Artificial lung gas exchanges depend on ECMO settings

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Introduction
Artificial membrane lung (AL) gas exchanges are usually evaluated according to PaO₂/FiO₂ ratio. In addition, dead space ventilation and shunt fraction can be measured by the same equations used for native lungs [1].

Objectives
To study the effect of AL settings - gas flow (GF), blood flow (BF) and FiO₂ - on AL PaO₂/FiO₂ ratio, dead space and shunt, to suggest how to properly monitor these parameters.

Methods
We performed three different tests:
  a) GF changes (from 1 to 10 L/min) in 8 AL at clinically set BF and FiO₂;
  b) BF changes in 6 AL at constant FiO₂ (1) and GF (10 L/min);
  c) FiO₂ = 1 vs. clinically set FiO₂ in 10 AL at clinically set BF and GF.

We performed pre- and post-oxygenator blood gas analysis and measured CO₂ at AL exhaust port by sidestream capnography, in order to evaluate PaO₂/FiO₂ ratio, dead space and shunt.

Results
  a) At clinically set BF (4.0 ± 0.9 L/min) and FiO₂ (0.87 ± 0.15), PaO₂/FiO₂ ratio did not correlate with GF, whereas dead space progressively increased with GF (R = 0.7904, p < 0.0001) (Figure 1).
  b) Data were collected at basal (3.3 ± 0.7 L/min), increased (4.1 ± 0.8 L/min) and decreased (2.5 ± 0.6 L/min) BF. With the progressive increase of BF, dead space did not change, whereas PaO₂/FiO₂ ratio decreased and shunt increased (p < 0.001) (Figure 2).
c) At clinically set BF (3.5 ± 1.1 L/min) and GF (5.1 ± 2.4 L/min), the mean difference ± standard deviation of PaO₂/FiO₂ ratio and shunt obtained at clinically set (0.80 ± 0.20) vs. FiO₂ = 1 was -76 ± 109 mmHg and 2.1 ± 11.6%, respectively.

Conclusions
To properly monitor AL CO₂ removal and oxygen transfer, evaluations should be performed at constant GF and at FiO₂ = 1 and constant BF, respectively.

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Reference