Measurement of Pre- or Post-Filter-Ionised Calcium Concentration during Continuous Veno-Venous Haemofiltration

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Dear Editor,

Thank you for publishing the results of our recent prospective, randomised, controlled study and for the commentary by Jacobs et al. in the same issue [1, 2]. In that commentary, the authors raise the issue of the measurement and control of post-filter-ionised calcium concentrations as a means of enhancing filter survival.

When we first began using regional citrate anticoagulation as our preferred method of continuous renal replacement therapy approximately 9 years ago, we were using a proprietary 14 mmol/l pre-filter substitution solution as regional citrate anticoagulation for a continuous veno-venous haemofiltration circuit at a rate of 2,000 ml/h [3]. At that time, we sampled post-filter blood for both clearance studies and adequacy of anticoagulation and invariably found that the post-filter $[ICa^{2+}]$ was less than 0.5 mmol/l and that our circuits lasted well. Since then for both purely practical safety reasons around the issues associated with drawing blood from a pressurised circuit using a sharp needle and in accordance with the local Health Department policy around preventing needle stick injuries [4], we have largely abandoned the practice. We do, however, continue to monitor serum-ionised calcium regularly by safely drawing blood from the indwelling intra-arterial cannula circuit

and replace both calcium and magnesium as necessary [1].

With the local discontinuation of the 14 mmol/l citrate solution and the subsequent use of first an 18 mmol/l and now a 15 mmol/l citrate solution, we see no practical requirement to sample post-filter blood; we, however, agree that such measurement may be necessary in the context of poor filter survival, for example, less than 24 h. At present, using a 15 mmol/l solution, our filters have a median survival of 66 h [1].

Our study was primarily concerned with the biochemical abnormalities associated with the different electrolyte compositions of the 2 fluids, notably the occurrence of a non-respiratory alkalemia with the 18 mmol/l solution. It also dealt with the effect that those differences had in patients over time – in those who were functionally anephric and hence unable to renally compensate for disturbances in their major extracellular electrolytes [1, 3]. In our study, filter survival was an interesting but only a secondary concern.

Finally, on an issue related to the use of citrate as an anticoagulant, I am motivated to make a remark. It is an erroneous and common misconception to state that citrate is metabolised to bicarbonate. In the Krebs Cycle, citrate is metabolised to carbon dioxide with the coproduction of NADH [5].

According to the tenets of the strong ion theory, any change in bicarbonate concentration is a result of secondary dissociation of carbonic acid in accordance with the law of mass action and the principle of macro-compartment electroneutrality and not as a result of primary metabolism [6]. In the plasma compartment, this defence of electroneutrality occurs as a consequence of perturbations in the concentrations of the major strong ions (sodium, chloride and L-lactate ($pK_a = 3.79$ at $25^\circ C$)) and the significant weak acids (albumin and inorganic phosphate). In our study, the non-respiratory alkalemia that occurred over time in the C18 group was due to the widening of the apparent strong ion difference (SIDa) as a result of the equilibration of the extracellular fluid over time with a high sodium content exogenous fluid (152 mmol/l) in patients who could not handle an excess sodium load because of renal failure. In the context of the assessment of a non-respiratory alkalemia, the use of SIDa is preferred over that of pH because of the co-dependency of pH and PCO_2 . Plasma chloride concentration remained within normal limits in both groups throughout. The presence of hypoalbuminemia also contributed to the significant non-respiratory alkalemia in the C18 group and the minor non-respiratory alkalemia in the C15 group.

References

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