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Ventilation-Perfusion Matching, Not Functional Residual Capacity, Should Be Used to Determine Oxygenation with PEEP

To the Editor:

The article by Hawker et al., which appeared in the April 1991 issue of Chest, demonstrates and confirms that it is the matching between ventilation and perfusion, not the increase in functional residual capacity, that determines the effectiveness of PEEP in terms of oxygenation of the blood. While the concept is basic, it is not just theoretical. We would like to share our recent experience with one case in which removal of PEEP actually improved oxygenation. In addition, we feel that the term “reverse mismatch” is obfuscating and should be abandoned.

The patient is a 55-year-old black woman with a history of chronic renal failure requiring hemodialysis. She developed colitis with perforation and underwent emergency laparotomy. Her postoperative course was complicated by new-onset seizure and sepsis, and she required intubation and mechanical ventilation. She subsequently developed total white-out of her right lung, as visualized with chest radiography. In spite of an increase in FIO2 to 1.0, her PacO2 continued to fall. Although PEEP was empirically increased stepwise to 15 cm H2O, arterial blood gas analysis and bedside pulse oximetry showed a progressive decrease in oxygen saturation. Table 1 shows the results of manipulation of PEEP.

The influences from changes in cardiac output could not be completely ruled out even though the patient appeared hemodynamically stable. It was also noted that, with identical ventilator settings, the patient did better with her left lung dependent. She was observed to have a pulse oximeter reading of 94 percent when lying on her left, compared with only 86 percent when lying on her right.

The above data support the mechanism proposed in previous studies, whereby the preferential distribution of ventilation to areas of high compliance can divert and increase the blood flow to less compliant nonventilated portions of the lung. Therefore, there is a worsening of V/Q mismatch with increase of shunt and dead space, and oxygenation deteriorates. To call this “reverse mismatch” is confusing and improper, since PEEP in these settings not only increases the effect of shunting but also increases the dead space of a preexisting mismatch; the condition gets worse, not better. “Worsening of V/Q mismatch” is more appropriate and should be borne in mind as an important complication of PEEP, especially in cases with uneven pulmonary pathologies. The pulse oximeter, which is convenient though not ideal, can be useful in bedside manipulation and titration of PEEP under these circumstances when hypoxemia is refractory or deteriorating. Of course, adequate oxygen transport should be the end point.

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To the Editor:

We thank Dr. Lee and Dr. Chen for their comments. The case described in their letter adds weight to the findings in our report and the reports of others, that PEEP may result in a reduction of PaO2 in patients with unilateral lung disease. We agree totally that the major mechanism is worsening of V/Q mismatch.

We use the term “reverse mismatch” simply to describe the findings on the ventilation-perfusion lung scan. In this context, the term “matched defect” denotes loss of both ventilation and perfusion to an area of lung and suggests collapse or consolidation. On the other hand, “mismatch” is frequently used to describe absence of perfusion with preservation of ventilation consistent with pulmonary embolism. “Reverse mismatch,” as described in our patient, is characterized by absence of ventilation with luxury perfusion to the involved area of lung. If this is observed in a patient receiving intermittent positive pressure ventilation and PEEP, reduction of airway pressure (eg, by decreasing PEEP) is likely to be followed by an improvement in V/Q mismatch and thus an increase in PaO2.

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Table 1 — Results of Manipulation of PEEP*

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<th>Time, min</th>
<th>PEEP, cm H2O</th>
<th>Paw, cm H2O</th>
<th>SaO2, %</th>
<th>Heart rate, beats/min</th>
<th>Blood Pressure, mm Hg</th>
<th>PaO2, mm Hg</th>
<th>PaCO2, mm Hg</th>
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*FIO2 = 1.0; tidal volume = 900 ml.