

Association between plasma ionized calcium and lactate concentration

Dear Sir,

Within this journal Cooper et al. [1] reported an unexpected association between decreased blood ionized calcium (cCa^{++}) and increased blood lactate concentrations in critically ill patients. They concluded that this might be clinically important and the mechanism deserves further investigation.

However, the described dependence can be totally explained by methodological reasons only. In a recent paper Zander [2] described a strong dependence between the concentration of ionized calcium (cCa^{++}) measured by ion-selective electrodes (ISE) and the concentrations of so-called metabolizable anions like acetate, lactate or malate. With increasing concentrations of these anions in aqueous solutions of defined calcium concentrations the measured cCa^{++} decreases. Cooper et al. [1] used measuring systems from Radiometer Copenhagen. Last year, this company gave us the following statement concerning ISE: 'The described interferences are caused by changes in ionic strength and by the chelating effect, and are, therefore, expected and known'. For comparison, the results of both groups (Cooper et al. vs. Zander) are plotted within the same figure (Fig. 1). Taking the results of Cooper et al. from Table 2 (mean values of 9 patients) after correction of the cCa^{++} for the given pH (according to the NCCLS standard [3]) as well as those of Zander, one can find a good correlation between both investigations.

Conclusion: ISE are not suitable for the measurement of ionized calcium under clinical conditions when anions like acetate, lactate or malate are present in concentrations of about 5–10 mmol/l.

Yours faithfully,

R. Zander

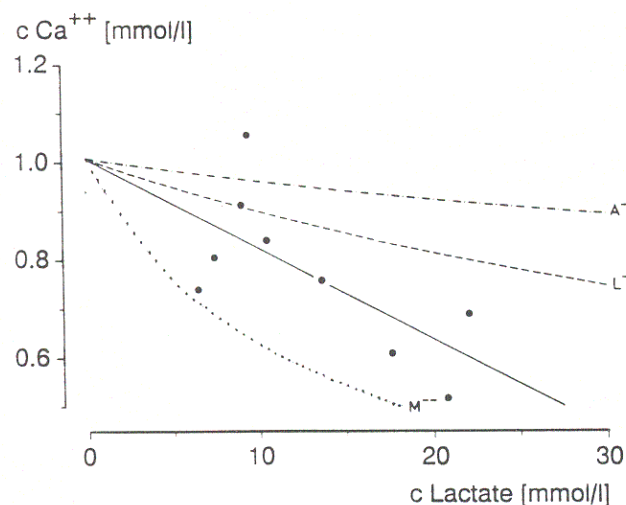


Fig. 1. Concentration of ionized calcium (cCa^{++}) in mmol/l as a function of the concentration of lactate ($cLactate$) in mmol/l from Table 2 of Cooper et al. (9 patients, dots) after pH-correction in comparison to results of Zander concerning cCa^{++} as a function of the given concentrations of acetate (A^-), lactate (L^-) and malate (M^-) in mmol/l

References

- Cooper DJ, Walley KR, Dodek PM, Rosenberg F, Russel JA (1992) Plasma ionized calcium and blood lactate concentrations are in-

versely associated in human lactic acidosis. *Intensive Care Med* 18:286–289

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Author's reply

Dear Sir,

Following in vitro studies in aqueous solutions Zander [1] reports that increasing concentrations of lactate ions are associated with decreased ionized calcium concentrations measured by ion selective electrodes (ISE). This observation in vitro is not new given that lactate ions are known to complex with and chelate calcium ions [2].

The observation of decreased plasma ionized calcium concentrations in critically ill patients with lactic acidosis [3], is therefore likely to be contributed to by lactate ions chelating calcium ions. Chelation is likely to occur equally in patients and in the blood being analysed by the ISE. Chelation is however unlikely to be the complete explanation for our observation given the complex biochemical environment of the critically ill patient.

Zander is not correct to conclude that "ISE's are not suitable for the measurement of ionized calcium concentrations under clinical conditions when lactate ions are present in concentrations of 5–10 mmol/l" for the following reasons: The calcium fraction which is physiologically active and which influences cellular function is the free or ionised fraction. The ISE "sees" the same uncomplexed or free calcium ions as are "seen" by the cells. When lactate ions chelate calcium ions the chelated calcium is no longer detected by the ISE and at the same time is no longer free to alter cellular function. The ISE therefore provides a clinically useful measurement in patients – the concentration of calcium ions which are physiologically active in the patient's blood. (For the same reason we believe that it is not appropriate to "correct" the measured ionized calcium concentration to a "normal" pH of 7.40, but instead the ionized calcium concentration at the actual pH of the patient's blood should be reported and used for clinical decision making).

The plasma ionized calcium concentration measured by ISE is a meaningful and clinically useful measurement in patients who have lactic acidosis.

Yours faithfully,

D. J. Cooper

References

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- Cooper DJ, Walley KR, Dodek PM, Rosenberg F, Russell JA (1992) Plasma ionised calcium and blood lactate concentrations are inversely associated in human lactic acidosis. *Intensive Care Med* 18:286–289

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