

# A review of home haemodialysis in Hong Kong



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## Introduction

Home haemodialysis (HD) refers to the treatment modality in which the end-stage renal failure (ESRD) patients perform the dialyses at their own homes, usually with family members as helpers in the process. Home HD had an important place in the early years of HD when hospital dialysis facilities were scarce and many patients were left to die without dialysis. This forced doctors to ask some stable patients to do the dialyses at home, reserving the valuable hospital dialysis resources for sicker patients. Another reason for home HD at early days was that many hospital dialysis centres were scared of the spread of hepatitis B infection and only HBsAg negative patients were admitted. For those patients who are hepatitis B carriers, their only choice was home HD.

To a layman, HD is a highly specialized and risky process, especially in the early days when the dialysis machines were complicated to use and their reliability not high. It is difficult to convince them that a non-medical patient can perform such risky and complicated treatment at home. Fortunately the risk can be mitigated by careful patient selection and training as only those who were stable and motivated were trained for home HD.

## Early home haemodialysis

The same situation occurred in Hong Kong in the early HD days. The renal unit in the Princess Margaret was operational in late 1970's and HD became available to the renal patients on the Kowloon side. However, the hospital HD vacancies were rapidly taken up and one had to explore home HD as 'a way out'. In 1986, the author reviewed the home HD cases in the Princess Margaret Hospital from April, 1978 to December, 1985.<sup>(1)</sup> A total of 35 patents were admitted to the program during that period, all of them were trained in the hospital for a period of about 3 months before embarking their dialyses at home by themselves

afterwards. All of them were successfully trained and all could continue their previous jobs or their household role. Of the 35 patients, 7 were admitted to the home HD program because there was no hospital vacancy, 3 patients were HBsAg positive and 25 did not fit the strict hospital HD admission criteria.

## Patient selection

Patients thus had to be chosen carefully. Their medical conditions had to be stabilized and they should be well motivated with a supportive family.

## Dialysis machine and setup

In the early days, hospital haemodialysis machines were complicated and expensive. It was imperative to find machines which were cheap, reliable and easy to maintain. At that time, a batch-tank system machine was recommended to the patients. (Figure 1)

In a batch tank system machine, there was a large plastic tank of 120 litres in volume. The user placed one part (3.43 litres) of dialysate concentrate into the tank and added water to fill up to the 120 litres mark. To ensure the correct dialysate concentration, the user took some dialysate sample to test for the conductivity using a handheld conductivity meter. Such system was cheap,

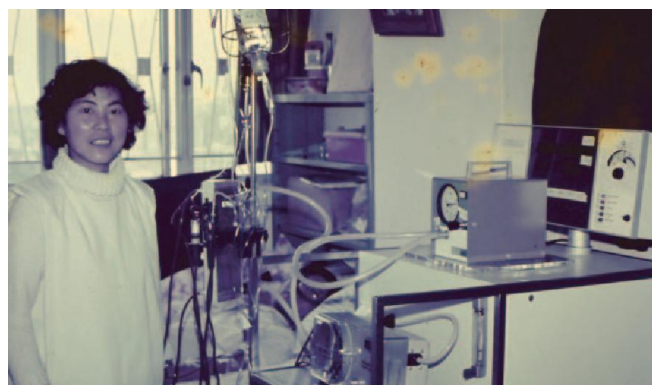


Figure 1 – the batch tank system

simple and reliable to use because it does not have any complicated electronic parts. The disadvantages were that it took up a lot of space and it took time to fill up to the water mark. Later patients tended to purchase more advanced machines that used 'proportional pumps' and these machines took up less space and took less time to set up. The dynamics of such machines were described elsewhere.<sup>(2)</sup>

## Water treatment

The water in Hong Kong came mainly from the Dong Kiang ('East River') in the Mainland. It contains soil particles and dissolved minerals. In the water treatment plants in Hong Kong, the Water Works Department added alum to cause the flocculation of soil particles and chlorine to kill the bacteria. Our municipal tap water thus contains a low concentration of aluminum ions from the alum and residual chlorine compounds. In hospital HD centres, they were removed by reverse osmosis and charcoal filters in the Centre's own water treatment plant.

In early days of home HD, such impurities were ignored as the patients could not afford the expensive reverse osmosis machines for water purification. Only a particle filter was installed (Figure 2) in the water inlet for water purification. One patient developed bone pain after years of dialysis. It was found to be due to the accumulation of aluminum in the bones and the bone biopsy showed the presence of aluminum line with osteomalacia. The patient was advised to install an industrial de-ionizer (Figure 3). Inside the deionizer, there was a cartridge which contains a tiny specific resin beads. The anions in the incoming water were adsorbed by the resin with hydroxyl ions released into the water. Similarly, the cations (such as aluminum and copper) were replaced with hydrogen ions. The hydrogen ion and the hydroxyl ion combined to become water. The water so treated was very low in metallic ions and the conductivity low. There was a built-in electrical conductivity meter in the deionizer to monitor the purity of the product water. If the conductivity was high, it indicated that there were (conducting) ions in the water and a warning light was on. This implied that capacity of the deionizer was saturated and had to be sent back to the dealer for recharging.

After the installation of the de-ionizer, the patient was given chelation therapy in the form of desferrioxamine. It was administered at the end of each HD, the drug circulated in the body to chelate the aluminum and drug-

aluminum complexes were removed in the next dialysis. The de-ionization method is not ideal for home HD water treatment but the patient made very good recovery.

## Home environment

Hong Kong was known for her crowded living conditions. The living area of the patients varies from



Figure 2 – the particle filter



Figure 3 – the de-ionizer

300 sq feet to 1200 sq feet, with an average of 700 sq feet. Even a small home can have the dialysis machines cramped in. (Figure 4). In the author's series, only one patient could afford a dedicated room for the home HD.

One of the downsides of home HD was that it required a family member as a helper during procedure and this may reduce the family income as the helper could not work during that period. There were capital costs in the machine installation and home alterations. It made the home environment even more crowded. At that time, the hospital policy allowed the author to provide consumables such as dialysers, blood tubings and syringes etc to the patients. Interestingly enough, the drug heparin was not included in the list and the patient had to buy them from the drug company. Despite all the inadequacies, home HD patients did well. The survival rate was compared to hospital dialysis patients.

## Other modes of dialysis since late 1980s

Continuous Ambulatory Peritoneal Dialysis (**CAPD**) was first introduced around 1980 to Hong Kong and then became widely used in the late 1980s. The patients performed the peritoneal dialysis at home just by manual





Figure 4 – haemodialysis at home

bag exchanges. No machines were needed in CAPD and the technique was much simpler compared with home HD. For this reason, home HD gave way to CAPD in Hong Kong. The main cost is the dialysis fluid bags (the dialysate) but the public hospitals provided them free to the patients, with the supplies delivered to the patients' homes by the suppliers.

In the late 1990s, the concept of **satellite HD centre** was getting wide acceptance. A satellite dialysis can take care of stable patient on dialysis. The dialysis centres are usually more conveniently located and the patient does not need to go to hospitals. The charge is much cheaper since it is not in hospital settings and this resulted in considerable convenience and saving for the patients. The patients just have to attend the dialysis centres for the dialyses. There was no need for home alterations, no need to stock up supplies at home and no need for a helper<sup>(3)</sup>. The charge was much more affordable and became the method of choice for stable patients. (Figure 5). It is useful for those patients who preferred HD to CAPD or those patients who could not perform CAPD for a variety of reasons, eg, repeated peritonitis with peritoneal membrane failure etc. For this reason, the author set up a private satellite centre to provide the much needed service.

Since the beginning of this century, the trend is CAPD in the Hospital Authority (due to the 'Peritoneal Dialysis First policy') and haemodialysis in the private sector. The private sector 'specialized' in hospital and satellite dialysis and both modalities complement each other. Home haemodialysis was not actively promoted and was on the decline.

## Resurgence of home HD

In recent years, there is a resurgence of interest in home HD worldwide. This started from the observation that CAPD patients had high blood urea (and creatinine) at all times and yet they felt well. The haemodialysis patients had high urea levels before dialysis and were reduced to a low level after the HD, gradually increasing to high level before the next dialysis. The survival rates of CAPD and HD patients were comparable. It seemed that our body system would work better under a constant biochemical environment. In CAPD, since dialysis is performed daily, the blood chemistry fluctuation is more constant than intermittent HD.

From 'the less the fluctuation the better' concept, it was postulated that if we performed HD more frequently, say four times a week instead of twice weekly, the fluctuation in the urea level would be much less and theoretically the outcome would be better. This was confirmed by analysis of the survival data on different HD schedules. It showed that the frequency of dialysis is the single most important factor in patient wellbeing and survival. A patient on three times per week dialysis, each time 4 hours does much better than a patient on twice per week dialysis, each dialysis lasts 6 hours. Initially it was attributed to the greater toxin removal in the frequent dialysis group. The amount of toxin removal is greater in the initial phase of HD and decreases exponentially with time, hence the three times per week dialyses achieved more toxin removal than the twice weekly schedule although the total dialysis duration is the same (12 hours per week). More complex kinetic equations were developed to calculate the 'dialysis dose', one of which was the  $Kt/V$  equation which was described elsewhere<sup>(2)</sup>. Again it was shown that a patient with more frequent haemodialysis would do better than a patient with less frequent HD with the same total weekly dialysis dose.



Figure 5 – satellite dialysis centre

Although it is accepted that frequent HD is desirable, its widespread application is limited by resources and logistics constraints. In Hong Kong, many patients received only twice weekly dialysis due to financial limitations. Although Hong Kong is a small place, the time spent on transport becomes significant if one has to attend hospitals for dialysis frequently. Home HD is much cheaper than hospital HD and the patient does not need to travel to renal centers for treatment. This paved the way for the comeback of home HD. Its resurgence is also augmented by the improvement of modern haemodialysis machines.

## Modern haemodialysis machines

The old style batch tank HD machine, being big and cumbersome, is no longer available. Modern HD machines incorporate proportionate pumps to save space and can perform bicarbonate dialysis instead of acetate dialysis as in early HD. The result is greater patient comfort and the full details are described elsewhere. <sup>(2)</sup> Modern machines are much more compact, reliable and user-friendly, making home HD much easier. Compact individual water treatment system, complete with water softener, reverse osmosis module and charcoal filter, is also available for use at home and thus the days of the deionizer was over. (Figure 6)

Home HD machines can be those standard machines used in satellite centres or those modified to make it more compact and user friendly ('baby machines'). There are three trends in their developments.

- Emphasis on simplicity to use, compact and reliability. They use proportionate pumps and

hence the size is small. They only incorporated essential functions and hence it is cheap, reliable and simple to use. They use generic blood tubings and hence the running cost is low. Such machines could last many years and it well suited to the home surroundings in Hong Kong. These machines are (jokingly) likened to the AK47 rifles by the staff. (Figure 7)

- Emphasis on automation and enhanced functions. There are enhanced functions such as online Kt/V measurement and the data display is improved with LED monitors. The tubings were fit into cartridge box and the setting up of the machine is much easier (auto-priming). However, the cartridge is proprietary and this increases the running cost. The machine is more expensive. They are likened (again jokingly) to the M16 rifles. (Figure 8)
- Reduce the size of the machine so that it takes up little space. Some machines even have the water treatment system incorporated. It is still new to the market and it is under evaluation.

## Dialysis Schedules

Apart from the conventional schedule, home HD can offer two additional schedules and they are summarized below

1. Conventional dialysis – the dialysis is done thrice per week, each time 4-5 hours.
2. Short daily home haemodialysis – HD is done 5-7 times a week, each dialysis lasts about 2-3 hours each. Since dialysis is done daily, the fluctuation in



Figure 6 – the individual water treatment system



Figure 7 – the machine with emphasis on simplicity



Figure 8 – the machine with emphasis on advanced functions

blood urea is much less. The symptoms such as headache, nausea and muscle cramps are much less and there was less fluid restriction required. The short and frequent approach.

- Nocturnal home haemodialysis – the dialyses were done while the patient was sleeping. It is a long, slow dialysis which is performed 6 nights a week or on alternate nights, each time about 6-8 hours. Because the dialysis is slow, patient tolerance is greatly improved. It would not interfere with the patients' work schedules at day time.

### Advantages of the new home HD

Since home haemodialysis facilitates more frequent dialysis, there are marked advantages

- There is much less fluid restriction for the patient. For patients with twice per week dialysis, the inter-dialysis fluid accumulation (reflected by the weight gain between dialyses) had to be removed during the dialysis. If the weight gain was 2-3 kg, fluid removal is usually no problem. However, with the decline urine output over the progress of time, the inter-dialysis weight gain can be up to 5 kg and it would be difficult, or even dangerous, to remove during the dialysis session. For patient on daily HD, the fluid gain would be much smaller and the patient does not need to have strict fluid restriction.
- The blood pressure is better controlled because there was not much excessive fluid, the medication for hypertension can be reduced or even stopped in some cases.
- The appetite is usually better. The increase in protein intake allows better muscle building. In some patient, the haemoglobin was increased. The patient feels better subjectively and had more energy for the daily tasks. The quality of life is much better.
- There is less fluctuation in the body biochemistry. The patient would not have a 'wash-out' feeling after each dialysis.
- Phosphate is a big problem in convention three times a week HD. This is because phosphate is

present in many foods, include meat. In ESRD patients, the renal excretion of phosphate is reduced and phosphate accumulation occurs. Since dialysis patients are encouraged to increase their protein intake, there was phosphate accumulation due to the decrease renal excretion. Usually the patients need to take phosphate binders such as calcium carbonate. (4) Daily dialysis allows adequate removal of phosphate and their serum phosphate levels are normal and phosphate binders are not needed in most cases. In some cases, the serum phosphate is **low** and phosphate replacement is necessary.

### Conclusion

There was a great change in utility of home HD. At the beginning, home HD development was dictated by circumstances – the scarcity of hospital HD. It was later over-shadowed by CAPD and satellite HD. The resurgence of home HD was caused by the better understanding of the pathophysiology of dialysis – the frequency of dialysis is the most important factor affecting survival and the quality of life. Home HD offers a practical way in which HD can be done more frequently at home at an affordable cost. This has a profound effect in improving the survival and the quality of life for renal patients.

It is said that HD is like love-making – the more frequent the better, the longer the better and the gentler the better. Modern home dialysis machines are now efficient and reliable. Home HD fulfills the requirement of more frequent, longer and gentler dialysis. It will regain some of its former glory in renal replacement therapy.

#### Declaration of Interest

Dr. HO Chung Ping is the director of the Integrated Dialysis Facilities (HK) Ltd, Ms. AU Yim Fong is the manager of the Centre. Ms. WONG Kwong Kam is the RN of the Centre.

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