Home haemodialysis with a novel machine in a patient with end-stage kidney disease: first case report from Asia

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Case report

The patient is a 38-year-old man who previously worked as a computer programmer and currently resides in Hong Kong with his parents and his younger brother in a flat of around 500 square feet. At age 22, he was diagnosed with diabetes mellitus subsequently complicated by diabetic nephrosclerosis and non–vision-threatening retinopathy. His comorbidity includes overweight, hypertension, hypothyroidism, and eczema. He developed end-stage kidney disease (ESKD) in late 2015 and commenced peritoneal dialysis (PD) that unfortunately failed after 3 years due to refractory PD-related peritonitis. Thereafter, he commenced in-centre haemodialysis (HD) in 2018.

The patient underwent 4 hours of in-centre HD 3 times per week via his left forearm arteriovenous fistula. He subsequently reported increased lethargy with poor appetite and was mainly sedentary after quitting his job. His daily fluid intake fluctuated widely with interdialytic weight gain up to 4 to 6 kg necessitating an increase in his antihypertensive medications. His appetite remained suboptimal, and his dry body weight gradually decreased from 72 kg (height: 1.72 m, body mass index: 24.3) at the start of in-centre HD in late 2018 to 67 kg (body mass index: 22.6) by late 2020. He also experienced a worsening of uremic pruritus. Cannulation for dialysis became increasingly difficult due to his eczema. His standardised Kt/V value averaged 1.4 only. His medications are shown in Table 1.

TABLE 1. Medications of the patient before starting home haemodialysis

Medications	Dose and frequency
Antihypertensives	
Methyldopa	250 mg BD
Metoprolol	100 mg BD
Amlodipine	10 mg BD
Hydralazine	50 mg BD
Isosorbide mononitrate	40 mg BD
Terazosin	2 mg daily
Other medications	
Calcitriol	0.5 μg daily
Calcium carbonate	3g BD
Thyroxine	75 μg daily
Simvastatin	15 mg nocte
Ezetimibe	10 mg daily
Darbepoetin alfa (injection)	180 μg every 2 weeks

Abbreviation: BD = twice a day

In late 2020, our centre started a home haemodialysis (HHD) programme using a novel HD machine (NxStage System One; Fresenius Medical Care, Tijuana, Mexico). The patient was keen to join the programme. The dermatology team was consulted and his eczema improved after treatment. He was taught to self-cannulate his arteriovenous fistula by our dialysis nurses and achieved independent self-cannulation after 10 HD sessions in 3 weeks. A home visit by engineers indicated a need for only minimal home modifications. Haemodialysis could be performed in a room of around 25 square feet, with water source from the washroom basin pipes and drainage to the original ground drain via connecting hoses. He received a further 2 weeks of machine training with the novel HD machine and commenced HD at home in early 2021. He has since adopted a HHD schedule of 3.5 to 4 hours of dialysis per session, 4 times per week since March 2021. We continue to provide 24-hour support for him via telephone and a communication phone application. To date, he has continued treatment with no significant problems reported.

After the commencement of HHD, his need for antihypertensive agents and erythropoiesis-stimulating agent gradually reduced and all were stopped after approximately 3 months. The patient's appetite greatly improved and his dry weight

TABLE 2. Mean parameters at baseline (during in-centre haemodialysis) and 6 months after commencement of home haemodialysis*

	Baseline	6 Months
Standardised Kt/V	1.8 (0.33)	2.2 (0.19)
β2 microglobulin (mg/L)	33.8	34.8
Albumin (g/L)	32 (1.73)	39 (1.73)
Haemoglobin (g/dL)	9.3 (0.56)	12 (0.11)
Creatinine (mmol/L)†	1071 (42.19)	923 (106.78)
Adjusted calcium (mmol/L)†	2.28 (0.25)	2.04 (0.12)
Phosphate (mmol/L)†	2.63 (0.34)	1.9 (0.34)
Erythropoiesis-stimulating agent (units per month)	360	0
Antihypertensives (No. of medications per day)	6	0
Phosphate binders (No. of medications per day)	1	1.5

* Data are shown as mean (standard deviation), unless otherwise specified
† Pre-haemodialysis parameters

gradually increased to 72 kg. Nonetheless this was accompanied by frequent pre-HD hyperkalaemia and hyperphosphataemia, hence he was referred for appropriate dietary advice. He achieved an average standardised Kt/V value of 2 to 2.1. A comparison of parameters while he was receiving in-centre HD and 6 months after he commenced HHD is shown in Table 2. It is of note that his hyperphosphataemia is of a lower magnitude after commencing HHD when compared with the level while he was on in-centre HD. He experienced increased energy, started going out more frequently, and resumed exercise that included regular walking and playing badminton. In January 2022, he resumed working as a computer programmer.

Discussion

When PD fails in patients with ESKD, it is necessary to commence HD, mostly at a conventional in-centre HD unit. A selected number of suitable patients are recruited into the HHD programme.

Conventional in-centre HD has several limitations including a shorter treatment time (about 8-12 hours per week) that may not provide adequate clearance, an inflexible schedule, and additional financial costs associated with travel, all of which could have a negative impact on patients' employment and social life. In contrast, frequent HHD with longer treatment time may have more benefits such as better fluid and solute removal with consequent improvement in blood pressure control, left ventricular mass index, sleep apnoea, anaemia, quality of life, pregnancy success rates, as well as reduced mortality.[1] Nocturnal home haemodialysis (NHHD) service has been provided in Hong Kong since 2006, with a typical regimen of alternate nightly HD for around 8 hours, and benefited numerous patients over the years. Indeed, Hong Kong has been promoting the use of home therapy including HHD and PD in ESKD patients to the global renal community.[2]

Nonetheless most Hong Kong citizens live in relatively small flats and may have insufficient space for the installation of both the conventional HD machine and the reverse osmosis machine plus other requisite consumables. Those who live in rented accommodation that precludes an ability to make necessary home modifications to meet the specific electricity and water pressure standards required during NHHD treatments may not be suitable for the NHHD programme. The mandatory requirement for NHHD candidates to have a helper who can safeguard them during treatments also excludes those living alone from joining this programme. Furthermore, the relatively longer training time (up to 3 months or more) associated with the use of the more 'complicated' conventional machines may pose learning difficulties for many patients.

To expand the HHD service in Hong Kong, a pilot HHD programme using the novel NxStage System One HD machine was introduced in 2019 at the Prince of Wales Hospital. Studies have shown benefits related to frequent HHD using the new system.[3] It uses a low–dialysate volume approach aiming to maximise the urea saturation in the dialysate by reducing the dialysate flow rate to a rate slower than the blood flow rate, resulting in very efficient use of the dialysate. Typically, a total of 30 to 60 litres of dialysate is used for a single session with the new system, whereas 120 to 140 litres of dialysate is typically required for the conventional HD machines. Dialysate is generated and stored before starting treatment, therefore the risk of water leakage during treatment is reduced, compared with the ongoing dialysate generation during conventional NHHD. Its simple design and much smaller footprint, on top of the advantage of no requirement for major home plumbing or electrical system modifications, facilitates a shorter machine training time of around 2 weeks.[4]

Initially the patient's family had reservations about him performing HD at home alone but were reassured after detailed discussion and understanding the simplicity of machine operation. The patient's eczema, especially around his arteriovenous fistula site, occasionally gives cause for concern but effective dermatological treatment and the use of the 'rope ladder' instead of the 'buttonhole' method for cannulation minimises his infection risk. His appetite was much increased after starting HHD and there was concern about his glucose and fluid control as well as rising potassium and phosphate

levels. Counselling by our dietitian has improved the situation.

Dialysis adequacy of HD schedules more frequent than thrice weekly is measured by the standardised Kt/V and the current clinical practice guidelines suggest a minimum value of 2.0. Nonetheless studies have shown that standardised Kt/V may not correlate well with clinical outcomes. A more comprehensive evaluation should include other parameters such as self-reported health status and physical measurements of cardiovascular health (such as blood pressure and echocardiogram). Traditional biochemical outcomes and measurements of solute clearance may also be considered.[5] Our patient improved clinically as well as socially after commencing HHD with the new system. We believe that this treatment modality has the potential to benefit many more patients with ESKD.

Author contributions

Concept or design: All authors.
Acquisition of data: VWK Kwong, CWY Au.
Analysis or interpretation of data: VWK Kwong, CWY Au, MC Law, PKT Li.
Drafting of the manuscript: VWK Kwong, PKT Li.
Critical revision of the manuscript for important intellectual content: VWK Kwong, CWY Au, MC Law, PKT Li.

Conflicts of interest

The authors have no conflicts of interest to disclose.

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Ethics approval

The patient was treated in accordance with the Declaration of Helsinki, provided informed consent for the treatment/procedures, and provided consent for publication.

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