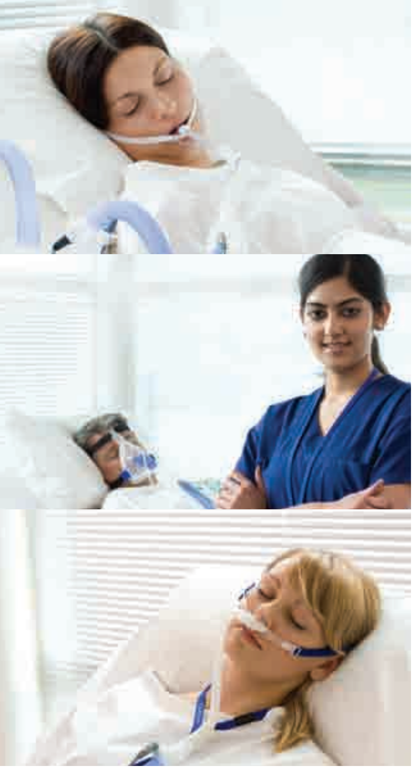
THERAPY OVERVIEW

Restoring Natural Balance

The F&P Adult Respiratory Care Continuum™



Fisher&Paykel
HEALTHCARE

Humidity is critical to human respiratory health and well-being. Our airways naturally condition inspired air to a level of temperature and humidity that enables physiological equilibrium in the airway. When this natural balance is disrupted the performance of the lung is inhibited, often resulting in difficulties delivering the necessary respiratory support and delaying recovery. Maintaining this physiological harmony is vital to a patient’s outcome.

Clinical efficacy is significantly improved by emulating the balance of temperature and humidity that occurs naturally in healthy adult lungs, bridging the gap between artificial breathing systems and a normally functioning airway. For clinicians, the principal benefits of heated humidification translate to more efficient delivery of care and improved patient outcomes.

Restoring Natural Balance

F&P ADULT RESPIRATORY CARE CONTINUUM™

The F&P Adult Respiratory Care Continuum illustrates the various respiratory therapies patients may require when in need of respiratory assistance. By delivering humidification along the continuum, Fisher & Paykel Healthcare's therapy solutions emulate the natural physiological balance in healthy human lungs. The result – optimal care and outcomes that extend the boundaries of traditional adult respiratory care.

INVASIVE VENTILATION

O **OPTIMAL HUMIDITY, OPTIMIZING AIRWAY DEFENSE & VENTILATION**

NONINVASIVE VENTILATION

e **ESSENTIAL HUMIDITY TO MAXIMIZE TOLERANCE**

NASAL HIGH FLOW

O **COMFORTABLE, EFFECTIVE OXYGEN DELIVERY**

3 KEY BENEFITS OF HUMIDIFICATION

1 ASSISTING NATURAL DEFENSE MECHANISMS IN THE AIRWAY

2 PROMOTING EFFICIENT GAS EXCHANGE AND VENTILATION

3 INCREASING PATIENT COMFORT AND TOLERANCE TO TREATMENT

HUMIDITY ACROSS THE F&P ADULT RESPIRATORY CARE CONTINUUM

Humidification is central to the F&P Adult Respiratory Care Continuum. There are two levels of humidity appropriate for the airway, to ensure the most effective and comfortable delivery of care.

FACE MASK OXYGEN

e ENHANCING TRADITIONAL OXYGEN THERAPY FOR IMPROVED PATIENT TOLERANCE

LOW FLOW OXYGEN

o COMFORT AT LOW FLOWS

HUMIDITY THERAPY

o FREEDOM TO BREATHE

o OPTIMAL HUMIDITY – 37 °C, 44 mg/L, 100% Relative Humidity**

During normal inspiration, the airway conditions inspired gases with heat and humidity to body temperature, 100% relative humidity with 44 mg/L of absolute humidity. The lungs rely on these optimal states to maintain the physiological balance of heat and moisture necessary for optimized airway defense and gas exchange while maintaining patient comfort.

e ESSENTIAL HUMIDITY – 31 °C, 32 mg/L, 100% Relative Humidity**

The use of humidification with noninvasive mask therapies is essential for maintaining the natural balance of heat and moisture in the airways. The level of conditioning required is directed by the amount of humidity produced naturally in the nasopharynx when breathing through the nose.

o OPTIMAL HUMIDITY

e ESSENTIAL HUMIDITY

***Refer to Quick Guide to Humidity at the back of this document for the definition of Absolute and Relative Humidity.*

Natural balance in the normal airway

The respiratory system is a highly balanced mechanism reliant on humidity. To provide therapies that maintain optimal lung function it is necessary to understand the physiological balance of humidity in the airway.

TWO MAIN LUNG FUNCTIONS

Gas Exchange

Air-flow to the alveoli is necessary for gas exchange. The natural heating and humidifying functions of the airway assist with maintaining clear and patent airways by promoting mucociliary clearance and reducing bronchoconstriction associated with airway cooling.

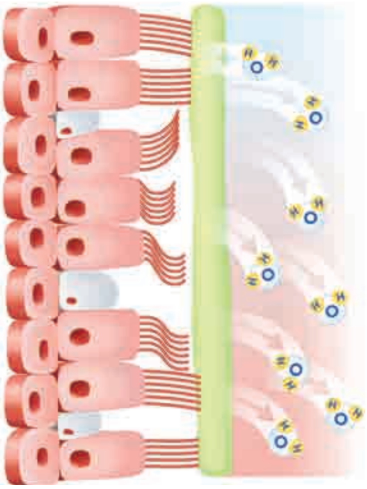
Airway Defense

Primary mechanical defense mechanisms are sneezing, coughing, gagging and the use of natural filters, i.e. nasal hairs. The second line of defense is the mucociliary transport system which traps and neutralizes inhaled contaminants (in mucus) and transports them up and out of the airway, keeping the lung free from infection-causing pathogens. This critical defense system is very sensitive to humidity.

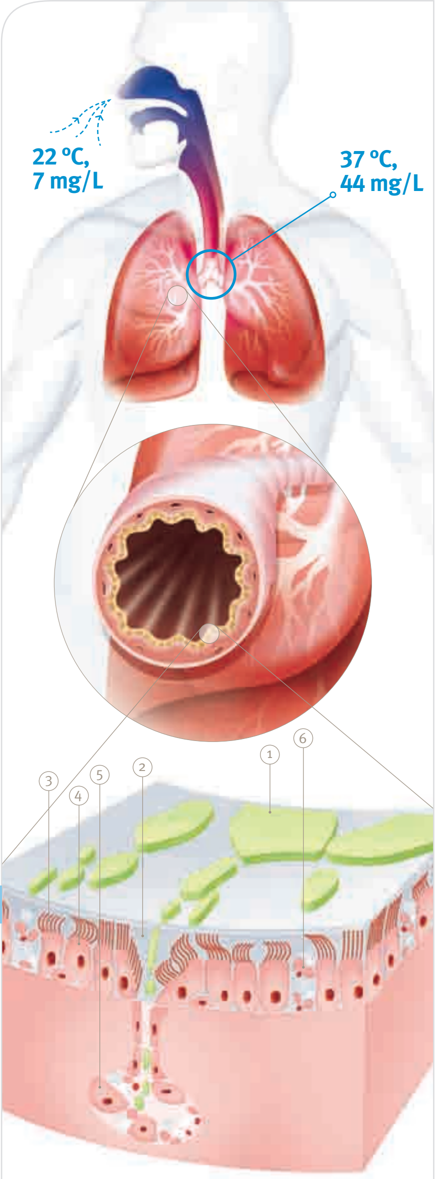
HUMIDITY MAINTAINS EFFICIENT GAS EXCHANGE AND PRESERVES AIRWAY DEFENSE

As air travels down the airway, heat and moisture is drawn from the airway mucosa to the point where the gas reaches 37 °C, 44 mg/L at the carina. The majority of this conditioning is carried out in the nasopharynx. It is important for the airway mucosa to retain a balance of heat and moisture to maintain a fully functioning mucociliary transport system and an efficient line of defense. This in turn plays an important role in efficient gas exchange by maintaining clear and open airways with effective mucus clearance.

A HEALTHY MUCOCILIARY TRANSPORT SYSTEM



The mucociliary transport system is comprised of three layers: mucus, the aqueous layer and ciliated epithelium. These layers all contribute heat and moisture to ensure a finely tuned mucociliary transport system. Millions of cilia lining the airway (around 200 individual cilia per cell) beat in the aqueous layer at up to 15 times per second. The beating cilia clear mucus and contaminants out of the airways. The clearance speed relies on the cilia beat frequency and quality of the mucus. Both are dependent on the body's ability to replenish moisture to all three layers.



Mucociliary Transport System

1 Mucus
2 Aqueous layer
3 Cilia
4 Epithelium cell layer
5 Submucosal gland
6 Goblet cell

Adapted from Williams et al. (1996)[3]

Complications of respiratory interventions

When a patient enters the hospital environment and requires respiratory support, the natural balance of the airway can become compromised. Three key factors in particular bring about complications, as described below.

1. Medical gases

Gas delivered from an artificial flow source, such as piped oxygen, is cold and extremely dry. The table below illustrates the range of temperatures and humidity levels of gas that can be delivered to patients.

	TEMPERATURE	ABSOLUTE HUMIDITY**
MEDICAL GAS	15 °C	0.3 mg/L
ROOM	22 °C	7 mg/L
COLD BUBBLER	Ambient	16 mg/L [1]
PASSIVE HUMIDIFIER (HME)	25–30 °C	17–32 mg/L [2]
HEATED HUMIDIFIER	37 °C	44 mg/L

2. A bypassed airway

An endotracheal or tracheostomy tube bypasses the upper airway where the majority of humidification would naturally occur.
The tube also bypasses the airway's filtering mechanisms and compromises protective cough, gag and sneeze reflexes.

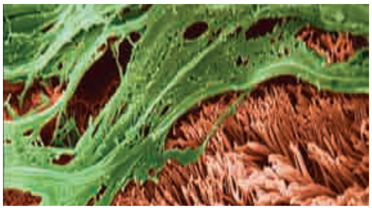
3. Higher gas flows

The respiratory mechanics of patients on noninvasive therapies change with potentially higher respiratory rates, larger tidal volumes and greater inspiratory flow rates. High gas flows are also required to deliver a number of therapies along the respiratory care continuum. These factors deplete the airway mucosa of heat and moisture. The airway mucosa will continue to lose heat and moisture to the gas flow, until the gas reaches body temperature, fully saturated.

***Refer to Quick Guide to Humidity at the back of this document for the definition of Absolute Humidity.*

MUCOCILIARY DYSFUNCTION AS A RESULT OF RESPIRATORY INTERVENTIONS

Image 1 – Healthy Ciliated Epithelium



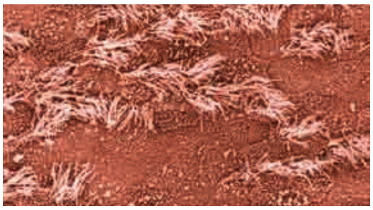


Image 2 – Damaged Ciliated Epithelium

The three mechanisms indicated above can have significant adverse effects on the function of the mucociliary transport system and lead to impaired airway defense and gas exchange.

The three layers of the mucociliary transport system are compromised, which decreases or stops mucus clearance as a result of:

- The mucus layer becoming thick and tenacious
- The thickness of the aqueous layer decreasing, causing cilia to slow down or stop
- Heat loss from the epithelium cells, making cilia beat less frequently.

If the mucosa is exposed to low humidity for a long period of time, irreversible cell damage will occur.[3] The lungs may already be compromised by pre-existing mucociliary dysfunction (e.g. due to age, smoking, chronic obstructive pulmonary disease (COPD), etc). To avoid further complications, provision of physiological levels of humidity becomes even more important for patients with these conditions.

Image 1 – Braga and Piatti. (1992)[9]
Image 2 – (Photograph) Courtesy of Hulbert W.C, University of Alberta Pulmonary Defense Group

Humidification allows the airway to maintain a natural balance of heat and moisture – optimizing gas exchange, lung defense and patient comfort.

Invasive Ventilation

Optimal Humidity, optimizing airway defense & ventilation

OPTIMAL HUMIDITY

Optimized Airway Defense

Optimized Ventilation

ADVANCES IN INVASIVE VENTILATION

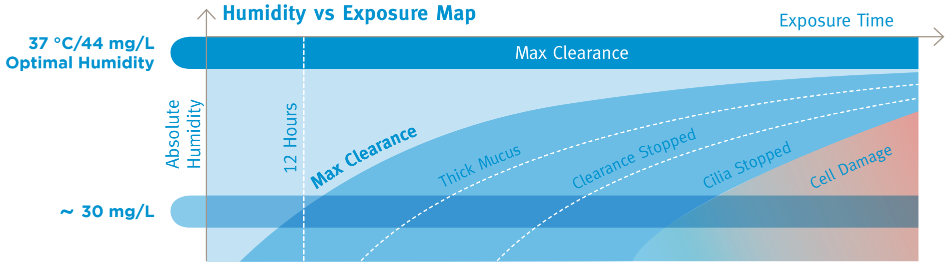
The delivery of Optimal Humidity for an intubated patient is crucial for optimal patient outcome.

Gases conditioned to body temperature, 37 °C, and fully saturated with 44 mg/L of water vapor, will optimize mucociliary clearance. As a result, the patient's airway defense and ventilation will emulate the natural physiological function of the airway.

OPTIMAL HUMIDITY

Optimal Humidity is the level of humidity at which mucociliary function is preserved. Gas delivered at optimal conditions (37 °C, 44 mg/L) will prevent the depletion of moisture in the mucociliary transport system[4] and maintain mucus clearance.

If the airway mucosa is exposed to humidity levels below Optimal Humidity, dysfunction will occur. As shown in the graph below, prolonged exposure leads to cell death. The lower the level of humidity delivered and the longer the duration, the quicker dysfunction will occur.[3]



Humidity vs exposure map, illustrating how mucosal function varies with inspired humidity over time. Adapted from Williams et al. (1996)[3]

PATIENT NEEDS

Airway defense An endotracheal or tracheostomy tube not only bypasses the body's natural humidification processes but also inhibits mechanical clearance such as cough, gag, sneeze and particle filtration. This leaves the mucociliary transport system as the airway's only remaining mechanical defense mechanism.

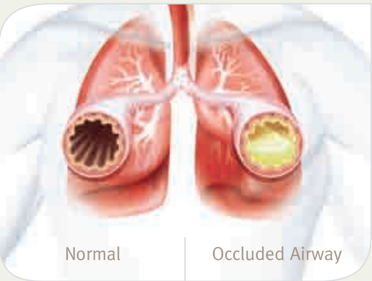
Ventilation Clear and unobstructed airways are necessary to effectively ventilate the patient. Although not always visible, secretions that are thick, tenacious, bloody or copious can block airways and endotracheal/tracheostomy tubes. Mobilizing these secretions to prevent and reduce airway blockage is of high priority.[5]

For effective ventilation it is vital to minimize the patient's instrumental dead space and resistance to flow in the breathing system. It is generally recognized that patients with acute respiratory distress syndrome (ARDS) require lower tidal volume ventilation strategies (enabled by a decreased amount of dead space) for improved outcomes.[6] Also, patients who are potentially difficult to wean (e.g. patients with COPD) will benefit from this reduction in dead space, resulting in less resistance to flow and work of breathing.[7] Heated humidification systems provide the opportunity to reduce dead space and resistance to flow.

OPTIMAL OUTCOMES

Optimal Humidity restores mucociliary clearance leading to:

- **Optimized airway defense**[8]
  Efficient secretion clearance will increase pathogen removal and reduce sites for pathogen replication.
- **Optimized ventilation**
  Efficient secretion clearance and use of a heated humidifier will increase airway patency,[3] [5] reduce work of breathing[7] and enable the delivery of lower tidal volumes.[6]



OPTIMAL HUMIDITY

Restores mucociliary transport system

Increases pathogen clearance

Reduces pathogen replication sites

Optimized airway defense

OPTIMAL HUMIDITY

Restores mucociliary transport system

Decreases endotracheal tube secretion build-up

Decreases airway blockage

Optimized ventilation

HEATED HUMIDIFICATION SYSTEM

Reduces dead space and resistance to flow*

Allows for low volume ventilation strategies

Reduces work of breathing

Optimized ventilation & weaning

* Compared to passive humidification

> *"...only inspired gas that is conditioned to core temperature and that has 100% relative humidity allows optimal mucociliary transport velocity; conversely, any greater or lesser condition reduces the transport rate."*[3]

BENEFITS OF INVASIVE VENTILATION WITH OPTIMAL HUMIDITY

PATIENT	CLINICIAN
Airway Defense	Provide the best level of patient care
Increased airway defense, reducing risk of respiratory infection[8]	Suctioning can become more effective
Ventilation	Aerosol and drug delivery may be reduced
Increased patency of endotracheal tubes via decreased secretion build-up[5]	May reduce institutional cost through effective patient care
Reduction in incidence of small airway blockage[3]	
Ability to deliver lower tidal volumes (e.g. ARDS)[6]	
Reduced respiratory effort[7]	
More effective weaning[7]	

Noninvasive Ventilation

ADVANCES IN NONINVASIVE VENTILATION

Noninvasive positive pressure ventilation therapy (NPPV or NIV) is respiratory support without the use of an endotracheal tube, such as continuous positive airway pressure (CPAP) or bi-level ventilation.[10]

NIV is used to support patients with a range of respiratory diseases without the complications associated with endotracheal intubation. NIV promotes gas exchange in the lungs by providing a bulk flow of fresh gas to the alveoli on each inspiration. The use of inspiratory and expiratory positive pressure helps to reduce the work of breathing for the patient.[11]

Essential Humidity to maximize tolerance

ESSENTIAL HUMIDITY

The use of humidification with NIV is vital for maintaining the natural balance of heat and moisture in the airways. Without Essential Humidity, the high pressures and flow rates used with NIV can overwhelm the patient's natural conditioning mechanism.[12] Large volumes of cool, dry gas may cause the patient's already compromised respiratory system to deteriorate further.

By heating and humidifying the gas flow to the same level which occurs naturally in the nasopharynx (31 °C, 32 mg/L)[13] patient tolerance to the therapy is maximized. This is through increased comfort, reduced airway drying and improved secretion clearance, while compensating for the cooling and drying effects of ventilation gases.[12 14 15]

"Humidification of the upper airway is important to improve comfort and tolerance"[11]

PATIENT NEEDS

It is often assumed that a patient being ventilated noninvasively can adequately humidify their own airway. However, there are several factors associated with NIV that can compromise the patient's ability to heat and humidify inspired gases, overwhelming the patient's airway conditioning system. These include:

Fluid depletion

The noninvasive patient is often fluid depleted due to respiratory distress and has pre-existing secretion removal problems caused by an underlying respiratory disorder, making them more susceptible to airway drying.[12 16]

Oral breathing reduces work of breathing

Patients receiving NIV tend to breathe through their mouth as this requires less work to breathe. As a consequence, gases reaching the airway are 4 °C cooler and, more importantly, contain 11 mg/L less moisture than if the air had been inhaled through the nose.[13 16]

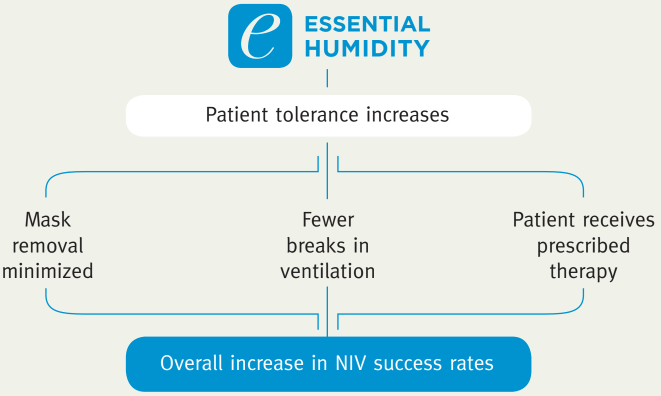
Increased ventilation rate

NIV patients are typically short of breath and increase their ventilation rate by breathing faster and deeper as they attempt to move more oxygen into their lungs. This increases the volume of gas passing through the respiratory system, increasing the amount of moisture lost from the airways.[16]

OPTIMAL OUTCOMES

Maximize patient tolerance to therapy

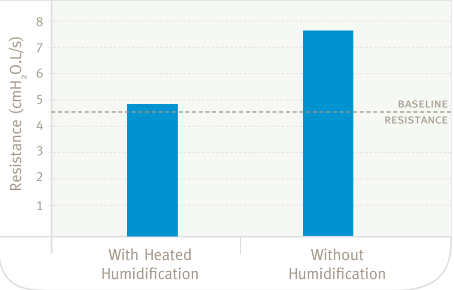
Complications occur in up to 70% of patients receiving noninvasive ventilation.[16] Many of these complications are related to a lack of humidity, leading to patient discomfort and intolerance to the therapy. Mask disturbance or removal will result in compromised ventilation, increasing the risk of intubation. Humidified therapy maximizes patient tolerance, improving the overall success rates of NIV.[12 14 17 18]



BENEFITS OF NONINVASIVE VENTILATION WITH ESSENTIAL HUMIDITY

PATIENT	CLINICIAN
Reduced dry mouth, cracked lips, nosebleeds	Fewer breaks in ventilation
Minimized airway drying, inflammation[19]	Less time required refitting face masks
Reduced congestion & bronchoconstriction[14 18 20]	Less oral care for dry mouth
Improved secretion clearance[21]	More comfortable patients[11 14]
Improved work of breathing[18]	Increased NIV therapy tolerance[11 17]
Improved ventilation[14 18 20]	Increased confidence in noninvasive therapy

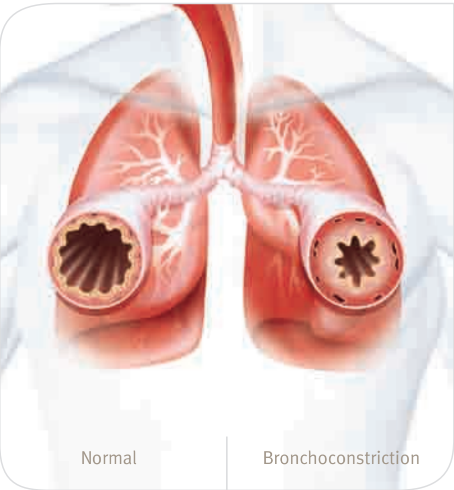
Effect of humidification on airway resistance during NIV after 5 – minute leak challenge



Adapted from Tuggey et al. (2007)[14]

Minimize airway drying

Delivering Essential Humidity with NIV can prevent drying of the airway, avoiding the inflammatory response caused by the drying of the mucosa.[12 19] Conditioning of the gas can also minimize airway constriction, reducing work of breathing.[14 15 20] This helps to maintain effective delivery of pressure to the lungs.[14 18]



Improve secretion clearance

Airway dehydration makes mucus secretions viscous and sticky, which causes them to build up in the airway, reducing its diameter and increasing resistance to flow.[5 20 21] As a consequence, the respiratory muscles must work harder, increasing work of breathing. Delivering Essential Humidity restores fluid levels in the mucociliary transport system, improving secretion clearance and maintaining work of breathing at normal levels.[19]

Nasal High Flow

ADVANCES IN OXYGEN DELIVERY

Nasal High Flow (NHF™) is a new respiratory care therapy delivering high flows of blended oxygen through a unique Optiflow™ nasal cannula. This allows comfortable, effective delivery of up to 100% oxygen, creating an ideal solution for your hypoxemic patients in mild to moderate respiratory distress.

Nasal cannula generally promote greater patient comfort and compliance than face masks. Patients can continue to eat, drink, talk and sleep easily without therapy interruption while still receiving benefits similar to face mask oxygen therapy or low-level continuous positive airway pressure (CPAP).[22, 23] NHF can therefore assist patients requiring a greater level of support than low flow nasal cannula who would traditionally be placed on a face mask because of greater acuity.

Comfortable, effective oxygen delivery

OPTIMAL HUMIDITY

Critical to NHF is the delivery of Optimal Humidity. Without it, the comfortable delivery of high flows directly into the nares would be impossible.[24] Emulating the natural balance of temperature and humidity that occurs in healthy adult lungs (37 °C, 44 mg/L) promotes greater patient comfort and improves tolerance to treatment while optimizing mucociliary clearance.[22, 24, 25]

OPTIMAL HUMIDITY

HIGH FLOWS OF OXYGEN DELIVERED COMFORTABLY THROUGH OPTIFLOW NASAL CANNULA

- Deliver up to 100% oxygen more accurately
- Flushing of anatomical dead space
- Positive airway pressure throughout the respiratory cycle
- Optimized mucociliary clearance

PATIENT NEEDS AND OPTIMAL OUTCOMES

The combination of Optimal Humidity with nasal cannula allows a greater level of respiratory support than traditional nasal cannula, delivering high flows effectively and comfortably. Contributing to this is the delivery of four key benefits:

1. Deliver up to 100% oxygen accurately
With NHF, the aim is to meet or exceed the patient's normal inspiratory demand, creating minimal air dilution, as indicated by Images 1 and 2.[24, 26]

Continued next page ›

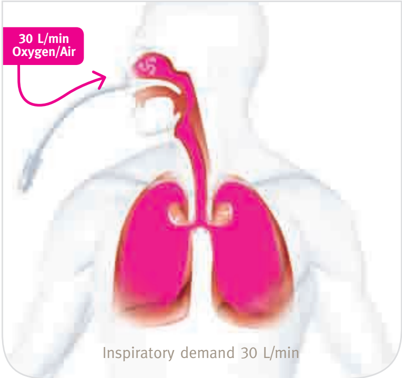


Image 1 – Nasal High Flow

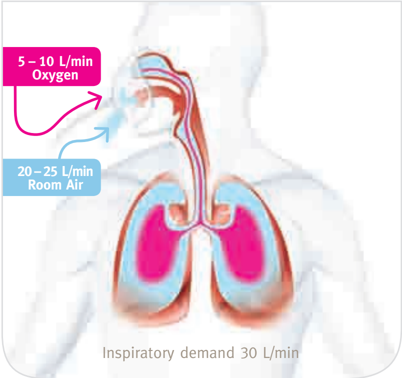


Image 2 – Face Mask Oxygen Therapy

PATIENT NEEDS AND OPTIMAL OUTCOMES (CONTINUED)

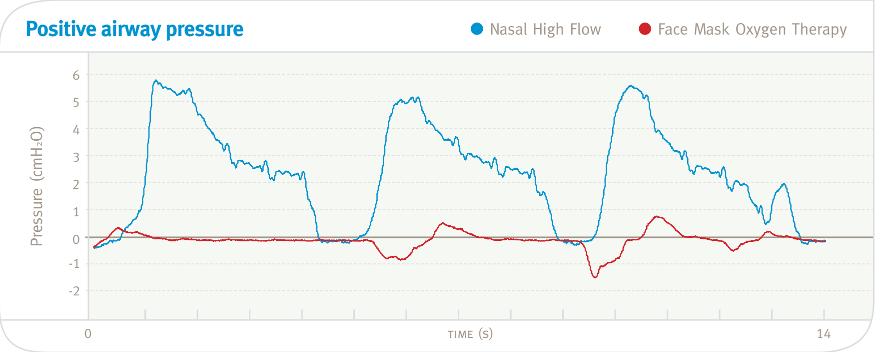
NHF can more accurately deliver prescribed oxygen concentrations at high flows providing both versatility and continuity of care as patients wean or their condition becomes more acute.[26 27] This greater flexibility eliminates the need to switch between oxygen therapy delivery systems.

2. Flushing of anatomical dead space
With the delivery of high flows directly into the nares, a flushing effect occurs in the pharynx.[24 28] The anatomical dead space of the upper airway is flushed by the high incoming gas flows. This creates a reservoir of fresh gas available for each and every breath, minimizing re-breathing of carbon dioxide (CO_2).[28]

3. Positive airway pressure throughout the respiratory cycle
Mean airway pressure throughout the respiratory cycle has been shown to be elevated with the delivery of NHF (as indicated by the graph to the right).[29]

The degree of pressure is likely to be dependent on a number of variables including flow rate, geometry of the upper airway, breathing method (through the nose or mouth) and size of the cannula relative to the nare.[22 30]

4. Optimized mucociliary clearance
Optimal Humidity emulates the balance of temperature and humidity that occurs in healthy lungs, maintaining mucociliary clearance.[4 25] This can be particularly important for patients with secretion problems such as those with chronic obstructive pulmonary disease.[25 31] By delivering Optimal Humidity, drying of the airway is reduced, which maintains the function of the mucociliary transport system, clearing secretions more effectively and reducing the risk of respiratory infection.



Pressure waveform of one subject with 35 L/min comparing face mask with Nasal High Flow, adapted from Parke et al. (2007)[29]

BENEFITS OF NASAL HIGH FLOW WITH OPTIMAL HUMIDITY

PATIENT	CLINICIAN
Comfortable oxygen delivery, reducing the likelihood of treatment failure[22]	Less attendance time assisting uncomfortable patients
Can continue to eat, drink, talk and sleep	No need to change between multiple oxygen delivery devices and interfaces
A broad range of flows and oxygen concentrations can be delivered, providing both versatility and continuity of care as patients wean or their condition becomes more acute	Increased confidence in the actual fraction of inspired oxygen (FiO_2) being delivered to the patient[26 27]
May displace the need for noninvasive or invasive ventilation through better patient tolerance[22]	Easier oral care, maintaining the moisture in the oral mucosa[32]
Improved respiratory efficiency[28]	May be used to wean patients off noninvasive or invasive ventilation
Better secretion clearance, reducing the risk of respiratory infection	

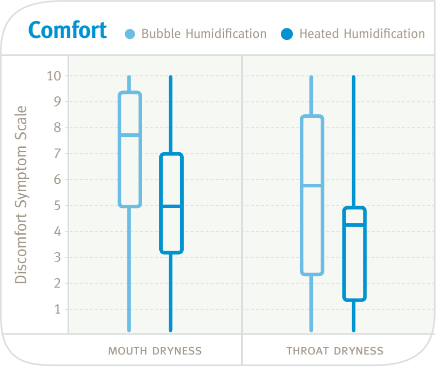
Face Mask Oxygen

Face Mask Oxygen is utilized when patients require higher levels of oxygen than traditional low-flow nasal cannula are able to deliver. These higher flow rates can overwhelm the nasal mucosa however, which causes drying of the upper airway, reducing patient comfort and tolerance to treatment especially with un-humidified or poorly humidified oxygen.[1] The addition of Essential Humidity (31 °C, 32 mg/L) can provide significant benefits for both caregiver and patient, and plays an important role in restoring natural balance to the state of the patient's lungs.[13 14]

Enhancing traditional oxygen therapy for improved patient tolerance

ESSENTIAL HUMIDITY

Humidification is one of the only mechanisms available to improve patient tolerance with Face Mask Oxygen. Conditioning the gas flow to the Essential level of humidity (31 °C, 32 mg/L) mimics the natural level of humidity found normally in the nasopharynx.[13] While bubble-through humidifiers have been utilized in the past, evidence indicates that significantly greater patient tolerance can be achieved with heated humidification.[1 14]



Heated Humidification significantly decreased the discomfort associated with mouth and throat dryness when compared with Bubble Humidification in 30 critically ill patients. Adapted from Chanques et al. (2009)[1]

PATIENT NEEDS AND OPTIMAL OUTCOMES

As most clinicians will be aware, patients using face masks can be difficult to manage. This can often be a direct result of poor patient comfort and mask tolerance.

Contributing to this discomfort is the cold, dry oxygen often at high flows that project onto the patient's face and into the upper airway, provoking dryness of the mouth, nose, throat and respiratory tract.[1] While often very time consuming for the clinician, the likelihood of treatment success for the patient can be reduced due to frequent therapy interruption. To improve continuity of treatment, patient comfort must be enhanced. By using heated humidification, uncomfortable symptoms associated with dryness of the mouth and throat, such as difficulty clearing secretions and swallowing, can be significantly reduced.[1]

Coupled with patient tolerance is the need to maintain the mucociliary transport system. Drying of the respiratory tract resulting from poorly humidified gas can compromise mucociliary clearance and increase airway resistance. Delivering Essential Humidity can therefore maintain the mucociliary transport system, ensuring secretions remain mobile and airway resistance is minimized.[14]

BENEFITS OF FACE MASK OXYGEN WITH ESSENTIAL HUMIDITY

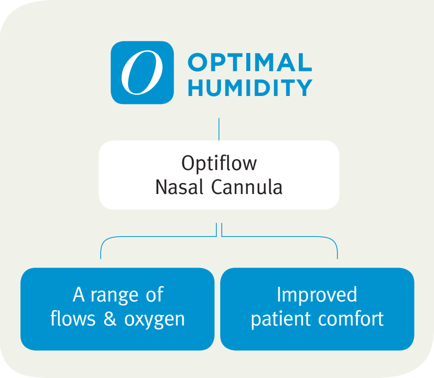
	CLINICIAN
Reduced drying of the upper airway leading to improved patient tolerance[1]	Less attendance time refitting face masks
Airway resistance is minimized which may reduce work of breathing[14 20]	Continuity of treatment due to better patient tolerance may improve likelihood of treatment success
Secretions remain mobile and easy to remove	Simpler chest physiotherapy, facilitating expectoration of secretions
Easier to swallow	Easier oral care, maintaining the moisture in the oral mucosa

Low Flow Oxygen

Delivery of oxygen with either a nasal cannula or face mask has traditionally been poorly humidified, reducing patient comfort. Two contributing factors to improved patient comfort are Optimal Humidity and nasal cannula delivery. With the Optiflow™ nasal cannula, oxygen can be delivered from 21 to 100% concentration with flows as required.

OPTIMAL HUMIDITY

Clinicians can now deliver oxygen to patients in a comfortable manner directly into the nares, by providing Optimal Humidity, 37 °C, 44 mg/L. This level of humidity can improve patient comfort by reducing drying of the upper airway caused by the cold, dry oxygen. The mucociliary transport system will also be maintained, ensuring secretions in the respiratory system remain mobile.[25]



Comfort at low flows

PATIENT NEEDS AND OPTIMAL OUTCOMES

The Optiflow nasal cannula for humidified Low Flow Oxygen can be utilized when weaning down from Nasal High Flow if needed, or as an initial treatment option instead of a face mask. Patient comfort is enhanced with reduced upper airway drying, improved nasal airway resistance and maintenance of the mucociliary transport system.[3 25] Secretions remain mobile, allowing simpler expectoration for the patient and easier oral care for the clinician. Greater patient comfort enables continuity of treatment delivery as the patient is less inclined to remove the interface, which may increase therapy effectiveness. The versatility of the system enables a broad spectrum of deliverable flows, eliminating the need to change the patient interface should more or less oxygen be required.

BENEFITS OF LOW FLOW OXYGEN WITH OPTIMAL HUMIDITY

PATIENT	CLINICIAN
Improved patient comfort	Less attendance time refitting interface
Secretions in the airway remain mobile[25]	Improved continuity of treatment; better likelihood of therapy success
Improved continuity of treatment; better likelihood of therapy success	A versatile system reducing the need to change equipment as the patient requires more or less support

Humidity Therapy

Freedom to breathe

OPTIMAL HUMIDITY

It is now possible to deliver high flows of air, optimally humidified to 37 °C, 44 mg/L using a Optiflow™ nasal cannula. This new therapy provides significant benefit for chronic respiratory patients by improving mucociliary clearance and increasing compliance, due to the greater level of comfort associated with nasal delivery.

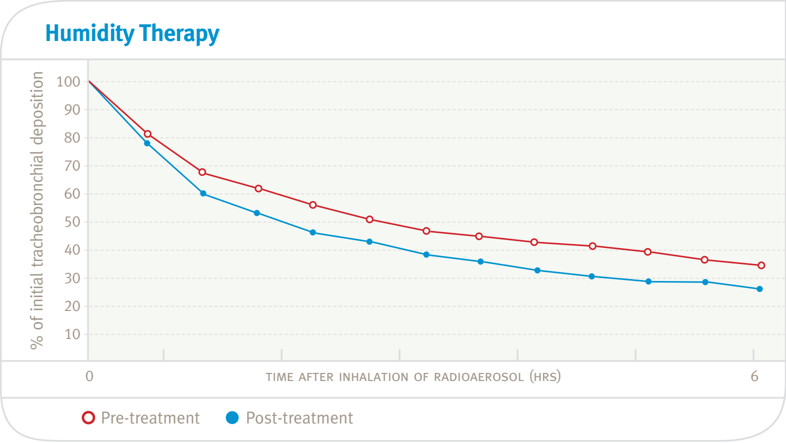
PATIENT NEEDS AND OPTIMAL OUTCOMES

In key patient groups, such as those with chronic obstructive pulmonary disease (COPD) or bronchiectasis, maintaining clear, unobstructed airways can be difficult due to the volume and thickness of secretions that are generated within the lungs. A compromised mucociliary clearance system further impedes the patient's ability to clear secretions. The velocity of mucus transport in a COPD patient may be less than 1 mm per minute, compared to 10 mm per minute in a healthy adult.[33]

Video microscopy of ovine tissue has indicated that delivery of heated and humidified air at body core temperature, and saturated, improves mucus transport velocity in the trachea. This effect was also investigated by Hasani et al.,[25] who found that in bronchiectatic patients treated with humidification therapy for only three hours per day, mucociliary clearance increased by 15%. The improvement in mucociliary clearance can be seen in the graph below.

Most importantly, the use of Humidity Therapy demonstrates real improvements in patient outcomes. Preliminary results from a long-term study into Humidity Therapy with 109 patients with COPD or bronchiectasis suggest improvements in exacerbation frequency, lung function, and quality of life.[31]

Humidity Therapy can provide significant benefit to patients in both the hospital and home environments.



Mean tracheobronchial aerosol retention › graph showing the clearance of inhaled labeled particles (radioaerosols) from the lung. Improvement in clearance is indicated by the smaller area under the curve post treatment.

Adapted from Hasani et al. (2008)[25]

BENEFITS OF HUMIDITY THERAPY WITH OPTIMAL HUMIDITY

PATIENT	CLINICIAN
May reduce exacerbations	Re-admissions due to exacerbations may be reduced
May improve quality of life for chronic patients	Easier chest physiotherapy, enabling expectoration
Patients may find coughing and expectoration easier	Secretions can be more easily managed

Our family of solutions to Restore Natural Balance

Fisher & Paykel Healthcare is committed to advancing our capabilities as a world leader in humidified therapy systems with a comprehensive family of solutions that restore natural balance. At every point of the F&P Healthcare Adult Respiratory Care Continuum™, high-performance respiratory systems deliver optimal patient and clinician outcomes.

	INVASIVE VENTILATION	NONINVASIVE VENTILATION	NASAL HIGH FLOW	FACE MASK OXYGEN	LOW FLOW OXYGEN	HUMIDITY THERAPY
PLATFORM	MR850 HC500	MR850 HC500	MR850	MR850	MR850	MR850
DELIVERY SYSTEM	• MR290 auto-fill humidification chamber • RT series breathing circuits	• MR290 auto-fill humidification chamber • RT series breathing circuits	• MR290 auto-fill humidification chamber • RT series breathing circuits	• MR290 auto-fill humidification chamber • RT series breathing circuits	• MR290 auto-fill humidification chamber • RT series breathing circuits	• MR290 auto-fill humidification chamber • RT series breathing circuits
PATIENT INTERFACES	• F&P DirectConnect™ Catheter Mount • F&P DirectConnect™ Tracheostomy Interface	• F&P FreeMotion™ Vented Face Mask • F&P FreeMotion™ Vented Nasal Mask • F&P FreeMotion™ Non-vented Face Mask	• F&P Optiflow™ Nasal Cannula		• F&P Optiflow™ Nasal Cannula	• F&P Optiflow™ Nasal Cannula • F&P DirectConnect™ Tracheostomy Interface

SUPERIOR SCIENCE AND CARE

Since entering the market in 1971 with a unique system design, Fisher & Paykel Healthcare has established a reputation for innovation and leading-edge product development. Its pioneering respiratory solutions have advanced the capabilities of healthcare professionals in over 120 countries around the world.

Every solution we deliver is the sum of almost four decades of clinical research. An innovative design culture and close relationships with healthcare professionals enable the company to create proprietary technologies that optimize patient outcomes, improve caregiver efficiencies and reduce care costs.

Fisher & Paykel Healthcare is continually improving the functionality and efficacy of respiratory systems available in the market – setting new standards in respiratory care. Our aim is to support healthcare professionals with leading-edge tools and resources, providing access to the very latest research and innovative therapy solutions.

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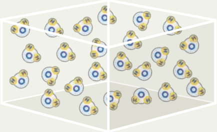
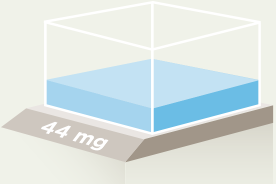
01 ABSOLUTE HUMIDITY (AH)

The total amount of water vapor in a given volume of gas in which it is contained. Absolute humidity is measured as mass divided by volume of gas (mg/L).



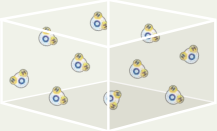


If the water held in a liter of gas was condensed out and weighed in milligrams, the absolute humidity of the gas would be measured in milligrams of water per liter of gas.

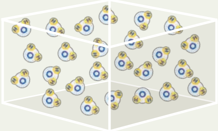
02 RELATIVE HUMIDITY (RH)

The water contained in the gas, compared with how much water it can hold before the vapor condenses out to liquid water. Relative humidity is measured as a percentage.

25% RH



100% RH

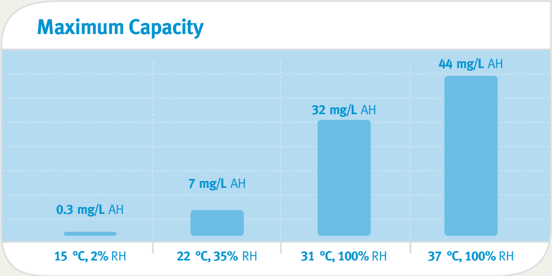


25% RH - If a liter of gas can hold a maximum 44 mg of water vapor, it contains only 11 mg of water vapor, it will be quarter-full. So its relative humidity (RH) is 11 mg / 44 mg or 25% RH.

100% RH - If the same volume of gas holds 44 mg of water vapor, it is full or saturated with water vapor. So its relative humidity is 44 mg / 44 mg or 100% RH.

03 MAXIMUM CAPACITY

The quantity of water vapor that gas can hold increases with the temperature of the gas. A warm gas can hold more water vapor than a cold gas.



04 PARTICLE SIZE

Water droplets (aerosols) are large enough that bacteria and viruses can be transported by them. Water vapor molecules are much smaller and pathogens can not attach themselves to be transported.

WATER VAPOR

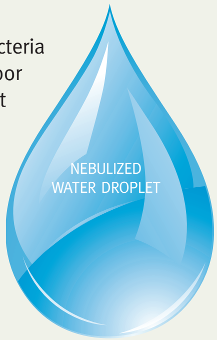
0.0001
Microns

VIRUS

0.017 – 0.3
Microns

BACTERIA

0.2 – 10
Microns



1 – 40
Microns

Quick Guide to Humidity

Humidity is a measure of the water vapor that is held in a gas.

Absolute Humidity

A measure of the total mass of water vapor that is contained in a given volume of gas.

AH

Relative Humidity

A comparison of how much water vapor is contained in a gas compared with the maximum amount it can hold.

RH

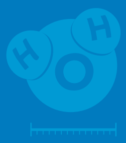
Temperature Affects Humidity

A warm gas can hold more water vapor than a cold gas.

°C

Size Does Matter

It is physically impossible for water vapor to transport bacteria and viruses.



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