Results of Daily Hemodialysis in Catanzaro: 12-Year Experience With 22 Patients Treated For More Than One Year

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Since 1985, we have been treating patients with daily hemodialysis (D-HD). We report our results with 22 patients treated on D-HD and daily home hemodialysis (DHHD) for a long-term period. Patients had very good survival of native forearm arteriovenous fistula access, and upper arm access with superficialized basilic vein. One access survived 18 years: 8 years on standard hemodialysis (STND-HD) and 10 years on D-HD. Only two fistulas failed. Blood pressure control in 12 hypertensive patients was obtained without antihypertensive drugs in 8 and with fewer medications in 4. Hematocrit and hemoglobin improved in all patients. Cardiothoratic index decreased in all patients, and we noticed a reduction in the most important echocardiographic indices in 12 patients with cardiac hypertrophy: intraventricular septum thickness, left ventricle posterior wall thickness, left ventricle internal diastolic diameter, and left atrium diameter. Data also showed improvement in nutritional status. For the most part, the levels of hormones normalized, with regular menstrual cycles in women and good sexual function in men.

In our experience both elderly and young patients with severe cardiovascular diseases, severe hypertension or hypotension, anemia, and nutritional problems can, with D-HD, achieve good quality of life and start work again. D-HD, in our opinion, is the treatment of choice for patients without comorbid conditions, because good metabolic control, good nutrition, and a more normal hormonal status allow them to feel well and to have an almost normal lifestyle.

(Home Hemodial Int, Vol. 2, 12–17, 1998)

Key words

Daily hemodialysis, daily home hemodialysis, vascular access, echocardiographic indices, nutritional status, quality of life, hormones

Introduction

Despite the new technical achievements in dialysis during the last two decades, the prognosis of chronic dialysis patients is still poor compared to that of the general population, and their quality of life and rehabilitation are often impaired. Furthermore, an increasing number of elderly and sick patients are accepted for dialysis.

A dialytic treatment that achieves lower morbidity and mortality, better quality of life with increased independence, full capacity for physical and intellectual work, and a good psychosocial status is a desired goal for nephrologists. In our experience, a daily dialysis schedule, first tried by Bonomini (1) and then extensively evaluated by Buoncristiani (2,3), yields the best results on a long-term basis.

Materials and methods

Records of 22 patients, 11 male and 11 female, with end-stage renal disease, treated with chronic daily hemodialysis (D-HD: 90–120 min, 6 to 7 times/week) from September 1985 to October 1997, and treated for more than one year, were reviewed retrospectively. Until 1992 we were using D-HD with recycled bicarbonate; since then, we have been using single-pass bicarbonate hemodialysis. Eleven patients performed D-HD at home and 11 patients at the center.

The following demographic information was obtained: age, sex, time on standard hemodialysis (STND-HD) and time on D-HD, underlying renal disease, and comorbid conditions (hypertension 12 patients; diabetes mellitus 3; dilated cardiomyopathy 3; ischemic cardiomyopathy 2; ascending aortic aneurysm 1; peripheral vascular disease 1; vasculitis 1; systemic lupus erythematosus (SLE) 1; cryoglobulinemia 1; rheumatoid arthritis 1; malignancy 1 patient). We also gathered other information: hospitalization (days/patient/year) (Table I), final outcome of patients and cause of death, type and survival of vascular access, blood pressure control in 12 hypertensive patients; cardiothoracic index changes in 22 patients; hematocrit and hemoglobin changes in 22 patients, including 5 patients receiving erythropoietin (Epo) 2000 U/week; and lipid lipoprotein serum profiles in 21 patients.

An annual echocardiogram was performed in 12 patients (left ventricular posterior wall thickness, intraventricular septum thickness, left ventricular diastolic diameter, left ventricular systolic diameter, and left atrium diameter). The following laboratory tests were assessed annually: triiodothyronine (T^3), thyroxine (T^4), thyroid-stimulating hormone, free T^3, free T^4, testosterone, luteinizing hormone, follicle-stimulating hormone, prolactin, adrenocorticotropic hormone, cortisol, estrogen, insulin, calcitonin, and osteocalcin. Serum transferrin and parathormone were measured semiannually. Some indices of nutritional status were assessed monthly: serum total protein, serum albumin, and serum cholesterol.

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TABLE I Twenty-two patients on daily hemodialysis (D-HD) investigated over 12 years

Patients	*Age at onset D-HD (range)*	*Months on D-HD*	*Hospitalization (days/patient)*	*Renal disease*	*Comorbid conditions*
Lifestyle ↓ 7 home 12 patients ↗ (5F, 7M) ↘ 5 clinic	47.5 (27–70)	74 (12–127)	8.33 (0–35)	GN 10 DM 3 PKD 4 IN 1 SLE 1 Vasc. 1 Nephroscler. 2	Hypert. 12 DM 3 Dilat. cardiom. 3 Isch. card. 2 Vasc. 1 SLE 1
Medical ↓ 4 home 10 patients ↗ (7F, 3M) ↘ 6 clinic	57.3 (39–73)	35 (13–74)	33.8 (0–93)		Rheumart. 1 Cryoglob. 1 Aorta aneur. 1 Malign. 1

Nineteen patients switched from standard hemodialysis (STND-HD). Time on STND-HD: 46 months (range 1–192 months).
GN = glomerulonephritis; hypert. = hypertension; DM = diabetes mellitus; PKD = polycystic kidney disease; Dilat. cardiom. = dilated cardiomyopathy; IN = interstitial nephritis; Isch. card. = ischemic cardiomyopathy; SLE = systemic lupus erythematosus; Vasc. = vasculitis; nephroscler. = nephrosclerosis; Rheumart. = rheumatoid arthritis; Cryoglob. = cryoglobulinemia; aorta aneur. = aorta aneurism; malign. = malignancy.

Sexual aspects were investigated, and the costs for D-HD and daily home hemodialysis (DHHD) were calculated.

Results

Nineteen patients switched from STND-HD to D-HD (mean time on STND-HD 46 months, range 1–192 months). Twelve patients chose D-HD for lifestyle reasons (LS group); 10 patients had medical indications for D-HD (MI group). The MI group had more severe comorbid conditions: hypertension 7 (together with other comorbid conditions); severe cardiomyopathy 2; ischemic cardiomyopathy 2; ascending aorta aneurysm 1; severe peripheral vascular disease 1; diabetes mellitus 2; and malignancy 1. The mean age in the MI group was older than the LS group at the start of D-HD: 57.3 years (range 39–73 years) versus 47.5 years (range 27–70 years), respectively.

The mean hospital days/patient/year were higher in the MI group than in the LS group: 33.8 (range 0–93) versus 8.33 (range 0–35), respectively (Table I). The outcomes were also different in the two groups. In the LS group the deaths resulted from respiratory distress after surgery for femoral fracture in an 80-year-old female, pulmonary embolism after abdominal surgery for peritonitis in another patient, and two strokes (a male with polycystic kidney disease and a 75-year-old female). In the MI group patients died from comorbid conditions.

Four patients switched to STND-HD, because they had no home dialysis partner, and they could not come to the center every day (Table II).

Vascular access survival was very good in all patients. The longest access survival with a native, forearm arteriovenous fistula was 18 years (8 years on STND-HD and an additional 10 years after switching to D-HD). We had the same good results with upper arm fistulas using superficialized basilic veins (up to 10 years on D-HD) in patients with severe hypotension and previous numerous distal fistulas on STND-HD. There were only two vascular access failures of native arteriovenous fistulas over the 12-year period: one forearm fistula due to irreparable stenosis after 18 years and one aneurysm in a superficialized basilic vein after six years (Figure 1). The latter patient also had failure of two successive polytetrafluoroethylene grafts over the next two years.

TABLE II Final outcome of patients over 12 years

Lifestyle (12)		*Medical (10)*	
• Home HD	1	• In-clinic HD	1
• In-clinic HD	2	• Switch to HD-S (no partner)	2
• Renal transplantation	2	• Death	7[b]
• Transferred to another hospital	1		
• Switch to HD-S (no partner)	2		
• Death	4[a]		

[a] Respiratory distress 1 (femoral fracture 80-year-old); stroke on polycystic kidney disease 1; stroke in 75-year-old 1; pulmonary embolism 1 (after abdominal operation).
[b] Serious cardiomyopathy 2; serious ischemic cardiopathy (1 diabetes mellitus) 2; stroke (diabetes) 1; malignancy 1; peripheral vascular disease (diabetes) 1.

Our routine protocol for access puncture required two 16-gauge needles and different sites for every puncture (6 times per week on D-HD at the hospital and 7 on DHHD). We used a bolus of 2500 U heparin. If heparin could not be used, a polyacrylonitrile membrane was used and flushed with normal saline every 15 min. A platelet aggregation inhibitor (ticlopidine) was used in patients with polytetrafluoroethylene arteriovenous access.

Blood pressure (BP) control in 12 hypertensive patients was achieved after a few months without antihypertensive drugs in 8 and with a lower dosage in 4 by achieving and maintaining true dry body weight. The initial mean BP of

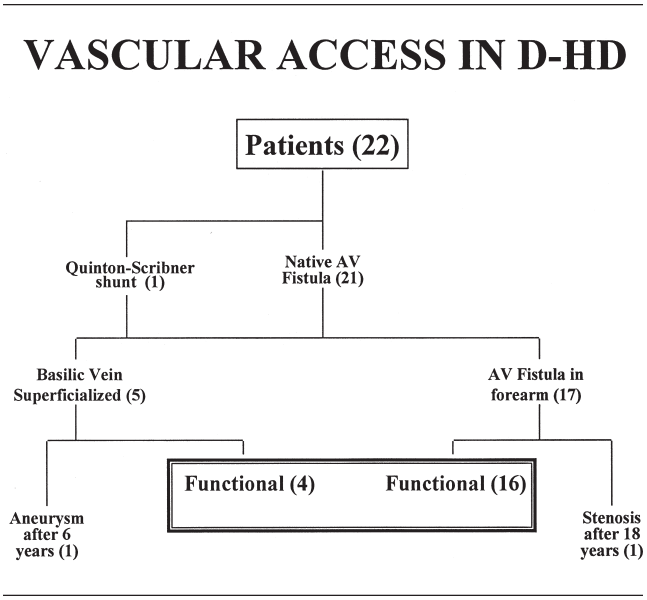

FIGURE 1 Vascular access results in 22 patients on daily hemodialysis (D-HD).

174/94 mm Hg was reduced to a mean of 141/82 mm Hg. The cardiothoracic index decreased in all patients from a mean of 0.52 (range 0.40–0.74) at the start of daily dialysis to a mean of 0.46 (range 0.40–0.63) after one year (Table III).

Hematocrit and hemoglobin increased in all patients. We used recombinant human erythropoietin (rHuEpo) 2000 U/week, in only 5 patients. The mean hematocrit increased from 24.7 (range 16.3–32.5) to 32.9 (range 26.9–37.4) after one year, with a mean of 37.3 (range 27.6–44.0) at the last study measurement. We had the same good results in 17 patients without rHuEpo (Table III).

The better control of hemodynamic conditions induced positive changes in the anatomic and functional status of the heart. Improvements in echocardiographic indices in 12 patients are shown in Table IV.

Good control of serum lipid and lipoprotein profiles is shown in Figure 2. Changes in some indices of nutritional status (serum total protein, serum albumin, serum transferrin, serum cholesterol, dry body weight) were good as a result of an improved appetite and free diet (Table V).

Levels of most hormones improved or normalized (Figure 3). At the beginning of D-HD, 4 patients had severe hyperparathyroidism, and parathyroidectomies were

TABLE IV Echocardiographic indices in D-HD. Mean (range) in millimeters

Index	*T0*[a]	*TL*[b]
Left ventricle posterior wall thickness	11.0 (8.2–12.9)	8.9 (7.5–12)
Intraventricular septum thickness	11.6 (8.6–13.7)	9.9 (7.6–12.5)
Left ventricle diastolic diameter	56.3 (48.5–78.6)	50 (37.6–66.5)
Left ventricle systolic diameter	37.6 (27.5–63.4)	31.5 (22.0–57.7)
Left atrium diameter	41.3 (30–58)	36 (26–47)

[a] Time 0.
[b] Time last control: mean 63 months (range 14–127 months); 12 patients (4F, 8M); mean age 44 years (range 27–73 years).

TABLE III Clinical, biochemical, and cardiothoracic index characteristics of patients on D-HD

		Time 0 T0	*Time 12 months T12*	*Time last control (a) T2*
(a)	Systolic blood pressure (mm Hg) (range)	174 (160–210)	141 (130–160)	141 (130–160)
(b)	Diastolic blood pressure (mm Hg) (range)	94 (80–120)	82 (70–95)	80.9 (70–95)
(c)	Hemoglobin (g/dL) (range)	7.7 (6.4–10.9)	10.5 (8.5–13.4)	11.8 (9.4–14.2)
(d)	Hemoglobin (g/dL) (range)	8.1 (6.6–10.9)	10.8 (8.5–12.4)	12.2 (10.2–14.2)
(c)	Hematocrit (range)	24.7 (16.3–32.5)	32.9 (26.9–37.4)	37.3 (27.6–44.0)
(d)	Hematocrit (range)	25.3 (16.9–32.5)	33.9 (24.9–44.6)	38.6 (27.6–44.1)
(e)	Cardiothoracic index (range)	0.52 (0.40–0.74)	0.46 (0.40–0.63)	0.42 (0.40–0.63)
(f)	Cardiothoracic index (range)	0.58 (0.48–0.74)	0.48 (0.45–0.63)	0.46 (0.45–0.63)

(a,b) 12 hypertensive patients; total observation time (TOT) mean 59.7 months (range 12–127 months);
(a,c) 22 patients (5 with rHuEpo 2000 U/week); TOT: 56.2 months (range 12–127 months);
(a,d) 17 patients without rHuEpo; TOT: 54.9 months (range 12–127 months);
(a,e) 22 patients; TOT: mean 56.2 months (range 12–127 months);
(a,f) 7 patients with hypotension; TOT: mean 64 months (range 14–126 months).

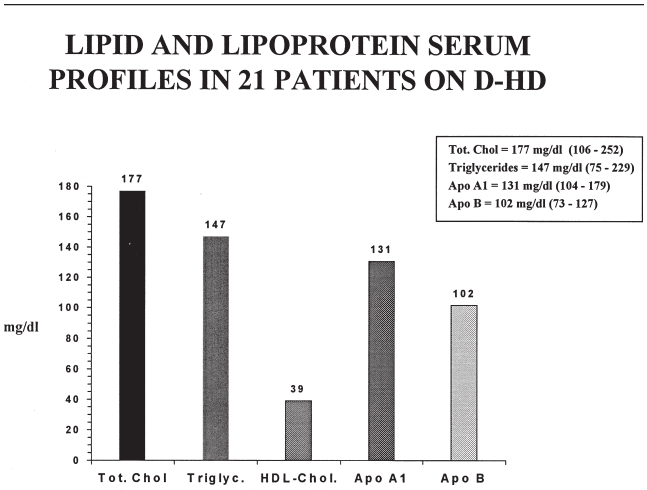

FIGURE 2 Serum lipid and lipoprotein profiles in 21 patients on daily hemodialysis (D-HD).

performed. A 37-year-old woman had three pregnancies (two abortions and one childbirth). Three young women had regular menstrual cycles. Sexual function clearly improved in five young men (Figure 4).

The cost for D-HD in-center was $35,000; DHHD cost less: $20,000 (Figure 5). These figures do not include the costs of drugs, but patients on D-HD require fewer medications (rHuEpo, antihypertensive drugs, etc.).

TABLE V Nutritional status on D-HD

	Time 0	Time 12 months	Time last control
Serum total protein (g/dL)	6.6	7.4	7.7
Serum albumin (g/dL)	3.5	4.26	4.49
Serum transferrin (mg/dL)	211	247	257
Serum cholesterol (mg/dL)	182	172	177
Dry body weight (kg)	58	57.6	58.7
Months	0	12	56 (mean)

Discussion

In a small, retrospective study we clearly showed that D-HD improves patients' clinical condition, particularly blood pressure control, hematocrit, and nutritional and hormonal status. All patients, regardless of demographics and comorbid conditions, improved after switching from STND-HD to D-HD. A dramatic improvement of functional and anatomical cardiac parameters was observed in 12 patients with various comorbid cardiovascular conditions.

Before 1985 it was very difficult for us to start STND-HD at home, but the proposal of a brief, daily dialytic treatment without intradialytic and postdialytic symptoms encouraged both young and elderly patients with a willing partner to try it.

When we have space, we perform D-HD in the center for patients with severe cardiovascular problems who cannot

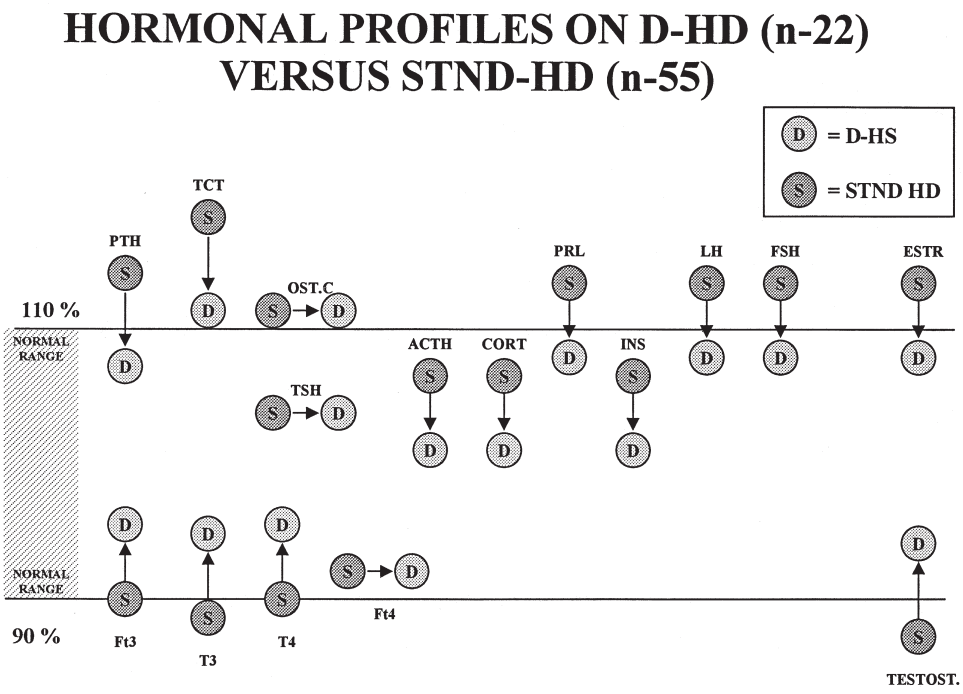

FIGURE 3 Hormonal profiles on standard hemodialysis (STND-HD) and daily hemodialysis (D-HD). ACTH = adrenocorticotropic hormone; CORT = cortisol; ESTR = estrogen; FSH = follicle-stimulating hormone; FT3 = free T^3; FT4 = free T^4; INS = insulin; LH = luteinizing hormone; TCT = calcitonin; OST.C = osteocalcin; PTH = parathormone; PRL = prolactin; testost = testosterone; TSH = thyroid-stimulating hormone; T3 = triiodothyronine; T4 = thyroxine.

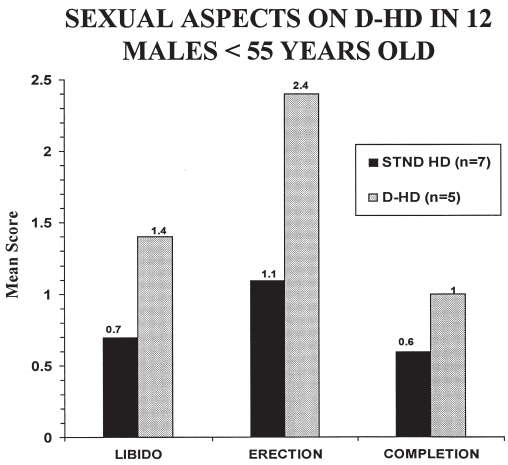

FIGURE 4 Mean scores of 12 men on daily hemodialysis (D-HD) from a questionnaire on sexual function (0.5 = low; 2.5 = very high).

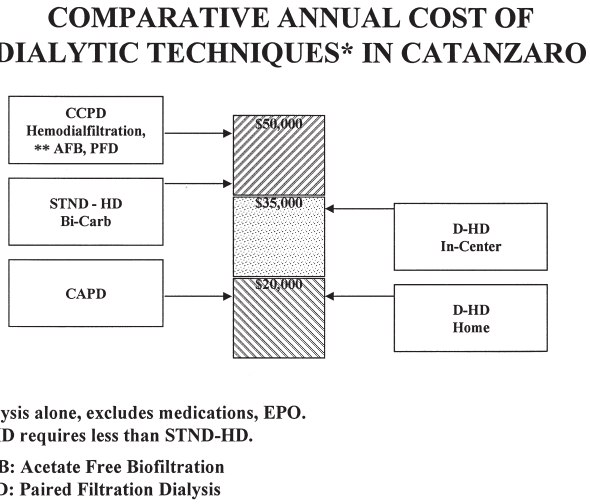

FIGURE 5 Comparative annual costs of dialytic techniques in Catanzaro, Italy. These figures only represent dialysis and exclude medications and Epo. Note that D-HD requires less medication than STND-HD. AFB = acetate-free biofiltration; CAPD = continuous ambulatory peritoneal dialysis; CCPD = continuous cycling peritoneal dialysis; D-HD = daily hemodialysis; PFD = paired filtration dialysis; STND-HD = standard hemodialysis.

tolerate other dialytic techniques, who do not have a partner at home, and who are willing and able to come to the center 6 days/week.

Although not the focus of this study, we would like to offer the following comment: among the dialysis techniques that we perform in our center (acetate-free biofiltration, hemodiafiltration, biofiltration, paired filtration dialysis, etc.), since 1985 we have preferred to treat almost all acute renal failure and all critically ill patients referred to us from other hospitals with D-HD. So we have a "temporary" use for D-HD for many patients. Three or 4 of these patients begin D-HD each month and dialyze daily for more than 10 days, up to 1–2 months, and sometimes longer.

In our experience, over a long-term period D-HD has no negative effect on vascular access survival and complications. The daily puncture with two needles, in different places, allows the native arteriovenous fistula to reach a good development without dilation after many years. We have never observed thrombosis of native fistulas in patients with hypotension, high hematocrit and/or diabetes mellitus and/or vasculitis, and have never used platelet aggregation inhibitors, except for heparin. The daily use of heparin could have a potential benefit in preventing intimal hyperplasia and vascular injury in native fistulas (4). Native fistulas, in our opinion, should be the access of choice for D-HD. If a traditional distal native fistula is not feasible, special vascular surgery on native veins (e.g., superficialized basilic vein) should be used (5).

Low serum albumin levels were the best predictor of vascular access thrombosis in the Canadian hemodialysis morbidity study. Our patients had good albumin levels. An important result in patients on D-HD is the optimal control of hypertension, probably by the achievement of the "true" body weight (6), thus avoiding chronic volume overload leading to an increase in systemic vascular resistance, which may be mediated by the swelling of endothelial cells and the release of vasoactive substances or by the secretion of a vasoconstrictive endogenous digitalis-like substance. Better control of the sodium balance and salt sensitivity could also play a role in the control of vascular resistance (7) in D-HD.

Improvement in anemia is another good result in D-HD. A better correction of acidosis and electrolyte imbalance, lower oscillations in osmolality, and better daily removal of toxins allow a more stable "internal environment," an important condition, along with good nutritional status, for the correction of bone marrow inhibition and the stimulus for synthesis of hemoglobin.

The behavior of the cardiothoracic and echocardiographic (8) indices reflects the better hemodynamic conditions achieved by correction of hypertension and anemia. The improvement in echocardiographic indices of left ventricular hypertrophy in patients with severe cardiovascular disease is an encouraging result in the choice of D-HD, since we know that these indices worsen with other dialysis techniques, at least two or three years later (9,10). The better control of electrolyte balance and acidosis with the lower predialysis or postdialysis variations of blood volume and good nutritional status support the equilibrium in hormonal systems that act on the cardiovascular system and a lower sympathetic hyperactivity (11).

The good control in lipid and lipoprotein profile could be in part the result of the free Mediterranean diet allowed in a daily treatment. Good appetite, a consequence of good and physiological depuration, with the freedom to choose food allows patients to achieve a normal nutritional status without particular supplementation or medications. In these conditions,

enzymatic systems and hormones can be synthesized in an almost normal range and can act in a good internal environment (12).

Finally, a comparative annual cost of dialysis techniques shows a lower cost at home for D-HD, and the cost of daily dialysis in-center is also lower than that of other dialysis techniques (acetate-free biofiltration, paired filtration dialysis, hemodiafiltration, etc.), especially if we consider that D-HD requires fewer medications (rHuEpo, antihypertensive drugs, etc.) than STND-HD (Figure 5).

In conclusion, our experience supports previous observations that D-HD is associated with the following positive aspects:

- reduced intradialysis and interdialysis symptoms
- optimal control of blood pressure, reduction of cardiac hypertrophy, and improvement of anemia
- good nutritional status with good control of lipids, acid-base status, and plasma osmolality
- a nearly free diet
- improvement in libido and sexual functioning
- no vascular access problems with native arteriovenous fistulas
- a better lifestyle
- improved physical and/or intellectual functions and quality of life
- lower costs in D-HD and fewer medications

In addition, our studies showed improvement or normalization of hormonal profiles on D-HD as compared to STND-HD. D-HD is particularly suitable for critically ill patients and young patients awaiting transplantation.

References

1 Bonomini V, Mioli V, Albertazzi A, Scolari MP. Daily dialysis programme: Indications and results. Proc Eur Dial Transplant Assoc 1972; 9:44–52.

2 Buoncristiani U, Quintaliani G, Cozzari M, Giombini L, Ragaiolo M. Daily dialysis: Long-term clinical metabolic results. Kidney Int 1988; 33(Suppl 24):S137–40.

3 Buoncristiani U, Cairo G, Giombini L, Quintaliani G, Bonforte G. Dramatic improvement of clinical metabolic parameters and quality of life with daily dialysis. Int J Artif Organs 1989; 12(Suppl 4):133–6.

4 Diskin CJ, Stokes TJ, Pennell AT. Pharmacologic intervention to prevent hemodialysis vascular access thrombosis. Nephron 1993; 64:1–26.

5 Chazan JA, London MR, Pono LM. Long-term survival of vascular access in a large chronic hemodialysis population. Nephron 1995; 69:228–33.

6 Buoncristiani U, Fagugli R, Pinciaroli AR, Kulurianu H, Bova C. Optimal blood pressure (BP) control with daily dialysis (D-HD). Abstracts, Clinical Hypertension in Nephrology Congress. Reggio Calabria, Italy, 1995:53.

7 Lins RL, Elseviers M, Rogiers P, *et al*. Importance of volume factors in dialysis related hypertension. Clin Nephrol 1997; 48:29–33.

8 Buoncristiani U, Fagugli RM, Pinciaroli AR, Kulurianu H, Ceravolo G, Bova C. Reversal of left-ventricular hypertrophy in uremic patients by treatment with daily hemodialysis (DHD). Contrib Nephrol 1996; 119:152–6.

9 Parfrey PS, Foley RN, Harnett JD, Kent GM, Murray D, Barre PE. Outcome and risk factors of ischemic heart disease in chronic uremia. Kidney Int 1996; 49:1428–34.

10 Lameire N, Bernaert P, Lambert MC, Vijt D. Cardiovascular risk factors and their management in patients on continuous ambulatory peritoneal dialysis. Kidney Int 1994; 46(Suppl 48):S31–8.

11 Bernardi D, Bernini L, Cini G, Ghione S, Bonechi I. Asymmetric septal hypertrophy and sympathetic overactivity in normotensive hemodialyzed patients. Am Heart J 1985; 109:539–45.

12 Filetti S. Disordini endocrini nell'Insufficienza Renale Cronica. In trattato Italiano di Dialisis. A cura di Vincenzo Cambi, vol. 2, VIII Clinica: 5 Alterazioni endocrine pp. 1–20. Milan: Ed Wichtig, 1990–1992.