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Title : CONCENTRATING EFFECT OF N_2O ON ALVEOLAR PO_2 IN LOW $\dot{V}_A/\dot{Q}$ REGIONS

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Introduction. Continuing uptake of nitrous oxide (50-60% constant inspired concentration) was recently observed to substantially raise calculated alveolar PO_2 in low $\dot{V}_A/\dot{Q}$ regions of patients for as long as 4 hours after induction (personal observation). To what extent this phenomenon could impair recognition of $\dot{V}_A/\dot{Q}$ inequality by blood gas measurements was not known. Therefore we examined the effect of known volumes of N_2O uptake on alveolar and arterial PO_2 in the sheep, for a modest range of $\dot{V}_A/\dot{Q}$ inequality.

Methods. Alveolar PO_2 values were calculated for 30% (5 sheep) and 40% (1 sheep) inspired oxygen concentrations in compartments of $\dot{V}_A/\dot{Q}$ = 0.005 to 100.0, using a computer program based on that of West (1). This program incorporated measured values of hemoglobin, hematocrit, p50, mixed venous PO_2, PCO_2, pH, nitrous oxide and halothane tensions, and derived distributions of $\dot{V}_A/\dot{Q}$ ratios (Ridge regression analysis). In addition, the resulting systemic arterial PO_2 was computed and compared with measured values of arterial PO_2. For comparison, alveolar and systemic arterial PO_2 values were computed at the same F_IO_2 for the same $\dot{V}_A/\dot{Q}$ distributions, but replacing N_2O and halothane with nitrogen as the balance gas. Ideal alveolar PO_2 values, determined with nitrogen as the balance gas, were then compared to those computed with N_2O and halothane as the balance gases.

Results. In 21 distributions of $\dot{V}_A/\dot{Q}$ ratios, with shunt ranging from 1.7 to 23.3% of cardiac output, blood flow to low $\dot{V}_A/\dot{Q}$ regions from 0.0 to 46.0%, and $\dot{V}_A/\dot{Q}$ inequality (standard deviation of the distribution of blood flow) from 0.52 to 1.29, calculated alveolar PO_2 in the presence of N_2O and halothane for units with $\dot{V}_A/\dot{Q}$ < 0.5 exceeded those of the same units when these gases were not breathed. The amount of increase in alveolar PO_2 depended on: (1) the $\dot{V}_A/\dot{Q}$ ratio, and (2) the rate of anesthetic gas uptake, especially N_2O. This is illustrated by comparing alveolar PO_2 values from 2 different distributions (see Figure 1A and B) both having comparable values for inspired gas concentrations, shunt, blood flow to low $\dot{V}_A/\dot{Q}$ regions and cardiac output. Note that the calculated rise in alveolar PO_2 of low $\dot{V}_A/\dot{Q}$ units when replacing nitrogen with N_2O and halothane depends greatly on the rate of uptake of N_2O. This produced rises in the expected arterial PO_2 from 5.2 to 56.7 torr, with a linear relationship being demonstrated for $\dot{V}_{N_2O}$ (x) and the rise in arterial PO_2 (y) such that y = 7.365x + 87.183, regression coefficient = 0.80. See Table I for mean ± 1 S.D. values. The ideal alveolar-arterial PO_2 gradient, with ideal $\dot{V}_A/\dot{Q}$ ratios ranging from 0.114 to 0.969, demonstrated 3.3 to 35.4 torr underestimation of $(A^I-a)\ PO_2$ when anesthetic gas uptake was not accounted for.

Discussion. Comparison of alveolar and arterial PO_2 values when nitrogen rather than N_2O and halothane are the balance gases has indicated that continued uptake of anesthetic gases, especially N_2O, can substantially raise alveolar PO_2 in poorly ventilated but perfused lung regions. This finding implied that standard clinical estimates of $\dot{V}_A/\dot{Q}$ inequality such as arterial PO_2 and alveolar-arterial PO_2 gradients, without knowledge of the amount of blood flow to low $\dot{V}_A/\dot{Q}$ units and the volume of uptake of anesthetic gases, may seriously underestimate the degree of ventilation-perfusion mismatching during anesthesia.

References.

1. West JB: Ventilation-perfusion inequality and overall gas exchange in computer models of the lung. Respir Physiol 7: 88-110, 1969.

TABLE I

N	F_IO_2	Ideal $(A-a)PO_2$		Predicted PaO_2		N_2O Uptake (ml/min)
		Nitrogen	N_2O+Halo	Nitrogen	N_2O+Halo	
3	0.4	41.2 ±31.8	72.1 ±23.5	136.0 ±12.8	163.9 ±13.0	268.3 ±93.3
18	0.3	35.2 ±10.5	*50.3 ±06.3	110.8 ±14.2	*132.92 ±26.70	256.9 ±125.3

*significant difference p < 0.01, paired t analysis