Humidification For the Critically Ill patient - ICU Guideline RDH & QHB

Reference no: 012/ICU/13

These are nursing guidelines for use within critical care to support best practice. They are not prescriptive and as with all nursing practice should be utilised in conjunction with the registrant's clinical judgement

1. Introduction

Humidification of air naturally occurs in health patients, in the upper airways which warm, filter and moisten the inspired air or medical gases (O'Driscoll et al 2017). However, when supplementary oxygen is applied this is cold and dry which if exposure is prolonged can cause inflammation of the trachea, mucosal damage, retention of secretions, reduction in ciliary function, risk of artificial airway occlusion and extended hospital stays (O'Driscoll et al 2017, The Royal Marsden 2020, Intersurgical limited 2023). Consideration for humidification should be for flows of oxygen above 4 litres/minute (Piraino et al 2022, The Royal Marsden NHS Foundation Trust 2020 Poiroux et al 2018). The normal physiological humidification and filtering process of the body is bypassed when patients have an artificial airway highlighting the need for humidification (Gillies et al 2018, Wellbeloved 2020, Patel et al 2021).

2. Aim and Purpose

To provide optimum humidification for patients receiving oxygen therapy via an artificial airway or intubated or receiving high flow oxygen therapy.

3. Main Body

Indications for Humidification:

- Mechanically Ventilated Patients
- Patients with altered airway (Tracheostomies)
- COPD patients to aid expectoration of secretions.
- Patients experiencing respiratory discomfort due to dryness.
- Supplemental oxygen delivery of greater than 4 litres.

(Royal Marsden Manual 2020)

Contraindications for Humidification:

- Patients isolated with respiratory droplet precautions requiring open (masks) systems ventilation (Royal Marsden Manual 2020)

High Flow Oxygen (Airvo2)

The humidification procedure for high flow oxygen is available with Royal Marsden Manual.

Humidification for the ventilated Patient

On admission of the patient routinely commence on a HMEF ventilator circuit unless decide otherwise by a senior nurse or Doctor.

Ventilator circuits with HMEF

- Maintain patient safety by ensuring the dry ventilator circuit is assembled correctly and the HMEF is situated in the correct place at the Y connection of the circuit above the patients ET tube / tracheostomy (NHS England and MHRA 2015, Patel et al 2021)
- No bacterial filter is required on either Mindray or Draeger ventilators if a HMEF is used (Appendix One and Two) (Mindray 2024, Draeger 2024).
- Ensure the HMEF is observed regularly for contamination of secretions or water as this can increase the resistance to gas flow and impact the work of breathing and obstruction of the patient's airway, ensuring if contamination is present the HMEF is changed (NHS England and MHRA 2015, Plotnikow et al 2018)
- Change the HMEF every 24 hours/prn (Intersurgical 2023) or when the filter has fluid, blood or secretions present as this can increase the work of breathing and risk of airway obstruction (Al Ashry and Modrykamien 2014).
- Consider changing to active heated humidification if the patient is going to be ventilated for longer than 7 days with no plans to extubate, unless specifically requested sooner by a senior member of the nursing or medical team (Intersurgical limited 2022a, Jafari and Severn 2023).
- **NEVER** use a HMEF and heated humidifier at the same time due to the risk of airway obstruction (Doyle et al 2015, NHS England and MHRA 2015).

Single Heated Limb Ventilator Circuits with Active Heated Humidifiers (MR850)

- Maintain patient safety by ensuring the circuit is assembled correctly and in accordance with the manufacture's recommendation and Fisher Paykel MR850 connected to a ventilator requiring humidification (The Royal Marsden 2020).

- Draeger and Mindray ventilators with an active humidified circuit need a bacterial filter on the expiratory limb (Appendix three and four) (Mindray 2024, Draeger 2024).
- Ensure Bacterial filters are changed every 24 hours/prn if waterlogged/soiled (Intersurgical limited 2023).
- Ensure the MR850 is assembled correctly – There are two settings, one for a face mask and one for artificial airways, this ensures the patient receives oxygen warmed and humidified to the correct temperature (The Royal Marsden 2020).
- Allow time for the heated humidifier to warm up prior to application as this ensures immediate humidification (Fisher and Paykel Health Care Limited 2020, The Royal Marsden 2020).
- Ensure the bag of sterile water is connected to ensure correct functioning of the device and changed every 12 hours or when empty. (The Royal Marsden 2020) Report to the nurse in charge if there is limited stock.
- Ensure the circuit is checked regularly to ensure the water level in the chamber and the temperature is correct to ensure the patient is receiving optimal humidified oxygen therapy, reducing the risk of harm to the patient and damage to the equipment (The Royal Marsden 2020, Plotnikow et al 2018).
- Check, drain and empty the water trap if one is present, and any condensation that may have collected in the tubing to reduce the risk of colonization of bacteria, resistance to gas flow and temperature variation (Plotnikow et al 2018)**.**
- Do **NOT** drain the condensation into the humidifier chamber to reduce the risk of contamination (Plotnikow 2018).
- Change wet circuit with one heated limb every 7 days/prn (Intersurgical Limited 2024) if the ventilator circuit is soiled or damaged (Hellyer et al 2016, The Royal Marsden 2020).

Dual Heated Limb Ventilator Circuits with Active Heated Humidifiers (MR850)

- Maintain patient safety by ensuring the circuit is assembled correctly and in accordance with the manufacture's recommendation and Fisher Paykel MR850 connected to a ventilator requiring humidification (The Royal Marsden 2020).
- Mindray ventilators with a dual active humidified circuit need a bacterial filter on the expiratory limb (Appendix Five) (Mindray 2024, Draeger 2024).
- Ensure Bacterial filters are changed 24 hours/prn if waterlogged/soiled (Intersurgical limited 2023).

- Ensure the MR850 is assembled correctly – There are two settings, one for a face mask and one for artificial airways, this ensures the patient receives oxygen warmed and humidified to the correct temperature (The Royal Marsden 2020).
- Allow time for the heated humidifier to warm up prior to application as this ensures immediate humidification (Fisher and Paykel Health Care Limited 2020, The Royal Marsden 2020).
- Ensure the bag of sterile water are available to ensure correct functioning of the device and changed every 12 hours or when empty. (The Royal Marsden 2020) Report to the nurse in charge if there is limited stock.
- Ensure the circuit is checked regularly to ensure the water level in the chamber and the temperature is correct to ensure the patient is receiving optimal humidified oxygen therapy, reducing the risk of harm to the patient and damage to the equipment (The Royal Marsden 2020, Plotnikow et al 2018).
- Do **NOT** drain the condensation into the humidifier chamber to reduce the risk of contamination (Plotnikow 2018).
- Change wet circuit with dual heated limbs every 14 days/prn (Intersurgical Limited 2024) if soiled or damaged (Hellyer et al 2016, The Royal Marsden 2020).

4. Definitions, Keywords

High Flow Oxygen – A respiratory support system that delivers high flows of concentrated oxygen which is heated and warmed often via nasal cannula or a connection that fits to a tracheostomy (Rochwerg et al 2020, Fisher and Paykel Limited 2021).

Active Heated Humidification - This is provided by a heated humidifier. Gases are passed over the surface of a heated plate, which warms and moistens the oxygen. Often these have a heated limb to prevent the oxygen from cooling before it reaches the patient (Al Ashry and Modrykamien 2014)

Heat Moisture Exchange (HME) - This device contains a condenser that passively humidifies inhaled gases by retaining the heat and moisture from the exhaled breath, to humidify the inspired breath, also known as passive humidification (Al Ashry and Modrykamien 2014, Intersurgical Limited 2023).

Heat Moisture Exchange Filter (HMEF) - This device contains a condenser that passively humidifies inhaled gases by retaining the heat and moisture from the exhaled breath, to humidify the inspired breath, which is also known as passive humdification. HEMF's also have a filter to reduce the risk of cross contamination (Al Ashry and Modrykamien 2014, Intersurgical Limited 2023).

Bacterial Filter - These filters protect the patient, hospital staff and equipment from potential microbial contamination. (Intersurgical Limited 2023).

Dry Ventilator Circuit - A two limb breathing circuit which is used for passive humidification (Intersurgical Limited 2022b)

Active Humidification Ventilator Circuit with one Heated limb - A two limb breathing circuit with the inspiratory limb heated after passing over the humidification chamber, with a water trap to drain condensation (Intersurgical Limited 2022b).

Active Humidification Ventilator Circuit with Two Heated limbs - A two limb breathing circuit with the inspiratory limb heated after passing over the humidification chamber, and the expiratory limb is heated (Intersurgical Limited 2022b).

Equipment:

Fisher Paykel Active Heated Humidifiers:

MR850 (Invasive Ventilation, Non-invasive Ventilation, Nasal High Flow and Low Flow Oxygen Therapy)

- Invasive mode temperatures 35.5-42Degrees Celsius
- Non-Invasive mode temperatures 31-36 Degrees Celsius
- Alarms for: High and Low Temperatures, water out, Temperature probe disconnection, heater wire disconnection Chamber and airway probe out.
- Approximately 30 minutes for humidifier to reach optimal temperature.

Fisher and Paykel Healthcare Limited (2020)

Airvo2 (Warmed High flow oxygen)

- Temperature Settings 31, 34, 37 Degrees Celsius
- Alarms for: Internal Fault, Check Tube, Check for Leaks, check for blockages, Oxygen too low and too high, cannot reach target flow, water out, cannot reach target temperature, check operating conditions and power out.
- Allow time for the humidifier to reach the target temperature, the temperature on the screen will pulsate whilst warming and a tick will be present on the screen to show it is ready for use.

Fisher and Paykel Healthcare Limited (2021)

HME filter (HMEF) (Intersurgical Clear-Therm 3)

- Filtration rate of 99.9-99.999%
- Optimum level of humidification for medical gases
- Maximum Recommend use 24hours.

Intersurgical Limited (2023)

5. References (including any links to NICE Guidance etc.)

Al Ashry H, S., and Modrykamien, A,M., (2014) Review Article Humidification during Mechanical Ventilation in the Adult Patient, *BioMed Research International* 2014 ID 715434. Available at: http://dx.doi.org/10.1155/2014/715434

Al Dorzi, H, M., Ghanem, A, G., Hegazy, M, M., AlMatrood, A., Alchin, J., Mutairi, M., Aqeil, A., amd Arabi, Y, M., (2022) Humidification during mechanical ventilation to prevent endotracheal tube occlusion in critically ill patients: A case control study. *Annals of Thoracic Medicine 2022* 17 pp37-43. Available at: http://doi.org/10.4103/atm.atm_135_21

Doyle, A., Mariyaselvam, M., Wijewardena, English, N., Gent, E., and Young, P., (2015) The simultaneous use of a heat and moisture exchanger and a heated humidifier causes critical airway occlusion in less than 24 hours *Journal of Critical care* 30(4). Available at http://doi.org/10.1016/j.jcrc2015.03.033

Draeger (2024) Internal email from the Draeger Representative to ICU Equipment Lead dated 21/01/2024.

Fisher and Paykel Healthcare Limited (2004) MR810 Respiratory Humidifier Technical Manual. Available at: https://fisher-paykel.manymanuals.com/humidifiers/mr810/user-manual-13889

Fisher and Paykel Healthcare Limited (2020) F&P 850 - MR850 - Respiratory Humidifier. Available at: https://resources.fphcare.com/content/850-respiratory-humidifier-pm-618136.pdf

Fisher and Paykel Healthcare Limited (2021) F&P Airvo2 User Manual. Available at: https://resources.fphcare.com/content/airvo-manual-uk-us-and-az-ui-185045495-h-15thmarch22.pdf

Gillies, D., Todd, D, A., Foster, J, P., and Batuwitage, B, T., (2018) Heat and Mositure exchangers versus heated humidifiers for mechanically ventilated adults and Children, *Cochrane Database of systematic reviews 2017*, 9. Available at: Http://doi.org/10.1002/14651858.CD004711.pub3.

Hellyer, T, P., Ewan, V., Wilson, P., and Simpson, A, J., (2016) The Intensive Care Society recommended bundle of interventions for the prevention of ventilator associated pneumonia, *Journal of the Intensive Care Society* 17(3) pp.238-243. Available at: https://doi.org/10.1177.1751143716644461

Intersurgical Limited (2022a) Product information: 22mm Breathing System Issue 3

Intersurgical Limited (2022b) Humidification Solutions for both ventilated and spontaneously breathing patients Issue 3, Available at: https://www.intersurgical.com/products/critical-care/flextube-breathing-systems-for-passive-humidification

Intersurgical Limited (2023) HMEs and HMEFs. Available at: https://www.intersurgical.com/info/HMEsandHMEFs

Intersurgical Limited (2024) Internal email from the Intersurgical Representive to ICU equipment lead dated 23/01/2024.

Jafari, Z., and Severn, M., (2023) CADTH Health Technology Review: Timing of Ventilator Circuit Tubing Replacement, *Canadian Journal of Health Technologies* 3(9) Available at: https://www.ncbi.nlm.nih.gov/books/NBK599789/

Mindray (2023) Internal email from the Mindray Representative to Trust Equipment Lead dated 17/11/2023.

NHS England and MHRA (2015) Stage one; Warning Risk of using different airway humidification devices simultaneously. Available at: https://www.england.nhs.uk/patientsafety/wp-content/uploads/sites/32/2015/12/psa-humidification-devices.pdf

O'Driscoll, B, R., Howard, L, S., Earis, J., Mak, V., (2017) BTS Guideline for Oxygen use in adults in health care and emergency settings, *Thorax 72(Suppl. 1)* i1-89 Available at: http://dx.doi.org/10.1136/thoraxjnl-2016-209729

Patel, V., Dean, J., Lawerence, J, V., Selvanayagam, S., Blunt, M, C., and Young, P, J., (2021) Humidicare - an implementation of study if a novel HME safety device designed to prevent ventilator occlusion due to inadvertent dual humidification. *Journal of Medical Engineering and Technology* 45(2) pp.129-135. Available at: https://doi.org/10.1080/03091902.2021.1873440

Piraino, T., Madden, M., Roberts, K, J., lamberti, J., Ginier, E., and Strickland, S, L., (2022) AARC Clinical Practice Guideline: Management of Adult Patients with Oxygen in the Acute Care Setting, *Respiratory Care* 67(1) pp.115-128

Plotinikow, G, A., Accoce, M., Navarro, E., Tiribelli, N., (2018) Humidification and Heating of inhaled gas in patients with artificial airway. A narrative review. *Rev Bras Ter Intensiva* Jan-Mar 30 (1) pp.86-97. Available at: http://doi.org/10.5935/0103-507X.20180015

Rochwerg, B., Einav, S., Chaudhuri, D., Mancebo, J., Mauri, T., Helviz, Y., Goligher, E, C., Jaber, S., Ricard, J-D., Rittayamai, N., Roca, O., Antonelli, M., Maggiore, S, M., Demoule, A., Hodgson,C, L., Mercat, A., Wilcox, M, E., Granton, D., Wang, D., Azouly, E., Ouanes-Besbes, L., Cinnella, G., Rauseo, M., Carvalho, C., Dessap-Mekontso, A., Fraser, J., Frat, J-P., Gomersall, C., Grasselli, G., Hernandez, G., Jog, S., Pesetni, A., Rivello, E, D., Slutsky, A, S., Stapleton, R, D., Talmor, D., Thille, A, W., Brochard, L., and Burns, K, E., (2020) The role for high flow nasal cannula as a respiratory support strategy in adults: a clinical practice guideline, *Intensive Care Medicine* 46(12) pp. 2226-2237. Available at: http://doi.org/10.1007/s00134-020-06312-y

The Royal Marsden Manual of Clinical and Cancer Nursing Procedures (2020) [online] available at: https://www.rmmonline.co.uk

Wellbeloved, M., (2020) Humidification and the HME filter *Sourthern African Journal of Anasthethia and Analagesia* 26(6 Suppl3) pps161-s163.

6. Documentation Controls (these go at the end of the document but before any appendices)

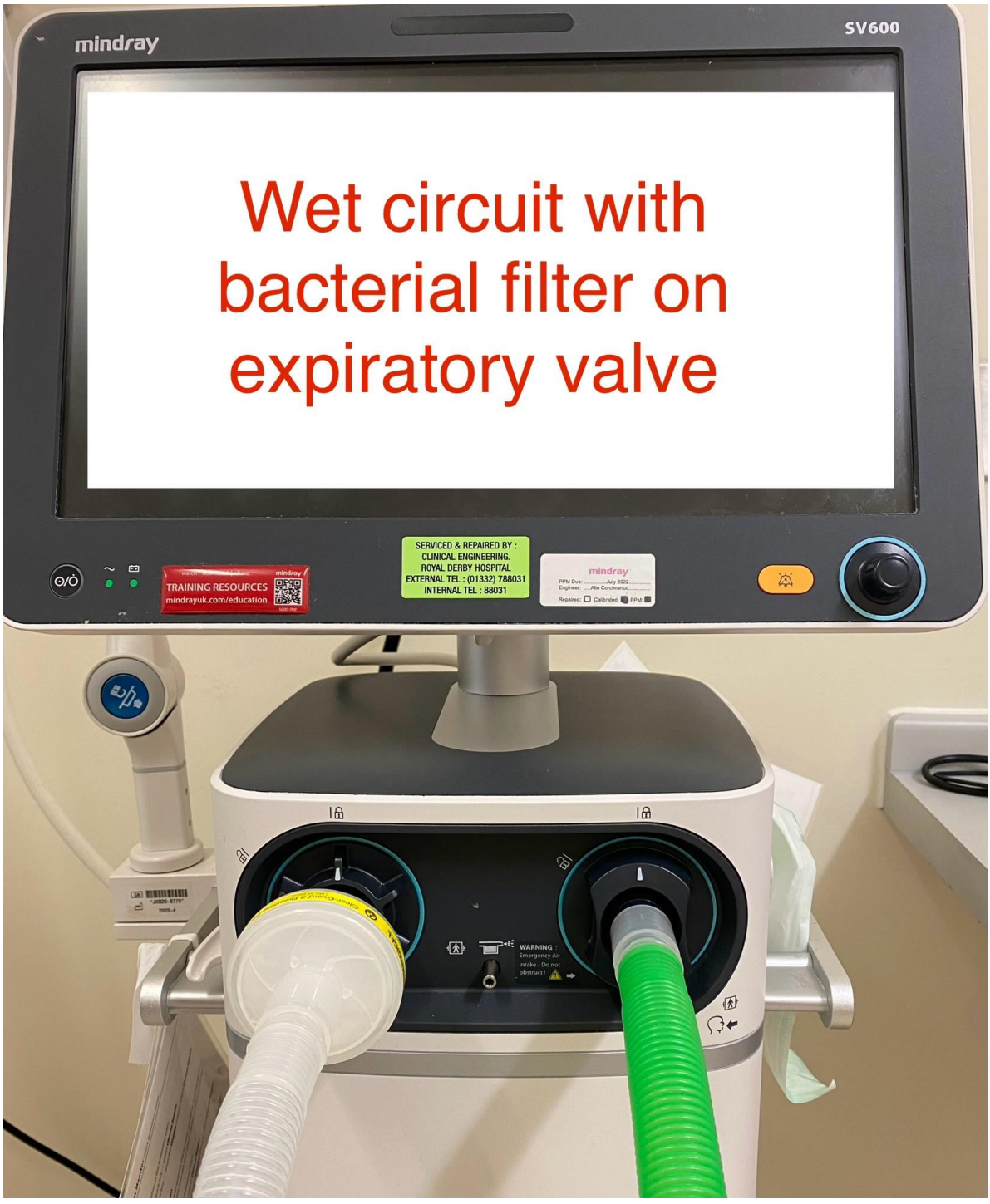
Reference Number 012/ICU/13 - 4436	**Version:** 2.0		**Status** Final	
Version / Amendment History	Version	Date	Author	Reason
	1.0	June 2013	Chris Gould	Routine reviewing of Nursing guidelines.
	2.0	June 2024		Review (new to Koha)
Intended Recipients: Registered Nurses in Critical Care				
Training and Dissemination: Changes in practice information emailed to the Nursing team and laminated signs put on the side of the ventilator.				
Development of Guideline: Joanne Mizuro **Job Title:** Senior Clinical Educator				
Consultation with: Education Team Cross Site, ICU Senior Nursing Team, Critical Care Risk Meeting				
Linked Documents: Royal Marsden Manual of Clinical and Cancer Nursing Procedures - High Flow Oxygen Humidification guidance.				
Keywords: Humidification, Ventilation, High Flow Oxygen, HMEF and HME				
Business Unit Sign Off	**Group:Critical Care governance** **Date:June 2024**			
Divisional Sign Off	**Group:Surgery DQRG** **Date:25/6/2024**			
Date of Upload	28/08/2024			
Review Date	September 2027			
Contact for Review	ICU Education Team/ICU Sisters			

7. Appendix one - Dry Ventilator Circuit Mindray Ventilator HMEF

Appendix Two - Dry Ventilator Circuit Drager with HMEF

Appendix Three - Active Humidification Ventilator Circuit with one Heated limb

Mindray Ventilator



Appendix Four - Active Humidification Ventilator Circuit with one Heated limb

Draeger Ventilator

Appendix Five - **Active Humidification Ventilator Circuit with Duel Heated limbs**