Middle Articles

CONTEMPORARY THEMES

Home Adaptations for Haemodialysis

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Introduction

Regular haemodialysis offers an acceptable substitute for renal function in selected patients with terminal chronic renal failure (*Brit. med. J.*, 1965). Space and staffing limit the number of patients who can be cared for in a hospital unit. Dialysis in the patient's home provides an alternative approach which will allow the treatment of more patients without a commensurate increase in hospital accommodation and nursing staff. Though initially sometimes stressful, the isolation and independence of home dialysis have medical, bacteriological, and psychological advantages both for the patient and for his family.

An important consideration in expanding a home dialysis programme is the funding and organization of the adaptations required in the patient's home. It is here that the help of the local authority is required. The full potential of the hospital unit can be realized only if it develops cordial working relations with the local health authorities in the area it serves. Home adaptations can then proceed smoothly.

Authorization

The Department of Health and Social Security has authorized the adaptations necessary to allow home dialysis under paragraph 1 of Section 28 of the National Health Services Act, 1946, and Circular H/A190/02. Under paragraph 2 of the Act the local health authority may, with the approval of the Minister, recover such charges as are considered reasonable from those availing themselves of the services provided. In fact, only a minority of local authorities exercise this option.

General Considerations

In order to avoid delays and misunderstandings early and adequate consultation on a personal level between the hospital doctor and the medical officer of health is desirable. Detailed arrangements can be dealt with by non-medical personnel. To represent the dialysis unit a home dialysis administrator, if and when appointed, is the obvious choice. For the local authority someone with previous experience of home adaptation for medical conditions is suggested. In Liverpool the health department's senior occupational therapist was chosen, as she was already responsible for adapting homes for patients with locomotor and other disabilities.

The engineer to the local water authority should also be consulted at an early stage, for though most equipment now

available for dialysis takes into account the legal safety requirements of the different authorities, the engineer's inspection of the proposals and equipment should be invited in order to ensure compliance with local by-laws. Since water is to be used for "non-domestic" purposes, the water authority is entitled to know of each planned additional installation in its area. In turn, should the mains water pressure be low or fluctuate unduly in a patient's house, the water authority may be able to remedy the situation. The patient can be informed in advance by the authority should a cut in supply or serious fall in pressure be likely. The unit should also arrange to be informed if changes in the source of supply are likely to affect the degree of hardness of the water, which, in turn, if a domestic softener is used, will alter the sodium content of the dialysing solution. Particularly in areas in which well water is used, very cold mains water in winter may require additional de-aeration if excessive bubbling occurs in the blood circuits. Equipment for this is available commercially.

In our experience, should the local water authority require special precautions, it is preferable that adaptations be made to existing equipment, in consultation with the manufacturer, rather than additional devices be introduced by the unit. When rain-water and domestic effluent are drained into the same sewerage system the spent dialysis fluid can be drained into the nearest convenient gully or waste-head, but usually separate systems exist and dialysis effluent should not be drained into the surface water drains. Local advice is necessary on this point.

If possible the medical officer of health should initially visit the hospital and a house already adapted to meet patients, and obtain first-hand experience of intermittent dialysis. He will then be better able to advise his committee, which, despite the considerable publicity that has surrounded this form of treatment, may be unaware that the patient is enabled to lead a productive if not altogether normal life. A committee might otherwise be hesitant in authorizing expenditure in the mistaken belief that money was being devoted to over-elaborate terminal care of bed-ridden patients. Some disappointments are inevitable, however. One death has occurred among the 17 home patients we have cared for, who among them have had 14 years of treatment at home. Drukker (1969) reported eight deaths among a total of 133 home patients in Europe during the first half of 1968.

The disposal of dressings, blood-contaminated cuprophane membranes or coils, and polyethylene tubing is also a field that concerns the local authority, since this waste constitutes a potential health hazard. Dressings and cuprophane are best burnt by the patient, if possible, but polyethylene tubing will not burn, and in melting gives off dense black fumes, which may prove a nuisance and be illegal in residential areas. Our first three home dialysis patients in Liverpool were suspected of being carriers of viral hepatitis and it was therefore arranged that special collections of dialysis refuse should be made from

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them. This material, collected in disposable bags, is buried deeply in the corporation refuse tip. It is debatable whether such precautions are necessary for all, but since any blood-stained material is potentially infectious some care seems indicated.

Save for the disposal of dialysis waste the commitments of the local authority finish after the completion of the home adaptations. The reimbursement of the cost of electricity expended in running the artificial kidney machine, and the cost of installation and rental of a telephone (if this was not already installed), fall on the hospital authority. Payment to patients for electricity is made on a rate "per dialysis" in our unit. Alternatively the supply to the machine can be separately metered.

Accommodation needed for Home Dialysis

In common with most centres in the United Kingdom, we use warm, single-pass dialysis with a modified Kiil dialyser. The dialysers require sterilizing after each dialysis and rebuilding by the patient after every third dialysis—that is, once weekly. Consequently more space and facilities are required than when disposable dialysers ("coil kidneys") are used. A separate room set aside specifically for dialysis treatment and preparation is considered advisable. We prefer a floor area of 11.3 sq. m. (120 sq. ft.), but as little as 8.5 sq. m. (90 sq. ft.) is acceptable if this avoids undue disruption of family accommodation. Unfortunately the small bedroom of most three-bedroomed, semi-detached houses is not large enough. A downstairs room is perfectly acceptable. Since there is a risk of accidental flooding in a dialysis room there are some advantages in having it on the ground floor.

In some cases it may be necessary for council-house tenants to be rehoused if overcrowding is to be avoided. Owner-occupiers may prefer to build an additional room in these circumstances. In some areas interest-free loans may be granted for this purpose from the local authority under Section 28 of the Health Services Act, but the practice is not widespread. Patients living in rented, privately owned accommodation may be at a disadvantage.

Home dialysis is usually conducted with a single-patient monitor and proportionating system or "artificial kidney machine," which produces dialysing fluid by mixing tap-water and a concentrate, monitors its constitution and temperature, and also monitors the pressure in the extracorporeal circuit. Alternatively the dialysing fluid may be prepared and stored in a tank previous to dialysis, to be metered out during the period of treatment. If this system is chosen it may be necessary to reinforce the floor of the room in order to take the weight of a full 400-litre (88-gallon) tank.

Adaptations

The required adaptations are mainly concerned with electrical outlets and plumbing. During the first 18 months of our home dialysis programme, during which 12 homes were adapted, the adaptations were more elaborate than necessary. (For instance, an extractor fan for formalin vapour is unnecessary, and an integral stainless steel sink and drainer extravagant.) Lay persons advising on materials and furnishings may in their enthusiasm be less cost-conscious than they would be in non-medical work, and once the pattern is set it is difficult to effect a change towards a cheaper adaptation or a "people's dialysis room." The cost of the first home dialysis units in Liverpool varied between £260 and £300. Later adaptations have cost £30 to £50 less. A figure of about £150 has been achieved elsewhere. Costs will obviously be influenced by the amount of work entailed in conversion, and this can vary considerably. More important, it should be realized that the employment of

direct labour can considerably raise the cost in some areas in which local council instructions forbid contracting such work out.

Spillage during preparation or dialysis is inevitable sooner or later and makes a waterproof floor-covering desirable. Professionally sealed vinyl sheeting with upturned edges has so far proved satisfactory.

Plumbing

The single-patient artificial kidney machine will require a minimum water pressure. Twenty pounds per square inch (1.4 kg./sq. cm.) will suffice for all equipment at present available through the Department of Health and Social Security. This requires a direct supply from the mains in most dwellings, for a tank would have to be at a height of 15.4 m. (50 ft.) above the treatment room to provide a pressure head of 20 lb./sq. in. Less pressure, satisfactory for some equipment, could be obtained from a roof tank in a single-storey house if dialysis were conducted at ground-floor level. Sometimes high mains water pressures develop overnight and a pressure-reducing valve may therefore need to be fitted (by the hospital technician) to prevent damage to equipment. An overnight rise in mains pressure coupled with an insecure fitting caused flooding in the room of one of our patients. Seasonal variations in pressure may have to be contended with, and occasionally difficulties are encountered owing to the amount of particulate matter in the water.

A water softener is necessary in hard-water areas, and is preferred in all areas by some equipment manufacturers in order to prevent furring of the stainless steel tubing in the artificial kidney machine, which is "sterilized" by water at 85° C. If a softener is used it should be remembered that a filter is usually built-in before the ion-exchange column, and commonly there

FIG. 1.—Water supply. FIG. 2.—Drainage arrangements in dialysis room.

is a second filter beyond the column. Although we have not had to fit special filters so far in any of our installations, should this be necessary we would probably first obtain advice from the local water engineer. All plumbing connexions beyond the supply tap are made by the artificial kidney technician, who will usually use reinforced plastic tubing. The use of any copper piping or connexions in the actual dialysis circuit must be avoided, since the acetate in the dialysing fluid will leach out copper and cause severe reactions in the patient.

Overall requirements for plumbing adaptations are shown in Figs. 1 and 2. Access to the water supply and drainage is an important consideration in planning the location of equipment within the dialysis room.

FIG. 3.—Method of arranging drainage from "machine" and softener at first-floor level. FIG. 4.—Below-grid/above-water trap exit, shown as used in a ground-floor installation.

The technician requires a mains supply in copper piping of 12.7 mm. ($\frac{1}{2}$ in.) internal diameter conveniently sited to allow easy connexion to the water softener. A length of piping 5 to 8 cm. (2 to 3 in.) will be necessary beyond a stopcock, and a non-return valve should be fitted upstream. The artificial kidney machine is connected downstream of the softener. The softener and artificial kidney machine each require independent drains. (Two separate drains are advised for one type of machine.) If reinforced plastic tubing is used from the machine and softener, short lengths of copper piping of the appropriate diameter, inserted through the wall 12.7 mm. ($\frac{1}{2}$ in.) above floor level with a slight fall through the wall, will suffice (see Fig. 3). If waste pipes are placed higher, air locking with machine malfunction is risked with some models. Where both surface and foul water are drained into a common sewerage system the dialysis and water softener effluent can be drained into any conveniently sited waste-head or gulley. (A back inlet gulley is preferable, but, alternatively, as shown in Fig. 4, a below-grid/above-water trap exit can be devised.) Otherwise the soil and vent pipe leading to the foul drain or, on the ground floor, a gulley leading to the foul drain must be used. If a deep seal trap is required before the soil and vent pipe this should be checked for back siphonage and air locking.

Sink and Drainer Surface

A combined stainless steel sink and drainer, though functional and elegant, is expensive, and a Belfast earthenware sink with a wooden, Formica-surfaced work-top is adequate and cheaper. The sink should be about 60 by 38 by 25 cm. (2 ft. by 1 ft. 3 in. by 10 in.) deep, and the side work-top 100 by 53 cm. (3 ft. 4 in. by 1 ft. 9 in.) at a height of 92 cm. (3 ft.). The side work-top should be horizontal.

We have found an additional cold tap with a hose-fitting nozzle—originally fitted into our first home by mistake—useful in allowing both the blood and the dialysate sides of the artificial kidney to be washed out simultaneously between treatments. In order to avoid the risk of mains contamination in the event of mains supply failure, both cold taps should be supplied from the domestic tank if they are to be used to wash out the artificial kidney. Alternatively a mains supply with a non-return valve may be acceptable to some water authorities.

Electrical Fittings

Although formalin-sterilized machines require only a 13-ampere point, it seems likely that heat sterilization will shortly take the place of formalin sterilization. We therefore advise provision of a 30-ampere outlet point in each installation. A further 13-ampere point conveniently sited is required for the water softener clock, if automatic recharging is used. Similar switch sockets for a wall heater and general purposes are also desirable. Efficient earthing of all sockets is essential. An isolated circuit to the dialysis room and the use of circuit breakers rather than fuses are refinements some may prefer.

In order to provide adequate shadow-free lighting we prefer rooms to be lit with a 40-watt fluorescent strip light. A 15-watt night light is also required. A two-way switch is preferable for the strip light. Finally a patient-attendant electrical alarm bell is fitted between the dialysis room and the spouse's bedroom. The wiring of the alarm bell should be mechanically separated from that carrying current at normal voltage.

Carpentry

The need for a Formica work-top by the sink has already been noted. Where appropriate we believe that a Formica splash-back behind this and the sink to a height of 1.1 m. (3 ft. 6 in.) is desirable. About 7 m. (23 ft.) of shelving 30 cm. (12 in.) deep is necessary, preferably in cupboard form, with a free space below the lower shelf not less than 0.7 m. (2 ft. 3 in.) from the floor, as this makes convenient storage space for four-litre containers of dialysis fluid concentrate. A built-in wardrobe should be utilized if available.

A shelf 1.1 m. (3 ft. 6 in.) above the bottom of the sink, 60 by 30 cm. (2 by 1 ft.) in size, is useful to support a vat of formalin. A general-purpose shelf 60 by 15 cm. above the side of the bed is also desirable. When drip stands are not incorporated in the dialysis equipment a suitably sited wooden lathe on the ceiling can be used to house screw-in hooks to suspend drip bottles.

Plastering and Decoration

Some making good will normally be necessary. We prefer patients to arrange their own decorations, since in the past these have tended to cause undue delay in the commissioning of a dialysis room when done professionally as part of the contract. Two coats of emulsion for the walls and ceiling and a gloss finish for the woodwork are adequate.

Telephone

A telephone is essential for home dialysis, and the G.P.O. extension arrangement ("Plan 4") provides an economical way of providing an extension for use in the treatment room on dialysis nights.

Beds

In a narrow room a bed 76 cm. (2 ft. 6 in.) wide may be preferable to one 91 cm. (3 ft.) wide. A few patients have purchased old hospital beds and had them refurbished. These are easy to clean, and the height of a hospital bed in many ways is more convenient than that of an ordinary single bed or divan. In order to protect the mattress in the event of accidental spillage of blood a plastic cover is advised.

Planning

The architect and housing manager of the local authority have usually been personally associated with the first adaptation in their area. Normally, however, the adaptations can be planned with a simple drawing and a set of general instructions. A scale drawing of the room with paper cut-outs to represent fittings, equipment, and a bed are helpful in deciding on the location of the various items. The plans must take into account the site of the drains and the window. Often overlooked is the need for easy access to the bedside and the rear of the artificial kidney machine. Sometimes rehanging the door so that it opens outwards or providing a sliding-door will considerably increase the utilizable room space. Electrical fittings should be well separated from water points. If central heating is not available a wall-mounted 1- to 2-kw. electrical heater, worked with a pull switch, fixed opposite the dialysis bed is convenient and safe. A site visit by the administrator or kidney unit technician is mandatory, and a unit representative must be readily available to answer the queries of workmen as the adaptation proceeds. A typical (architect-drawn) plan is shown in Fig. 5.

FIG. 5.—Typical plan of a room adapted for haemodialysis.

Total Cost

Excluding decoration the total cost of adaptations should, we believe, lie between £200 and £280. Decorations will add about £10 to £15 to the bill. The breakdown of costs is shown in the Table. Council instructions in Liverpool do not allow these home adaptations to be put out to tender, but clearly this is desirable when permitted, as direct labour costs are usually in excess of those quoted for work contracted out.

Typical Estimate of Costs of Adaptations for Haemodialysis in the Home

Work	Cost Sterling
Plumbing (water softener not included)	70
Electrical (including alarm-bell circuit, but excluding provision of wallfire)	45
Joinery	40
Flooring { vinyl sheet flooring	30
{ if laid on existing tongued and grooved boards	
{ allow for hardboard to receive vinyl	20
Make good to plaster, brickwork, joinery, etc., on completion of all trades	20
Decorations (if allowed—see text). Two coats of emulsion to wall and one coat gloss to woodwork	15
	240

Liaison

If a smooth and reasonably rapid turnover is to be achieved the medical officer of health should be notified of the required home dialysis installation before or as soon as the patient begins his hospital dialysis. Baillo *et al.* (1968) complete home dialysis training in seven weeks, on average, a speed that we are now also able to achieve. Fortunately, once authorized, adaptations can be completed inside four to six weeks. In practice, delays most commonly arise through the need to await local health committee approval, particularly during the summer holiday period. Block permission for up to eight adaptations is now given annually to the Liverpool Health Department by its committee, and this delay is thus avoided. In order to ensure a smooth transition to home dialysis we recommend that the medical officer of health should be given delegated power by his council to put the work of conversion in hand as soon as is appropriate.

Installation of Equipment

The installation of equipment, including the water softener, is the responsibility of the renal unit. The work entailed and the proper testing of equipment take about a day. It is our practice to undertake the first two or three home dialyses during the day-time. These are supervised by a member of the unit staff, since mechanical failure or other snags at this stage can considerably undermine a patient's confidence, and can more easily be ironed out if someone is on the spot.

In carrying out this work we have had the benefit of advice and helpful discussion with Dr. S. Shaldon, who pioneered home dialysis in this country, as well as his colleagues and successors at the Royal Free Hospital. Miss N. B. Jones, Senior Occupational Therapist, Liverpool Health Department; Mr. J. W. Boddy, Housing Manager to the Liverpool Corporation; and Mr. J. H. T. Stilgoe, Liverpool Corporation Water Engineer, are thanked for their help and patience. Figs. 1, 2, and 3 were prepared in the Liverpool Corporation Housing Department.

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