Time Needed to Improve Clinical Parameters By Daily Hemodialysis

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Daily hemodialysis therapy (DHD), 2 hours, 6 times per week, is able to cure complications that persist on standard hemodialysis (SHD), 4 hours, 3 times per week. Cardiovascular manifestations (high blood pressure, left ventricular hypertrophy), nutritional deficient states, and postdialysis asthenia are improved during the first month of DHD therapy and are usually cured at 3 months. Daily hemodialysis may be considered as a rescue therapy. The next step will be to select which patients can return to the classical SHD therapy without recurrence of their complications.

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Key words

Daily hemodialysis, rescue therapy, blood pressure control, left ventricular hypertrophy, nutrition

Introduction

Standard hemodialysis (SHD) has been considered unphysiological because of large swings in pre- and postdialysis concentrations of solutes and fluid volumes [1]. It has been shown that daily hemodialysis (DHD) is a more physiological strategy, leading to a better urea time-averaged concentration (TAC), urea time-averaged deviation (TAD), and standard Kt/V [std(Kt/V)] [2], along with reduced interdialytic weight gains, thus allowing an improved cardiovascular status with better blood pressure (BP) control and regression of left ventricular hypertrophy (LVH). Malnutrition is also ameliorated with an increased normalized protein catabolic rate due to the disappearance of anorexia [3–5].

Persisting complications with SHD (3 times/week) disappear when the patients transfer to DHD strategy. Daily hemodialysis may thus be considered as a "rescue therapy." The purpose of this report is to present data to determine how much time is needed to reverse the malnutrition, cardiovascular complications, and dialysis intolerance present in SHD patients after transfer to DHD.

Material and methods

Five patients on SHD (4 hours, 3 times/week) for several years were transferred to DHD (2 hours, 6 times/week) for 14 – 22 months. The same hemodialysis parameters were used: same machines, same dialyzer (polysulfone and polymethylmethacrylate), same blood flow (250 – 300 mL/min), same bicarbonate buffer, and the same dialysate flow (500 mL/min). The weekly dialysis duration remained unchanged (12 hours/week).

Patients' ages varied from 24 to 67 years. Some were hypertensive with left ventricular hypertrophy. Native arteriovenous fistulas provided blood access with desired blood flow of 250 – 300 mL/min.

Blood pressure was measured every day. Pre- and postdialytic urea levels were measured once weekly. Time-averaged concentration and TAD were calculated according to the simplified equations reported elsewhere [2]. Standard Kt/V and equilibrated Kt/V (eKt/V) were calculated according to the formulas of Gotch [6]:

$$\text{std(Kt/V)} = 7 \times 1440\,[0.184\,(\text{PCRn} - 0.17)]/C_0 \text{ weekly},$$

where PCRn is the normalized protein catabolic rate and C_0 is the predialysis BUN;

$$\text{eKt/V} = \text{spKt/V}[1 - 0.6/(t/60)] + 0.03,$$

where spKt/V is single pool Kt/V.

Hemodialysis quantification was performed once a month during a midweek session, using a Biostat 1000 on-line urea monitor (Baxter Healthcare, Deerfield, IL, U.S.A.) and a semi-automatic bath dialysis sampler (Quantispal, Hospal, France). Dietary assessment over 3 – 4 days was carried out every 3 months. Every 6 months echocardiography was performed with left ventricular mass determination.

Data are expressed as mean ± SD at 3 months on SHD, and at 1, 2, 3, 6, 9, and 12 months on DHD. Student's *t*-test was used for statistical analysis, and a was set at 0.05.

All patients gave informed consent according to the Declaration of Helsinki.

Results

Interdialytic weight gain was significantly reduced from 3.15 kg to 1.39 kg at one year. The mean weight gain between dialyses for the whole 12 months of DHD was 2.1. Systolic blood pressure (SBP) decreased from 145 mm Hg to 130 mm Hg after one year. Diastolic blood pressure (DBP) decreased from 88 mm Hg (SHD) to 82 mm Hg (DHD) at one year. Mean arterial blood pressure decreased from 107 mm Hg (SHD) to 97 mm Hg (DHD) at the same time. These changes are statistically significant. Figure 1 shows an obvious trend of decreasing BP from the first month of DHD, and the drop

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became significant after 2 and 3 months of DHD for SBP and DBP, respectively. Left ventricular mass index and left end diastolic diameter decreased in all patients, and these changes are evident at 3 months (Fig. 2). These changes may appear even earlier as determined in one patient in whom echocardiographic investigations were performed every 2 months instead of every 6 months.

Nutritional status also improved. The PCRn rose from 1.04 g/kg/day (SHD) to 1.26 kg/day (DHD) after one year. These changes appeared rapidly during the first month of DHD and are statistically significant. Dry weight increased at the first month, and the tendency to increase dry weight persisted through the following months together with the clinical appearance of a better nutritional status. This was correlated with an increased calorie intake from 31 kcal/kg/day (SHD) to 41 kcal/kg/day (DHD) at 6 months (Fig. 3).

After one year of DHD, mean urea TAC was reduced from 18.16 mmol/L to 12.85 mmol/L; moreover, mean urea TAD was reduced from 4.41 mmol/L to 2.16 mmol/L. Reduction of urea TAC begins during the first month of DHD and becomes statistically significant after 6 months. Urea TAD is significantly reduced from the first month (Fig. 4). Weekly Kt/V significantly increased from a mean of 4.01 (SHD) to 5.0 at 12 months of DHD and std(Kt/V) from 2.14 (SHD) to 4.07 at 12 months of DHD. This change in TAD appears rapidly after the onset of DHD and is statistically significant at one month (Fig. 5).

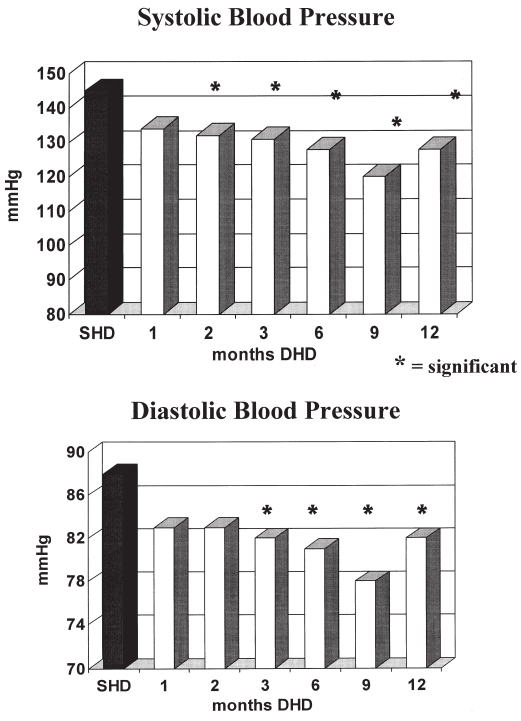

FIGURE 1 Systolic and diastolic blood pressure on standard hemodialysis (SHD) and daily hemodialysis (DHD).

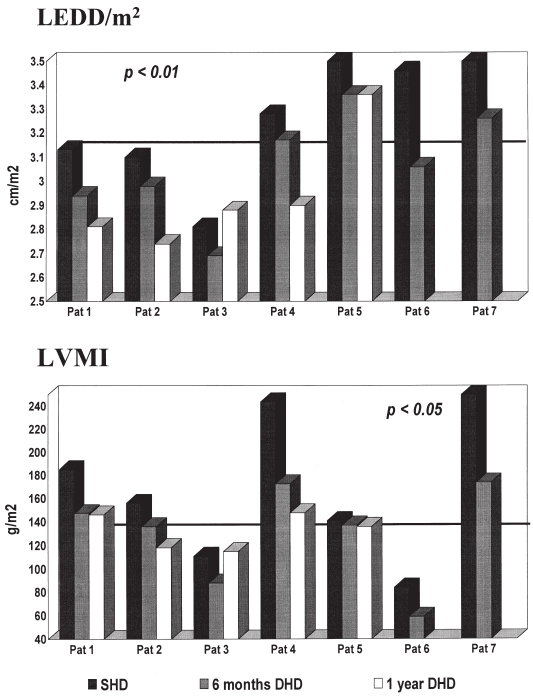

FIGURE 2 Left end diastolic diameter (LEDD) and left ventricular mass index (LVMI) in individual patients on standard hemodialysis (SHD) and at 6 and 12 months on daily hemodialysis (DHD).

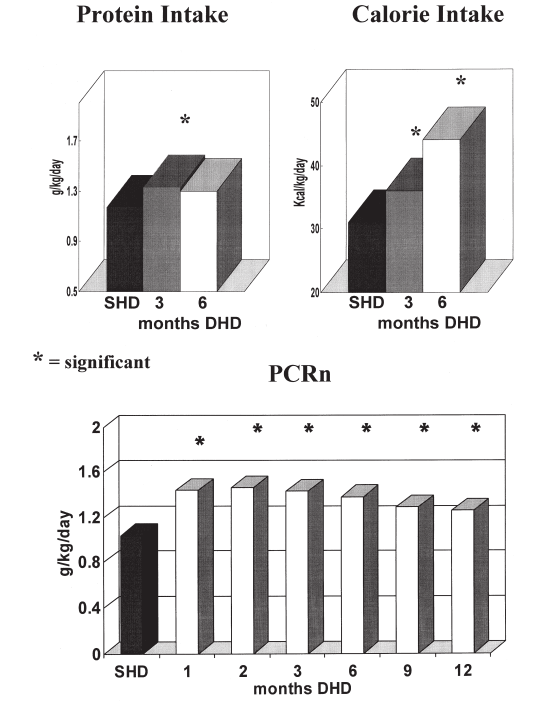

FIGURE 3 Protein and calorie intakes on standard hemodialysis (SHD) and at 6 and 12 months on daily hemodialysis (DHD), and normalized protein catabolic rate (PCRn) on SHD and DHD.

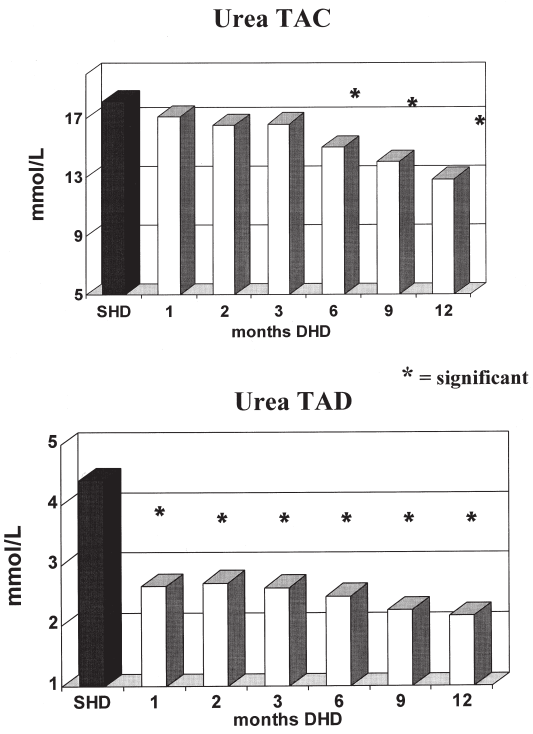

FIGURE 4 Urea time-averaged concentration (TAC) and urea time-averaged deviation (TAD) on standard hemodialysis (SHD) and daily hemodialysis (DHD).

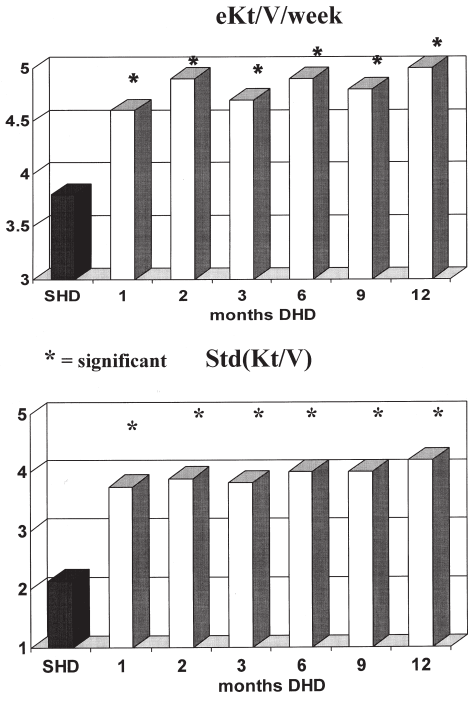

FIGURE 5 Equilibrated Kt/V (eKt/V) and standard Kt/V [std(Kt/V)] on standard hemodialysis (SHD) and daily hemodialysis (DHD).

The mean predialytic hemoglobin level on SHD was 13.5 g/L and 14.3 g/L at 12 months of DHD with the mean erythropoietin dose reduced from 4000 U/week on SHD to 850 U/week on DHD, a reduction of 79%. Blood phosphorus concentration decreased significantly after one month of DHD and went from 2.07 (SHD) to 1.9 mmol/L and remained lower throughout the whole time on DHD (Table I).

Discussion

Daily hemodialysis allows better control of interdialytic fluid gains (the change in weight was 3.15 kg during SHD and 2.1 kg during DHD and dropped to 1.36 at 12 months). This is probably one of the main advantages of DHD, which leads to better control of SBP and DBP and to regression of LVH. The present analysis shows that these changes appear rather rapidly after the beginning of DHD. Interdialytic weight gains are immediately reduced, leading to better BP control within 2 weeks. Left ventricular hypertrophy is reduced during the first 3 months.

Nutritional status improves during the first month as shown by increased dry body weight. Reduction of anorexia and an increase in PCRn appear during the first month. Optimal calorie and protein intakes are obtained after 3 months.

Lower TAD is one of the main factors that ameliorates postdialysis asthenia.

Drug administration was rapidly reduced within one month, and antihypertensive drugs were stopped. Erythropoietin was discontinued in 2 patients after the change to DHD. The reduction in erythropoietin dose with stable hemoglobin levels may be due to the increase of the dialysis dose and improved nutritional status, and has been observed by others with increased frequency of hemodialysis sessions [7].

Daily hemodialysis strategy applied for 3 – 6 months to chronic renal insufficiency patients with high blood pressure, LVH, nutritional deficient states, and postdialysis asthenia will lead to a disappearance of preexisting complications. We think that 10% – 15% of SHD patients could benefit from this strategy. The next step will be to select which patients can return to the classic SHD therapy without recurrence of these complications.

Conclusion

Daily hemodialysis is usually considered to be a definitive long-term strategy, mainly as home dialysis. It can also be conceived as a rescue therapy for patients doing poorly on SHD, despite adequate dialysis as judged by Kt/V above 1.2. These patients with persistent high BP, LVH, poor nutritional status, and postdialysis asthenia have a good chance of benefiting from DHD performed for 3 – 6 months.

TABLE I Results on SHD and at 1, 2, 3, 6, 9, and 12 months on DHD

	SHD	*1*	*2*	*3*	*6*	*9*	*12*
Change in weight (kg)	3.16	1.53[a]	1.46[a]	1.56[a]	1.75[a]	1.60[a]	1.39[a]
MBP (mm Hg)	107	100	99	99	97[a]	92[a]	97[a]
LVMI (g/m^2)	172				132[a]		133[a]
LEDD (cm)	5.46				5.1[a]		4.7[a]
Urea TAC (mmol/L)	18.16	17.11	16.55	16.61	15.02[a]	14.04[a]	12.85[a]
Urea TAD (mmol/L)	4.41	2.65[a]	2.7[a]	2.62[a]	2.48[a]	2.25[a]	2.16[a]
Weekly eKt/V	4.01	4.6[a]	4.9[a]	4.7[a]	4.9[a]	4.8[a]	5.0[a]
Std(Kt/V)/week	2.14	3.75[a]	3.89[a]	3.82[a]	4.01[a]	4.0[a]	4.07[a]
PCRn (g/kg/day)	1.04[a]	1.44[a]	1.46[a]	1.43[a]	1.38[a]	1.29[a]	1.26[a]
Dry weight (kg)	56.4	57	57.2	57.5[a]	58.2[a]	58.8[a]	61.9[a]
Hb (g/100 mL)	13.5	13.9	13.9	14.4	14.1	13.7	14.3
Phosphorous (mmol/L)	2.07	1.9[a]	1.79[a]	1.66[a]	1.77[a]	1.71[a]	1.79[a]

SHD = standard hemodialysis; DHD = daily hemodialysis; MBP = mean arterial blood pressure; LVMI = left ventricular mass index; LEDD = left end diastolic diameter; TAC = time-averaged concentration; TAD = time-averaged deviation; eKt/V = equilibrated Kt/V; std(Kt/V) = standard Kt/V; PCRn = normalized protein catabolic rate; Hb = hemoglobin.

[a] $p < 0.05$ compared to SHD.

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