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## Temperature Correction of the Calculated Alveolar Oxygen Tension

*To the Editor:*—Determination of partial pressure of alveolar oxygen ( $P_{A_{O_2}}$ ) is necessary in several pathophysiologic conditions, including evaluation of alveolar-arterial oxygen gradient ( $\Delta_{(A-a)O_2}$ ) and calculation of shunt fraction. The equation by which the  $P_{A_{O_2}}$  is calculated, the alveolar air equation,<sup>1</sup> is

$$P_{A_{O_2}} = F_{I_{O_2}}(P_B - P_{H_2O}^*) - \frac{P_{A_{CO_2}}}{R} + P_{A_{CO_2}} \cdot F_{I_{O_2}} \cdot \frac{1 - R}{R} \quad (1)$$

where,  $F_{I_{O_2}}$  is the inspiratory oxygen fraction,  $P_B$  is the inspiratory air pressure,  $P_{H_2O}^*$  is the alveolar saturated water vapor pressure,  $P_{A_{CO_2}}$  is the alveolar carbon dioxide tension, and  $R$  is the respiratory exchange ratio ( $\dot{V}_{CO_2}/\dot{V}_{O_2}$ , normally 0.8).

The alveolar air equation (equation 1) necessitates a knowledge of  $P_{H_2O}^*$ . In most texts of physiology,  $P_{H_2O}^*$  is designated to be 47 mmHg.<sup>1</sup> This value, however, is a function of alveolar (body) temperature and varies markedly from approximately 13 mmHg at 15°C to approximately 72 mmHg at 45°C.<sup>2</sup> The values for  $P_{H_2O}^*$  at different temperatures are readily available in handbooks of physical chemistry and in texts of anesthesia and respiratory physiology.<sup>2</sup> At a particular absolute temperature  $T$ ,  $P_{H_2O}^*$  may also be calculated by the following empirical equation:<sup>3</sup>

$$P_{H_2O}^* = e^{\left( \frac{18.3036 - \frac{3816.44}{T - 46.13}}{1} \right)} \quad (2)$$

To facilitate the calculation of  $P_{H_2O}^*$ , based on equation 2, we developed a simple nomogram by which derivation of  $P_{H_2O}^*$  at different temperatures can be performed easily within a few seconds. The accuracy of this nomogram (fig. 1) is sufficient for routine clinical practice. The corresponding  $P_{H_2O}^*$  can be found easily at any particular temperature, which ranges from 15 to 45°C. As an example, to find out the  $P_{H_2O}^*$  at 30°C, the corresponding point to the 30°C on the temperature axis (left side values) should be located first. Then, at the same ordinate, the value for the desired  $P_{H_2O}^*$  can be read from the  $P_{H_2O}^*$  axis (right side values), which, in this case, is approximately 31.6 mmHg. Assuming the following scenario, the importance of this simple correction could be evident.

Assume a body temperature of 30°C, the  $P_{H_2O}^*$ , as was found out earlier, is therefore 31.6 mmHg. Now assume  $P_B = 760$  mmHg,  $F_{I_{O_2}} = 21\%$ ,  $P_{A_{CO_2}} = P_{a_{CO_2}} = 40$  mmHg,  $P_{A_{O_2}} = 103$  mmHg, and  $R = 0.8$ . Using equation 1, then  $P_{A_{O_2}} = 105.06$  mmHg, and, as a consequence,  $\Delta_{(A-a)O_2} = 2.06$  mmHg.

If instead of using the correct value of 31.6 mmHg for  $P_{H_2O}^*$ , the usual value of 47 mmHg is utilized, the result then becomes  $P_{A_{O_2}} = 101.83$  mmHg, and, subsequently,  $\Delta_{(A-a)O_2} = -1.17$  mmHg < 0.

Arterial  $P_{O_2}$  could never be higher than that of the alveolar pressure, therefore, a zero or a negative  $\Delta_{(A-a)O_2}$ , in any case, reflects an error. In the aforementioned case, although the calculated value of  $P_{A_{O_2}}$  differs by only 3% from its actual value, the resultant  $\Delta_{(A-a)O_2}$  became negative and, therefore, meaningless.

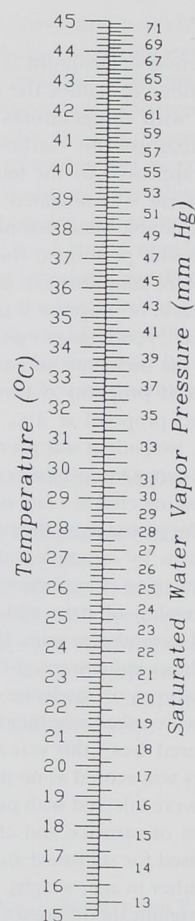


Fig. 1. A nomogram for temperature correction of saturated water vapor pressure.

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### References

- West JB: Best and Taylor's Physiological Basis of Medical Practice. 12th edition. Baltimore, Williams & Wilkins, 1990, pp 558-9
- Himmelblau DM: Appendix C, Basic Principles and Calculations in Chemical Engineering. 4th edition. New Jersey, Prentice-Hall, 1982, pp 568-72
- Himmelblau DM: Appendix G, Basic Principles and Calculations in Chemical Engineering. 4th edition. New Jersey, Prentice-Hall, 1982, pp 591

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