Gas volumes corrections in Intensive Care Unit: needed or pointless?

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BACKGROUND

The conditions of temperature, pressure and saturation in which respiratory gas volumes are expressed (STPD, ATPS or BTPS) are physiologically important but often ignored or unknown. The aim of this study was to quantify the changes in gas volumes in different conditions and to describe their clinical implications when computing key respiratory variables, including during extracorporeal support (ECMO).

METHODS

We used three physiological models in which calculations of physiological variables have been performed with and without correction of gas volumes:

- Physiological dead space, computed as:

$$\frac{Vd}{Vt} = \frac{PACO_2 - \frac{VCO_2}{VE}}{PACO_2}$$

- For the computation of venous admixture, two variables are affected by the gas conditions, PAO_2 and C_vO_2:

$$PACO_2 = FiO_2 * 713 - PACO_2 * \frac{VO_2}{VCO_2};$$

$$CvO_2 = CaO_2 - \frac{VO_2}{Q}$$

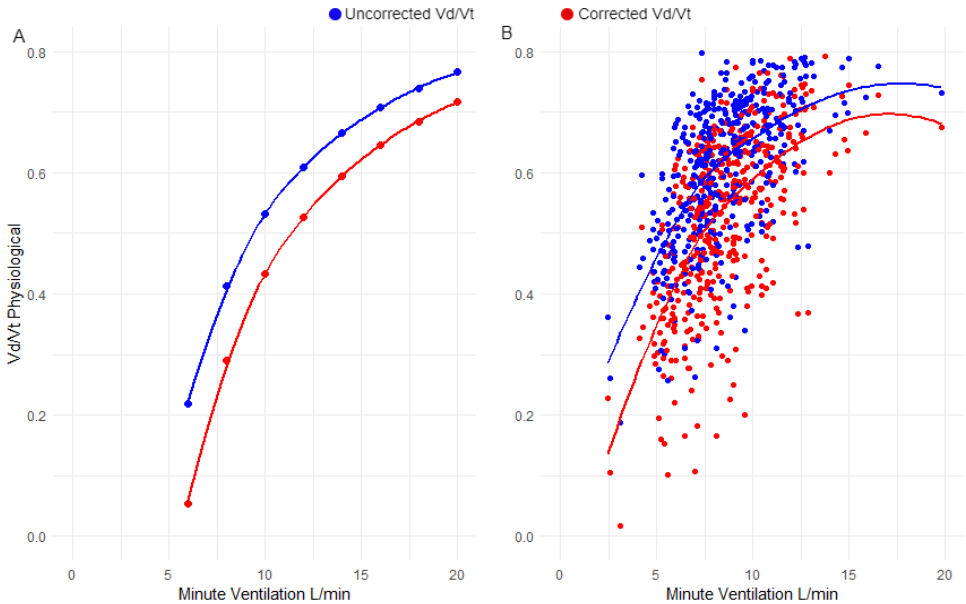
- The CO_2 clearance between the natural and the artificial lung during extracorporeal support.

RESULTS

Using a population of 448 ventilated patients and physiological modelling, we found that the lack of gas volumes correction leads to an absolute error in the computation of physiological dead space fraction ranging from 0.06 to 0.15. The oxygenation assessment was minimally affected by the absence of correction (0.02-0.04 error in venous admixture). Considering VCO_2 from natural and membrane lung in different conditions during ECMO potentially leads to large errors (0-18.4%) in the computation of total VCO_2 (VCO_2 tot = VCO_2 ML + VCO_2 NL) which may lead to erroneous ventilator settings with higher plateau pressure.

CONCLUSIONS

The most relevant consequences of lack of gas volumes correction is in CO_2 exchange (physiological dead space and assessment of CO_2 clearance during ECMO). This may lead to errors in the assessment of clinical severity and application of appropriate treatment, particularly during ECMO weaning.



Differences between corrected and uncorrected VD/Vt$_{phys}$ computation (0.06-0.15 range)