

It's Time to Look at Home Hemodialysis in a New Light

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Hemodialysis for chronic renal failure, first made possible by invention of the Teflon shunt by Scribner and Quinton in Seattle in 1960, was reported in the Transactions of the American Society for Artificial Internal Organs (ASAIO) of that year (1, 2). The first mention of home hemodialysis came only one year later in the presidential address to the ASAIO by Charles Kirby, a cardiac surgeon, who said “Perhaps what we need is a home dialysis unit to be placed by the patient’s bedside, so that he can plug himself in for an eight-hour period once or twice a week” (3).

There is some controversy about the first use of dialysis in the home. Nosé appears to have done a few dialyses in the home with a nurse in 1961 in Japan using a coil dialyzer and a domestic washing machine. However, the first use of maintenance home hemodialysis for chronic renal failure was in 1963, when a rich Indian businessman, his family, and physician, came to Seattle for training and then returned to Madras where he was dialyzed at home.

Be that as it may, home hemodialysis began in 1964, in Boston, Seattle, and London. Merrill and colleagues in Boston used twin-coil dialyzers with a nurse in the homes of four patients at a cost of \$5,000 to \$7,000 a year (4, 5). At the same time, Scribner in Seattle sent a 15-year-old patient home with her mother, using a shunt, the low-resistance Kiil dialyzer, and a proportioning system developed by Les Babb and colleagues at the University of Washington that incorporated monitoring and fail-safe devices (6, 7). This was the prototype for almost all single-patient machines in use today, and was the first machine designed specifically for safe hemodialysis in the home without professional assistance (8). Shortly thereafter, Shaldon in London began a home hemodialysis program using a setup similar to that used in Seattle, and in October, 1963 became the first to use overnight home

Figure 1. Home hemodialysis in Seattle, 1964 and 2006.



hemodialysis (9, 10). In 1966, Kolff and Nakamoto developed a home hemodialysis program using Maytag washing machines and coil dialyzers but soon changed to Baxter twin coil machines because of the Maytag Company’s concern about potential litigation (11). By the early 1970s, some 90% of Seattle dialysis patients were treated at home by overnight three-times-a-week hemodialysis (12).

Advantages and Disadvantages of Home Hemodialysis

It soon became obvious that home hemodialysis provided many advantages for patients. Independence, confidence, and responsibility were encouraged, scheduling was flexible, travel to a center three times a week was eliminated, dialyzing at home was more comfortable and convenient and reduced the risk of infection. Most importantly, home dialysis cost significantly less than center dialysis (13) and so about 40% of all patients in the U.S. were on home hemodialysis by the early 1970s (14).

Disadvantages for patients included the space required

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for the equipment and storage of supplies, the need for modifications of domestic plumbing and electricity supply, and increased utility bills. Most patients needed at least some help from a family member or other individual, and dialysis in the home had an effect on all the family members. An often-neglected issue is the problem of disposal of medical and other waste generated with home hemodialysis (15)

Early on it was recognized that patients dialyzed in a center quickly become dependent and give up control of their treatment to staff, eventually reaching a stage that has been called “learned helplessness” (16). Experience with chronic diseases generally has shown that involvement of patients in their own care is important, particularly in the case of patients with chronic renal failure, and must be encouraged by physicians, nurses, and others who have contact with patients (17).

A number of studies over the years have shown home hemodialysis provides the best patient survival (18-25). Similarly, it provides better quality of life and opportunity for rehabilitation and ability to work that closely approach that seen in patients with a successful kidney transplant (26-29). Another important advantage is that with longer dialyses it provides much better control of hypertension (30). The advantage recognized recently is that home hemodialysis provides the best opportunity for patients to be treated by the most physiological modalities of dialysis—more frequent (five or more times weekly), short “daily,” and long “nightly” hemodialysis.

Candidates for Home Hemodialysis

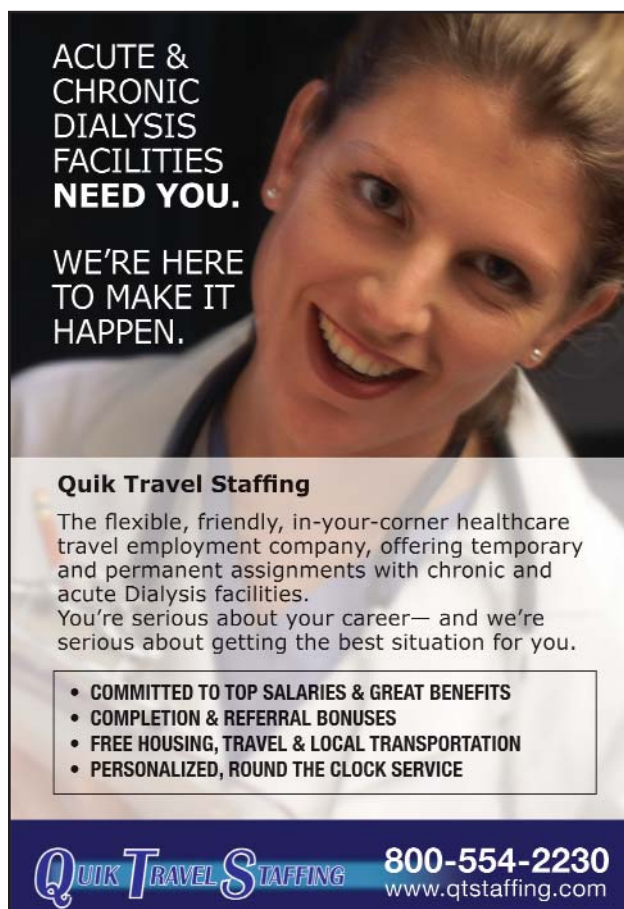
Almost anyone can do home hemodialysis if motivated, compliant, and willing and able to learn. Medical contraindications include severe cardiovascular disease with instability during dialysis, blindness (unless dialysis is done by a helper), and contraindications to heparin use. Age is not itself a contraindication, but lack of a suitable living accommodation is. Intelligence is much less of an issue than many suppose: a study of 100 consecutive patients successfully trained for home hemodialysis in Seattle showed them to have an average IQ of 103 ± 16.2 , with a range between 76 and 147, compared with the normal IQ range of 100 ± 15.0 . In addition, in 2001 we compared our home hemodialysis patients with the total populations of hemodialysis patients in Washington State and in the U.S. and found the age distribution was similar in all three populations. There was a slightly higher proportion of male patients in our home population and a similar number of

diabetics (38% vs. 37% vs. 39%). Thus, in theory the majority of U.S. patients could be trained to do home hemodialysis.

Even so, for a number of reasons not all patients trained remain on home hemodialysis. A recent study of 116 patients trained in our program over 22 months showed that 14 (12.0%) returned to center dialysis, 12 (10.3%) were transplanted, and 37 (31.9%) died. Patients remaining on home hemodialysis tended to be older, male, and had been on treatment longer. Predictors of mortality were age, diabetes as cause of renal failure, and having an unrelated helper. As for risk of failure, unconditional logistic regression showed that sex, cause of renal failure, and helper status were not important; the important factor was patient age. Patients aged between 50 and 65 were less likely to fail than younger and older patients (31).

Requirements for Successful Home Hemodialysis

Patients must have blood access that is easy to use and preferably should stick this themselves or, if they cannot



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do this, have a family member or other helper to do this for them. The dialyzer, time on dialysis, and ultrafiltration rate should be sufficient for adequate dialysis while minimizing symptoms both during and between dialyses, and antihypertensive drugs should be used cautiously. The equipment should be designed for use by patients in the home. The center should have skilled, experienced training staff, one of whom is available for patient phone calls at all times, and should provide or arrange for skilled technical support. Staff should visit the patient at home during a dialysis at least once a year. The nephrologist should see the patient routinely once a month and as may otherwise be required. Patients should complete dialysis log sheets and send a monthly blood sample for routine chemistries, the results being reviewed by the physician, training staff, and patient. Both patient and family should be trained to handle emergencies in the home. Our experience and that of others has been that on-line monitoring in real-time is unnecessary for safe dialysis, although in the U.S. it may ultimately become necessary from a medico-legal standpoint. However, it can be helpful in sending information on dialyses to the unit rather than the patient having to complete and submit a log sheet for each treatment.

The home should be surveyed before starting training to ensure an appropriate area to install the equipment, adequate electricity, water, and drainage, and availability of a telephone by the machine, and any necessary home modifications should be done. Water treatment must be based on analysis of the local water supply. In addition to space for the equipment and a dialysis chair or a bed, there must also be space to store necessary supplies (32).

Home Hemodialysis Over the Years

In 1972, about 40% of the 10,000 or so dialysis patients in the U.S. were on home hemodialysis (14, 33). Since the advent of almost universal coverage with the Medicare ESRD Program in 1973, the proportion of dialysis patients on home hemodialysis has fallen steadily and was only 0.41% in 2003 (34). The highest rates were in Washington State at 1.92% and Illinois at 1.60%. Twenty-five states had 10 or fewer patients on home hemodialysis. The proportion of patients on peritoneal dialysis was very small until development of continuous ambulatory peritoneal dialysis (CAPD) in the late 1970s. It then increased to about 15% during the first half of the 1990s with the introduction of continuous cycling peritoneal dialysis (CCPD), but more recently has declined and now accounts for 8.0% of all dialysis patients (34). Similar changes have been

described in other countries (35-37). The exceptions are Australia and New Zealand. In Australia in 2003, 13.8% of patients were on home hemodialysis, 23.8% were on peritoneal dialysis, and 15.6% of patients dialyzed in satellite centers where patients did most or all of their own treatment. In New Zealand, 13.8% were on home hemodialysis, 45.3% were on peritoneal dialysis, and 38.9% dialyzed in satellite centers (38).

Some of the reasons for the decline in home hemodialysis in the U.S. were inadequate payment for home hemodialysis during the first five years of the Medicare ESRD Program; the high rate of reimbursement for center dialysis in the first decade of the program; the rapid proliferation of dialysis units, many of which were for-profit and not interested in establishing a home hemodialysis program; changing patient demographics resulting from the almost universal entitlement with marked increases in the number of diabetic and older patients; and the introduction of CAPD and CCPD (33). At that time, as is still the case today, nephrologists from most training programs had little or no experience with home hemodialysis, and neither did most of the staff of the new facilities. As a result, patients were no longer expected to take any responsibility for their own care. Patients generally do not like the idea of sticking themselves with large needles, are concerned about the machine and technical aspects of doing dialysis themselves, do not like the extra effort involved, and may be concerned about becoming isolated (39). Today in the U.S. most patients are not told of the options of either home hemodialysis or peritoneal dialysis (40). The continuing use of home hemodialysis in Australia and New Zealand probably reflects the absence of for-profit dialysis and ESRD treatment programs that are mainly coordinated through teaching and large community hospitals.

Costs

Home hemodialysis grew during the 1960s and early 1970s because, after training of the patient, the ongoing costs are less than for facility dialysis, primarily because of lower staffing costs (13). All studies since the earliest days have confirmed this for three times a week conventional dialysis at home. In our Seattle program, the cost of a home hemodialysis is about two thirds the cost of a dialysis in a center. Similarly, a Canadian report showed an annual cost (in Canadian dollars) of \$30,626 for dialysis in a facility, \$24,937 for CCPD, \$20,029 for CAPD, and \$17,547 for home hemodialysis (41). These figures do not take into

account patient training costs that are expensive because of the need for more staff and materials, and current Medicare reimbursement for training is inadequate. There is the cost of the equipment, some \$10,000 to \$30,000, depending on its sophistication, and many programs lease the equipment together with technical support and delivery of supplies to the home. There are also the cost of any plumbing or electrical modifications and the increased utility bills.

Peritoneal Dialysis

Continuous ambulatory and continuous cycling peritoneal dialysis are primarily home treatments and, like home hemodialysis, their use varies widely among countries (35). The proportion of U.S. patients using these treatments increased through the late 70s, the 80s, and until the mid-90s, but now has decreased somewhat. Both modalities are extremely simple to learn and use, and new patients can be using these within one or two weeks of starting treatment. Many of the advantages associated with home hemodialysis apply also to peritoneal dialysis, and its cost lies between that of center hemodialysis and home hemodialysis (41). Many patients can continue using peritoneal dialysis successfully for several years before it fails, usually due to repeated infections and loss of membrane surface area. It is unfortunate that when it does fail, most U.S. patients do not have access to home hemodialysis. Even so, it is worth considering establishing an arteriovenous fistula in most peritoneal dialysis patients once they are stable.

Longer and More Frequent Hemodialysis

Even though the first report on more frequent hemodialysis was published in 1969 (42), it is only in the last 10 years or so that interest in this has been revived. The multi-million dol-

lar HEMO Study showed no significant effect on overall patient mortality in patients treated three times a week when dose of dialysis measured as Kt/V was increased or when high-flux membranes were compared with low-flux membranes (43), although secondary analysis suggested that high-flux dialysis might improve cardiac outcomes (44). One of the investigators said that “[The results] do indicate that for patients receiving thrice-weekly treatments lasting 2.5-4.5 h each we have reached or neared the maximum benefit that can be attained when the benefit is viewed in the traditional dose-response sigmoid curve. This is not to say that future technological advances in dialysis may not provide new solutions or that either longer

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or more frequent dialysis will not improve outcomes” (45).

Longer dialysis was the norm prior to 1973 and, in programs such as that in Seattle, almost all patients dialyzed at home, overnight, three times weekly for six to eight hours at a time (46). This changed after introduction of the Medicare ESRD Program with the proliferation of dialysis units, development of larger surface area disposable dialyzers, and the obsession that a Kt/V of 1.0 represented adequate dialysis. As a result, the usual dialysis became two-and-a-half to three hours three times a week. Even today, most U.S. patients dialyze for less than four hours three times a week compared with Australia where 91% and New Zealand where about 96% of patients dialyze for four or more hours three times a week (47). Australian data, adjusted for age, race, smoking, body mass index, hypertension, coronary artery disease, cerebrovascular disease, diabetes, and primary renal disease show that if four to four-and-a-half hour dialysis is taken as the norm, less than four hours is associated with a relative risk of death of between 1.06 and 1.29 and with four-and-a-half hours and more the relative risk of death is reduced to between 0.77 and 0.93. The preponderance of short dialysis in the U.S. is one of the major factors explaining the higher mortality for hemodialysis patients compared with those in Australia, New Zealand, many European countries, and Japan (48). Short dialysis has also resulted in acceptance that patient symptoms during and between hemodialyses are normal phenomena and why almost all U.S. dialysis patients need drugs for control of hypertension. It is forgotten that these were not issues until the late 1970s. The program in Tassin, France, which continued long dialysis three times weekly, has the best long-term survival results and more than 95% of the patients there no longer require antihypertensive drugs after six months on this regime (48).

The last 10 years or so has seen the appearance of glowing reports from Canada, the U.S., Europe, and Australia on the benefits of more frequent short daily and/or long nightly hemodialysis (49-55). As a result there has been a revival of interest in home hemodialysis as the obvious place to do this. The results are striking in terms of improvements in many of the complications associated with hemodialysis, marked reductions in symptoms during and between dialyses, and improvements in patient well-being. Results are very similar with short daily and long nightly dialysis, but the latter is associated with greater reduction in phosphate levels, usually doing away with the need for oral phosphate binders, and more removal of β_2 -

microglobulin (55). The most important effects of more frequent dialysis may well be the improvement in cardiovascular outcomes seen with short daily hemodialysis (56), and even more so with nightly hemodialysis (57). From a financial point of view, the increased supply costs are more than offset by the reduction in costs associated with significant reduction in hospitalizations and hospital days (58, 59). The rationale for more frequent hemodialysis is that three-times-a-week dialysis is relatively more unphysiological (60). This is strikingly illustrated by the fact that Mondays and Tuesdays are the commonest days for sudden and cardiac deaths in U.S. hemodialysis patients, while these are evenly distributed throughout the week in peritoneal dialysis patients (61).

The Future

The exciting results of more frequent hemodialysis and revival of interest in home hemodialysis have led to reconsideration of equipment requirements for home and more frequent hemodialysis (62). At least three new machines have been developed in the U.S. that are specifically designed to be patient-friendly for self-dialysis in the home and major manufacturers are modifying their machines for home use, too (63-69). An equipment issue still to be resolved is remote monitoring of the patient, treatment, and machine (70). Our own experience over many years and that of others has been that remote real time monitoring of the patient is unnecessary for patient safety in appropriately trained patients. Nevertheless, as new machines are developed, the advantages of monitoring machine and treatment parameters will be increasingly recognized as this will do away with the need for patients to complete a log sheet with each dialysis.

However, because of the increased supply costs, reimbursement for more frequent hemodialysis in the U.S. may well require specific legislation. This in turn may have to wait for the results of a trial of long nightly home hemodialysis and short daily center hemodialysis cosponsored by CMS and the NIH that has just begun. Meanwhile, governments in the Netherlands (71), Australia (72), and the Province of British Columbia in Canada (73) have all agreed to support more frequent hemodialysis.

In the meantime, recognition of the benefits of more hemodialysis will lead to increased use of home hemodialysis, both three times a week and alternate nights, as both provide much more dialysis than conventional center dialysis in the U.S. at this time. Also, the importance of educating patients on the benefits of home hemodialysis and self-

care dialysis before the need to start dialysis is again being recognized (74-76). Certainly, the large dialysis corporations are becoming interested in home hemodialysis and are beginning to look at self-care dialysis in at least some of their facilities.

Home hemodialysis in the U.S. has a long way to go, but recently the Annual Dialysis Conference has more papers and time devoted to home hemodialysis and more frequent hemodialysis each year and the number of publications on these subjects is also increasing. Experienced physicians, both here and elsewhere, believe that at least 20% of patients could do home hemodialysis if training and support services were available together with the new more patient-friendly machines.

The need now is to convince patients, nephrologists, dialysis unit staff, and administrators, payers, and especially the federal government that home hemodialysis is by far the best treatment for many of our patients.

“There’s no place like home [for hemodialysis]!” ■

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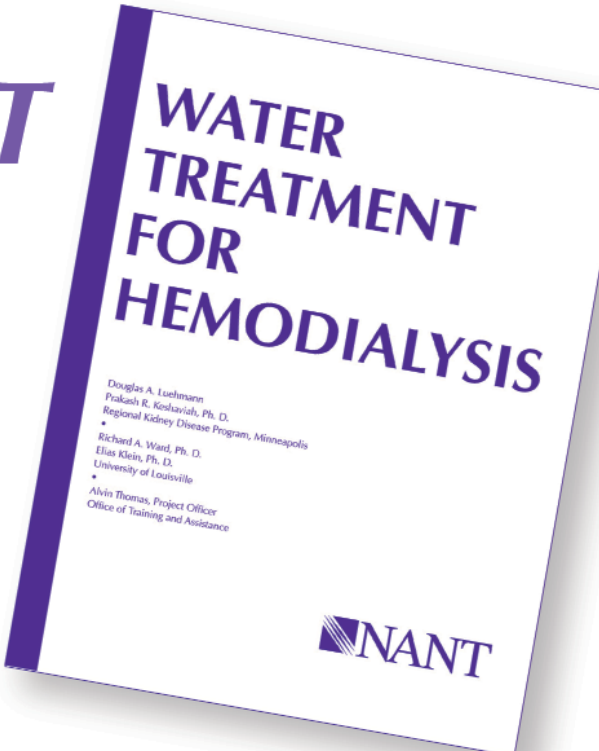
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