TITLE: COMPARISON OF TWO FORMULAS FOR CALCULATING ALVEOLAR OXYGEN TENSION IN CANINE OLEIC ACID-INDUCED PULMONARY EDEMA

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Introduction Alveolar oxygen tension (PAO2) is a major variable in the calculation of venous admixture or intrapulmonary shunt. PAO2 can be derived from either of two formulas: one assumes a respiratory quotient of 0.8 (1,2); the other requires analysis of inspired, expired, and end-tidal gases using the mixing equation (3).

In an experimental model of oleic acid-induced pulmonary edema, we examined the differences in PAO2 and venous admixture resulting from these two different methods of calculating PAO2.

Methods Thirty-six mongrel dogs were anesthetized with pentobarbital and succinylcholine, intubated, and ventilated with an inspired oxygen tension (FiO2) of 0.4. The tidal volume was 18-20 ml/kg, and the respiratory rate was adjusted to achieve normocarbia. Arterial blood was sampled from the femoral artery; mixed venous blood was sampled from the pulmonary artery. Percent oxygen saturation in blood samples was measured directly using cooximetry.

PAO2 was calculated using the following formulas:

$$PAO2\text{-}1 = PiO2 - [PaCO2][FiO2 + [(1 - FiO2) \div R]]$$

$$PAO2\text{-}2 = PiO2 - [(PetCO2 - PiCO2) \div (P\bar{e}CO2 - PiCO2)][PiO2 - P\bar{e}O2]$$

where R = respiratory quotient (assumed to be 0.8); PiO2 and PiCO2 = inspired O2 and CO2 tensions, respectively; PaCO2 = arterial CO2 tension; PetCO2 = end-tidal CO2 tension; $P\bar{e}O2$ and $P\bar{e}CO2$ = mixed expired O2 and CO2 tensions, respectively.

Mixed expired gas samples were obtained from a 3-liter reservoir, which filled over 6 to 7 breaths. Alveolar O2 saturation was calculated using PAO2-1 and PAO2-2 values by the method of Ruiz et al (1). Oxygen content and venous admixture were calculated using standard formulas with PAO2 obtained by the PAO2-1 or the PAO2-2 formula.

Following baseline measurements, oleic acid, 0.06-0.08 ml/kg, was administered into the right atrium while the left pulmonary artery was temporarily occluded to produce a model of asymmetric pulmonary edema. Two hours later, repeat measurements were obtained.

Data, expressed as mean ± standard deviation, were analyzed by paired t-tests. This study was approved by the Institutional Research Practice and Animal Care Committees.

Table 1. PAO2 and Venous Admixture using PAO2-1 and PAO2-2 Formulas (mean ± SD)

PAO2-1	Baseline	Oleic Acid
PAO2 (mmHg)	213±22	211±25
Venous admixture (%)	8.7±2.9	29.9±12.2
PAO2-2		
PAO2 (mmHg)	211±22	223±28*
Venous admixture (%)	8.5±2.9	30.2±12.3*

*$p < 0.01$ compared to corresponding PAO2-1 value

Results As seen in Table 1, there were no differences in the calculated PAO2 or venous admixture values at baseline. Following the administration of oleic acid, PAO2 and venous admixture were significantly higher when the PAO2-2 formula was used. However, the correlation of venous admixture values calculated from PAO2-1 and PAO2-2 was 0.998 after oleic acid (Figure 1).

Discussion Both methods of calculating PAO2 yielded similar results at baseline. Although the differences in PAO2 after oleic acid were statistically significant, we believe that a 1% difference in venous admixture would have minimal clinical importance. As can be seen in Figure 1, the calculated values of venous admixture following oleic acid were quite similar and highly correlated. Thus, in our model, the PAO2-1 and PAO2-2 formulas yield essentially similar values, and the simpler PAO2-1 formula can be used.

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References

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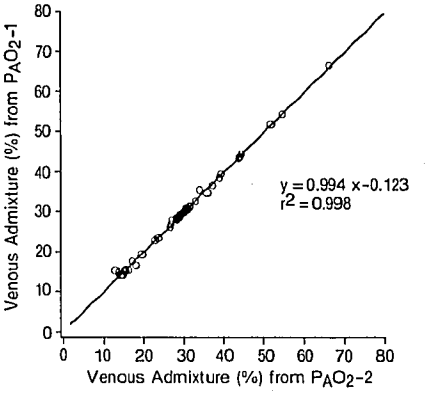

Figure 1. Correlation of venous admixture calculated by the two PAO2 formulas after oleic acid.