Influence of sodium profile in preventing complications during hemodialysis

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Abstract

Although a safe procedure, hemodialysis (HD) can cause numerous complications. The objective of this study was to evaluate the incidence of complications during dialysis, interdialytic weight gain, and the predialysis and postdialysis blood pressure in HD patients with and without variable sodium. Patients were observed during 12 HD sessions and those presenting with recurrent hypotension were selected for a step-wise model of variable sodium profiling. A total of 53 patients were evaluated; the mean-SD age was 53.7 ± 16.3 years and 22 (41.5%) were male. Of these, 18 (34.0%) were selected to receive variable sodium profiling: the mean (SD) age was 59.9 ± 12.6 years, and 10 (55.6%) were female. A significant decline in the occurrence of cramps ($p<0.027$), in the mean interdialytic weight gain ($p<0.009$), and a tendency to reduce the number of hypotensive episodes were detected in patients using variable sodium profiling. On the other hand, predialysis systolic blood pressure presented a significant increase ($p<0.048$). Using variable sodium, there was a statistically significant reduction in cramps and in the mean interdialytic weight gain. There was a significant increase in predialysis systolic pressure. Regarding hypotension episodes, only a tendency toward a reduction in the frequency of hypotension episodes could be detected.

Key words: Sodium, sodium profiling, hemodialysis, dialysis solutions, hemodialyis complications

INTRODUCTION

Around 90% of end-stage renal disease (ESRD) patients in Brazil are treated with hemodialysis (HD). Although a safe procedure, it can have adverse effects. Hypotension still occurs in 20% to 30% of HD patients. It is primarily the result of the removal of a large quantity of fluid in relation to the plasma volume during a HD session. A reduction in blood volume results in decreased cardiac filling, which in turn reduces the cardiac output and leads to hypotension.[1] Therefore, the pathophysiology of hypotension during dialysis is a reduction in the circulating volume induced by ultrafiltration, which is facilitated by the decline of extracellular osmolarity caused by the active removal of solutes, especially sodium. This results in the transfer of fluids from outside to inside the cell, increasing the intracellular volume and lowering the extracellular volume.[2]

Due to technological advances, modern HD machines are equipped with features that allow programming the ultrafiltration profile and varying sodium concentrations in the dialysate ("variable sodium or sodium profiling"), features that may reduce the occurrence of symptoms during and after each HD session.[3,4]

Other complications that can occur during HD, in order of frequency, are cramps (5–20%), nausea and vomiting (5–15%), headache (5%), chest pain (2–5%), back pain (2–5%), itching (5%), fever and chills (<1%), and these adverse events have been implicated in termination of dialysis before the prescribed time.[1,3]

Regarding the opinion of nephrologists on the use of variable sodium, 26% favored its use in order to reduce

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complications during dialysis for all patients, 33% believed that variable sodium should only be used with excessive weight gain, and 38% were in favor of using it only in selected patients.[5]

The objective of this study was to evaluate the incidence of complications during HD, interdialytic weight gain, and the predialysis and postdialysis blood pressures in HD patients with and without variable sodium profiling.

PATIENTS AND METHODS

Patients were observed during 12 HD sessions and those presenting with symptomatic hypotension and treated with saline, mannitol, and/or Trendelenburg position were selected for sodium profiling during their next 12 HD sessions. Fresenius Medical Care machines 4008B, 4008E, and 2008C were used. Sodium profile treatment was used from the first hour of dialysis. The standard concentration of sodium in the dialysate was 139 mEq/L, and for sodium profiling the concentration was set at 147 mEq/L and then reduced by 2 mEq/L at 20-min intervals until the final concentration of 139 mEq/L was reached, at 1 hr and 20 min of treatment, characterizing the step-wise model of variable sodium.[4] To be included in the study, patients had to be older than 18 years and on HD 3 times a week for more than 3 months. During each dialysis session, the following information was gathered: complications during dialysis, interdialytic weight gain, predialysis and postdialysis blood pressures. The study was approved by the University Ethics and Research Committee and all participants signed the informed consent. Data were analyzed using EpiInfo 2000 Version 1.0.3 (Centers for Diseases Control and Prevention, Atlanta, GA, U.S.A.) and Excel software (Microsoft, Redmond, WA, U.S.A.). Student's t test was used to evaluate the difference between the averages of 2 independent groups. The significance level adopted was $\alpha = 0.05$.

Table 1 Clinical and demographic characteristics of the patients (n = 18)

Variable	Summary
Age (years)	59.9 ± 12.6
Female, n (%)	10 (55.6)
Vascular access	
Arteriovenous fistula n (%)	17 (94.4)
Dialysis time per week	
Twelve hours n (%)	17 (94.4)
Etiology	
Hypertensive nephropathy n (%)	9 (50.0)
Diabetes n (%)	7 (38.9)
Glomerulopathy n (%)	1 (5.6)
Polycystic kidneys n (%)	1 (5.6)

Data are presented as mean ± standard deviation or frequency (percentage).

RESULTS

Fifty-three patients were initially evaluated, and the clinical characteristics were as follows: 22 (58.5%) were male, mean age 53.7 ± 16.3 years. An arteriovenous fistula was the vascular access in 46 (86.8%) patients and 50 (94.3%) were dialyzed for 12 hr a week. The etiology of ESRD was hypertensive nephropathy in 47% (n = 25), diabetes in 30.2% (n = 16), polycystic kidney disease in 3.8% (n = 2), glomerulopathy in 3.8% (n = 2), and others 15% (n = 8).

The review of 636 sessions showed that adverse effects occurred in 182 (28.6%) sessions. The frequency of complications was as follows: hypotension (42.3%), cramps (16.5%), malaise (10.4%), headache (8.2%), and nausea and/or vomiting (7.1%). Of the 53 patients observed, 18 (34.0%) presented recurrent hypotension and received variable sodium, and their clinical and demographic characteristics are shown in Table 1.

Table 2 Mean interdialytic weight gain and mean prehemodialysis and posthemodialysis systolic and diastolic blood pressures (BP) with and without the use of variable sodium

	Without sodium profile (n = 204 sessions)	With sodium profile (n = 177 sessions)	p[a]
Interdialytic weight gain (kg)	2.78 ± 1.0	2.5 ± 1.1	0.009
Predialysis systolic BP (mmHg)	149.5 ± 23.5	154.5 ± 25.4	0.048
Predialysis diastolic BP (mmHg)	84.1 ± 12.2	86.4 ± 13.4	0.091
Postdialysis systolic BP (mmHg)	136.8 ± 22.3	140.7 ± 23.4	0.097
Postdialysis diastolic BP (mmHg)	80.3 ± 11.4	78.2 ± 10.7	0.073

Data are presented as mean ± standard deviation.
[a]t test for independent samples.

Table 3 Incidence of complications during dialysis with and without the use of a sodium profile

Complications during dialysis	W/O variable sodium (n = 204 sessions)	OR	95% CI	W/variable sodium (n = 177 sessions)	Chi-square
Hypotension n %	63 (67.7)	0.70	0.43 to 1.13	42 (53.2)	0.148
Cramps n %	10 (10.7)	0.11	0.01 to 0.85	1 (1.3)	0.027
Malaise n %	11 (11.8)	1.16	0.46 to 2.7	11 (13.9)	0.902
Headache n %	4 (4.3)	3.31	0.95 to 12.59	11 (13.9)	0.062
Nausea and/or vomiting n %	9 (9.7)	1.03	0.35 to 2.97	8 (10.1)	0.843

W/ = with; W/O = without.

Of the 18 patients included in the study, 14 (77.8%) completed the 12 HD sessions follow-up. One was transplanted after the first session with a sodium profiling, one became hypertensive during the first 2 hr of HD, and one was transferred to peritoneal dialysis, but still received the treatment for 7 sessions. Table 2 shows the interdialytic weight gain and pre and post systolic and diastolic blood pressures.

Table 3 presents the complications with and without sodium profiling.

DISCUSSION

Hypotension as an intradialytic event was less frequent when a sodium profiling was used, although the data are not statistically different. Some authors describe no difference in the frequency of hypotension with and without the use of variable sodium,[6–11] although a statistically significant decline has been described by others.[2,12–14] The use of variable sodium treatment in association with the ultrafiltration profiling seems to result in a significant decline in hypotensive episodes.[15] It is possible that with the use of sodium and ultrafiltration profiling, together with adequate fluid restriction and a low-sodium diet, the adverse events registered could be even less frequent, improving patients' well-being.

Cramps showed a statistically significant decline, similar to other studies.[14,15] A step-wise model of sodium profiling was used; however, the linear model, which lowers the concentration of the sodium in the dialysate in a constant and linear way,[4] is recommended to prevent cramps.[7] There was not a significant difference in malaise and nausea and vomiting, which are common complications, in agreement with a previous study.[14]

The mean interdialytic weight gain was significantly less, which is in agreement with another study.[8] Some authors have reported a significant increase in weight gain[3,12,14] while other studies report no significant change in interdialytic weight gain.[9,10,13] The predialysis systolic pressure increased significantly. Several studies described no changes in the predialysis and postdialysis systolic and diastolic blood pressures with and without the use of variable sodium.[2,9,13]

Excessive interdialytic weight gain and inability to achieve target weight may result in pulmonary congestion and/or heart failure. In the present study, the use of variable sodium did not result in weight gain; therefore, its use may benefit patients by reducing the incidence of adverse events during dialysis. Despite the controversial opinions about sodium modeling, it is not a one-size–fits-all solution[3] and should be used for those patients who have difficulty in achieving dry weight due to adverse events during dialysis.

In the present study, using variable sodium, there was a statistically significant reduction in cramps and in the average interdialytic weight gain, and a significant increase in predialysis systolic pressure. Regarding hypotension episodes, only a tendency to reduce the frequency of hypotension episodes could be detected. The role of nephrology nurse is vital in the management of day-to-day monitoring and balancing which adverse events to accept.[3]

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REFERENCES

1 Bregmen H, Daurgidas JT, Ing TS. Complicações durante a hemodiálise. In: Daurgidas JT, Blake PG, Ing TS eds. *Manual de diálise*. 3rd ed. Rio de Janeiro: MEDSI; 2003:151–172.

2 Jenson BM, Dobbe SA, Squillace DP, McCarthy JT. Clinical benefits of high and variable sodium concentration dialysate in hemodialysis patients. *ANNA J*. 1994; **21**:115–120.

3 Henning M. The controversy over sodium modeling: Should we use it or not? *Nephrol Nurs J*. 2006; **33**:505–509.

4 Corea AL, Christensen LS, Vogel SC. Patient and machine monitoring and assessment. In: Guth CF, Stoner MH, Corea LA eds. *Review of Hemodialysis for Nurses and Dialysis Personnel*. 5th ed. St Louis, Missouri: Mosby; 1993:125–145.

5 Stiller S, Bonnie-Schorn E, Grassmann A, Uhlenbussch-Körwer I, Mann H. A critical review of profiling for hemodialysis. *Semin Dial*. 2001; **14**:337–347.

6 Po CL, Afolabi M, Raja RM. The role of sequential ultrafiltration and varying dialysate sodium on vascular stability during hemodialysis. *ASAIO J*. 1993; **39**:M798–M800.

7 Sadowsky RH, Allred EM, Jabs K. Sodium modeling ameliorates intradialytic symptoms in young dialysis patients. *J Am Soc Nephrol*. 1993; **4**:1192–1198.

8 Dominic SCR., Ramachandran S, Somiah S, Mani K, Dominic SS. Quenching thirst in dialysis patients. *Nephron*. 1996; **73**:597–600.

9 Levin A, Goldstein MB. The benefits and side effects of ramped hypertonic sodium dialysis. *J Am Soc Nephrol*. 1996; **7**:242–246.

10 Flanigan MJ, Quersh T, Khairullah QT, Lim VS. Dialysate sodium delivery can alter chronic blood pressure management. *Am J Kidney Dis*. 1997; **29**:383–391.

11 Movilli E, Camerini C, Viola BF, Bossini N, Strada A, Maiorca R. Blood, changes during three different profiles of dialysate sodium variation with similar intradialytic sodium balances in chronic hemodialyzed patients. *Am J Kidney Dis*. 1997; **30**:58–63.

12 Fischbach M, Tarral E, Geisert J. Sequential hypertonic haemodialysis in children. *Pediatric Nephrol*. 1988; **2**: 442–446.

13 Acchiardo SR, Hayden AJ. Is Na^+ modeling necessary in high flux dialysis? *ASAIO Trans*. 1991; **37**:M135–M137.

14 Sang GL, Kovithavongs C, Ulan R, Kjellstrand CM. Sodium ramping in hemodialysis a study on beneficial and adverse effects. *Am J Kidney Dis*. 1997; **29**:669–677.

15 Al-Hilali N, Al-Humoud HM, Ninan VT, Nampoory MR, Ali JH, Johny KV. Profiled hemodialysis reduces intradialytic symptoms. *Transplant Proc*. 2004; **36**:1827–1828.