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LETTER TO THE EDITOR

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A proposal for a new temperature-corrected formula for the oxygen content of blood

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To the Editor,

Oxygen (O_2) is essential for normal aerobic metabolism in mammals. O_2 delivery is the process of transport of oxygenated blood from the alveolar capillaries to the tissues and is dependent on two factors: arterial O_2 content (CaO_2) and cardiac output. The carriage in the blood occurs as O_2 bound to hemoglobin and O_2 dissolved in the plasma and is expressed as the sum of these components with the following equation: $CaO_2 = 1.39 \times \text{Hb (g/dl)} \times SaO_2 + 0.0031 \times PaO_2$ (mmHg) (1). CaO_2 is the milliliters of O_2 per 100 mL of blood, SaO_2 is the fraction of hemoglobin (Hb) that is saturated with O_2, the O_2-combining capacity of Hb is 1.39 mL of O_2 per gram of Hb, Hb is grams of Hb per 100 mL of blood, PaO_2 is the O_2 tension, and solubility of O_2 in plasma is 0.003 mL of O_2 per 100 mL plasma for each mm Hg of PaO_2 [1, 2]. The pressure is 1 atm (101.325 kPa). However, the temperature is not clearly specified. In fact, the coefficient of 1.39 in the previous item of the equation was obtained under the standard condition of 0 °C (273 K). It is obtained as 22.4 (volume of 1 mol of gas at 273 K) × 4 (molecular number bound to 1 molecule of hemoglobin)/64,458 (molecular weight of hemoglobin)/1000 (correction coefficient) [3, 4]. In the case of 37 °C (310 K), the coefficient should be 1.58 due to Boyle-Charles law or combined gas law (273 + 37)/273 × 1.39. On the contrary, the coefficient 0.0031 from the last item of the equation is derived from evidence on O_2 solubility at 37 °C (310 K). It is obtained as 0.0239 (Bunsen absorption coefficient α of oxygen at 37 °C) × 100/760 [5]. These items from the same equation are derived at different temperatures. Although equation (1) is established and is described in almost all published textbooks, the equation should be revised so that it is more clinically relevant. In lieu of equation (1), we propose a new temperature correction formula: CaO_2 (ml/dl) = 1.58 × Hb (g/dl) × SaO_2 + 0.0031 × PaO_2 (mmHg) at 37 °C and 1 atm. Lack of experimental results is one of limitations of our proposal, and we need to confirm them in clinical settings.

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