Personal Opinion

Home haemodialysis in the 1990s

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Rise and fall of home haemodialysis

Home haemodialysis has been utilized successfully in the treatment of end-stage renal failure (ESRF) since 1961. After an initial expansion in home haemodialysis during the 1970s and early 1980s, the number of patients receiving this mode of dialysis has decreased progressively over the past decade despite a major expansion in the total number of patients on chronic renal replacement therapy [1]. In the US, the percentage of dialysis patients on home haemodialysis was 39.2% in 1972, 23.7% in 1976 and 1.3% in 1992 [1,2]. This international trend was also apparent in Scotland, where the number of patients receiving home haemodialysis decreased from 160 in 1987 to 75 in 1995 while the total number of dialysis patients increased from 760 to 1180 over the same time period [3]. In Lombardy, Italy, which, like Scotland, also has a complete registry of patients on renal replacement therapy, the percentage of dialysis patients on home haemodialysis decreased from 15.7 to 5.3% over the decade from 1983 in spite of a major increase in the acceptance rate for dialysis and only a minor increase in renal transplantation rates [4]. In our centre, the number of home haemodialysis patients at the end of each consecutive year from 1990 to 1997 was 60, 56, 48, 44, 41, 43, 39 and 42, indicating that home haemodialysis patient numbers have remained stable over the past 4 years.

Why has home haemodialysis declined in recent years?

The reduced uptake of home haemodialysis has occurred despite the reported survival advantage of home haemodialysis in comparison with hospital haemodialysis after adjustment for patient case mix and co-morbidity [2], the higher quality of life, independence and rehabilitation provided by home haemodialysis in comparison with other dialysis modalities [5,6], and the restricted resources available for hospital haemodialysis in many countries [7]. This reduction in home haemodialysis has been attributed to the increased age and co-morbidity of patients now commencing long-term dialysis, but the number of low risk patients beginning dialysis, who would have been assessed previously as suited to training for home haemodialysis, remains unchanged. Such low risk patients must now be opting for either peritoneal dialysis or hospital-based haemodialysis. This trend may be due to an increase in the number of regional renal units resulting in the provision of hospital haemodialysis nearer patients’ homes, the expansion of continuous ambulatory peritoneal dialysis (CAPD) and automated peritoneal dialysis (APD) in the 1980s and socio-demographic changes in the family unit and in the workplace which may have led to fewer unpaid helpers being able to assist with home haemodialysis. During the past 10 years in the West of Scotland (population ~2.8 million), the number of renal units has risen from three to six, the median age and number of patients receiving chronic dialysis have increased, the proportion of single person households has increased, and peritoneal dialysis patient numbers have remained stable while the number of home haemodialysis patients has halved. Other factors may also have influenced the decline of home haemodialysis over the past decade: the perceived complexity of the technique, the low risk of air embolism, the additional time before and after every treatment required for setting up and clearing the haemodialysis system, and doubts about the cost-effectiveness of the technique when patient numbers in each unit are small.

Who have been selected for home haemodialysis in recent years?

Only a proportion of patients reaching ESRF are able to perform home haemodialysis. Patients may opt for home rather than hospital haemodialysis because of its flexible dialysis schedule and freedom from travel to and from the dialysis unit. Home haemodialysis is restricted to patients who have no major medical contra-indications, have a home with a suitable spare room or garden for location of a converted dialysis portacabin, have vascular access which they can cannu-
late reliably, are able to learn to use the relatively complicated equipment and procedures necessary for safe and high quality haemodialysis, and have no plans for live donor renal transplantation. In our own unit, the patient also needs to have a helper who is willing to be trained over a period of at least 6 weeks to supervise the patient during each haemodialysis session.

During the period January 1, 1990 to December 31, 1995, 90 patients were trained in our unit to perform haemodialysis at home, 18 of whom had undergone previous renal transplantation. The mean age ± 1 SD of these patients when commencing home haemodialysis was 40 ± 12 years (range 18–67 years), 60 patients were male and six had documented ischaemic heart disease (two patients with prior myocardial infarctions, two patients with angina, two patients with prior coronary artery bypass surgery) and one patient had a previous cerebrovascular accident. The primary renal disease in this patient population was chronic glomerulonephritis 30, reflux nephropathy 11, adult polycystic kidney disease nine, unknown nine, obstructive uropathy seven, diabetic nephropathy three, vasculitis three, anephric three, chronic interstitial nephritis two, renal tuberculosis two and single cases of other causes of ESRF 11. Relatively few of the patients, therefore, had significant co-morbidity. All patients dialysed thrice weekly using an arterio-venous fistula and dialysate flow rate of at least 250 ml/min. Haemodialysis was performed in a converted room in their home by 67 patients (in 11 cases after rehousing by the local Housing Authority and by one patient using a converted garage) and in a converted portacabin by the other 23 patients. The helper was the spouse of 73 patients (wife in 55 cases), the long-term girlfriend of one patient, a parent of 15 of the patients (mother in 11 cases), and the daughter of one patient. The majority of patients’ helpers, therefore, were female relatives.

How do clinical outcomes compare with hospital haemodialysis and peritoneal dialysis?

Woods et al. [2] have demonstrated that the relative risk of death in 70 home haemodialysis patients and 3102 centre haemodialysis patients in the US using the Cox proportional hazards model was 0.58 (P = 0.03) when adjusted for co-morbidity, age, sex, race and diabetes. Prescribed dialysis dose (Kt/V) and serum albumin were similar in both groups of haemodialysis patients [2]. Identified risk factors present at the time of dialysis modality selection do not explain the reduced mortality rates of home haemodialysis which may be due to differences in patients’ lifestyle, motivation, compliance with treatment or the severity of co-morbid conditions. Long-term technique survival on home haemodialysis is not unusual if patients do not undergo renal transplantation, and 36 (19%) of 192 consecutive home haemodialysis patients in one centre in the US continued on uninterrupted haemodialysis at home for at least 10 years [8].

A retrospective comparison of home haemodialysis and CAPD in the West of Scotland for the 6 year period 1982–1988 demonstrated a 3 year patient survival rate of 93.8% and a 3 year technique survival rate of 94.2% in 139 home haemodialysis patients, compared with 86.2 and 80.8% respectively in 139 age and sex-matched non-diabetic CAPD patients [9]. A prospective comparison of home haemodialysis and CAPD patients showed hospitalization rates of 2.8 and 7.5% respectively, and technique failure rates of 16 and 43% respectively [10]. The differences in these hospitalization rates were due primarily to CAPD-associated peritonitis [10]. Utilizing objective and subjective parameters, home dialysis therapies offer better rehabilitation and quality of life than hospital haemodialysis [5], and using the Spitzer quality of life index, Fox et al. showed that home haemodialysis provided higher quality of life than either CAPD or hospital haemodialysis [6].

These data indicate that home haemodialysis is associated with better patient survival rates and quality of life than hospital haemodialysis, and higher technique survival rates and quality of life than CAPD.

Are clinical outcomes still good?

There have been no detailed reports of clinical outcomes of patients on home haemodialysis in the 1990s. At the end of a 6 year period from January 1, 1990, during which the aforementioned 90 patients were trained to perform home haemodialysis at Stobhill hospital, eight had died, eight were transferred to hospital haemodialysis (inadequate vascular access for home haemodialysis in three patients, loss of helper support for haemodialysis at home in three patients and anxiety and stress associated with home haemodialysis in two patients), three transferred to the care of other renal units, 37 received renal transplants (second transplant in five patients) and 34 remained on home haemodialysis at the end of 1995 (Table 1). The causes of death were not dialysis related or due to underlying

Table 1. Clinical outcomes at December 31, 1995 of all patients accepted and trained for home haemodialysis 1990–1995 at Stobhill hospital

<table>
<thead>
<tr>
<th>Year</th>
<th>Trained</th>
<th>Technique</th>
<th>Renal</th>
<th>Transfer</th>
<th>Death</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>survival</td>
<td>transplant</td>
<td>(hospital HD)</td>
<td></td>
</tr>
<tr>
<td>1990</td>
<td>18</td>
<td>3</td>
<td>8</td>
<td>4 (2)</td>
<td>3</td>
</tr>
<tr>
<td>1991</td>
<td>18</td>
<td>3</td>
<td>10</td>
<td>2 (1)</td>
<td>3</td>
</tr>
<tr>
<td>1992</td>
<td>10</td>
<td>2</td>
<td>7</td>
<td>1 (1)</td>
<td>0</td>
</tr>
<tr>
<td>1993</td>
<td>15</td>
<td>6</td>
<td>7</td>
<td>1 (1)</td>
<td>1</td>
</tr>
<tr>
<td>1994</td>
<td>18</td>
<td>12</td>
<td>3</td>
<td>2 (2)</td>
<td>1</td>
</tr>
<tr>
<td>1995</td>
<td>11</td>
<td>8</td>
<td>2</td>
<td>1 (1)</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>90</td>
<td>34</td>
<td>37</td>
<td>11 (8)</td>
<td>8</td>
</tr>
</tbody>
</table>

*Includes three patients transferred in 1990 and 1991 to other units and remaining on home haemodialysis.
renal disease. The 1, 2 and 3 year patient survival rates including transplantation and transfers from home haemodialysis were 96, 95 and 91% respectively. None of the eight patients transferring from home haemodialysis to hospital haemodialysis at our centre died during the 6 year study period.

The 1, 2 and 3 year technique survival rates, censored for death and transplantation, were 90, 86 and 82%. If the three patients transferring to another renal unit while remaining on home haemodialysis were not censored as technique failure, a further two patients remained on home haemodialysis after 3 years, and the 3 year technique survival rate increased to 84%. These patient and technique survival rates are similar to rates reported from the West of Scotland in the 1980s [9].

During a 2 year period (1994–1995) when patient numbers on home haemodialysis were stable, there were 140 admissions to hospital, equivalent to 1.7 admissions per patient per year (range 0–8 per patient) and a total of 695 in-patient days, equivalent to 8.3 days per patient per year (range 0–65 days per patient). It is noted that five patients contributed to 23 admissions and 222 in-patient days. The reasons for hospital admission are summarized in Table 2. At the end of 1995, 21 of the 43 patients on home haemodialysis dialysed for at least 4.5 h three times per week.

Kaplan–Meier life table analysis of the 90 patients showed that slightly less than 50% of patients remained on home haemodialysis 2 years after completing training, and >50% of patients were transplanted after 3 years. These observations may raise concerns about the cost-effectiveness of home haemodialysis during this time period.

### Is home haemodialysis still cost-effective?

Cost comparisons amongst the different dialysis modalities are difficult because of variations in patient case mix, the transfer of patients between modes of dialysis and transplantation, and problems in accurately calculating fully allocated as well as dialysis treatment costs [11].

Finance costs for the period from January 1, 1994 to December 31, 1995 were utilized to determine the annual cost of home haemodialysis in our unit since the number of home haemodialysis patients had remained static over this time period and, to permit a comparison with the cost of hospital haemodialysis, the costs of treatment were calculated if the same patient population had received hospital haemodialysis in our centre assuming that their direct treatment costs remained constant (Table 3). This cost analysis showed that home haemodialysis during a study period with a relatively high successful renal transplantation rate and an average of 15 home modifications per year was more cost-effective than treating the same patient population by hospital haemodialysis. The cost differential of hospital haemodialysis in our study would have been significantly greater if hospital overheads and hospital transport costs could also have been included. Similar cost differences were reported in New Zealand where home haemodialysis was calculated to average NZ $28 175 and hospital haemodialysis NZ $35 270 per patient per annum excluding marginal costs [12]. The difference between fully allocated and dialysis treatment costs was well demonstrated by Goeree et al. in Canada [13] who showed that total and dialysis treatment costs for hospital haemodialysis were $88 585 and $54 929 respectively, and for home haemodialysis were $32 570 and $26 048.

The major factor determining the relative cost-effectiveness of home and hospital haemodialysis is the number of years each patient remains on dialysis. The higher initial cost of home dialysis facility provision and the higher cost of dialysis equipment depreciation and maintenance per home haemodialysis patient are counterbalanced by the greater nursing staff costs of hospital haemodialysis treatment and the capital cost, depreciation and fixed overheads of the hospital.

<table>
<thead>
<tr>
<th>Table 3. Comparative costs of home and hospital haemodialysis at Stobhill Renal Unit, 1994–1995</th>
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</thead>
<tbody>
<tr>
<td>Haemodialysis cost variables</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Dialysis disposables (dialyser, sundries, dialysate)</td>
</tr>
<tr>
<td>In-patient treatment (average of 8.3 days per year)</td>
</tr>
<tr>
<td>Erythropoietin (51% of patients; target Hb &gt;8.5)</td>
</tr>
<tr>
<td>Laboratory investigations</td>
</tr>
<tr>
<td>Dialysis equipment depreciation and maintenance</td>
</tr>
<tr>
<td>Nursing and medical staff</td>
</tr>
<tr>
<td>Home conversions (15/year) or hospital facilityb</td>
</tr>
<tr>
<td>Telephone and power</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

*aMean treatment costs of 42 home haemodialysis patients were compared with the costs that would have accrued had the same patients been treated with hospital haemodialysis on two shifts per day excluding patient transport and hospital overhead costs.

*bIncludes the annual cost per patient of depreciation, maintenance and local authority rates of either home conversions or hospital haemodialysis facility.
haemodialysis facility. The concept of the ‘pay-back period’ defines the time after which the higher training and initial start-up costs of home haemodialysis are exceeded by the greater long-term costs of hospital haemodialysis. Delano et al. calculated that the payback time on home haemodialysis in their unit in New York, was 14.4 months based on higher initial costs in the first 3.5 months of home haemodialysis of $6854 and subsequent lower costs of $7472 per year when compared with hospital haemodialysis [14]. Our study, with an average home conversion cost of £3889 and other annual support costs of home haemodialysis of £4644 compared with annual support costs of hospital haemodialysis of £7926, showed that haemodialysis patients may be treated cost-effectively by home haemodialysis provided they remain on dialysis for at least 14.2 months. The ‘pay-back time’ for home haemodialysis in this analysis is an overestimate since the costs of patient transport and general hospital overheads were not included in the cost allocated to hospital haemodialysis.

Home haemodialysis provides higher technique survival rates [9] at an equivalent average annual cost to CAPD [12,13] and will be more cost-effective than CAPD in patients requiring long-term dialysis [8]. Therefore, at similar cost, home haemodialysis provides a better prospect of long-term technique survival than CAPD.

What is the future of home haemodialysis?

Thrice weekly home haemodialysis in the modern era continues to provide favourable clinical outcomes and cost-effectiveness in comparison with hospital haemodialysis and peritoneal dialysis. In addition, in the future, daily home haemodialysis with in situ automated disinfection and reuse of the entire extracorporeal circuit [15,16] has the potential to provide an improvement upon the established good clinical outcomes and cost-effectiveness of thrice weekly home haemodialysis [17]. Nevertheless, the relative importance of home haemodialysis as a mode of chronic dialysis continues to decline in most countries; at the end of 1997 in the West of Scotland there were only 46 home haemodialysis patients but 504 hospital haemodialysis patients, 268 peritoneal dialysis patients and 745 patients with functioning renal transplants (personal communication).

The initial higher costs of home haemodialysis vs hospital haemodialysis will be recovered provided that patients on average remain on home haemodialysis for at least 14 months [14]. Average waiting times for cadaveric renal transplantation are increasing at present and greatly exceed the ‘pay-back’ period for home haemodialysis of 14 months. Therefore, patients who are not considering living related or non-related renal transplantation should be able to opt for either home or hospital haemodialysis. Home haemodialysis is not provided by all renal units, and consequently may not be discussed with all potentially suitable patients requiring long-term dialysis. The cost of providing home haemodialysis per patient will also increase greatly if the number of such patients in individual renal units is low. A solution to this scenario is to have only one renal unit providing home haemodialysis training and support within one geographical region, akin to the organization of renal transplant provision. Nursing, technical, administrative and medical expertise would be also maintained by centralizing home haemodialysis when total patient numbers decrease.

Home haemodialysis remains the optimal mode of chronic dialysis for a sub-group of patients with end-stage chronic renal failure and the future of home haemodialysis as a universally available, cost-effective mode of dialysis may be best secured by centralizing training and support facilities in one centre in each geographical region. Current debate about the long-term adequacy of peritoneal dialysis and the high economic cost of hospital-based haemodialysis may permit a resurgence in home haemodialysis.

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