Calculating the optimal ventilator strategy to reduce mechanical power in patients with extracorporeal carbon dioxide removal (ecco2r).

**Introduction:**
ARDS is a syndrome with high morbidity and mortality. An emerging treatment option is ECCO2R, but the benefit its remains unclear. We assess different degrees of ECCO2R and varying dead space (DS) on ventilator settings in order to minimize mechanical power.

**Methods:**
We calculated mechanical power as
\[ \text{Power} = \text{RR} \times [\Delta V_t \times \left( \frac{1}{2} \times \text{EL} \times \text{RR} \times (1 + I:E) \right) \times \text{R}] + \Delta V_t \times \text{PEEP} \]
(EL: system elastance, R: airway resistance, PEEP: positive end expiratory pressure, I:E: Inspiratory to expiratory ratio).

We calculated the combination of respiratory rate (RR) and tidal volume (VT) (“optimal RR” and *optimal VT*) leading to minimal applied power for a stable carbon dioxide elimination of 300 ml/min (VCO2) for two scenarios:
1) variation of physiological DS from 10 to 40 % of VT at a fixed rate of ECCOR2. 2) variation of ECCO2R of either 80, 120, 160 or 200 ml/min at a fixed physiological DS of 20%. The alveolar ventilation (VA) necessary to eliminate the VCO2 was calculated as
\[ \text{VA} = \frac{(-VCO2 \times \sigma_{CO2} \times R \times T \times (1 + K_c))}{(VCO2/Q \cdot P_vCO2 + VCO2 \times \sigma_{CO2} \times R \times T \times ((1 + K_c)) / 760)} \]
\(\sigma_{CO2}: \) CO2 solubility in blood, \(R: \) gas constant, \(T: \) temperature. \(P_vCO2: \) venous partial pressure, \(K_c: \) function of pH (12.5 for a pH of 7.2), \(Q: \) blood flow [5 l/min]).

**Results:**
Increasing DS from 10 to 40% increases the minimal mechanical power from 5.9 to 10.8 J/min, primarily caused by an increase of optimal VT (495 – 672 ml). Optimal RR was only slightly increased (6.4 – 7.5 /min, Panel A). For varying ECCO2R removal, necessary ventilation ranges from 1.6 to 3.6 L/min. This predicts a minimal power between 5.6 and 10.4 J/min with an unchanged optimal Vt (540 - 543 ml) and an increasing optimal RR (5.4 to 12.3 /min, (Panel B)).

**Conclusion:**
In order to minimize mechanical power, increasing shunt or CO2 production should be met with increases in RR while increases in DS should be met with increases in VT. Our results indicate that during ECCO2R, mechanical power and thus risk for lung injury can be minimized with higher VT compared to conservative ventilation strategies.
Mechanical power as a function of RR and VT for varying ECCO2R and deadspace.