The HemoControl System in On-Line Hemodiafiltration: "The SOCRATHE Study" on Sodium Balance

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Aims:

The European Best Practice Guidelines on hemodynamic instability [1] propose, among the possible strategies to prevent intradialysis hypotension (IDH), the use of convective treatments and the application of individualized blood volume controlled feedbacks. It is well documented that convective therapies reduce cardiovascular mortality, especially with high infusion volumes [2, 3, 4]. Furthermore, numerous studies demonstrated that the HemoControl™ (HC) biofeedback system on Blood Volume (BV) improves intra-dialysis cardiovascular stability [5, 6]. However, this system has never been used in On-Line Hemodiafiltration treatments (OL-HDF): the combination of HC benefits with those of high-volume convective treatments could instead be of major clinical interest. Since HC continuously modifies the dialysate conductivity, the aim of this study was to verify if both the applications of HC (in HD or OL-HDF) produce the same results in terms of sodium (Na^+) balance.

Methods:

A new Na^+ kinetic model was developed, as compared with the previous one used in HD+HC, to take into account, apart from dialysate Na^+, both the infused Na+ and that removed by convective transport [7]. This model was tested in a prospective, randomized, cross-over, pilot study (**SOCRATHE**, NCT01582867). Six patients were treated on 2 different modalities, i.e. HD+HC and OL-HDF with HC (HDF+HC). Each phase consisted of 6 HD (or OL-HDF) conventional treatments followed by 12 treatments with HC activated. Each patient acted as his/her own control. Plasma Na^+ concentrations (Na_p, measured every hour by ion selective sodium electrode), Na^+ mass balance (Na_{MB}, estimated through the model and normalized to the total weight loss, Na_{MB}/TWL), interdialytic weight gain (IDWG), blood pressures (BP), BV trends and thirst scores reported by the patients (TS, Likert type scales from 1=never to 5=always thirsty) were collected. The initial HC prescription was the same in both phases and the investigator could lower the target Na^+ in the middle of HDF+HC phase basing on TS, BP and Na_p.

Results:

The mean infusion volume achieved in HDF+HC was comparable with that in OL-HDF (19,6 ± 3,4 vs 19,1 ± 3,7 L, p=0,50).

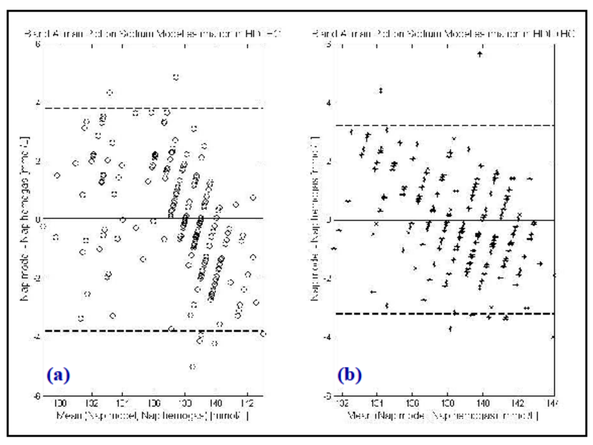


Figure 1

The accuracy of the new Na+ model was verified by comparing, for 72 HDF+HC treatments, plasma sodium concentrations measured by ion selective electrode with those estimated by the model (Bland-Altman plot (Figure 1(b)). The same analysis has been conducted on the previous model, used in HD+HC (Figure 1 (a)), that can be considered as a benchmark. The new model is able to estimate plasma sodium concentration with an accuracy not lower than the previous one.

No significant difference was found in IDWG, mean variation of Na_{MB} normalized to TWL, Pre and Post-Dialysis Systolic and Diastolic Blood Pressures. The thirst score was low in both therapies, slightly higher in HDF+HC (Table 1).

Table 1

	IDWG [Kg]	Na_{MB}/TWL [mmol/Kg]	Initial Na_p [mmol/L]	Final Na_p [mmol/L]	Pre-dialysis BP [mmHg]	Post-dialysis BP [mmHg]	Thirst Score
HD+HC	2,64 0,64	139 26	134,9 4,5	135,7 2,5	Systolic (**S**): 130 25 Diastolic (**D**): 63 17	**S**: 119 17 **D**: 63 15	7,4 2,9
HDF+HC	2,69 0,75	149 29	135,9 4,3	136,9 2,4	**S**: 126 22 **D**: 63 16	**S**: 119 16 **D**: 61 11	9,2 2,7
p-value (ANOVA)	p=0,63	p=0,080	p<0,05*	p<0,05*	**S**: p=0,080 **D**: p=0,663	**S**: p=0,968 **D**: p=0,054	p<0,05*

Figure 2

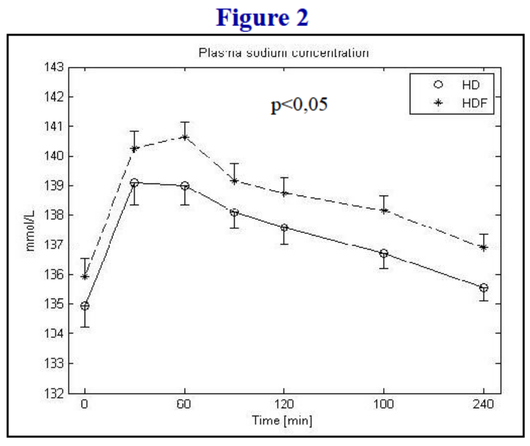
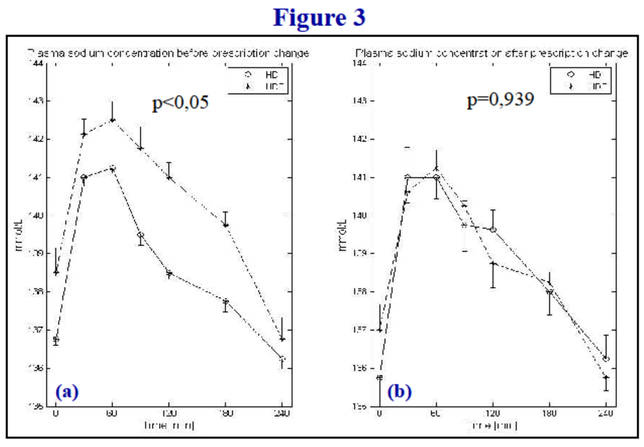


Figure 3



No significant difference was found in the relative changes of BV between the two treatments (ANOVA, p=0,419). Overall analysis on Plasma Na^+ concentration indicates the possibility of Na_p increment during HDF+HC treatments (ANOVA, p<0,05), Figure 2. This evidence is confirmed comparing Initial and Final Plasma Na^+ concentrations (Table 1). In the middle of HDF+HC phase, a decrease of 1 mmol/L in Final Target Plasma Na^+ concentration has been prescribed for three patients.

Figure 3 reports the comparison between the Plasma Na^+ concentrations in the two modalities before (a) the HemoControl prescription change (ANOVA, p<0,05) and after (b) this modification has been actuated (ANOVA, p=0,939).

Conclusions:

The concurrent use of a biofeedback system does not lower the effectiveness of standard OL-HDF treatments. The new Na^+ kinetic model implemented in OL-HDF resulted able to estimate plasma sodium concentrations in a reliable way. The integration of this model with HC system allows to profile dialysate Na^+ and WLR in high-volume convective treatments, with no significant differences in terms of blood pressures and interdialytic weight gain. To obtain the same post-dialysis plasma Na^+ concentration in HDF+HC, compared to conventional HD+HC, the recommendation is to lower the Final Target Na^+ prescribed in HC by 1 mmol/L avoiding, in this way, the risk of Na^+ retention. Further studies are necessary to demonstrate if such a system is able to produce relevant clinical benefits in the long term.

References:

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[7] Patents ID WO 2012/172398 *and WO 2012/127298*