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CORRESPONDENCE

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Effectiveness of cycling-off during pressure support ventilation

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Sir: Patient–ventilator dissynchrony remains a substantial problem during pressure support ventilation (PSV). Prinianakis and coworkers [1] have recently tested—during invasive PSV—a new triggering and cycling-off system based on analysis of the flow waveform signal (flow shape system, Vision, Respironics). These authors found moderate inspiratory delay with traditional flow triggering, and demonstrated a slight reduction of the delay, together with a greater number of autotriggerings, with the new system.

Little attention was paid to cycling-off: the authors described the behaviour of the two systems as similar, but did not produce mean values of expiratory delay. By means of the neural inspiratory time, mechanical inspiratory time, and inspiratory delay data of this study, we calculated mean expiratory delay values of 288 ms, 365 ms and 766 ms during low, baseline, and high levels of PSV with traditional cycling-off (and very similar values with the flow shape system). These results confirm our opinion that the expiratory delay during PSV is usually underestimated, is often more significant than the inspiratory one, and is greatly dependent on the ratio between inspiratory effort (Pmusc) and pressure support level (PSL). It is noteworthy that data of Prinianakis and coworkers confirm PSV's ability to progressively unload respiratory muscles by means of increments of PSL: their patients showed a decrease of Pmusc from low to baseline PSL and from baseline to high PSL. Therefore, the Pmusc/PSL ratio greatly decreased, whereas expiratory delay greatly increased, as a result of PSL increments.

The two cycling-off systems are designed to detect the end of the patient's inspiratory effort by means of a decrease of inspiratory flow from peak value (traditional system) or by means of a sudden change of inspiratory flow trajectory (flow shape system). Unfortunately, when the Pmusc/PSL ratio decreases, the influence of the patient's inspiratory effort on the inspiratory flow waveform also decreases, and for very low values of this ratio the inspiratory flow exhibits the typical exponential decay of passive inflation, as we can see during pressure-controlled ventilation. In such a condition, the traditional cycling-off system of PSV becomes unable to detect the patient's inspiratory muscles relaxation, and the mechanical inspiratory time (T_IM) depends almost exclusively on flow threshold (fT, expressed as percentage of peak inspiratory flow) and the respiratory system's time constant (τ), according to the law $T_IM = -\tau * \log(fT/100)$. Therefore, patients with longer time constants can experience expiratory delay, whereas patients with shorter time constants are prone to anticipated cycling-off. Adjusting inspiratory flow thresholds with regard to the patient's respiratory mechanics [2] can be helpful but, especially in the presence of near passive inflation patterns, it seems to be a complicated way to impose the mechanical inspiratory time, rather than to protect the patient's control over inspiratory length.

On the other hand, data collected by Prinianakis and coworkers support no improvement of expiratory synchronization by means of the flow shape system during low Pmusc/PSL conditions, despite this system having been originally conceived to overcome the difficulty of cycling-off due to air leaks during non-invasive ventilation. Probably the release of low inspiratory efforts can produce only small changes on the trajectory of inspiratory flows sustained by much higher levels of pressure support.

With regard to expiratory asynchrony during PSV two main questions remain unsolved. First, whether a perfect synchronization is desirable even in presence of very short, sometimes almost evanescent, neural inspiratory times. Second, whether expiratory asynchrony has considerable clinical impact: patients may react to expiratory delay by slowing down respiratory rate, lengthening neural expiratory time, and/or by recruitment of expiratory muscles [3]. The final effect on respiratory pattern, gas exchange, dynamic hyperinflation, inspiratory triggering, and work of breathing is often unpredictable, and probably dependent on the patient's pathology and level of consciousness.

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