Early estimation of plasma conductivity (PC) in dialysis patients: correlation with sodium (sNa^+) and potassium (sK^+) serum levels

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Carlo A. Lodi[1], Alessandro Surace[1], Elena Grandi[1], Paolo Rovatti[1], Elena Mancini[2], Antonio Santoro[2]

[1]Innovation Department, Gambro Dasco S.p.A., Medolla, Italy; [2]Nephrology Dialysis Hypertension, Teaching Hospital S.Orsola-Malpighi, Bologna, Italy

Introduction

Dialysis fluid composition may influence treatment tolerance, body fluid distribution and, accordingly, the achievement of a correct dry body weight in hemodialysis (HD) patients [1].

Hypertonic dialysis fluid will cause intracellular dehydration, with consequent increase in vasopressin release and thirst perception, resulting in a greater inter-dialytic weight gain and hypertension [2, 3].

On the other side, hypotonic dialysis fluid will cause a water shift in the intracellular pool, favoring hypovolemia and hypotension risk during dialysis [1, 2, 4].

Recently, opinions are moving towards the idea that sodium and, more generally, tonicity in the dialysis fluid should be individualized according to patients' peculiarities [2, 3, 5].

Thus, estimating the plasma composition at the beginning of the HD session may be a great support for a correct dialysis fluid prescription.

Unfortunately, in dialysis centers the initial serum concentration of the main ions can be estimated only by external instruments.

Objectives

We conceived a new method for an early estimation of PC by the dialysis machine. In order to assess the effectiveness of this estimation, the correlation between estimated PC and the values of sNa^+ and sK^+ measured before treatment start was evaluated.

Methods

The patient initial PC was empirically estimated by a formula based on blood flow and dialysis fluid flow and conductivity upstream and downstream the dialyzer as soon as the diffusion process is stable.

We retrospectively analyzed data from 250 HD sessions executed in 2012 and 2013 on 25 patients (19 males) at S.Orsola-Malpighi Hospital (see Table 1).

For each session pre-dialysis sNa^+ and sK^+ were measured by means of an ion selective electrode. The initial PC was estimated by applying *a posteriori* the new proposed method on treatment data automatically stored by the machine.

Table 1: Patients' characteristics (Mean SD)

Age	74 11
Dry Weight [Kg]	71.6 16.2
Pre-dialysis Na^+	136.0 3.4
Pre-dialysis K^+	4.7 0.8
Diagnoses of renal disease	Diabetic nephropathy (10) Hypertensive Nephropathy (8) Polycystic kidney disease (3) Others (3)
Treatment type	Hemodialysis

A regression analysis was conducted in order to evaluate the relationship between estimated PC, sNa^+ and sK^+. A Bland-Altman plot was finally applied to highlight possible estimation errors bias and to show 95% confidence interval of such errors.

Results

The relationships between PC and sNa^+ and between PC and the sum of sNa^+ and sK^+ are shown in Figure 1 and 2, respectively.

Figure 1: PC – sNa^+ correlation

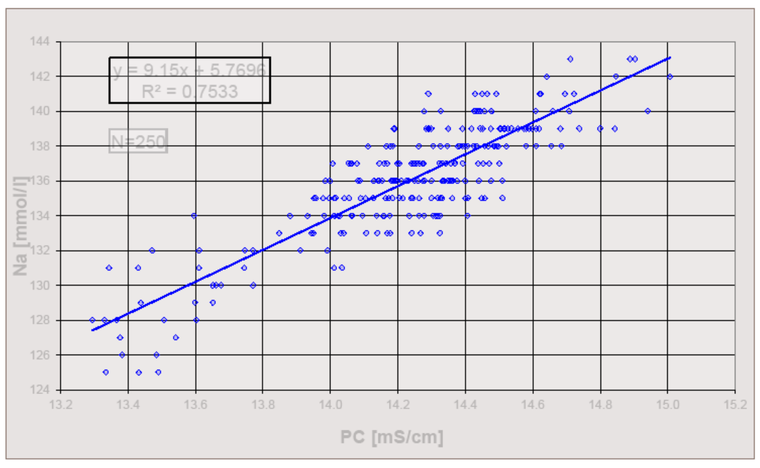


Figure 2: PC – (sNa^+ + sK^+) correlation

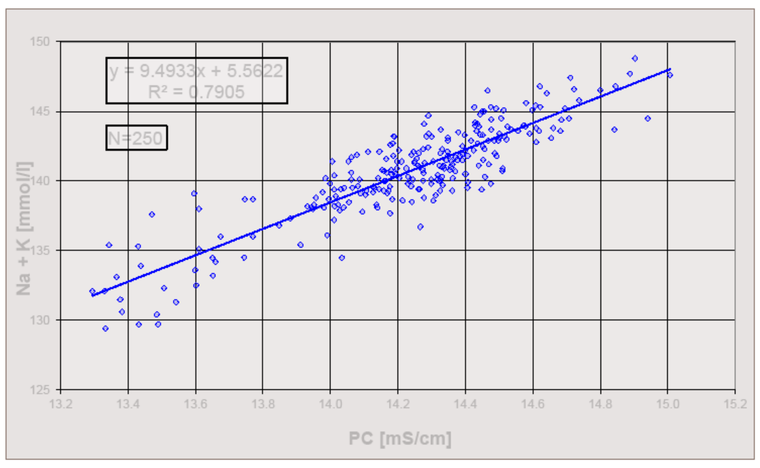
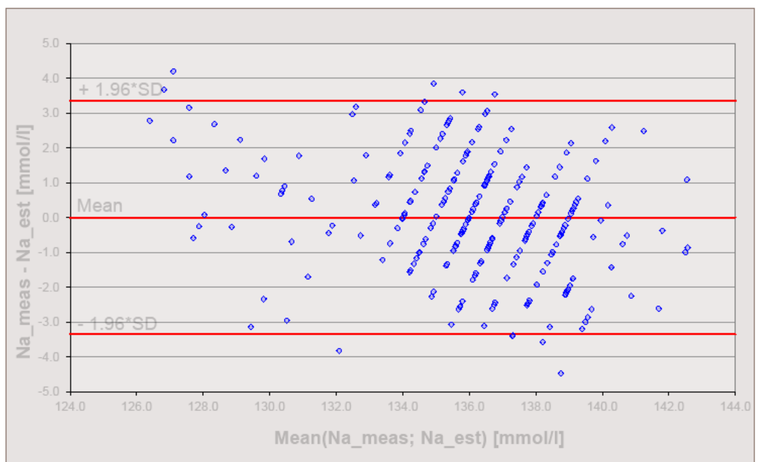
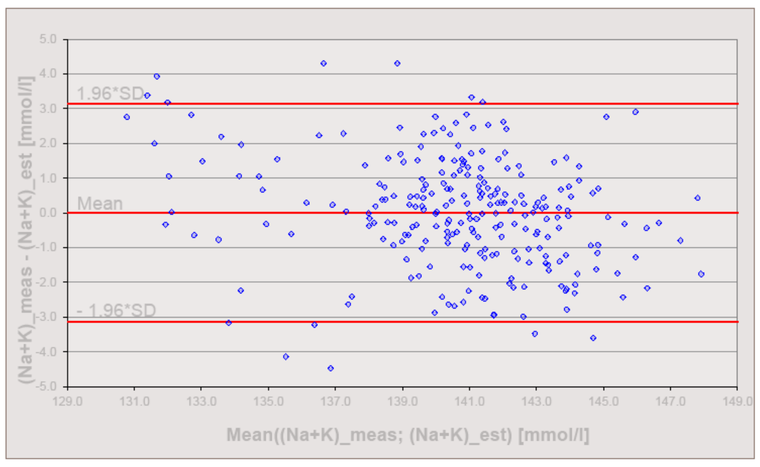


Figure 3: PC – sNa^+ Bland-Altman plot



Na_meas and Na_est are sNa^+ measured and estimated through the correlation with PC, respectively.

Figure 4: PC – (sNa^+ + sK^+) Bland-Altman plot



The correlation resulted high for both sNa^+ (R^2 = 0.75) and (sNa^+ + sK^+) (R^2 = 0.79).

The concentrations' estimation error was not biased, with a null mean value and with 95% confidence intervals equal to 3.36 mmol/l for sNa^+ and 3.13 mmol/l for (sNa^+ + sK^+) estimation (see Figure 3 and 4, respectively).

Conclusions

The proposed method is very simple, as the calculation is based on parameters acquired by any dialysis machine equipped with a conductivity sensor downstream the dialyzer. Moreover, there is no need of prescription changes.

Early detection of the initial PC value, obtained after few minutes from diffusion process start and without any manual intervention, allows individualizing plasma tonicity variation on the basis of the patient's initial status.

The calculated PC correlates very well with both sNa^+ and the sum of sNa+ and sK^+. The estimation errors are comparable with the accuracy of the instrumentation used to measure the benchmark values of these concentrations.

The contemporary use of the two presented estimators could be useful to evaluate initial sNa^+ and sK^+ and to personalize the dialysis prescription consequently.

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Disclosure

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