

## Commentary

# ICU cornerstone: 'Triggering effort'

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### Abstract

In an autobiographical manner, I describe the pathophysiology of auto-PEEP (positive end-expiratory pressure) and its role as a factor that increases the work of breathing in mechanically ventilated patients.

**Keywords** mechanical ventilation, patient-ventilator interaction, work of breathing

The most frequent reason for admission to an intensive care unit is need for ventilatory assistance. At least, this is my experience over the past 20 years from working in university and county hospitals. Regardless of the illness that provokes respiratory insufficiency, the majority of patients with respiratory failure eventually require mechanical ventilation. If there is an improvement in oxygenation after a few days, then we are forced to consider reducing the intensity of ventilatory support. In the early years of my critical care training, when we checked ventilated patients under the effects of low-level sedation and were attempting to wean them off ventilation, such patients normally had to make an effort to trigger the ventilator. At that time, our teachers told us that this was normal; 'it is a kind of exercise training' said one, and 'it is our way of finding out which patients can work harder' said another. It was not clear why the 'trigger knob' had always to be in the standard position (not too difficult or too easy). One of my mentors told me to take advantage of the triggering effort because he thought that this effort could be related to a sophisticated parameter used in respiratory physiology, namely the occlusion pressure, or P0.1. After that, I started conducting research by obtaining many recordings of airflow and airway pressure in intubated, ventilated patients while they attempted to breathe. My mentor was right, and we published some stimulating papers about the 'triggering effort' [1].

Nevertheless, patients continued having to work to breathe while they were on the ventilator. When I reviewed our experimental tracings, I realized that patient response was not

so predictable. Each patient had his or her own pattern of response, and most of them started inspiration before finishing expiration. At that time, not much was known about this type of patient response. We looked at these results again and made new tracings in different patients. Among those patients who showed abrupt changes in expiratory flow when they started inspiration early before the end of expiration, we realized that inspiratory efforts were not immediately rewarded by the sound of ventilator's insufflation. There was as much delay in the response of the ventilator as there was abnormality in the flow tracings. At the same time, the description of auto-PEEP (positive end-expiratory pressure) by Pepe and Marini [2] gained acceptance in the critical care field. We then realized that our patients probably had auto-PEEP, and that expenditure of effort in order to overcome auto-PEEP could possibly account for our findings [3].

In order to help our patients by reducing the triggering effort, we attempted to improve trigger sensitivity. Our teachers in the intensive care unit were right; if one increases the sensitivity too much, then the ventilator will trigger itself. Therefore, we went back to the drawing board, and by studying the auto-PEEP effect we discovered the reason why not all cases have the same pathophysiological basis. In those patients without a known record of chronic obstructive pulmonary disease (COPD) the air trapping phenomenon could be attributed to the short expiratory time relative to minute ventilation and airflow obstruction, whereas in COPD patients it could be related to dynamic airflow limitation. We then had two different approaches to reduce auto-PEEP and

its related increase in triggering effort. First, in non-COPD patients, we could increase expiratory time by shortening inspiratory time, or we could reduce minute ventilation. Second, in the COPD patients, the addition of PEEP to the ventilator's modes could equilibrate auto-PEEP [4,5].

The clinically important thing was that, with any approach, we were able to monitor the improvement in the patient's condition by examining the delay between the start of inspiratory effort and the sound coming from the ventilator. Now, after years of clinical experience with mechanically ventilated patients, I always look at the patient's inspiratory effort and the ventilator delay to check whether there may be problems associated with triggering. We now realize that our patients were not uncooperative when they felt uncomfortable on the ventilator. In contrast, when one asks them how they feel after the application of PEEP to compensate for auto-PEEP, they thank you for alleviating their dyspnoea.

### Competing interests

None declared.

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