

Letter to the Editor

Comment on: Effect of inspiratory rise time on sputum movement during ventilator hyperinflation in a test lung model

We read with great interest the article by Chapman *et al.* [1], who investigated the effects of different levels of inspiratory rise time (IRT) on the flow bias and sputum movement during ventilator hyperinflation in a test lung model. The authors showed that, as IRT increased, peak expiratory flow (PEF) did not change, but peak inspiratory flow (PIF) reduced significantly increasing the expiratory flow bias. The flow bias was described as both the PIF:PEF ratio and PEF–PIF difference. They also identified that the critical thresholds for cephalad sputum movement of 0.9 for PIF:PEF ratio and 17 L/min for PEF–PIF difference were exceeded with 5% and 10% IRT, respectively. Moreover, the expiratory flow bias increased further for each subsequent 5% increase in IRT suggesting that sputum movement should be enhanced further. On the contrary, and surprisingly, cephalad sputum displacement achieved a plateau and did not enhance for IRT values exceeding 5%, despite the significant expiratory flow bias increment. The authors' explanation for this finding was that the PEF was not high enough to form mist flow, limiting sputum displacement.

We reasoned that there is a better explanation for their results. Ventilator hyperinflation maneuver is likely to clear pulmonary secretion by the two-phase gas–liquid transport mechanism, as stated by the authors. This mechanism is influenced by three critical factors: viscosity of mucus, inspiratory/expiratory air velocity and thickness of the mucus layer (which must exceed a minimum of 5–20% of the airway diameter) [2]. In the study of Chapman *et al.* [1] this last factor was disregarded. In their protocol, baseline ventilation was undertaken to allow the sputum to settle and, then, six to seven breaths were applied before the tested hyperinflation level was reached. We hypothesize that the sputum layer was probably close to its critical thickness after baseline ventila-

tion. However, the application of the next six to seven breaths, with an expiratory flow bias that was closer (but lower) than the tested one, probably spread out the sputum layer thinly. Consequently, the following breaths applied with the tested IRT percentage could not move mucus further, no matter how much the flow bias was.

Lastly, we would like to comment that their study was not methodologically designed to compare the PIF:PEF ratio with the PEF–PIF difference to deduce which one predicts mucus movement more accurately. Most importantly, we would like to clarify here that, in our study [3], which also investigated the effect of ventilator settings on the flow bias and mucus movement, the key-message was that mucus displacement was better dictated by the difference rather than the ratio between airflows, and not that a net PEF of exactly 17 L/min should be pursued to clear secretion. Indeed, we now believe that a PEF–PIF difference higher than 33 L/min, found in pigs under mechanical ventilation [4], is more likely to be closer to the threshold necessary to clear secretion in humans.

Conflict of interest: None declared.

References

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Marcia S. Volpe*

*Department of Sciences of Human Movement, Federal
University of São Paulo, Brazil*

Maria Aparecida M. Nakamura

*Laboratory for Medical Research 09, School of Medicine,
University of São Paulo, Brazil*

Marcelo B.P. Amato

*Cardio-Pulmonary Department, Pulmonary Division,
Heart Institute, University of São Paulo, Brazil*

Corresponding author.

*E-mail address: marciasvolpe@gmail.com
(M.S. Volpe)*

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