camera system provides a complete view from the perspective of the laryngoscopist, including essential oropharyngeal elements.

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Alveolar Oxygen Partial Pressure, Alveolar Carbon Dioxide Partial Pressure, and the Alveolar Gas Equation

To the Editor:—I wish to comment on a frequent misconception found in many textbooks of anesthesia and critical care concerning the alveolar gas equation. The usual form of the equation has led to the incorrect conclusion that a change in alveolar oxygen partial pressure ($P_{A_{O_2}}$) following a change in alveolar ventilation (V_A) is secondary to a change in the alveolar carbon dioxide partial pressure ($P_{A_{CO_2}}$). $P_{A_{O_2}}$ does not change secondary to changes in $P_{A_{CO_2}}$ but depends on three factors: inspired oxygen partial pressure ($P_{I_{O_2}}$), oxygen consumption (V_{O_2}), and alveolar ventilation. These three factors can be altered clinically to affect $P_{A_{O_2}}$.

The alveolar gas equation, in its simplest form, derives $P_{A_{O_2}}$ from the expression $P_{I_{O_2}} - P_{A_{CO_2}}/R$, where R is the respiratory exchange ratio.[1] Riley *et al.*[2] derived the original form of the equation from the statement $R = V_{CO_2}/V_{O_2}$, where V_{CO_2} is the production of carbon dioxide, to overcome practical problems in the measurement of $P_{A_{O_2}}$. Further, a Fick equation states; $V_{O_2} = V_A(F_{I_{O_2}} - F_{A_{O_2}})$, where $F_{I_{O_2}}$ is the fraction of oxygen in inspired air and $F_{A_{O_2}}$ is the fraction of oxygen in alveolar air. This can be modified to:

$$P_{A_{O_2}} = P_{I_{O_2}} - P_B - 47)\ V_{O_2}/V_A, \tag{1}$$

where P_B is barometric pressure, partial pressures are in mmHg, and all measurements are at BTPS, which Nunn describes as a universal alveolar air equation.[3] This equation demonstrates the features that determine $P_{A_{O_2}}$.

Moreover, a second Fick equation for carbon dioxide states, where

$$F_{I_{CO_2}} = 0,\ V_{CO_2} = V_A \cdot P_{A_{CO_2}}/(P_B - 47). \tag{2}$$

From the definition of R, it follows that

$$V_{CO_2} = R \cdot V_{O_2}. \tag{3}$$

Substituting equation 3 into equation 2, one finds that

$$R \cdot V_{O_2} = V_A \cdot P_{A_{CO_2}}/(P_B - 47)$$

or

$$V_{O_2}/V_A = P_{A_{CO_2}}/R \cdot (P_B - 47). \tag{4}$$

Equation 4 demonstrates how the ratio V_{O_2}/V_A from equation 1 is directly related to $P_{A_{CO_2}}$. Substituting equation 4 into equation 1, $P_{A_{O_2}} = P_{I_{O_2}} - P_{A_{CO_2}}/R$. Some authors assume that the alveolar gas equation also illustrates the underlying physiology and conclude that changes in $P_{A_{CO_2}}$ result in changes in $P_{A_{O_2}}$.[4]

Therefore, the term $P_{A_{CO_2}}/R$ in the alveolar gas equation is used as an indirect measure of V_{O_2}/V_A. Further, the alveolar gas equation is only valid under steady-state conditions with no inspired carbon dioxide, and as $F_{I_{O_2}}$ approaches 1.0, a correction factor must be applied to allow for differences in inspired and expired volumes. This is explained more completely by Hlastala.[5]

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