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BJAN-D-21-00200 - Letter to the Editor

Inefficient humidification as the cause of noninvasive ventilation failure in COVID-19 patients[☆]

Amarjeet Kumar^a, Chandni Sinha^b, Abhyuday Kumar^b, Neeraj Kumar^a, Ajeet Kumar^b, Kunal Singh^b, Prabhat Kumar Singh^c

^a All India Institute of Medical Sciences Patna (AIIMS Patna), Department of Trauma and Emergency, Patna, India

^b All India Institute of Medical Sciences Patna (AIIMS Patna), Department of Anaesthesiology, Patna, India

^c All India Institute of Medical Sciences Patna (AIIMS Patna), Patna, India

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*** Corresponding author.**

E-mail: chandni.doc@gmail.com (C. Sinha).

ORCID ID: 0000-0002-4272-5750

[☆] Study conducted at All India Institute of Medical Sciences Patna (AIIMS Patna), Patna, India.

Dear Editor,

Five to six percent of COVID-19 patients developed acute hypoxemia respiratory failure.[1] The hypoxemia might not respond to high-flow nasal cannula therapy (HFNC), and eventually require escalation of oxygen therapy to continuous positive airway pressure (CPAP) or noninvasive ventilation (NIV). Patients who failed NIV had high minute ventilation, which may be due to increased alveolar dead space, increased CO₂ production from the inflammatory response and impaired carbon dioxide clearance, or both.[2] Successful NIV leads to more patient comfort, reduced ventilatory work of breathing, decreased chest wall motion and minute ventilation, improvement in arterial oxygen saturation, and dyspnea resolution. Patients on NIV frequently complain of dry

mouth. Because of ineffective humidification and high minute ventilation, COVID-19 patients develop dry and thick bronchial secretions, which might lead to airway obstruction. This also results in increased requirements of airway procedure like bronchoscopy or endotracheal tube replacement in COVID-19 patients. There is lack of clear guideline or recommendation regarding the appropriate humidification application during NIV, as this is poorly understood.

Either of the two humidification systems, heated humidification (HH), or a heat and moisture exchange filter (HME) is used for NIV. The humidification system's selection should be based on the patient's lung condition, ventilator settings, intended duration of use, and other factors like the presence of leaks and body temperature. Switching from HME to HH was found to be associated with a significant decrease in PaCO₂ levels. Many centers use filters to provide passive humidification and reduce the risk of exhaled gas/aerosol dispersion during NIV [3]. In our clinical experience, we have found better results in patients with prolonged NIV who were switched from HME to HH. Few patients who were on CPAP mode of NIV for more than five days (HME filter attached) were observed to be noncompliant with complains of dry throat. All these patients required high FiO₂ (0.6 to 0.8) with high minute ventilation (12–15 L.min⁻¹). In these patients, we changed the humidification system from HME to HH. The patients became more compliant to the NIV with better synchrony and sputum clearance. We were able to wean all patients in due course of 15 to 20 days.

During invasive ventilation, the natural humidification system of the upper airway is bypassed. Theoretically 30 mg H₂O.L⁻¹ is the minimum humidity required for ventilation;[4] however, it is not clear whether the same is required during NIV. The minimum absolute humidity during NIV is 15 mg H₂O.L⁻¹. [5] If no humidification is used, the absolute humidity during NIV comes down to 5 mg H₂O.L⁻¹. [4] Lellouche et al. [5] stated that if mask leak is present, humidification dropped by 30% when HME is used, but remained the same with heated humidifier.

An international survey was conducted by Esquinas et al. [4] to determine humidification practices and its relationship with untoward outcomes during NIV. They found that in NIV failure patients, difficult intubation was encountered in 5.4%. It stated that in 50% of this subgroup of patients, no humidification system was used during NIV.

Hence, we suggest regular use of active humidification (heated wire) in COVID-19 patient, as humidification improves airway function by clearing secretion from the

airway. This would result in increased comfort to the patient, increases NIV tolerance, and prevent the creation of a challenging environment for endotracheal tube placement.

There is a lack of clear guideline or recommendation regarding the appropriate humidification application to COVID-19 ARDS patients during NIV. Different humidification methods applied for intubated patients cannot be extrapolated to NIV. A well-structured comparative study between humidification versus ambient air during NIV will answer the question.

Conflicts of interest

The authors declare no conflicts of interest.

References

1. Yang X, Yu Y, Xu J, et al. Clinical course and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: a single-centered cc, retrospective, observational study. *Lancet Respir Med.* 2020;8:475-81.
2. Avdeev SN, Yaroshetskiy AI, Tsareva NA, et al. Noninvasive ventilation for acute hypoxemic respiratory failure in patients with COVID-19. *Am J Emerg Med.* 2021;39:154-7.
3. Cheung TM, Yam LY, So LK, et al. Effectiveness of noninvasive positive pressure ventilation in the treatment of acute respiratory failure in severe acute respiratory syndrome. *Chest.* 2004;126:845-50.
4. Esquinas A, Nava S, Scala R, et al. Intubation in failure of noninvasive mechanical ventilation: preliminary results (abstract). *Am J Respir Crit Care Med.* 2008;177:A644.
5. Lellouche F, Maggiore SM, Lyazidi A, et al. Water content of delivered gases during non-invasive ventilation in healthy subjects. *Intensive Care Med.* 2009;35:987-95.