# Rebreathing of carbon dioxide during non-invasive ventilation. Is PEEP the final solution?

Mridul Dhar[1], Sameer Sharma[1], Antonio M. Esquinas[2]

**M Dhar, S Sharma, AM Esquinas. Rebreathing of carbon dioxide during non-invasive ventilation. Is PEEP the final solution? Can J Respir Ther 2022;58:169. doi: 10.29390/cjrt-2022-054.**

**Key Words:** *non-invasive ventilation; PEEP; rebreathing; COPD; mechanical ventilation*

Dear Editor,

We have read the article published by Al Hussain and Vines [1] with keen interest. This was a simulated experiment on healthy volunteers examining the effect of varying levels of positive end-expiratory pressure (PEEP) on the level of rebreathing of carbon dioxide ($CO_2$) during non-invasive ventilation (NIV) with a dual limb critical care ventilator [1].

The authors mentioned in the limitations that the results may be different for those with an elevated baseline partial pressure of alveolar $CO_2$. The indications for NIV as mentioned in the introduction of the article were chronic obstructive pulmonary disease (COPD) or type 1 respiratory failure like acute respiratory distress syndrome (ARDS) or pulmonary edema [2]. But these conditions require specific PEEP settings, for example in COPD to counter auto-PEEP or in ARDS according to the level of hypoxia. Thus, the absence of or low PEEP in an NIV setting in these cases would be unlikely.

The authors also mentioned in the limitations that the sample size was small but statistically significant. In the article, it was not clear what the primary objective was or if any sample size was calculated based on that. Thus, it would perhaps be better to comment only on clinical significance instead of statistical significance in such a study. It might be possible that the results, even though statistically significant, may not have a clinically significant effect and a future study with blood gas parameters, if feasible, in real patients may be formulated. The authors also commented that due to the short duration of the experiment any possible effects of $CO_2$ rebreathing on respiratory rate and tidal volume were not observed and were similar at all PEEP levels. Thus, it would have been better to have longer experiments to allow such changes to be observed while keeping in mind the ethical issues of subjecting healthy volunteers to potential $CO_2$ rebreathing and its effects [3].

A few observations regarding the methodology are as follows. Mask fit is an important component of effective ventilation during NIV. Although the authors excluded facial deformity, they could have commented on the presence or absence of a beard in the inclusion or exclusion criteria, which is a more practical clinical problem in such patients (as evident in the lightly bearded volunteer in Figure 1 of the article). This study was conducted as a crossover randomized controlled trial where each volunteer experiences four different masks at different PEEP levels. The main concern with such trials is the "washout period" to eliminate the effect of one group/intervention on the other [4]. In the current study, the main outcome or objective (based on the alternate hypothesis) appears to be the comparison of four different PEEP levels. Thus, the washout period should have been between two PEEP levels instead of or in addition to between two different masks. Here, PEEP levels are changed without a gap in the 20-min experiment, which effectively changes the baseline characteristics of each PEEP group reading. In our opinion, this makes the comparison of outcomes between PEEP groups unreliable. A similar study quoted in the article by Holanda et al. [5] addresses the washout period issue to some extent.

In the discussion, the authors tried to bring out the relation between mask leak and $CO_2$ clearance during NIV. The results showed higher mask leaks at higher PEEP levels. But there was no difference in ventilation, which seems unlikely if the leak was significantly more in higher PEEP groups. The authors could have commented on any possible leak compensation feature of the ventilator in this case. Also, as the authors have themselves pointed out, mask leak can affect the $CO_2$ washout, so comparing the results between different PEEP levels in such a situation, again, becomes unreliable. The authors, towards the end, based their conclusions on the assumption that mask leak is a desirable mechanism of $CO_2$ clearance in NIV. But in critical care ventilators, a good seal with no or minimal leak is essential for effective ventilation, PEEP maintenance, as well for $CO_2$ clearance [6]. This correlation between mask leak and $CO_2$ clearance appears to be not satisfactorily conveyed.

## REFERENCES

1. Al Hussain A, Vines D. Potential rebreathing of carbon dioxide during noninvasive ventilation provided by critical care ventilator. Can J Respir Ther 2022 Jul 27;58:111–4. doi: 10.29390/cjrt-2022-013.
2. Nava S, Hill N. Non-invasive ventilation in acute respiratory failure. Lancet 2009 Jul 18;374(9685):250–9. doi: 10.1016/S0140-6736(09)60496-7.
3. Bailey JE, Argyropoulos SV, Kendrick AH, Nutt DJ. Behavioral and cardiovascular effects of 7.5% CO2 in human volunteers. Depress Anxiety 2005;21(1):18–25. doi: 10.1002/da.20048.
4. Sedgwick P. What is a crossover trial? BMJ 2014 May 9;348:g3191. doi: 10.1136/bmj.g3191.
5. Holanda MA, Reis RC, Winkeler GF, Fortaleza SC, Lima JW, Pereira ED. Influence of total face, facial and nasal masks on short-term adverse effects during noninvasive ventilation. J Bras Pneumol 2009;35(2):164–73. doi: 10.1590/S1806-37132009000200010.
6. Ueno Y, Nakanishi N, Oto J, Imanaka H, Nishimura M. A bench study of the effects of leak on ventilator performance during noninvasive ventilation. Respir Care 2011 Nov;56(11):1758–6. doi: 10.4187/respcare.01145.

[1]*Department of Anaesthesiology, All India Institute of Medical Sciences, Rishikesh, India*
[2]*Intensive Care Unit, Hospital Morales Meseguer, Murcia, Spain*
*Correspondence: Dr Mridul Dhar, All India Institute of Medical Sciences, Rishikesh, India. E-mail: mriduldhar@hotmail.com*