of this device quickly exchanges temperatures when expiration condensation is formed between the layers of this material. The retained heat and moisture are returned during inspiration. Adding a fibrous element helps retain moisture and reduces the accumulation of condensation in the dependent position of the device [24, 25]. Hydrophobic is an adjective for those substances or elements that repel water and cannot mix or absorb. They use a paper or polypropylene treated with calcium or lithium chloride, to increase moisture conservation and repel water that is not absorbed [26]. It is Important to mention that these devices also function as a bacterial filter [17]. The HME are installed between the Y-piece of the patient, which can increase the resistance to airflow, not only during inspiration, but also during expiration. The minimum resistance to the flow is 0.5 to 3.6 cm H2O/L/sec [27, 28]. It is important to take into account the dead space produced by these devices, which can be variable. Among different devices according to some measurements, it can reach 95 mL [29, 30]. Passive humidifiers should never be used in conjunction with active humidifiers [31].

If water or fluids occlude the HME, the patient is not ventilated properly, and may be unable to fully exhale during ventilation with positive pressure [32]. Studies recommend using HHMEF for their hydrophobic, hygroscopies and filter characteristics, as shown in Table **2** [9].

3. WHAT IS THE MINIMUM VALUE OF MOISTURE THAT A DEVICE MUST DELIVER?

The American National Standards Institute (ANSI) and the American Association for Respiratory Care (AARC) recommend an AH ≥30 mg H2O/L for the inspired air during mechanical ventilation [16, 33], while the ISO (International Organization for Standardization) prefer AH values ≥ 33 mg H2O/L [34]. It is important to consider that the performance specifications provided by the manufacturers of HMEs are based on *in vitro* measurements when delivering moisture, using the ISO 9360 method [7, 35]. However the *in vivo* performance of HMES may differ from the manufacturer's specifications when defining the ability to heat and humidify, these configurations do not fully reflect the physiology of human respiration [7, 36]. An important aspect is that we have to know the performance of the devices we use in our unit. In a study by Lellouche *et al.* in 2009 [29] tested 32 HME and showed that only 37.5% had a good performance (> or = 30 mg H2O/L), while 25% did poorly (<25 mg H2O/L). The difference in values between their measurements and the data supplied by the manufacturer regarding the humidification was 3.0 ± 2.7 mg H2O/L, that is why we must check if the devices at our units have been tested and if they meet the standard, regardless of what the manufacturer states. Restrepo *et al.* [7] states that the device to use, either active or passive, must provide a moisture level of 33 mg H2O/L and 44 mg H2O/L and a temperature between 34°C and 41°C with a RH 100% to prevent drying of secretions in the artificial airway.

4. HUMIDIFICATION IN IMV, WHICH DEVICE CAN WE USE?

The Mechanical ventilation delivered through a tracheal tube (ETT) to critically ill patients, requires appropriate heating, moistening and filtering of the airway in order to counteract bypassing of the upper respiratory tract due to the use of an ETT [37]. Any moisture deficit must be offset by the large airways of the tracheobronchial tree, which are poorly suited for this task, the gas with low RH rapidly absorbs moisture from the tracheobronchial mucosa and secretions in the airway, this can result in dry secretions, plugging with mucus, and obstruction of the airways [38]. The heating and humidifying of inspiratory gas, with different devices, can prevent complications associated with dryness of the respiratory mucosa, which can lead to the occlusion of the ETT [39]. That is why the humidification is recommended in all patients receiving IMV with a level of evidence 1A [7].

There are variables that could affect us in the moistening, and can influence the choice of the appropriate humidifying device:

4.1. Ambient Air Temperature

Lellouche *et al*. [40] measured two passive and one active/passive (Hudson Heat Teleflex Humid-Medical) HMEs, at three different environment temperature (22 to 30°C), and concluded that there is a negligible effect of room temperature in the moisture delivered by HMEs, since these devices can be used to provide adequate moistening in different climates.

4.2. Minute Ventilation (VE)

Various studies that measure the impact of tidal volume (VT), respiratory rate (RR) and minute ventilation (VE) in humidification, have used high VT from 0.5 to 1.0 L and higher VE between 10 and 20 L/min [41]. A randomized controlled trial that compared HME with hydrophobic properties, an HME with hydrophobic and hygroscopic properties compared and HH, with minute ventilation of 10.8

L/min, 11.6 L/min and 10.2 L/min, showed that after 72 hours, the internal diameter of the ETT had decreased 6.5 mm with hydrophobic HME, 2.5mm with hygroscopic and hydrophobic HME, and 1.5 mm with an HH [42]. This would allow the conclusion that in patients with high VE (over 10 L/min), we should choose a HH. In a recent study Lellouche *et al*. [40] they reached the conclusion that VE variation was not significant in the HME humidification performance when using VT of 0.5 and 0.65 L, with a respiratory rate of 20 to 30 breaths/minute, and with VE of 10 and 20 L/M, respectively. An important aspect to consider is that the strategies mentioned above do not correlate with lung protective strategies for IMV. The current guidance of ventilation strategies is based on predicted body weight according to height, were the use of ventilation is recommended between 6 mL/kg and 8 mL/kg, even further reduced to a minimum of 4 mL/kg when possible [43]. As Antony R Wilkes [41] says, the manufacturers are forced to declare the range of values of VT in which the HME can be used, therefore we suggest you to consider this information when you have to acquire these devices in your unit.

4.3. Dead Space

One of the drawbacks of using HMEs, and which may restrict their use, is that due to its large internal volume, increase the dead space of the circuit, which in turn can increase minute ventilation, carbon dioxide arterial pressure ($PaCO_2$) and work of breath during pressure support ventilation [44]. This increase in dead space decreases alveolar ventilation, and produces an increase in arterial PaCO2, in order to maintain the same level of alveolar ventilation. A ventilatory strategy would be to increase the tidal volume, thereby exposing patients to induced lung injury by volume [8]. This has a great relevance in patients with Acute respiratory distress syndrome (ARDS), because as described above it is important to look ventilatory strategies of 4 mL/kg to 6 mL/kg [43]. In the study by Moran *et al*, 2006 [45], in patients with acute lung injury (ALI) and ARDS were ventilated with HME devices in which PaCO2 was measured, and then maintaining the same VT, positive end expiratory pressure (PEEP), RR and FiO2 were changed to a HH device, with these they saw that PaCO2 decreased from 46 +/- 9 to 40 +/- 8 mmHg. Prat *et al.* [46] showed a decrease in PaCO2 levels of 17 mmHg in patients with ARDS when a HH are used instead of HME. This will be related to a difference in the dead space of 95 ml between devices [8, 46]. The reduction in dead space using HH decreases PaCO2 and most importantly, if isocapnic conditions are maintained through a VT reduction strategy, which would improve lung compliance and would reduce the plateau pressure [45].

4.4. Quantity and Quality of Airway Secretions

The presence of biofilm on the inner wall of the endotracheal tube is represented, formed by microorganisms that produce exopolysaccharides whose function is to protect from antibiotics the immune system [47, 48]. This biofilm provides the basis for the accumulation of secretions in the tube, with the risk of further obstruction in the presence of secretions adhered to this layer, resulting in reduced lumen at about 7% without observing an occlusion if using a suitable humidification. Poor moistening is associated with a high incidence and greater degree of ETT obstruction by secretions [49]. A proposal for the evaluation of this biofilm it is shown in a study by Coppadoro *et al.* [50] through MicroCT, where exhibits the layer of biofilm and also stablishes that the volume of secretions in the ETT is not associated with microbial colonization. With these data, we can say that there is more than one risk factor that can facilitate ETT obstruction. Branson *et al.* [51], based on a series of studies, proposes some contraindications for the use of HME, among them mentions: the presence of hematic secretions with risk of HME occlusion, which would increase the work breathing and adherent secretions, so more humidification is needed to liquefy secretions and decrease the risk of mucus plugging and airway occlusion.

4.5. Gas Exhaled Temperature

In hypothermia patients, the use of HH is recommended because it maintains a suitable temperature in the respiratory tract and prevents heat loss to the environment, taking a marginal role (10%) in the elevation of body temperature [52].

4.6. Mechanical Ventilation-Associated Pneumonia (VAP)

Various authors since the 90`s, have attempted to establish the relationship between the type of humidifier and the rate of mechanical ventilation-associated pneumonia. In this search, there have been randomized trials [53-55], where Kola *et al.* [55] compared the hygroscopic HME and HH, wherein show among other causes of VAP as the oropharyngeal aspiration, condensation deposited in ventilator circuits, that by itself is a source of infection due to high levels of colonization in the system, especially after seven or more days of IMV. At this point we should consider incorporating heating cable circuits to minimize the possibility of condensation on the circuit and prevent colonization produced by the above mentioned condensation. Other authors, Lorente *et al.* 2006 [56], in the search to establish guidelines that lead to reduced VAP, state that in periods of IMV at least five days using HH, the incidence of VAP is reduced when compared to HME, considering that previous studies showed patients data with shorter periods of IMV, and with new measures such as incorporating heating cables circuits and servo controlled water chambers, optimum temperature and moisture levels are achieved for the operation of the mucociliary escalator.

In a meta-analysis of Ilias *et al.* (2007) [57], about the benefits of HME compared with HH reduced: the incidence VAP, mortality, length of ICU stay, duration of IMV, ETT occlusions and costs associated with humidifier device. They conclude that the available evidence does not allow establishing differences in the performance of HME and HH in relation to the incidence of VAP, neither in mortality, length of ICU stay, duration of IMV or obstruction episodes. More recently, M. Help-Martins *et al.* 2012 [58] found that there are no significant differences in the use of HH and HME on the incidence of VAP, IMV days, days of ICU stay and overall mortality rate. In the same line, these authors

report in a recent meta-analysis [59] that there is insufficient evidence to recommend the use of HME for the prevention of VAP, due to methodological limitations in the meta-analysis as sample size, lack of any description of randomization not mentioned in blind studies, etc. suggesting with a degree of uncertainty that the HME does not decrease the incidence of VAP.

In summary, all patients with IMV should use some moistening and heating system. Based on some variables such as those mentioned above and the available evidence, it is recommended to use HH in patients with certain clinical conditions, since the HME have certain contraindications [7, 8, 51], which are detailed below:

1. Patients with hypothermia (body T° <32°C), since HME occupy temperature and moisture of exhaled gas, if this is decreased, the moisture inspired will also decrease.
2. Patients with hematic secretions, due to risk of coagulation, they may occlude ETT and/or HME, which would increase work of breathing.
3. Patients with adherents and/or copious secretions, we must deliver high humidity (44 mg/L and 100% RH), to prevent the inspired gas from capturing heat and moisture of large caliber airway drying secretions, altering mucociliary belt, and producing mucus plugging of the airways.
4. Patients with leaking air, with an exhaled VT less than 70% of VT inspired, such as bronco pleural fistula, the entire volume of exhaled gas does not enter the HME, thus losing heat and humidity.
5. Patients with low VT, with protective ventilation strategies (4-6 ml/kg), because they contribute to increased dead space, and increase levels of PaCO2.
6. Patients with high values of minute volume (> 10 L/min).

5. IS NECESSARY HUMIDIFICATION IN NIMV?

Evidence supports the use of NIMV in the management of acute respiratory failure (ARF) to avoid endotracheal intubation in patients with exacerbations of COPD or acute cardiogenic pulmonary edema, and immunocompromised patients as well as to facilitate extubation in patients with COPD [60]. Although there are several aspects that provide us a better patient-ventilator synchrony, and thus better adherence and success of NIMV, there is a lack of evidence that improved patient-ventilator synchrony is related to greater success of NIMV. However, as far as the patient-ventilator interaction, dyspnea and comfort are related, no one can argue against efforts to improve the synchrony during NIMV [61]. One aspect to consider is the moistening in patients who are undergoing NIMV. Inspiratory gases delivered by mechanical ventilators in ICU are dry, breathing rate is high, and mouth breathing is common during NIMV [62]. In the presence of mouth leaks with a nasal interface, the unidirectional flow dries upper airway and increases nasal airway resistance. When the upper airway is dried, increases patient discomfort, and may affect tolerance to NIMV [63].

Improper gas conditioning has been associated with anatomical and functional impairment of nasal mucosa (ciliary activity, mucus secretion, local blood flow, nasal resistance) [64]. Epithelial metaplasia and keratinization changes of nasal submucosa have been reported in patients with home NIMV when the level of humidification is inadequate for long periods of time [65].

Especially when gas without humidifying is used in NIMV, the upper airway can suffer mucosal dryness and respiratory dysfunction. Leakage compensation applied by NIMV deliver high flows throughout the respiratory cycle, which contributes to the loss of heat and humidity [14, 66].

A recent study found that even with the same configuration of the HH, the AH varied between subjects, as well as increased inspiratory gas leak in some patients, AH decreased. The oral breathing decreased oral moisture and aggravated the feeling of dryness in patients [66].

The use of domiciliary NIMV for a few hours a day is widely used in different pathologies, although there are no general recommendations or guidelines for humidification during home NIMV [66], a 40-60% of nasal CPAP users with obstructive sleep apnea syndrome (OSA) reported nasal congestion, dry mouth and throat pain after breathing cold and dry air [67], which explains in detail the nasal discomfort during CPAP treatment [68]. RH decrease can be attenuated significantly through thermal and humidification of inspired air, even during periods of mouth leak in patients with OSA [69]. Based on this, the American Academy of Sleep Medicine has recommended the use of HH to improve adaptation and adherence to CPAP as a standard practice [63].

In hospitalized patients there is more controversy whether humidification is routinely required during NIMV in acute patient care [14, 70]. Richard Branson *et al.* [14] says that the controversy continues about whether if routinely supplemental humidification is required during NIMV in acute patients. Gas law principles and clinical experience suggest that humidification can be used according to the patient's comfort and NIMV duration, and concludes that there is insufficient evidence to support the routinary use of active humidification during NIMV. Dean R. Hess [70] based on his personal experience in patients with ARF, states that an HH improves comfort and tolerance to NIMV, and produces less dryness of upper airway. Humidification level does not need to be so great as to an intubated patient; 100% of relative humidity and around 30°C is usually sufficient, higher temperatures may be less comfortable during NIMV.

Esquinas *et al.* [64] says that the analysis of the need for humidification during NIMV should clearly take into account the following parameters: Air leaks; NIMV interface; mechanical ventilator type; room temperature; inhaled gas temperatures and chamber vaporization; air flow and inlet pressure of the humidification system and humidification system type. And according to early observed histopathological changes in nasal mucosa, by the author in a study not yet published, in four patients with ARF, which are treated for seven days with NIMV without a humidification system, suggests that these nasal mucosa changes are relatively produced after starting NIMV in an acute situation,

and that humidification should be considered even when a short term NIMV use is expected.

6. ACTIVE OR PASSIVE NIMV HUMIDIFICATION?

Jaber *et al.* refer that minute volume (VE) was significantly greater with HME than with HH, this increase in VE was the result of increased respiratory rate with HME than with HH, and $PaCO_2$ was significantly greater with HME than with HH, and concludes that during NIMV, increased dead space with HME can negatively affect ventilatory function and gas exchange, this may decrease the effectiveness of NIMV in patients with ARF [71].

Recent recommendations favor the use of heated humidifiers (HH) during NIMV [7, 72], reducing nasal resistance, helping expectoration and improving adhesion and comfort, especially in patients with bronchial secretions [72]. HME is not recommended in NIMV, because dead space of the device has a negative impact on CO_2 elimination and minute ventilation in patients treated with NIMV in ICU, this is more evident in hypercapnic patients [72, 73] also, there has been seen that it increases work in breathing [65, 71]. Restrepo *et al.* [7] supports this by saying that the active humidification is suggested for NIMV, because it can improve adherence and patient comfort (2B level evidence), and adds that the use of an HME is contraindicated in patients in NIMV (2C level evidence) with great mask leaks, because the patient does not exhale sufficient VT to replace heat and humidity to an adequate inspired gas. However a recent multicenter randomized controlled trial of 2014, Lellouche F. *et al.* [62] says that no short-term physiological benefits of HH were observed, compared with HME during NIMV, with "ICU ventilators" (bi branch) and no differences in the rate of intubation were found, thus concluding that the physiological effects may have been mitigated by leaks or other clinically important factors. Therefore states not to support the recent recommendation for the use of HH v/s HME during NIMV with "ICU ventilators ".

We believe that in the application of NIMV, the type of ventilators takes an important role in the decision of the humidifier to be used. For a single branch turbine ventilator and with leakage compensation, it would be considered the use of HH in patients undergoing periods greater than 24 hrs of NIMV to enhance the feeling of oral dryness and tolerance as recommended Oto in 2014 [66]. It is also important to consider the recommendations of Esquinas *et al.* [64] in terms of the factors involved in selecting the type of humidification to use such as; air leakage, interface type, type of ventilator, ambient temperature, inhaled gas temperature among others. Taking into consideration when using HME in single-branch NIMV, there must be taken into account where the exhalatory port is in the system.

CONCLUSION

Humidification of the airway is required in all patients with artificial airway and/or connected to IMV (1A evidence). Humidification devices can be HH or HME, being the clinical characteristics the ones that determine which device should be chosen. It is important to select the right system to avoid the complications of deficient humidification, such as dryness of the respiratory mucosa, damage to the epithelium of the respiratory tract and airway obstruction by secretions. This entails increased respiratory effort and alteration of the homeostasis gas exchange system.

During NIMV an inadequate gas conditioning has been associated with anatomical and functional impairment of the nasal mucosa. It is suggested the use of active humidification (2B evidence), while the use of passive humidification is not recommended (2C evidence). However recent publications using ICU ventilators are disagree with these recommendations.

We believe that to choose the type of humidifier to be used during NIMV, there are some aspects that must be taken into consideration such as the type of ventilator, the interface type and leakage, among others, that could favor the use of HH over HME to improve the tolerance and patient comfort.

CONFLICT OF INTEREST

The authors declare that there are no conflict of interest.

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