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The influence of the ventilation methods on respiratory variables – model studies

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Motivation and Aim: During mechanical ventilation, it is essential to regulate inspiratory pressure, air flow and ventilation power to minimize the risk of lung damage [1-3]. Modern lung ventilators are sophisticated devices designed to automatically supply inspiratory gas to a patient's lungs. Newer ventilation modes, such as Adaptive Support Ventilation (ASV) and Intelligent-ASV [4, 5], are considered the first ventilator systems to utilize targeting solutions, automatically determining the optimal ventilation frequency to minimize the patient's work of breathing. But these ventilation modes have their drawbacks:

- ***Potential for Excessive Mechanical Power*** – ASV adjusts tidal volume and respiratory rate automatically, but in certain cases, it may generate excessive mechanical power, leading to lung overdistension and ventilator-induced lung injury (VILI), especially in patients with reduced lung compliance.
- ***High Inspiratory Flow*** – ASV tends to deliver relatively high inspiratory flows to meet its target minute ventilation. This can create rapid lung inflation, potentially increasing the risk of volutrauma or barotrauma [6].
- ***Limited Adaptation in Severe Lung Conditions*** – In conditions like **ARDS** (Acute Respiratory Distress Syndrome), where lung mechanics are highly heterogeneous [7], ASV may not always optimize flow patterns effectively, leading to uneven lung ventilation.
- ***Inconsistent Response to Sudden Changes*** – ASV relies on real-time monitoring and algorithm-based adjustments, but it may lag in responding to sudden changes in lung mechanics, such as airway collapse or secretion buildup, potentially causing inappropriate ventilatory support [8].

To address these limitations, in the present study we adjusted inspiratory pressure and flow patterns to minimize mechanical ventilation power.

Novelty: In this study, we were able to adjust the inspiratory pressure and flow to minimize the power of mechanical ventilation.

Methods: To validate the proposed concept of adapting inspiratory pressure and flow to stabilize respiratory power during the inspiration phase, studies were conducted using a system comprising a servo ventilator (*Siemens-Elema 900B*) and a physical lung model (*SmartLung 2000*). The mechanical parameters of the test lung, including compliance (C) [$mL \cdot mbar^{-1}$] and flow resistance (R) [$mbar \cdot s \cdot L^{-1}$] in series, were progressively adjusted to simulate healthy, obstructive, and resistive lung conditions. Before simulations, the test lung was assessed to establish the range of its compliance linear characteristics.