

LETTER

Heterogeneity in ventilation during positive end-expiratory pressure

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See related commentary by Costa and Amato, <http://ccforum.com/content/14/2/134>, and related research by Zhao *et al.*, <http://ccforum.com/content/14/1/R8>

We read with interest the commentary 'Can heterogeneity in ventilation be good' [1] and the related article by Zhao and colleagues [2]. We agree with the comments that instead of incremental positive end-expiratory pressure (PEEP) levels, a decremented PEEP titration might be an attractive option for determining optimal PEEP [1,3]. However, we feel that physiological inhomogeneity in ventilation and perfusion related to the gravitational effect in normal lungs occurs during spontaneous breathing, and during spontaneous breathing a negative alveolar pressure develops during inspiration and facilitates pulmonary blood flow. Contrary to when applying PEEP, the positive pressure remains throughout respiration and paradoxically affects the pulmonary flow. We feel that it would be wiser not to compare the physiological inhomogeneity in ventilation with PEEP-related inhomogeneous ventilation. PEEP is a slow recruitment technique for aerating collapsed alveoli, which can happen in a non-uniform fashion. Hence, anticipating any good effect of inhomogeneity of

ventilation during PEEP may give a false impression to physicians regarding mechanically ventilated patients in the ICU.

Respiratory parameters such as lung mechanics and arterial blood gas reflect global ventilation. The readily available bedside chest X-ray is useful to map the inhomogeneity of the alveolar recruitment during PEEP in acute respiratory distress syndrome patients. The lung infiltration score for the different lung zones can map heterogeneity in lung recruitment [4]. This heterogeneity between the two lungs (lung infiltration score difference ≥ 3) was associated with postural hypoxemia when the worst lung was down in the lateral position and predisposed to skin sores on the worst lung side [4]. We opine that lung changes comprise a dynamic process in the ICU. Any PEEP level that is appropriate at one point of time may be required to be reevaluated at a later time or, for that matter, even after chest physiotherapy. Understandably, there cannot be a single ideal PEEP level that satisfies all clinical objectives and situations.

Authors' response

Eduardo Leite Vieira Costa and Marcelo Britto Passos Amato

In our recent commentary [1], we proposed that a certain degree of ventilation heterogeneity could be good during mechanical ventilation. Heterogeneity of ventilation and perfusion is inevitable whether or not the patient is under mechanical ventilation. In healthy volunteers under mechanical ventilation, Nyrén and colleagues [5] showed that regional lung perfusion and ventilation were heterogeneous, but matched each other, which was essential to optimize gas exchange. Heterogeneity along the ventral-dorsal axis accounted for roughly 20% of the total

variance of ventilation [5]; this 'good' heterogeneity was mainly a result of the lung anatomy itself, although gravity also played a role.

In sick lungs, the proportion of the total variance attributed to the ventral-dorsal axis probably increases due to the extra heterogeneity (the 'bad' heterogeneity) caused by different degrees of lung collapse and hyperdistension. Our major point in our commentary was that by simply trying to minimize the heterogeneity in ventilation, it is not possible to know whether one is reducing the 'good' heterogeneity (due to lung anatomy and gravity) or the 'bad' heterogeneity (due to atelectasis and/or hyperdistension). We recently proposed a method based on electrical impedance tomography capable of identifying recruitable lung collapse and hyperdistension [6]. This method can be used to minimize the

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extra-heterogeneity of ventilation due to atelectasis and hyperdistension.

In conclusion, we need to avoid the misconception that one of the goals of mechanical ventilation is the simplistic

minimization of the heterogeneity of ventilation. Only the extra-heterogeneity due to atelectasis and hyperdistension is worth eliminating.

Abbreviations

PEEP, positive end-expiratory pressure.

Competing interests

MA has received research grants from Dixtal Biomédica Ltda (São Paulo, Brazil) in the last 3 years. All other authors declare that they have no competing interests.

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Published: 17 August 2010

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doi:10.1186/cc9212

Cite this article as: Tripathi M, Pandey M: Heterogeneity in ventilation during positive end-expiratory pressure. *Critical Care* 2010, **14**:436.