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CORRESPONDENCE

Understanding blood gas analysis

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Dear Editor,

Gattinoni et al. claim that the base excess (BE) is always higher, by 1.5–2 mmol/l, in venous blood (i.e., before the lung) than in arterial blood (i.e., after the lung), owing to lower pH and higher pCO_2 values [1]. However, the BE reflects the metabolic, non-respiratory, aspect of acid–base homeostasis, and there should therefore be no significant difference in BE values between venous and arterial blood samples, i.e. in the case of the metabolic harmless organ lung. If the difference were as high as stated by Gattinoni et al., the lung would have to generate 1.5–2 mmol/l H^+ every minute, thus decreasing the BE, i.e. (assuming a cardiac output of 5 l/min) 10,800–14,400 mmol H^+ per day; this is very unrealistic. Rather, the reported difference in the BE between venous and arterial blood is a method-related error resulting from use of non-optimal equations for calculating the BE. In fact, when using the modified Van Slyke equation, according to Zander [2], rather than the one originally proposed by Siggaard-Andersen [3] or by the National Committee for Clinical Laboratory Standards (NCCLS) [4], there is essentially no difference in the BE, irrespective of whether venous or arterial blood is used. The recommended equation for calculating the BE is as follows [2]:

$$\begin{aligned} BE = {} & (1 - 0.0143 \cdot cHb) \cdot [\{0.0304 \cdot pCO_2 \cdot 10^{pH} \\ & - 6.1 - 24.26\} + (9.5 + 1.63 \cdot cHb) \cdot (pH - 7.4)] \\ & - 0.2 \cdot cHb \cdot (1 - sO_2), \end{aligned}$$

where cHb (the content of hemoglobin) is measured in g/100 ml and pCO_2 in mmHg; the last term is a correction for oxygen saturation (sO_2) as a fraction. This is absolutely necessary due to the fact that oxygenated Hb is a stronger acid than deoxygenated Hb (the basis of the famous Christiansen–Douglas–Haldane-effect, i.e. oxygenation of the blood expels the CO_2 from blood into the alveoli). By using this equation, the BE can be obtained with very high accuracy from any blood sample, venous or arterial; furthermore, over a wide range of BE values (−30 to +30 mmol/l), mean inaccuracy is less than 1 mmol/l [2]. The proof of this has been published [5]: typical measured results (mean ± SD) obtained with blood from a cubital vein (50 healthy volunteers: colleagues and medical students) were pH 7.352 ± 0.023, pCO_2 51.2 ± 4.9 mmHg, pO_2 28.6 ± 10.2 mmHg, sO_2 49.2 ± 22.0%, and calculated BE, as a mean, was −0.1 ± 1 mmol/l.

As the BE is increasingly considered to be one of the most important tools in determining the severity of illness and in clinical decision making in the acute care setting, it is even more important to calculate the BE by means of a method that minimizes the influence of respiratory components on this merely metabolic parameter of the acid–base status of the blood. Venous blood can often be obtained more easily than arterial blood, and venous BE values are hardly different from arterial values, if calculated correctly.

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Compliance with ethical standards

Conflicts of interest
On behalf of all authors, the corresponding author states that the authors have no conflict of interest.

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