Sodium variations during continuous veno-venous hemofiltration: A mathematical model and in-vitro study.

Francesca Mulazzani(1), Francesco Zadek(1), Beatrice Brunoni(1), Amos Bonaiti(1), Stefania Ubiali(1), Giovanna Esposito(2), Ilaria Giovannini(2), Thomas Langer(1),(2), Roberto Fumagalli(1),(2)

Affiliations
(1) Department of Medicine and Surgery, University of Milan-Bicocca, Monza, Italy.
(2) Department of Anesthesia and Intensive Care Medicine, Niguarda Ca' Granda, Milano, Italy.

Introduction

We recently observed a significant incidence of hyponatremia (Sodium<135 mmol/L) in patients treated with continuous venovenous hemofiltration (CVVH) (unpublished data). The possible role of fluids employed for regional anticoagulation and replacement was hypothesized. We simulated mathematically and measured in-vitro the sodium variations occurring during CVVH treatment.

Methods

A mathematical simulation was performed to estimate sodium variation occurring during CVVH with a set blood flow of 150 ml/min, regional anticoagulation and post-dilution replacement at 1500 ml/h. The sodium concentration [Na] of both citrate and replacement solutions was set at 140 mmol/L, as declared by the manufacturer. A 2 L-reservoir (either with 130 or 150 mmol/L of NaCl solution) was considered for the circuit. No weight loss nor recirculation was simulated.
An in-vitro CVVH study (PrisMax, Baxter; Prismaflex M150) was performed with the same parameters of the mathematical model, using diluted citrate (Prismocitrate 18/0, Gambro) and a balanced replacement fluid (Phoxilium, Baxter).

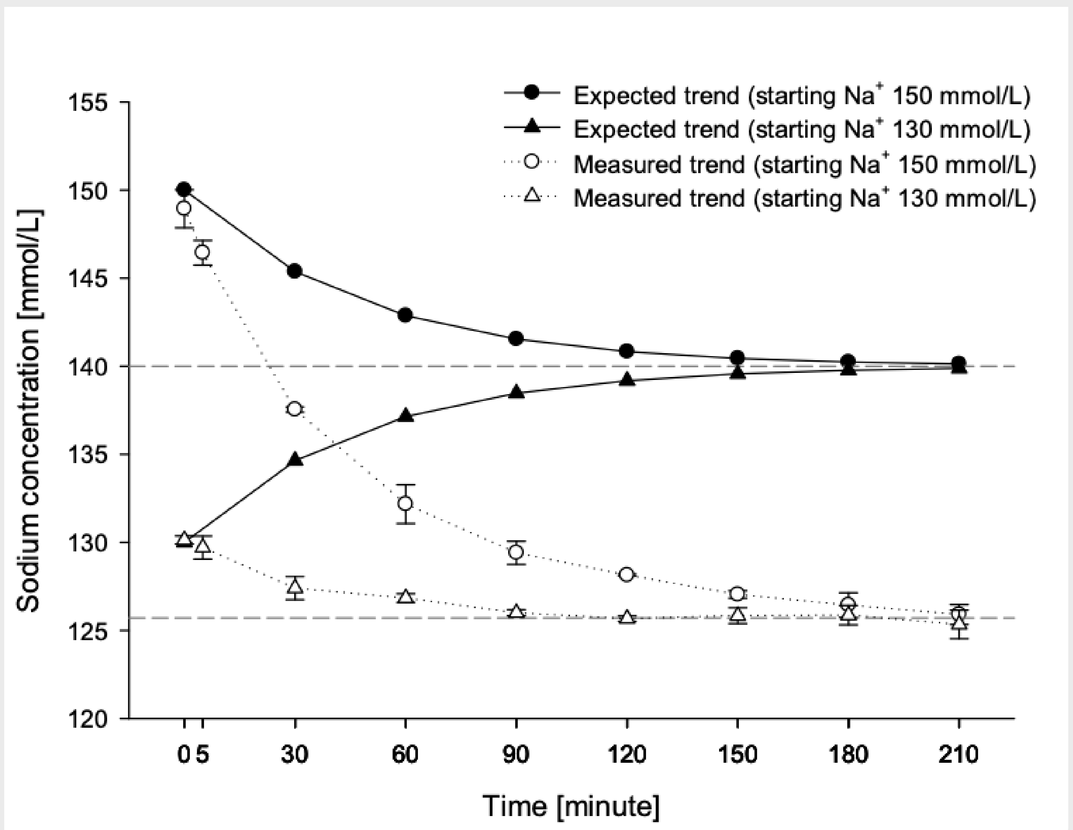

Figure 1A. [Na] according to mathematical model compared to [Na] changes observed in vitro.

Both employed solutions have a declared [Na] of 140 mmol/L. A 2-L fluid reservoir with starting [Na] of 150 or 130 mmol/L was linked to the CVVH circuit, and three experiments were repeated for each starting [Na]. [Na] was measured every 30 minutes (Rapid e500, Siemens Healthcare). A linear regression was performed between [Na] and Osmolality (mOsm/kg) measured by the freezing point technique at baseline and after 120 min.

Results

According to the mathematical model, [Na] of the reservoir should equilibrate to 140 mmol/L (i.e., [Na] of the employed fluids), regardless of the starting [Na]. Differently, [Na] of the in-vitro study tended to be 126 mmol/L (**Figure 1A**). The osmolarity measurement confirmed the reliability of sodium measurements (R=0.98, p<0.001) (**Figure 1B**).

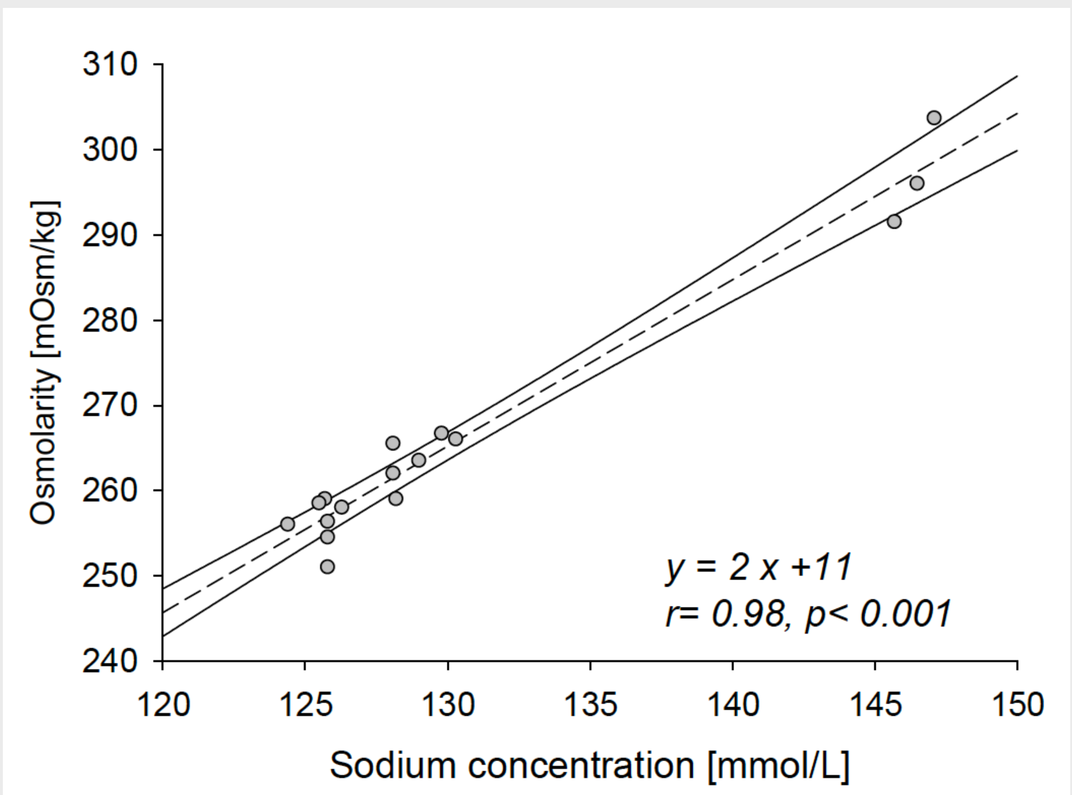

Figure 1B. Linear regression between [Na] and Osmolality.

Conclusion

In this in-vitro CRRT study, sodium tends toward a value of 126 mmol/L, which markedly differs from the expected value of 140 mmol/L.