Comparison of Staff-Assisted Home Hemodialysis with In-Center Hemodialysis and In-Hospital Hemodialysis

Mahendra Agraharkar,[1] Yong Du,[1] Tejinder Ahuja,[1] Cynthia Barclay[2]

Nephrology Division,[1] Department of Medicine, University of Texas Medical Branch, Galveston; Quality Dialysis Incorporated,[2] Stafford, Texas, U.S.A.

Home hemodialysis (HHD) is superior to in-center hemodialysis (ICHD) in terms of survival, quality of life, and cost-effectiveness. However, assistance from family members in performing HHD is not always available to patients, and professional assistance for HHD can be cost prohibitive. For certain patients, ICHD can be impractical due to difficulties in transportation, which may necessitate ambulance transportation or hospitalization for in-hospital hemodialysis (IHHD). We describe 4 patients that have had problems receiving ICHD for various reasons. Two of these patients had problems with transportation, while the other two could not remain on dialysis for the prescribed duration of time and, therefore, received inadequate dialysis. These patients had difficulty while receiving ICHD in meeting the adequacy criteria set by Dialysis Outcomes Quality Initiative. One of these patients had a neuropsychiatric disorder and displayed disruptive behavior. When these 4 patients were switched to staff-assisted home hemodialysis (SAHD), the dialysis core indicators improved compared with ICHD, and the patients needed significantly fewer hospitalization days. In this paper, we demonstrate that, in patients that cannot be easily transferred, and in patients with neuropsychiatric disorders, SAHD can be a less expensive and more efficacious modality of dialysis.

(Hemodial Int., Vol. 6, 58–62, 2002)

Key words

In-center hemodialysis, in-hospital hemodialysis, staff-assisted home hemodialysis, dialysis adequacy

Introduction

Home hemodialysis (HHD) promotes independence and rehabilitation, improves quality of life, and has a better patient survival rate compared to peritoneal dialysis and in-center hemodialysis (ICHD) [1–5]. Although HHD patients generally tend to be younger with fewer comorbid conditions, when a comparison was made using the Cox proportional hazards model adjusting for age, gender, race, diabetes, and comorbid condition, the risk of death in HHD patients was 44% less than in ICHD patients [relative risk (RR) = 0.56, $p = 0.02$] [1]. Despite this fact, HHD remains a grossly underutilized modality. One reason for this could be lack of a willing assistant, in most cases, a spouse or a family member. Some patients then opt for peritoneal dialysis or, more frequently, ICHD. However, ICHD may be unsuitable or even unsafe for certain patients.

We have already shared our extensive experience in staff-assisted home hemodialysis (SAHD) in patients that are terminally ill [6]. Mortality in such patients is obviously very high. In this paper, we present a group of chronically ill patients that had other indications precluding them from receiving ICHD and therefore were treated with SAHD.

Material and methods

We identified 4 patients that were desirous of receiving HHD and/or had physical, psychosocial, or neuropsychiatric conditions that precluded them from receiving ICHD. All 4 patients were treated either at the university hospital, receiving in-hospital hemodialysis (IHHD), or at a freestanding dialysis facility staffed by university faculty members. We studied dialysis core indicators such as hemoglobin, serum albumin and phosphorus, urea reduction ratio (URR), and Kt/V_{urea} while patients were receiving SAHD and while they were receiving ICHD or IHHD. We also compared the number of hospitalization days in both groups.

Patients

Patient 1

A 76-year-old Caucasian female with diabetes mellitus, hypertension, and chronic renal insufficiency secondary to diabetic nephropathy was admitted to hospital due to cellulitis of her right foot. Her medical history included trauma to the left foot necessitating several surgeries resulting in deformity of the foot. She was morbidly obese and weighed approximately 350 pounds. She lived alone. During this admission, she developed acute on chronic renal failure secondary to sepsis. Since this acute renal failure did not resolve, she was declared an end-stage renal failure (ESRD) patient and initiated on maintenance hemodialysis. Due to sepsis, she had a protracted hospital course of 3 months. Her infected right foot required several surgeries, subsequently resulting in deformity of the foot. The patient was discharged home with arrangements for ICHD. Because of the bilateral foot deformity and morbid

Correspondence to:

Mahendra Agraharkar, MD, FACP, Nephrology Division, Department of Medicine, 4.200 John Sealy Annex, University of Texas Medical Branch, 301 University Boulevard, Galveston, Texas 77555-0562 U.S.A.

email: mlagraha@utmb.edu

obesity, ambulation or transfer by ordinary means was not practical; therefore, transfer by ambulance was arranged. On the first day, during an attempt at transportation by ambulance to the dialysis center, she sustained a fall, resulting in thrombosis of the polytetrafluoroethylene (PTFE) graft. Consequently, she was rehospitalized for salvaging the access, and at this point it was decided to offer her SAHD until she was fit for transportation.

Patient 2

A 52-year-old African American female with a history of diabetes mellitus, hypertension, cerebrovascular accident (CVA), and ESRD secondary to diabetes was receiving ICHD. After her CVA, she developed a generalized seizure disorder and became combative. While receiving hemodialysis, she screamed and attempted to harm dialysis personnel and, therefore, heavy sedation was required for the entire duration of dialysis. Despite all these measures, her dialysis time was consistently shortened. She remained underdialyzed and needed frequent admissions to hospital for various reasons. She had received 10 months of ICHD before she was offered SAHD.

Patient 3

A 67-year-old Caucasian female with a history of hypertension-related ESRD was receiving ICHD. She had longstanding rheumatoid arthritis causing fixed flexion deformities of the wrists and metacarpophalangeal joints. She had several episodes of gastrointestinal bleeding from the use of non-steroidal anti-inflammatory drugs, and was diagnosed with depression. She received ICHD for 4 years; however, her dialysis time had to be shortened due to severe back pain 3 hours into dialysis, due to reclining in a fixed position. It became very difficult to dialyze her for more than 3 hours and, as she continued to shorten the duration of dialysis further, we elected to switch her to SAHD where her position could be better manipulated and she would be able to dialyze for 4 hours.

Patient 4

A 68-year-old Caucasian female with diabetes mellitus with severe retinopathy, peripheral and autonomic neuropathy, and nephropathy resulting in ESRD was receiving ICHD. Additionally, she had severe peripheral vascular disease resulting in diabetic foot ulcers. She also had malodorous pressure ulcers and osteomyelitis of the hip. She had depression, which may have been further aggravated after she was isolated from other patients due to the offensive odor. As she faced ever-increasing difficulties in transportation, SAHD was prescribed following 18 months of ICHD.

Procedure

Staff-assisted home hemodialysis

The nephrologists determined whether these patients would benefit from SAHD following a physical and psychosocial assessment. The patients would then be referred to Quality Dialysis Incorporated (QDI), which provided the services for SAHD. QDI would further evaluate and educate these patients, visiting their homes to verify these patients had clean and secure areas and space for the dialysis machine and supplies. Upon acceptance to the SAHD program, the dialysis nurse, social worker, and dietician explained the procedure and outlined the goals. Informed consent was obtained, the necessary structural and plumbing modifications were made, and the dialysis machine was installed. The patients were dialyzed either on Fresenius 2008 H (Lexington, MA, U.S.A.) or Baxter 550 (Baxter Healthcare, McGaw Park, IL, U.S.A.) machines, using Fresenius F-80 and F-70 NR dialyzers. The dialyzers were not reused. Dialysis was performed as per the prescription of the treating nephrologist and, since most of these patients needed intravenous administration of medications, only a certified registered nurse (RN) performed the dialysis procedures. When feasible, the same RN performed the treatments to maintain continuity of care and to develop a relationship with the patient. Regular monthly, bimonthly, and quarterly laboratory studies were performed as per the Dialysis Outcomes Quality Initiative (DOQI) guidelines [7] and were reviewed by the nephrologist. The first multi-disciplinary patient care conference (PCC) was conducted within 10 days of starting SAHD, and they continued on a monthly basis as required by Texas Department of Health regulations. In these PCCs, all health care-related issues were discussed. Physician clinic visits took place at least quarterly; however, the treating nephrologist decided the frequency.

Dialysis procedure

All 4 patients had permanent accesses in the form of arteriovenous fistulas or grafts. They were dialyzed for 4 hours; blood flow was 400 mL/minute and dialysate flow was 800 mL/min. Ultrafiltration was tricky in Patient 1 as she could not be weighed due to her morbid obesity. Her ultrafiltration was constant at 2 L on Wednesdays and Fridays, and 3 L on Mondays. The other patients were weighed regularly and their ultrafiltration was calculated to achieve their target weights, which were determined on a regular basis by the nephrologist. Patient 1 was dialyzed on a Fresenius 2008 H machine using a Fresenius F-70 NR dialyzer. Patients 2, 3, and 4 were dialyzed on Baxter 550 machines and Fresenius F-80 dialyzers. Patient 1 was dialyzed on a hospital bed, Patient 3 was dialyzed on a regular bed, and the other 2 patients were dialyzed on recliners.

Results

The first patient received only IHHD before switching to SAHD. The other 3 patients received ICHD prior to switching to SAHD. Therefore, we compared the dialysis core indicators while the first patient received IHHD and SAHD, and compared outcomes on ICHD and SAHD in the remaining 3 patients (Table I).

TABLE I Mean hemoglobin, albumin, and phosphorus levels, urea reduction ratio (URR), Kt/V_{urea}, and hospitalization days in 3 patients that were on both in-center hemodialysis (ICHD) and staff-assisted hemodialysis (SAHD).

	Hemoglobin (g/dL)	*Albumin (g/dL)*	*Phosphorus (mg/dL)*	*URR (%)*	*Kt/V_{urea}*	*Hospitalization (days/year)*
Patient 2						
ICHD	10.81±1.73	3.72±0.32	9.36±0.53	52.61±11.84	0.98±0.34	21
SAHD	12.97±1.65	3.93±0.30	5.21±1.47	78.18±6.86	1.93±0.29	10
Patient 3						
ICHD	10.63±2.25	3.91±0.16	4.10±0.37	77.32±1.89	1.81±0.15	6
SAHD	12.71±1.28	3.97±0.08	3.41±0.90	81.43±4.45	2.04±0.18	1
Patient 4						
ICHD	10.33±1.33	3.16±0.04	5.29±1.85	71.50±2.60	1.53±0.11	13
SAHD	10.40±0.53	3.44±0.21	3.33±0.44	73.22±8.62	1.68±0.32	2

Patient 1 could not be placed on ICHD due to problems in transfer arising from obesity and hesitation due to her anxiety following her accident. She was therefore referred to QDI for SAHD. Mean Hb while the patient received IHHD was 8.13 g/dL versus 11.46 g/dL while she was receiving SAHD. Mean albumin was 2.56 g/dL on IHHD and 3.6 g/dL on SAHD. Mean phosphorus levels were 5.17 mg/dL on IHHD and 4.9 mg/dL on SAHD. Hospital days were not compared, as the patient was in-hospital for the entire 3 months while receiving IHHD; however, she has not been hospitalized since starting SAHD.

The other 3 patients had received ICHD for 10 months, 48 months, and 16 months, respectively, before starting SAHD. The mean values are from the last three monthly chemistries. These values were taken from the PCC records while receiving ICHD and while receiving SAHD. Mean (±SD) Hb for Patient 2 was 10.81 ± 1.73 g/dL on ICHD and 12.97 ± 1.65 g/dL on SAHD. Hemoglobin for the other patients was 10.63 ± 2.25 g/dL on ICHD and 12.71 ± 1.28 g/dL on SAHD; and 10.33 ± 1.33 g/dL on ICHD and 10.40 ± 0.53 g/dL on SAHD, respectively (Fig. 1A). Serum albumin levels in these 3 patients were 3.72 ± 0.32 g/dL, 3.91 ± 0.16 g/dL, and 3.16 ± 0.04 g/dL on ICHD, and 3.93 ± 0.30 g/dL, 3.97 ± 0.08 g/dL, and 3.44 ± 0.21 g/dL on SAHD, respectively (Fig. 1B). Although the levels were slightly better on SAHD, the increase was statistically insignificant. Mean serum phosphorus levels were higher on ICHD (9.36 ± 0.53 mg/dL, 4.10 ± 0.37 mg/dL, and 5.29 ± 1.85 mg/dL) compared to SAHD (5.21 ± 1.47 mg/dL, 3.41 ± 0.90 mg/dL, and 3.33 ± 0.44 mg/dL, respectively; Fig. 1C). Again, none of these differences were statistically significant.

Clearances

Urea reduction ratios on ICHD were 52.61% ± 11.84%, 77.32% ± 1.89%, and 71.50% ± 2.60%, and on SAHD were 78.18% ± 6.86%, 81.43% ± 4.45%, and 73.22% ± 8.62%, respectively. In Patient 2, there was a significant increase in URR ($p < 0.05$); however, in the other 2 patients, even though it was improved, URR was not statistically significant. Kt/V_{urea} values were 0.98 ± 0.34, 1.81 ± 0.15, and 1.53 ± 0.11 while on ICHD, versus 1.93 ± 0.29, 2.04 ± 0.18, and 1.68 ± 0.32 on SAHD, respectively. These differences did not reach statistical significance.

Hospitalizations

There was a considerable difference in hospitalization days. Patient 2 had an average 21 days of hospitalization while on ICHD versus 10 days while receiving SAHD. The other 2 patients were hospitalized for 6 and 13 days per year on ICHD, versus 1 and 2 days on SAHD (Table I).

Discussion

There are several advantages of HHD over ICHD and peritoneal dialysis. It prolongs survival and enhances quality of life in addition to promoting independence and rehabilitation. Prior to 1973, more than 40% of the ESRD patients received HHD, and it was perceived to be cost-effective and efficient [8]. The observations and experience with home assistants revealed that paid home-helpers were more useful than a family member or a friend, and HHD costs inclusive of home-helper payments were 77% – 80% of ICHD costs [9]. Although SAHD can be more expensive than ICHD, in certain patients, such as those with terminal illnesses or severe debilities that require ambulance transportation, SAHD can be cost-effective [6]. The difference in dialysis costs in patients that have difficulty in transfer or transportation can be enormous, as these sick patients require an ambulance for transfer. Our earlier analysis revealed that the costs of ICHD with ambulance transportation could be greater than twice that of SAHD. However, if the same patients were to be hospitalized to provide dialysis, dialysis would cost four times that of SAHD (Table II).

Our first patient had several comorbid conditions. She had hypertension and diabetes and was morbidly obese, with a left foot deformity that necessitated the use of devices to assist her in ambulation. Cellulitis of the right foot with several debridement and reconstruction surgeries resulted in deformity. Due to sepsis, she developed acute on chronic renal failure and eventually became dialysis dependent. Her obesity precluded her from transfer to a dialysis center on a regular basis, and an accidental fall during the first transfer attempt

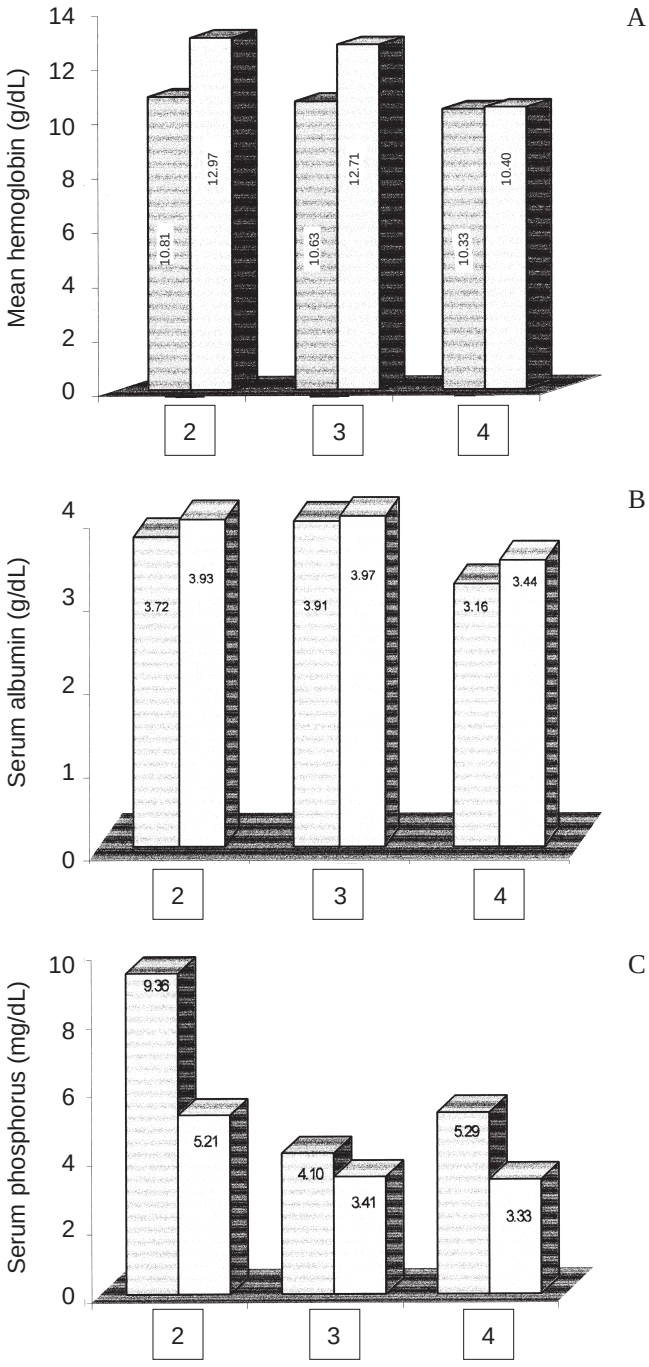

FIGURE 1 Comparison of blood hemoglobin (A), serum albumin (B), and serum phosphorus (C) in 3 patients on in-center hemodialysis (shaded bars) and staff-assisted hemodialysis (white bars).

resulted in damage to the PTFE graft, further increasing her anxiety of ambulance transfer.

Efficacy

Although the dialysis core indicators on IHHD for Patient 1 were worse than while she was on SAHD, this was attributable mainly to the fact that she was septic while in hospital, and the acute illness had resolved while she was on SAHD. We do not feel that SAHD was a superior modality to IHHD with respect to efficacy. However, based on our earlier experience, when costs and comforts are considered, IHHD was more than four times more expensive than SAHD (Table II), and patients are more comfortable and at ease dialyzing at home [6].

TABLE II Calculated weekly costs for different dialysis modalities in a select group of patients. [Modified from Ref. (6). Used with permission of Kluwer Academic Publishers, Dordrecht, The Netherlands.]

In-hospital hemodialysis	
Room cost	$585×7=$4,095
Dialysis cost	$373×3=$1,119
Total cost per week	$5,214
In-center hemodialysis with ambulance transportation	
Ambulance cost (one way)	approximately $375
Weekly ambulance cost	$375×6=$2,250
Weekly dialysis cost	$130×3=$390
Total cost per week	$2,640
Staff-assisted home hemodialysis	
Treatment cost	approximately $400
Total cost per week	$400×3=$1,200

Patient 2 had a neuropsychiatric disorder and disruptive behavior due to the CVA and she could not be dialyzed without heavy sedation. She posed a significant threat to the dialysis staff, as she had a tendency to scratch and bite staff members. As the effect of sedatives wore off, she also demanded to terminate dialysis, which affected her dialysis core indicators. She received insufficient and poor dialysis. Although the dialysis core indicators were notably worse on ICHD compared to SAHD, the differences did not reach statistical significance, except for URR. However, inadequate dialysis was evident from poor health, as it resulted in more admissions to the hospital while receiving ICHD compared to SAHD.

The remaining 2 patients received better dialysis on SAHD than ICHD, but the differences in the dialysis core indicators were marginal. Patient 3 could not lie still or in one position for the entire dialysis duration due to her rheumatoid arthritis. The resulting frequent shortening of the dialysis sessions ceased once she started to receive dialysis at home in her own bed.

Costs

We demonstrated earlier that dialysis costs for SAHD averaged approximately $400 per session, or approximately $1,200 per week. The cost of ICHD alone is approximately $130 per session and $390 per week. In our locale, ambulance costs are approximately $375 for a one-way trip, making the total ambulance cost $750 per session or $2,250 per week. Thus, the ICHD cost with ambulance transportation was $2,640, which is more than twice the cost of SAHD. At the University of Texas Medical Branch, the average acute-care bed costs approximately $585 per day, or $4,095 per week. The costs are much higher for intensive care beds. The cost for in-hospital acute dialysis is approximately $373, of which $246 is

direct cost and $127 is indirect cost for food, transportation, *etc*. This makes the weekly dialysis costs alone approximately $1,119, and the total cost, that is, hospital bed cost and dialysis cost ($4,095 + $1,119) $5,214, which is greater than four times the cost of SAHD [6] (Table II). All the dialysis costs are covered by additional insurance, as Medicare covers only the basic dialysis costs. In most cases, the patient bears a one-time cost for structural and plumbing modifications, which is approximately $400 to $500.

Subjective quality of life

Patient 1 has been receiving dialysis at home for the past 42 months. She feels that SAHD has made a tremendous difference in the quality of her life as she lives alone and has developed a unique rapport with the RN. She apparently looks forward to dialysis days. In the past 42 months, she has not had a single day of hospitalization.

Patient 2 has been on SAHD for 33 months. Although her neuropsychiatric condition has remained unchanged, she is less combative and does not require sedation for dialysis. Initially, it was necessary for family members to be present during dialysis; however, she has developed a very good rapport with the nurse and remains on dialysis for the entire duration of 4 hours. This reflects positively on the dialysis adequacy indicators, and her hospitalization days have been significantly reduced.

Patient 3 had deforming rheumatoid arthritis with significant back pain that required changing her position frequently. This was difficult in the dialysis facility. She also has needle phobia. Prior to each dialysis, she had severe anxiety that raised her systolic blood pressure consistently above 220 – 230 mmHg. Her blood pressure promptly returned to normal within a few minutes of starting dialysis without much ultrafiltration. She was on ICHD for 48 months and has been receiving SAHD for the past 22 months.

Patient 4 was getting sicker on dialysis and that was one of the reasons for SAHD. The patient and her family expressed great relief and satisfaction when she was switched to SAHD, mainly because they felt that the patient lost her dignity while in the waiting area as well as while on the machine in the same bay with other patients, due to the horrible smell from her infected ulcers.

All the patients expressed more comfort and better quality of life while on SAHD.

Conclusion

SAHD is safe for our patients and significantly cost-effective. The dialysis core indicators are in conformity with the DOQI guidelines and have showed consistent improvement compared to ICHD, although the improvement is not statistically significant. Subjective reports of quality of life improved considerably, and satisfaction among these patients was more noticeable. We recommend that SAHD be considered as a viable option for patients that may face significant difficulty in receiving ICHD.

Acknowledgment

The authors thank Mr. Vishal Agraharkar for his help in preparing and editing our manuscript.

References

1 Woods JD, Port FK, Stannard D, Blagg CR, Held PJ. Comparison of mortality with home hemodialysis and center hemodialysis: A national study. Kidney Int. 1996; 49(5): 1464–70.
2 Mailloux LU, Bellucci AG, Mossey RT, Napolitano B, Moore T, Wilkes BM, Bluestone PA. Predictors of survival in patients undergoing dialysis. Am J Med. 1988; 84(5): 855–62.
3 Grant AC, Rodger RS, Howie CA, Junor BJ, Briggs JD, MacDougall AI. Dialysis at home in the west of Scotland: A comparison of hemodialysis and continuous ambulatory peritoneal dialysis in age- and sex-matched controls. Perit Dial Int. 1992; 12(4):365–8.
4 Evans RW, Manninen DL, Garrison LP Jr, Hart LG, Blagg CR, Gutmann RA, Hull AR, Lowrie EG. The quality of life of patients with end-stage renal disease. N Engl J Med. 1985; 312(9):553–9.
5 Bremer BA, McCauley CR, Wrona RM, Johnson JP. Quality of life of in end-stage renal disease: A reexamination. Am J Kidney Dis. 1989; 13(3):200–9.
6 Agraharkar M, Barclay C, Agraharkar A. Staff-assisted home hemodialysis in debilitated or terminally ill patients. Int Urol Nephrol. 2002; 33(1):139–44.
7 NKF-DOQI clinical practice guidelines. II Hemodialysis dose. Am J Kidney Dis. 1997; 30(3 suppl 2):S32–7.
8 Blagg CR. A brief history of home hemodialysis. Adv Ren Replace Ther. 1996; 3(2):99–105.
9 Orkand Corporation. Evaluation of the Home Dialysis Aide Demonstration. Silver Springs, MD: The Orkand Corporation, 1982. Contract HDFA 500-79-0054.