Key role of hematocrit on Strong Ion Difference variation induced by acute in-vitro changes of partial pressure of carbon dioxide in whole blood and isolated plasma.

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Introduction According to Stewart's approach, partial pressure of carbon dioxide (PCO_2) and Strong Ion Difference (SID) are considered independent variables determining the pH of a simple solution. However, recent studies have shown that changes in PCO_2 cause SID variations in complex fluids, such as whole blood. These SID changes are due to electrolyte shifts from red blood cells to plasma (and vice versa). [1]

Aim of this study was to describe the interplay between hematocrit (Ht) and SID during acute in-vitro PCO_2 changes in whole blood and isolated plasma.

Methods The blood of 28 healthy volunteers was studied. Whole blood, isolated plasma and blood diluted with its own isolated plasma were tonometered (Equilibrator, RNA Medical) with gas mixtures at varying CO_2 concentrations ranging between 2 to 20% in air. After equilibration, blood was analyzed for gases, pH and electrolytes (ABL800 FLEX, Radiometer). We calculated ΔPCO_2 and ΔSID as the difference between each value and the reference, defined for each subject as the sample with the lowest CO_2. A linear 3D equation was used to describe the interplay between $\Delta PCO2$, ΔSID and Ht (Sigmaplot 11.2, Systat Software Inc.). Data are expressed as median [IQR].

Results Hematocrit ranged from 0 to 62.1% (37.4 [0-45.5]%), PCO_2 ranged from 13.4 to 155 mmHg (58.2 [29.8-99.0] mmHg) and SID ranged from 29 to 53 mEq/L (42 [39-45] mEq/L). A strong correlation between hematocrit, ΔPCO_2 and ΔSID (r^2=0.81, p<0.001) was observed. The plane equation was $\Delta SID = -1.75 + 0.13*Ht + 0.07*\Delta pCO_2$.

Conclusions Hematocrit plays a key role in determining the magnitude of SID variation induced by variations in PCO_2.

References

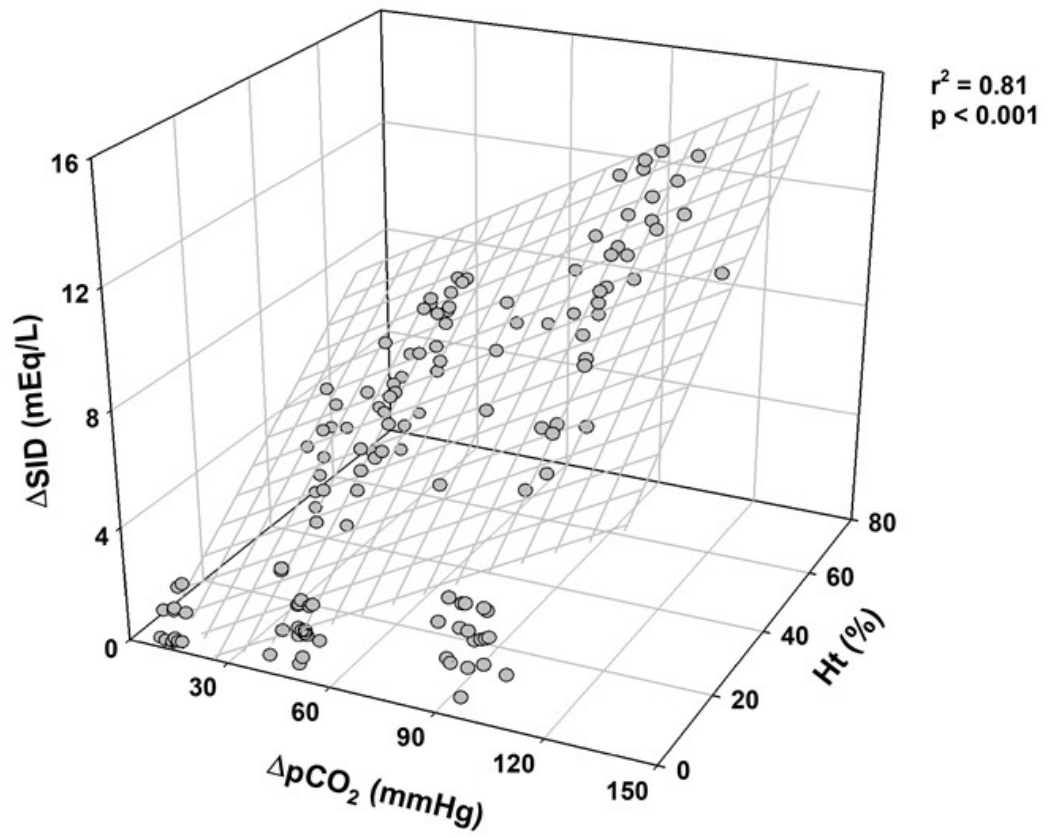[1] Langer T et al. J Crit Care 30(1):2-6, 2015

Fig. 1 Relationship between, ΔpCO_2 (mmHg), Ht (%) and ΔSID (mEq/L). The grid represents the 3D fitting of the data points. $r^2 = 0.81$ $p < 0.001$.