

Daily Dialysis: Toward a New Standard in Well-Being

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Daily hemodialysis (DHD) is a promising option; however, logistic obstacles and clinical perplexities limit its dissemination. Understanding the mechanisms of, and the time until, the onset of improved well-being may help to quantify clinical advantages and to define the minimum length of a “trial” of daily dialysis. By following 30 patients treated in 4 centers, this study aimed to determine how long a period of time is needed until a patient experiences subjective improvement.

From November 1998 to November 2000, 30 patients tried at least 2 weeks of short daily dialysis in four Northern Italian centers of Piemonte and Valle d’Aosta. The DHD (2–3 hours; blood flow 270–350 mL/min; individual HCO₃, Na, K) was performed at home or in a center. Motivations to try DHD, fears and concerns regarding DHD, and changes in perceived well-being were assessed by semi-structured interview.

The main clinical indications for a trial of DHD were poor tolerance of conventional treatment, cardiovascular disease, and hypertension or hypotension; only 6 patients had no comorbidity at start. The patients’ main reasons for choosing DHD were related to job problems and the search for a better treatment. Most of the patients continued DHD because of improved well-being; logistic reasons accounted for the drop-outs (5 patients). The main fears were related to logistic aspects, vascular access problems, and excessive involvement of the partner on home dialysis. Improved well-being was reported by 28 of 30 patients; 2 patients reported no difference. Subjective improvement was perceived within 2 weeks in 22 of 30 patients, and within 1 month in 28 of 30 patients.

An offer of a 2–4 week trial of DHD may help patients and caregivers to determine whether subjective and objective benefits outweigh logistic problems and whether a permanent transfer to DHD is worthwhile.

(*Hemodial Int.*, Vol. 5, 19–27, 2001)

Key words

Daily hemodialysis, self care, limited care, quality of life, comorbidity, home hemodialysis

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Introduction

Daily hemodialysis (DHD) has been termed “the dialysis of the new century” [1]. Despite the growing interest in this modality, only a few centers offer it. The total number of patients does not exceed a few hundred [2–4].

There are many reasons for skepticism regarding the practical application of this old idea [5–7]. First of all, DHD is a rather expensive treatment, particularly in countries where reuse is not allowed (as in most of Europe) [8]. When DHD is considered only as a home treatment, its application is limited to a small number of patients, even in the most active home dialysis programs [9–11]. However, experiences with in-center treatment are growing, and they confirm positive results when DHD is employed as a rescue treatment, as was initially proposed [12].

The explanations for the clinical advantages of daily dialysis fall into two groups. Authors focus either on the lower fluctuations in body solutes and volumes under daily treatment (“less unphysiology,” particularly in the case of short daily schedules), or on the higher efficiency (more evident with long, nightly schedules) [13–15]. If patients were not under-dialyzed, a fast subjective improvement would be more compatible with the “less unphysiology” hypothesis. Because the increase in efficiency is usually perceived after a longer period, a slow improvement would probably be related to increased efficiency.

From the practical point of view, knowing when improvements occur may help to define the trial period of DHD needed to determine the suitability of this modality for a particular patient. After the trial period, patients may conclude whether the benefits of DHD outweigh its disadvantages.

The goals of this multicenter study were to assess, from the patient’s perspective, the advantages and disadvantages of DHD, the reasons for choosing DHD, the reasons for dropping out, and the length of time until the onset of improved well-being.

Material and methods

Centers and patients

Four centers participated in the present study, three in Piemonte and one in Valle d’Aosta. These centers were the first in northern Italy to start programs of short DHD (from

1998 to 2000). The referral area encompasses about 4.5 million inhabitants, and, as of December 31, 1998, 2950 patients were on chronic dialysis. All patients who experienced at least a trial of daily dialysis took part in the study.

CENTER 1: SMOM UNIT (SOVRANO MILITARE ORDINE DI MALTA)

The freestanding SMOM Unit, which performs home hemodialysis, self-care dialysis, and limited-care dialysis, is located in Torino (0.9 million inhabitants), the main city of Piemonte. The Unit is a satellite of the University Hospital, which follows 200 – 215 chronic dialysis patients. During the study period, the SMOM Unit followed 40 – 45 patients. Daily dialysis was performed both at home and in the unit.

From November 1998 to November 2000, 19 patients (16 men, 3 women) experienced at least 2 weeks of short DHD. Median age of the group was 51 years (range: 22 – 78 years), and median duration of renal replacement therapy (RRT) was 4 years (range: 1 – 24 years). Sixteen patients had at least one comorbid condition. All patients had arteriovenous fistulas (two with prosthetic bridge grafts).

The dialysis prescription was 6 sessions per week, 2 – 3 hours, polysulfone or polycarbonate dialyzers with 1.6 – 1.8 m² surface area, blood flow (Q_b) 250 – 350 mL/min, dialysate flow (Q_d) 500 mL/min, maximum weight loss 0.8 – 1.2 kg per hour, and dialysate composition: K⁺ 1.5 – 3.5 mEq/L, Na⁺ 138 – 142 mEq/L, HCO₃ 28 – 32 mEq/L. Dialysis schedules were flexible; patients were allowed to modify time on dialysis within individually prescribed ranges and to switch occasionally to three sessions per week.

CENTER 2: SAN GIOVANNI BOSCO HOSPITAL

The center in San Giovanni Bosco Hospital, also located in Torino, follows about 230 dialysis patients. The center runs a home hemodialysis program (15 active patients, 4 in training). Daily dialysis is offered as an option for home hemodialysis. Two patients started daily dialysis in 1995 as a rescue treatment for critical clinical conditions, so they could remain on home dialysis. Three more patients started DHD after February 2000. The median age was 42 years (range: 20 – 66 years), the ratio of men to women was 4:1, and the median duration of RRT was 2 years (range: 2 – 29 years). Three patients had at least one comorbid condition. Dialysis access was an arteriovenous fistula in 4 patients and a Tesio catheter (Medcomp, Harleysville, PA, U.S.A.) in 1 patient.

The dialysis prescription was 6 sessions per week; 2.5 hours (4 patients) or 2 hours (1 patient); Q_b 270 – 350 mL/min; Q_d 500 mL/min; Hemophan dialyzers, GFS Plus 16 with 1.7 m² surface area and GFS Plus 20 with 1.8 m² surface area (Gambro, Hechingen, Germany); and K⁺ 1.5 – 3.5 mEq/L, Na⁺ 138 – 142 mEq/L, HCO₃ 28 – 32 mEq/L.

CENTER 3: CEVA HOSPITAL

The Ceva Hospital center is located in a town with about 8,000 inhabitants. It follows 50 – 55 dialysis patients. The daily di-

alysis program was started in June 1999 and enrolled 4 patients: 3 men and 1 woman. Two patients performed daily dialysis at home, and two patients dialyzed in center. The median age was 44 years (range: 25 – 49 years), and the median duration of RRT was 5 years (range: 3 – 9 years). All patients had at least one comorbid condition. Dialysis access was an arteriovenous fistula in 3 patients and a Tesio catheter in 1 patient.

The dialysis prescription was 6 sessions per week for 2 hours, 30 minutes, using cuprophane dialyzers with 1.4 m² surface area. Blood flow was 420 – 450 mL/min in the 3 patients using single needles and 300 mL/min in patients using double needles or the Tesio catheter. Dialysate flow was 500 mL/min, and composition was K⁺ 1.5 – 3.5 mEq/L, Na⁺ 138 – 142 mEq/L, HCO₃ 28 – 32 mEq/L.

CENTER 4: AOSTA

Aosta is the main city of Valle d'Aosta, with about 35,000 inhabitants. The regional center there follows 120 – 125 dialysis patients. The daily dialysis home program was started in 1999 and enrolled 2 patients: a 36-year-old man, on RRT for 4 years with no comorbid conditions; and a 45-year-old woman, on RRT for 15 years with no comorbid conditions. One patient's blood access was an arteriovenous fistula; the other patient's access was a Tesio catheter.

The dialysis prescription was 6 sessions per week; 2 hours; Q_b 270 – 350 mL/min; Q_d 500 mL/min; synthetically modified cellulose dialyzers, NC 1485 SD (Bellco, Mirandola, Italy) with 1.45 m² surface area; and K⁺ 1.5 – 3.5 mEq/L, Na⁺ 138 – 142 mEq/L, HCO₃ 28 – 32 mEq/L.

Dialysis kinetics

Efficiency of small-molecule removal was measured according to the Lowrie Kt/V_{urea} formula [16] and the Casino-Lopez formula for single-pool equivalent renal clearance (EKR_c) [17].

Interview on reasons for choice and drop-out, and on well-being

A semi-structured interview was carried out by two of the authors (one nephrologist and one nephrologist-in-training). The choice of a semi-structured interview was motivated by the advantage of this method for obtaining unanticipated responses that might not otherwise be included in a closed questionnaire, and because of its feasibility in non homogeneous cohorts of patients [18–20]. All patients who were asked agreed to participate in the interview.

Patients were interviewed when they started daily dialysis and after at least 1 month of treatment. Questions included in the first interview were these:

- Why did you choose daily dialysis?
- Why did you continue or discontinue daily dialysis?
- Did you have fears or concerns regarding daily dialysis?

Caregivers were asked to provide clinical indications, if any, for DHD.

Questions after 1 month of treatment were these:

- What are the main advantages and disadvantages of daily dialysis?
- Did your well-being improve with daily dialysis?
- How did you evaluate the improvement (for example, walking one more block, participating in a sport)?
- How long did it take to see the difference? days? weeks? months?
- Do you have further remarks or suggestions?

Statistical analysis

Descriptive analysis was performed by usual methods. Data are reported as mean \pm standard deviation, or median and range.

Results

Of the 30 patients who started a trial of daily dialysis, only 5 returned to standard hemodialysis. Four patients decided to discontinue DHD owing to logistic problems, and one, for personal reasons. Two patients died: one of melanoma, which developed during DHD; and one of preexisting vascular disease.

Indications for, reasons for choice of, and fears at start of daily dialysis

Overall, indications for daily dialysis were diverse. Several patients with a long history of RRT were enrolled (9 with more than 15 years and 6 with more than 20 years of RRT). Consequently, cardiac or vascular comorbidity was frequent (present in 12 cases). Table I reports the characteristics of the patients who experienced a short trial of daily dialysis in the four centers. Dialysis schedule and Kt/V and EKR_c per session at baseline (standard HD) and after 1 and 6 months of DHD are also reported. Regardless of the schedule, daily dialysis provided better results in terms of weekly efficiency than did previous treatments.

Table II reports clinical indications for DHD, the patients' personal motivations for choosing the modality, and the patients' fears. The main clinical indications cited by the nephrologist were hypertension (6 patients) and cardiovascular or vascular disease (9 patients). Long RRT history and optimization of treatment were further indications in 4 and 5 cases, respectively.

From the perspective of the patients, the main reasons for choosing DHD were the search for the best treatment and poor tolerance of conventional hemodialysis. Logistic advantages were associated with employment, easier management of shorter dialysis, and flexible time schedules; these were the important or fundamental reasons in 10 patients.

The fears most often reported pertained to the vascular access (9 patients), expressed both as the fear of more frequent needle punctures, and as a concern that more frequent

dialysis would shorten fistula survival. Before the start of daily dialysis, the logistic aspects scared 12 patients. Three patients were particularly concerned about the involvement of the partner for home dialysis in such a time-consuming schedule (Table II).

Advantages and disadvantages of daily dialysis

Improved well-being was the main reason for choosing daily dialysis as a permanent treatment, despite the presence of drawbacks. The main tradeoff for improved well-being was the time involvement, particularly for patients who had to cross the city to visit the dialysis center (Table III). Home dialysis patients emphasized the increase in expenditures for electricity and water, and the need for more space for supplies and wastes.

Besides the recorded opinions, the main evidence for the advantages felt by the patients is that 25 of 30 patients continued DHD. Even among the 5 patients that dropped out, 4 chose a more frequent dialysis schedule (alternate-day dialysis in 1 case, and 4 sessions per week in 3 cases).

Time until perceived improvement of well-being

Improved well-being within 2 weeks was reported by 22 patients; 5 others reported improved well-being within 1 month (Table IV). Only 1 patient reported no improvement in well-being, but he had switched to daily dialysis from a very efficient treatment—long nightly dialysis, 8 hours thrice weekly. Another patient was unable to define whether her well-being improved, but she chose to stay on daily treatment, even though she lived far from the center.

In response to the question about the timing of improved well-being, 8 patients gave complex answers. In these cases, a clear response was given after subsequent short periods of conventional dialysis (logistic or clinical reasons, vacations—Table IV).

The elements identified by each patient as markers of well-being varied. They ranged from the ability to perform the simplest activities of daily life (cooking, walking two blocks, etc.) to more complex ones that require physical strength (playing tennis for two hours) or particular concentration and coordination (playing a piano concert—Table IV).

Discussion

Daily dialysis is a promising treatment; however, its dissemination is limited by several logistic and economic problems, and by debates regarding the clinical cost/benefit ratio [1–7]. Previous clinical experiences emphasized improvements in well-being and quality of life in patients on DHD. Furthermore, the patients' choice to continue such a time-consuming treatment may be seen as further confirmation of the subjectively perceived benefits [4–22].

Two different hypotheses are proposed to explain the improved well-being on DHD: according to the first, the "secret" of daily dialysis is related to "less unphysiology"; according to the second, the benefits are due to higher efficiency [13–15].

TABLE I Main characteristics of 30 patients who experienced daily dialysis in the four centers of Piemonte–Valle d'Aosta.

Case	Sex	Age (years)	RRT (years)	Start of daily dialysis	ESRD	Comorbidity	Pre-daily dialysis (range per session)	Daily dialysis (range per session)	Kt/V^c (pre ^a) [post: 1 (6) ^b]	EKR_c^d (pre ^a) [post: 1 (6) ^b]		
SMOM Home Dialysis												
1	M	41	21	25/11/1998	CPN	Vascular	4 h 15 min × 3	2 h	1.2	0.64 (0.69)	14	16.0 (17.4)
2	M	51	23	07/12/1998	CPN	None	4 h 15 min × 3	2 h	1.2	0.75 (0.54)	14	18.5 (13.8)
3	M	36	4	11/12/1998	CGN	Hypertension	4 h 30 min × 3	2 h – 2 h 30 min	1.0	0.80 (0.72)	12	19.7 (17.9)
4	M	33	2	26/04/1999	MPGN	None	5 h × 3	2 h – 2 h 45 min	1.2	0.84 (0.72)	14	20.5 (17.8)
5	M	61	20	28/04/1999	CGN	Cardiovascular (ischemic)	4 h × 3	2 h – 2 h 40 min	1.4	0.85 (1.08)	16	21.0 (25.0)
6	M	42	1	10/05/1999	Diabetes NAS	Obesity MODY	4 h × 4	2 h 15 min – 3 h	1.0	0.43 (0.65)	16	11.5 (16.3)
7 ^e	M	51	2	26/06/1999	PKD	Melanoma ^f	4 h × 3	2 h	1.2	0.81 (0.69)	14	19.8 (17.4)
8 ^g	M	55	1	03/11/1999	IN	Diabetes type 2	2 h × 3	2 h	0.9	0.56 (0.60)	11	14.2 (15.5)
9 ^h	M	22	1	02/05/2000	SLE	Hypertension	3 h × 4	2 h – 2 h 40 min	1.0	0.76 (0.69)	16	18.5 (15.7)
SMOM Self-Care/Limited-Care Center												
10 ^j	F	51	1	04/01/1999	Diabetes	Diabetes type 1 Neuropathy	—	2 h – 2 h 40 min	—	1.20 (1.25)	—	>25 (>25)
11 ^k	M	42	9	15/07/1999	Diabetes NAS	MODY Cardiovascular (ischemic, bypass)	4 h 15 min × 3	2 h 40 min – 3 h	1.1	0.70	16	18.0
12	M	54	18	16/08/1999	MPGN	Cardiovascular (ischemic, angioplasty)	4 h × 3	2 h – 2 h 30 min	1.2	0.80 (0.87)	14	19.7 (21.1)
13	M	46	19	05/06/2000	CPN	Cardiovascular (PAF)	4 h 30 min × 3	2 h 30 min – 3 h	1.1	0.63 (0.70)	13	16.0 (18.0)
14	M	49	18	05/06/2000	MPGN	Spondyloarthritis B27-related Cardiovascular (ischemic)	4 h × 4	2 h 15 min – 2 h 30 min	0.8	0.81 (0.69)	13	19.8 (15.7)
15 ^k	M	48	1	02/08/2000	CPN	Hypertension	4 h 30 min × 3	2 h	Dropped out after 3 weeks			
16	F	78	2	14/08/2000	IN	Cardiovascular (ischemic, hypertension)	4 h × 3	2 h	1.1	0.99	16	24.5
17 ^k	M	54	23	21/08/2000	CGN	Vascular	4 h × 3	2 h 30 min	Dropped out after 3 weeks			
18	F	52	2	22/08/2000	SLE	SLE	3 h 30 min × 3	2 h	1.2	0.86	14	21.6
19	M	51	5	22/08/2000	Diabetes	Cardiovascular (ischemic) Diabetes type 1	4 h × 3	2 h – 2 h 15 min	0.9	0.58	12	15.1
San Giovanni Bosco												
20	M	62	29	15/04/1995	PKD	Cardiovascular (ischemic)	4 h × 3	2 h 30 min	0.9	0.80 (0.90)	11	20.4 (22.3)
21	F	66	26	15/04/1995	CGN	Cardiovascular (ischemic)	4 h × 3	2 h 30 min	0.9	0.90 (0.90)	11	22.3 (22.3)
22	M	29	2	05/05/2000	IgA	Hypertension	4 h × 3	2 h 30 min	1.4	1.10 (1.10)	16	>25 (>25)
23	M	42	2	15/03/2000	FGS	None	4 h × 3	2 h 30 min	1	0.80 (0.80)	12	20.4 (20.4)
24 ^k	M	20	2	01/08/2000	CPN	None	4 h × 3	2 h	Dropped out after 2 weeks			
Ospedale Civile (Ceva)												
25 ^c	M	46	9	15/06/2000	CGN	Hypertension	4 h × 3	2 h 30 min – 3 h	N/A	0.35 (N/A)	N/A	9.5 (N/A)
26	M	49	5	15/05/2000	NAS	Cardiovascular (ischemic)	4 h × 3	2 h 30 min	N/A	0.50 (N/A)	N/A	13.5 (N/A)
27	M	41	5	15/06/2000	MPGN	Hypertension	4 h × 3	2 h 30 min	N/A	0.80 (0.62)	N/A	20.4 (15.7)
28	F	25	3	15/06/2000	CPN	Hypertension	4 h × 3	2 h 30 min	1.1	0.74 (0.40)	14	18.7 (10.5)
Ospedale Della Valle D'Aosta (Aosta)												
29 ^k	M	36	4	19/01/2000	IgA	None	8 h × 3	2 h	1.6	0.57 (0.66)	>15	15.1 (18.0)
30	F	45	14	03/07/2000	CGN	None	4 h × 3	2 h	0.87	0.8 (0.82)	10	20.4 (20.7)

^a Before start of daily dialysis.^b After 1 month (6 months) of daily dialysis.^c Lowrie formula.^d Corrected equivalent renal clearance according to the Casino–Lopez formula [17].^e Died: melanoma (case 7); vascular (case 25).^f No comorbidity diagnosed at start; malignant melanoma diagnosed on daily dialysis.^g Switch after surgical procedure.^h Performs dialysis 3 days in-center and 3 days at home.^j Started renal replacement therapy on daily dialysis.^k Drop-out cases.

RRT = renal replacement therapy (overall follow-up); ESRD = end-stage renal disease; SMOM = Sovrano Militare Ordine di Malta; MPGN = membranoproliferative glomerulonephritis; NAS = nephroangiosclerosis–ischemic nephropathy; MODY = maturity onset diabetes of the young; PKD = polycystic kidney disease; IN = interstitial nephritis; SLE = systemic lupus erythematosus; CPN = chronic pyelonephritis; PAF = paroxysmal atrial fibrillation; CGN = chronic glomerulonephritis; IgA = immunoglobulin A nephropathy; FGS = focal glomerulosclerosis; N/A = data not available.

TABLE II Clinical indications, personal motivations, and fears at start of daily dialysis.

Case	Clinical indications	Personal motivations	Fears
SMOM Home Dialysis			
1	Long-time RRT	Poor tolerance of conventional dialysis	Feared venipuncture
2	Long-time RRT	Search for the best treatment	Feared losing residual diuresis
3	Severe hypertension	Logistic reasons	None
4	Severe hypertension	Logistic reasons	Feared venipuncture
5	Cardiovascular disease	Search for the best treatment	Feared losing vascular access
6	Obesity, need for weight loss	Job problems	None
7 ^a	Recovery after surgery	Job problems	Excessive partner involvement
8	Recovery after surgery	Search for the best treatment	None
9	Severe hypertension	Search for the best treatment	Excessive partner involvement
SMOM Self-Care Center			
10	Neuropathy, hypotension	Search for the best treatment	Feared losing vascular access
11 ^b	Cardiovascular disease	Search for the best treatment	Skeptical of benefits
12	Cardiovascular disease	Search for the best treatment	Feared losing vascular access
13	Cardiovascular disease	Search for the best treatment	Feared being on dialysis every day
14	Cardiovascular disease	Search for the best treatment	Feared being on dialysis every day
15 ^b	Hypertension, need for weight loss	Search for the best treatment	Job problems
16	Cardiovascular, poor dialysis tolerance	Search for the best treatment	None
17 ^b	Long-time RRT	Search for the best treatment	Job problems
18	Hypotension, pain on dialysis	Back pain during longer dialysis	Feared being on dialysis every day
19	Neuropathy, hypotension	Search for the best treatment	Feared being on dialysis every day
Ospedale San Giovanni Bosco			
20	Cardiovascular disease	Remaining on home hemodialysis Poor dialysis tolerance	Feared losing vascular access Feared being on dialysis every day
21	Cardiovascular disease Treatment optimization	Remaining on home hemodialysis Poor dialysis tolerance	None
22	Hypertension	Job problems Poor dialysis tolerance	Feared losing for vascular access
23	Hypertension	Job problems	None
24 ^b	Treatment optimization	Search for the best treatment	Job problems
Ospedale Civile (Ceva)			
25 ^a	Vascular disease	Job problems	Feared losing vascular access
26	Long-time RRT	Search for the best treatment	Feared losing vascular access
27	Search for best treatment	Search for the best treatment	Feared being on dialysis every day
28	Search for best treatment	Job problems	Feared being on dialysis every day
Ospedale Della Valle D'Aosta (Aosta)			
29 ^b	No specific indication	Job problems	Feared being on dialysis every day
30	Treatment optimization	Job problems Search for the best treatment	Feared being on dialysis every day Excessive partner involvement

^a Died: melanoma (case 7); vascular (case 25).

^b Drop-out cases.

Clinical data support each hypothesis. The first positive experience of Buoncristiani and coworkers [4], who obtained improved well-being with recycled dialysis fluids, and Kt/V (retrospectively calculated) as low as 0.20 – 0.24 per session, supports the “less unphysiology” hypothesis. A similar conclusion is supported by data published by Kooistra [14], who targeted dialysis efficiency as equal to the Kt/V on the previous treatment, and who reported improved well-being, together with better metabolic control, on daily dialysis. However, according to the model of Casino and co-workers, EKR_c is a better kinetic index of treatment efficiency than is conventional Kt/V [17]. According to this model, EKR_c rises with the number of sessions per week, for the same aggregate weekly Kt/V, thus explaining the good results obtained by Buoncristiani with a very low Kt/V per session, and offering

an alternative explanation of the results reported by Kooistra, in which the same aggregate Kt/V as on conventional dialysis was associated with a higher weekly EKR_c [13–14,22].

The lack of clear-cut differences between long nightly and short daily dialysis also supports the hypothesis of dialysis frequency being more importance than dialysis efficiency in effecting well-being. However, both daily and nightly dialysis may be considered highly efficient treatments. The difference in outcomes between the two modalities may require more time (years, perhaps) to become clinically evident, while the subjective difference compared to conventional treatment can be more easily and quickly perceived.

According to the nephrologists (Table II), the main indications for a trial of DHD were: presence of diffuse cardiovascular impairment (9 patients), long term RRT (4 patients),

TABLE III Patients' opinions about daily dialysis and timing of perceived well-being.

Case	Follow-up	Positive opinions	Negative opinions
SMOM Home Dialysis			
1	25/11/1998 Continues	I'd never have thought to perform a concert after dialysis. I'm less tired and thirsty.	Increase of domestic expenses
2	07/12/1998 Continues	After few weeks, appetite and residual diuresis increased; sexual performance is better. I'm less tired and thirsty.	A lot of dialysis material at home.
3	11/12/1998 Continues	I have more freedom; my quality of life improved. We are a family again (a baby was conceived on daily dialysis).	None.
4	26/04/1999 Continues	I see the difference when I play tennis. On daily dialysis I can play two hours without problems; on three times a week, I feel tired after one hour. With frequent needle punctures, I've lost my fears of needles	Daily dialysis is a good option only with the possibility of doing conventional dialysis for some periods. Few days off.
5	28/04/1999 Continues	Blood pressure control is easier; anxiety and thirst are less. The treatment allows good daily organization.	
6	10/05/1999 Continues	It's ideal for my work (owner and cook in a restaurant); I'm less tired after treatment. On conventional dialysis, I could not work any more.	None.
7	26/06/1999 Died 01/11/2000	I feel better and have better appetite. I'm not tired after treatment. I think that daily dialysis allowed me to recover better from all the problems and surgeries I have had.	None.
8	03/11/1999 Continues	I'm not tired after treatment. I feel better. I eat and drink freely.	None.
9	02/05/2000 Continues	I was skeptical, and I realized the difference from the blood tests. Now I can't stand two days off. Note: Patient performs dialysis in alternate settings: home and center.	My mother (dialysis partner) has problems with treatment every day.
SMOM Self-Care Center			
10	04/01/1999 Continues	I cannot easily make comparisons, because I started on daily dialysis. I think it's good for my major problems (hunger and thirst). It's the best choice in the wait for a kidney and pancreas graft.	I'm every day at the center.
11	15/07/1999 Dropped out	I felt better, but I have too many logistic problems.	I need at least 3 days off dialysis.
12	16/08/1999 Continues	I feel better, and I have the impression of having more time for myself, despite the fact that I have to cross the city for coming to the center.	The time of crossing the city every day.
13	05/06/2000 Continues	I feel better even if at the beginning I was too worried for the changes in my life.	I'm every day at the center.
14	05/06/2000 Continues	My mother said that I'm a new person. I really feel better. My colleagues didn't believe it was me. So now I work too much.	I'm every day at the center.
15	02/08/2000 Dropped out	I felt well but the problem was my job; I don't accept dialysis, I'm scared by renal graft. I need some days without dialysis.	I can't manage to work if I'm on dialysis every day.
16	14/08/2000 Continues	I didn't tolerate more than 2 hours of treatment, now I feel better and I can drink with more freedom	I'm every day at the center.
17	21/08/2000 Dropped out	I felt better, but I didn't realize it fully because of several clinical problems in this phase of return to dialysis after a decade of transplantation.	I'm every day at the center; the problem was my job.
18	22/08/2000 Continues	I feel better. I gained weight, eating the same food; this probably means that I'm better, even if I'll have to stay on a diet. Some days I feel very well, some days I'm still sick and depressed.	I'm every day at the center (in particular on Saturdays).
19	22/08/2000 Continues	I feel better, I will continue with this type of treatment. I don't think as much of transplantation as I did before.	The center for daily dialysis is far from my home.
Ospedale San Giovanni Bosco			
20	15/04/1995 Continues	I feel well, without hypotension after dialysis. At first I saw that my blood test improved. Now I often go to walk and to ride. I enjoy myself working in my garden.	None
21	15/04/1995 Continues	I feel well, without hypotension after dialysis (better tolerance). I have more freedom in eating and drinking	None.
22	05/05/2000 Continues	I felt better in a couple of weeks. (I felt like before starting dialysis.) I have more freedom in eating and drinking. I feel less tired.	No more day off. Loss of time in preparing the monitor.
23	15/03/2000 Continues	This type of dialysis is perfect for my job (night job).	None.
24	01/08/2000 Dropped out	I felt better and stronger. I appreciated more freedom in the diet. I will try it again when I'll work.	Being on dialysis every day (because now I'm not working).
Ospedale Civile (Ceva)			
25	15/06/2000 Died	I can go to work after dialysis. Blood pressure, thirst and hunger are better. Even if I make dialysis at home, it is a time consuming procedure, I would prefer to dialyze in the hospital. However, because I feel better, I continue.	Expenses for electricity, water, and telephone are growing; we need time for dialysis; we have the problem of wastes.

continued

TABLE III continued

Case	Follow-up	Positive opinions	Negative opinions
26	15/05/2000 Continues	I feel better, the examination results have improved. I would prefer to dialyze in the hospital or otherwise at home, but in the evening.	Refunds for home hemodialysis are not enough.
27	15/06/2000 Continues	Before daily dialysis, on the long break, I felt sick. On daily dialysis, I felt better. It gave to me again the wish to live. I feel stronger and hungrier. My weight increased. I have also convinced other patients.	None.
28	15/06/2000 Continues	I can't say if I'm better on daily dialysis. However, my outlook improved; I go out more frequently.	Some generic fears. I have problems to find a job.
Ospedale Della Valle D'Aosta (Aosta)			
29	19/01/2000 Dropped out	It's better for my job. The center is too far from home, so that I'm glad to be on home dialysis.	To be on dialysis every day.
30	03/07/2000 Continues	I suddenly felt better. Thirst and blood pressure improved.	None.

and severe hypertension (6 cases). According to the patients (Table II), the main indications for a trial of DHD were: the search for the best dialysis treatment, poor tolerance of conventional dialysis, and logistic considerations.

At the start of daily dialysis, the patients were concerned about various aspects of the schedule. The main fears pertained to the risk of damaging the vascular access. However, the frequent needle punctures were considered to be a problem by only a few patients. One patient (case 4) even reported that he lost his previous fears after the start of daily dialysis (Table II). The logistic problems—related to the changes in everyday life required by the switch from a schedule that left 4 days per week free from dialysis to a schedule that left only 1 day free—were anticipated as a crucial point by several patients. They were confirmed as drawbacks even by some patients who continued daily dialysis. For 5 patients, the benefits of DHD were outweighed by logistic problems, and they discontinued DHD (Table II). It is interesting to note, however, that only 1 patient dropped from a daily schedule to a conventional one (3 sessions per week). Four patients chose a compromise schedule with 4 sessions per week or alternate-day dialysis, thus confirming the importance of the “lesson” of daily treatment (Table IV).

Subjective improvement was noted in all but 2 cases: one being a patient who shifted to daily dialysis from a very efficient treatment (long, nightly dialysis: 3 sessions of 8 hours each), and the other a young lady who was unable to say whether her well-being improved, but who decided to continue daily dialysis despite the long trip from home to center (Table IV).

In most cases, patients perceived improvement within a short period: 22 of 30 reported improved well-being within 2 weeks; 6 more reported it within 1 month. However, the patients were not always able to perceive improvement in a straightforward manner. In several cases, the patients realized the advantages of daily treatment only afterward. For example, 1 patient (case 9, Table IV) returned to DHD after a vacation on a standard schedule and then realized the benefits. Patients in very good clinical condition may require time to perceive the changes; in other patients, severe concomitant

clinical problems may partly mask the beneficial effect of daily dialysis.

Even though no drawback was identified from the clinical viewpoint, patients reported several logistic problems: the lack of days off dialysis, and the time required at home for machine set-up or, in a limited self-care center, for traveling back and forth. Even if flexible schedules answer these needs in part, a further growth of daily dialysis in outpatient centers is feasible only with a well-developed network of small centers in the area.

On the basis of the data, some general remarks may be made. First, defining the maximum level of well-being for an individual patient is impossible. This fact is exemplified by case 4, a young man who reports that he was able to play 1 hour of tennis when on conventional dialysis and up to 2 hours when on a daily schedule. If this patient had not tried daily dialysis, we would have considered his ability to play tennis for 1 hour a maximum achievement indicating full rehabilitation. However, he perceived a significant increase in well-being, above a level usually considered optimal. In this case, only an empirical trial of DHD was able to discern sub-optimal treatment. Even if anecdotal, this case confirms the trend observed in all patients studied, and raises some interesting questions: How should we assess adequate treatment? Should we strive to reach maximum fitness in all patients? How do we determine that a patient has achieved the real maximum? How many patients fail to reach their rehabilitation potential with the present, standard treatment?

Conclusion

Even in high-risk and long-term dialysis patients, DHD with a short, daily schedule is a good clinical option. A subjective, important improvement in well-being is perceived by most patients and is usually reported within about 2 weeks. This pattern is consistent with the “less unphysiology” hypothesis of daily treatment.

Based on these data, we suggest a policy of offering a short trial of DHD (2–4 weeks) to all patients who consider this choice compatible with daily life or for patients who do poorly on conventional hemodialysis.

TABLE IV Subjective parameters reported for evaluating increased well-being and timing of perceived well-being.

Case	Parameter for evaluating increase in well-being	Time to perception of increase in well-being
SMOM Home Dialysis		
1	Playing a piano concert after dialysis (on conventional treatment could play a concert the day after treatment)	1 week
2	Farm work (more hard work possible, also shortly after dialysis)	1 month
3	Making love	1 week
4	Playing tennis (on conventional treatment could play one hour; on daily dialysis, could play up to 2 hours)	2 weeks
5	Walking around the block. Playing with niece	2 weeks
6	Working (owner and cook in a restaurant; he can cook all nights.) Traveling abroad (last time: Santo Domingo)	1 week
7	Working or traveling when was well; recovering faster after surgery.	1 month <i>When I had severe problems, I realized better the advantages.</i>
8	Walking, organizing daily life.	1 month
9	Walking, studying, and working full time (university student, works during summer).	1 month. <i>I was persuaded after a vacation periods on standard dialysis.</i>
SMOM Self-Care Center		
10	When she tried conventional dialysis on vacation, she didn't tolerate sessions longer than 3 hours.	Few days. <i>I was persuaded after a vacation period on standard dialysis.</i>
11	He felt generically better, but not enough to continue.	2 days
12	Walking, cooking (hobby), organizing daily life.	1 week
13	Generic well-being.	1 month
14	Working (employee in a bank). Increased concentration capacity; walking a few blocks instead of one.	1 week
15	Generic well-being.	1 week
16	I feel better, and I can drink with more freedom	2 days
17	Generic well-being.	Few days <i>I had problems in realizing the differences, because I switched to daily dialysis in the presence of clinical problems.</i>
18	Walking, generic well-being.	Few days <i>This is only way to face my back pain (unbearable on standard dialysis).</i>
19	Walking, daily activities (driving, cleaning home instead of watching television).	2 weeks <i>At the start, I was sick for one week; it was very hot (it was summer), and it was difficult to understand what was going on.</i>
Ospedale San Giovanni Bosco		
20	Working in the garden all the afternoon (impossible before).	1 week
21	Generic well-being.	1 week
22	Generic well-being.	2 weeks
23	Working (also from the logistic point of view)	2 weeks <i>More than the clinical benefits, I appreciate the compatibility with my night job.</i>
24	Generic well-being	Suddenly.
Ospedale Civile (Ceva)		
25	Working after dialysis.	1 week
26	Generic well-being.	2 weeks <i>Before seeing the clinical difference, I realized it from the lab tests.</i>
27	Going out with his little son for a whole afternoon (previously unable to play with him).	Less than a week.
28	Generic well-being (but she is not sure of the difference).	I don't know.
Ospedale Valle D'Aosta (Aosta)		
29	No difference in well-being.	<i>No increase in well-being. (On nightly dialysis 8 h × 3 previously)</i>
30	Generic well-being	1 week

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