A Systematic Approach To Promoting Home Hemodialysis during End Stage Kidney Disease

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Abstract

Home dialysis has garnered much attention since the advent of the Advancing American Kidney Health initiative. For many patients and nephrologists, home dialysis and peritoneal dialysis are synonymous. However, home hemodialysis (HHD) should not be forgotten. Since 2004, HHD has grown more rapidly than other dialytic modalities. The cardinal feature of HHD is customizability of treatment intensity, which can be titrated to address the vexing problems of volume and pressure loading during interdialytic gaps and ultrafiltration intensity during each hemodialysis session. Growing HHD utilization requires commitment to introducing patients to the modality throughout the course of ESKD. In this article, we describe a set of strategies for introducing HHD concepts and equipment. First, patients initiating dialysis may attend a transitional care unit, which offers an educational program about all dialytic modalities during 3–5 weeks of in-facility hemodialysis, possibly using HHD equipment. Second, prevalent patients on hemodialysis may participate in "trial-run" programs, which allow patients to experience increased treatment frequency and HHD equipment for several weeks, but without the overt commitment of initiating HHD training. In both models, perceived barriers to HHD—including fear of equipment, anxiety about self-cannulation, catheter dependence, and the absence of a care partner—can be addressed in a supportive setting. Third, patients on peritoneal dialysis who are nearing a transition to hemodialysis may be encouraged to consider a home-to-home transition (*i.e.*, from peritoneal dialysis to HHD). Taken together, these strategies represent a systematic approach to growing HHD utilization in multiple phenotypes of patients on dialysis. With the feature of facilitating intensive hemodialysis, HHD can be a key not only to satiating demand for home dialysis, but also to improving the health of patients on dialysis.

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Introduction

Home hemodialysis (HHD) remains the least used dialytic modality in the United States, despite its old age: Merrill and Scribner started HHD programs in Boston and Seattle, respectively, in 1965 (1); there was widespread utilization in the 1970s, with a third of United States patients undergoing HHD (2); and then a modern renaissance began in 2005, when equipment that was designed for easy installation and use in the home was cleared by the US Food and Drug Administration (FDA) (3). According to the United States Renal Data System, $<$2% of patients on dialysis underwent HHD at the end of 2017 (4). Whether this proportion could or should increase is a curious topic, insofar as aspirations regarding the growth of home dialysis typically revolve around peritoneal dialysis (PD). In this article, we do not aim to pit HHD and PD in a battle of home dialysis superiority, as some observational studies have endeavored. Both HHD and PD have important roles. Nevertheless, considering the pathophysiology of contemporary patients on dialysis and the aims of the Advancing American Kidney Health initiative (5), we contend that widespread availability of intensive HHD is a necessary ingredient in a successful system.

In this article, we describe the role of HHD in the dialytic armamentarium, with emphasis on customizing treatment frequency and duration to manage volume, construction of transitional care units (TCUs) that encourage HHD, trial utilization of HHD equipment in the facility setting, approaches to expanding the set of HHD candidates from prototypical "healthy patients" to those with perceived limitations, and integration of PD and HHD during a patient's life plan.

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Volume Control and the Heart

For decades, the adequacy of dialysis has been defined by the total clearance of urea. By that measure, in-facility hemodialysis (IHD) in the United States is very effective. Mean single-pool Kt/V is 1.6, and 97% of treatments deliver single-pool Kt/V ≥1.2 (4,6). Essentially, contemporary IHD is equivalent to the high-dose, high-flux arm of the HEMO trial (7). Nevertheless, age-adjusted rates of cardiovascular death and hospitalization in patients on dialysis in the United States are highly elevated, relative to the general population (4). Furthermore, the rate of all-cause death in patients on dialysis has failed to decline during the last 5 years (8). Logic dictates that uremia is not the dominant pathophysiologic mechanism. Of course, there may not be a dominant mechanism. Ischemic events, arrhythmias, hemorrhage, and infection all contribute to limited survival.

However, we contend that focusing on fluid overload is highly likely to yield substantial improvement. In a European consensus statement, Sarafidis *et al.* (9) wrote, "Sodium and volume excess appear to be the most important causes of hypertension in dialysis patients." In 2014, chief medical officers of United States dialysis providers proposed a "volume-first" strategy and argued that "extracellular fluid status should be a component of sufficient hemodialysis" (10). Despite this encouragement, evidence of progress is limited. Surveillance data indicate that intradialytic weight loss decreased by 5% between 2014 and 2020, whereas session duration increased by 2% (6). Consequently, mean ultrafiltration rate (UFR) fell to 7.7 ml/hour per kg (6). Lower UFR should have improved outcomes, but the cardiovascular hospitalization rate in 2015–2017 was slightly higher than in 2012–2014 (4). This constellation of changes suggests that some patients may be left "wet" in pursuit of lower UFR. A recent study using bioimpedance spectroscopy showed that 30% of patients on IHD experience chronic fluid overload, which was associated with higher mortality at all levels of systolic BP (11).

Three aspects of the hemodialysis (HD) prescription determine the nature of fluid accumulation and removal: dialysate sodium concentration, the duration of gaps between consecutive treatments, and cumulative treatment hours per week. In the SoLID trial, in which most patients underwent thrice-weekly HHD, lowering dialysate sodium reduced interdialytic weight gain, but did not significantly reduce left ventricular mass and increased the odds of intradialytic hypotension (12). These results suggest that uremic toxin clearance and HD intensity were not adequately addressed. In a study of 16 patients undergoing thrice-weekly HD, a cardiac microelectromechanical sensor device was used to record pulmonary pressures for 8 days; one such recording is displayed in Figure 1 (13). Right ventricular systolic pressure (RVSP) climbed immediately after each session. RVSP climbed further as time elapsed between each pair of consecutive treatments; normal RVSP was observed only at the end of HD. Another study detected markedly high incidence of bradycardia during the final hours of interdialytic gaps (14). Cyclical volume and pressure loading are probably

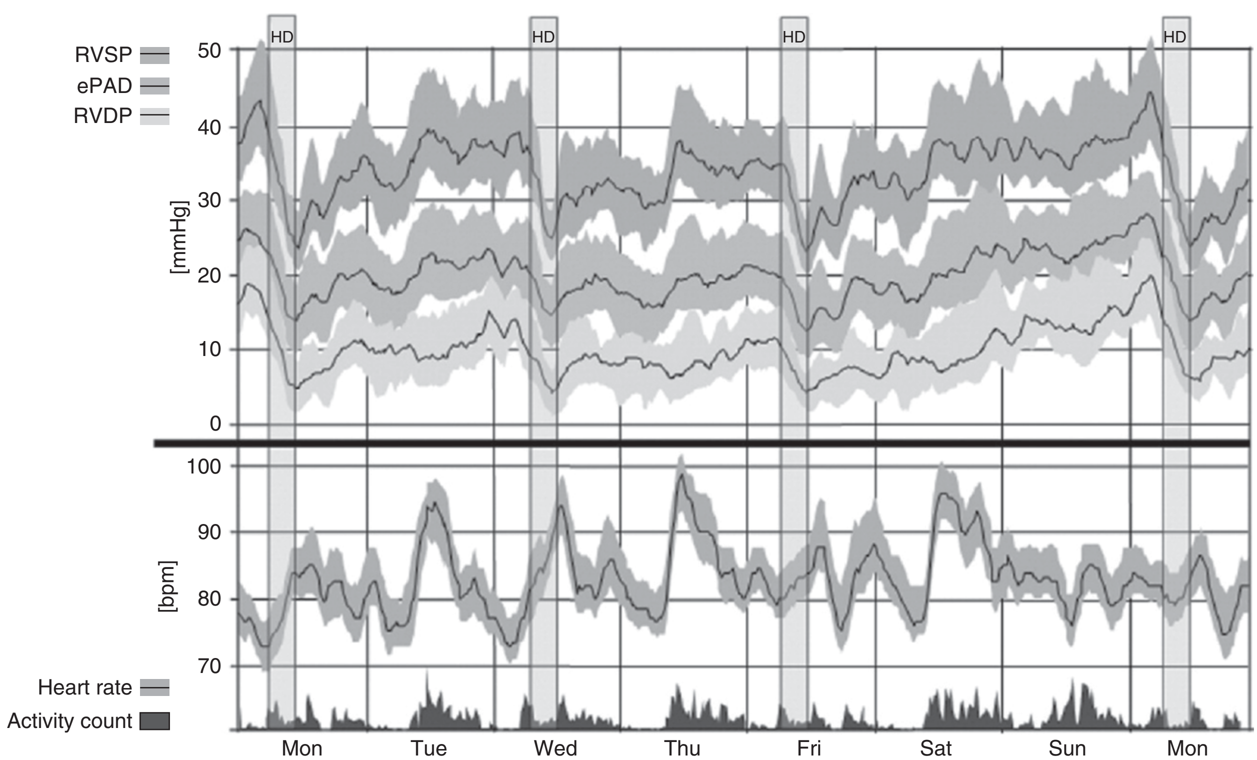

Figure 1. | An 8-day continuous hemodynamic trend in a patient who underwent thrice-weekly hemodialysis, according to a cardiac electromechanical sensor device recording. A marked reduction in right ventricular systolic pressure occurred during each dialysis session, followed by progressive pressure increments until the next dialysis session. ePAD, estimated pulmonary arterial diastolic; HD, hemodialysis; RVDP, right ventricular diastolic pressure; RVSP, right ventricular systolic pressure. Reprinted from reference 13, with permission.

Table 1. Patient criteria for transitional care unit and trial run programs

Patient Criteria
Patients who are candidates for a TCU program
Incident patients with ESKD who have not already chosen a home therapy
Failing peritoneal dialysis and expected to change modality
Failing kidney transplant and expected to initiate dialysis
Patients who are candidates for a TR program
Undergoing IHD and are employed, including by childcare at home
Undergoing IHD and expected to be wait-listed for a kidney transplant for >4 yr
Undergoing IHD with ejection fraction <45%
Undergoing IHD with chronic fluid overload and use of two or more antihypertensive medications
Undergoing IHD with unstable cardiovascular status (*e.g.*, two or more hospital admissions during previous 6 mo)
Undergoing IHD with frequent intradialytic hypotension
Undergoing IHD with repeated isolated ultrafiltration sessions
Failing peritoneal dialysis
Failing kidney transplant
Patients who are not candidates for either TCU or TR programs
Permanent resident of long-term care facility and without a care partner
In hospice
Significant cognitive impairment precluding meaningful participation
Unstable living arrangement

TCU, transitional care unit; TR, trial run; IHD, in-facility hemodialysis.

inevitable with thrice-weekly HD. Patients on HD who are anuric spend 93% of their time accumulating salt and water and merely 7% undergoing treatment to remove what was accumulated. This distortion of normal physiology presents a major challenge, insofar as retained fluid must be removed, but only at a sufficiently low rate to avoid iatrogenic effects, including myocardial stunning, hypotension, dizziness, and nausea (15).

In many patients, successfully managing volume and reducing RVSP will require the completion of three objectives: (*1*) achievement of true dry weight; (*2*) an increase in weekly hours of kidney replacement therapy, thereby meeting cumulative ultrafiltration demand, but at an UFR that is sufficiently low to avoid intradialytic complications; and (*3*) an increase in frequency of therapy, thereby decreasing both peak RVSP during interdialytic gaps and the area under the

Table 2. Sample schedule for transitional care unit program

Sample Schedule
Week 1: Welcome to the TCU
Explain purpose of TCU and introduce team members
Discuss patient's goals, concerns, and fears
Adjust hemodialysis prescription and medications
Week 2: Education
Discuss benefits, risks, and expected outcomes associated with IHD, HHD, PD, kidney transplant, and conservative care
Discuss vascular access types
Discuss and address vaccination
Adjust hemodialysis prescription and medications
Week 3: Ongoing education and selection
Continue education with home therapies team
Facilitate interaction with other patients on home dialysis
Allow patients to see and experience HHD equipment
Ascertain decisions about continuation of dialysis and dialytic modality
Initiate referral for creation of vascular access (as applicable)
Adjust hemodialysis prescription and medications
Week 4: Graduation
Transition to appropriate dialysis setting
Confirm plan for creation of vascular access
Confirm transplant evaluation appointments
If conservative management is selected, then arrange palliative care or hospice
Discuss advanced care planning

TCU, transitional care unit; IHD, in-facility hemodialysis; HHD, home hemodialysis; PD, peritoneal dialysis.

RVSP curve. These objectives are in reach with proper prescription of HHD, which is customizable to the individualized needs of patients.

In general, we need to aim for better BP control, both primary and secondary prevention of left ventricular hypertrophy, and significant reduction in risks of cardiovascular death and hospitalization. We also need to aim for symptom-free HD sessions, as numerous patients have loudly stated (16). Intensive HHD is one treatment that can address these needs (17–19). Indications for intensive HHD include persistent hypertension (which may present with predialysis systolic BP in goal range, but with use of three or more antihypertensive medications), left ventricular hypertrophy, heart failure, recurrent intradialytic hypotension, postdialysis fatigue, and refractory hyperphosphatemia. Most of these indications are currently accepted by Medicare as justification for coverage of additional HD sessions.

TCUs: Promoting HHD in Incident Patients

Of 124,500 incident patients with ESKD in 2017, up to 33% received little or no nephrology care before dialysis initiation (4). Lack of preparation for the life-altering nature of maintenance dialysis exacts profound physical and emotional tolls on patients and their family members. In >303,000 patients who initiated dialysis in 1997–2009, with >94% undergoing IHD, mortality risk was 2.7 times greater and hospitalization risk was 2.0 times greater during dialysis weeks 1–2 versus week 53 (20). Greater utilization of home dialytic modalities may improve outcomes during the first year but, in 2017, only 0.4% and 10% of incident patients with ESKD used HHD and PD, respectively (4). However, the efficacy and safety—including loss of residual function—of intensive HD in incident patients with ESKD is ultimately uncertain (21).

TCUs offer a better path forward for patients. This concept is not new, for it was initially described by Northwest Kidney Centers almost 40 years ago (22). Today, the TCU program can be defined by the following characteristics:

- A patient-centered educational program for all suitable patients initiating HD, with a usual duration of 3–5 weeks.
- More frequent HD at gentle (*i.e.*, slower) rates of blood and/or dialysate flow, preferably using the HHD machine of choice (although a combination of conventional and home-optimized HD machines may be used).

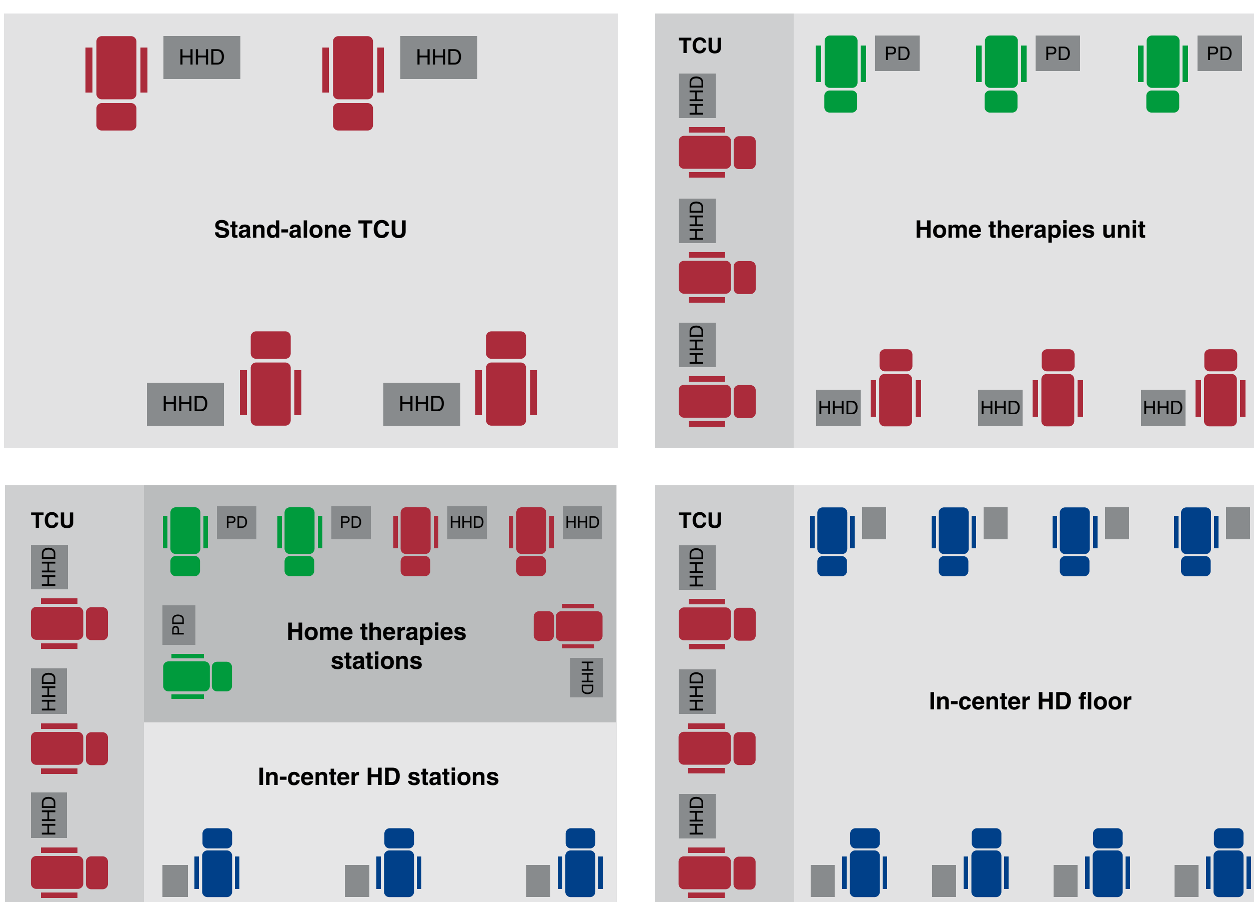

Figure 2. | Schematics of transitional care unit floor plans. These schematics depict a stand-alone transitional care unit (upper left), a home therapies training unit that includes a transitional care unit (upper right), a home therapies training unit that includes both a transitional care unit and in-center hemodialysis stations (lower left), and an in-center hemodialysis floor that includes a transitional care unit (lower right). HD, hemodialysis; HHD, home hemodialysis; PD, peritoneal dialysis; TCU, transitional care unit.

Table 3. Sample curriculum for trial run program

Sample Curriculum
Day 1
Frequency and schedule of HHD, relative to in-facility hemodialysis
HHD without a care partner, as appropriate
Day 2: Introduce the technical components
Machine
User interface (displays, buttons)
Cartridge
Dialysate
Day 3: Explain the benefits and risks of HHD
Day 4: Describe self-cannulation
Probe patient's interest in or fear of self-cannulation
Describe techniques to overcome fear, as is necessary
Discuss use of a central venous catheter for vascular access
Day 5: Invite a current patient on HHD to share experience
Training
Daily routine at home
Effect of frequent hemodialysis on health and quality of life
Cannulation
Patient responsibilities
Care partner role

HHD, home hemodialysis.

- Staff effort focused on addressing fears and preconceived ideas about dialysis.
- Identification of both medical and lifestyle goals of the patient.
- Provision of unbiased education about all RRT, including IHD, HHD, and PD, and kidney transplant.
- Provision of education about vascular access and financial considerations.

Table 1 displays suggested patient selection criteria for a TCU program.

A comprehensive curriculum that is delivered by a multidisciplinary team—which must include nurses, technicians, dietitians, social workers, financial coordinators, nurse practitioners, physician assistants, and nephrologists—is critical to the success of the TCU program. Although the curricula and designs of TCU programs may vary among dialysis organizations, programs generally adopt an intensive curriculum of 3–5 weeks. A sample curriculum is displayed in Table 2. We recommend that a defined group of patient care technicians and nurses staff the TCU. These team members should be fluent in technical and practical aspects of home dialytic modalities and are encouraged to speak enthusiastically about the benefits of the modalities.

Data about utilization of home dialytic modalities in TCU program graduates have been promulgated primarily in published abstracts of conference proceedings. These data suggest that, among patients with a "crash start" into dialysis (*i.e.*, patients who received no pre-ESKD education and initiated dialysis in a hospital), between 30% and 75% will select a home dialytic modality; among those patients, between 25% and 50% will select HHD (23–26). More research is needed.

There is consensus that TCUs should be designed to give patients firsthand experience with home dialysis equipment and the opportunity to interact with prevalent patients with ESKD who are undergoing PD, HHD, and IHD; if time permits, interaction with patients who have a functioning transplant may also be worthwhile. TCUs can be stand-alone units or incorporated into an existing IHD unit or a home therapies unit, as displayed in the schematics in Figure 2. The number of chairs that are needed in the TCU should reflect the monthly sum of incident patients with ESKD, patients who experienced PD technique failure, and patients who experienced graft failure within a catchment area or nephrology practice. Although schematics depict HHD machines beside TCU chairs, some programs may employ conventional HD machines.

HD prescriptions in TCU programs should prioritize both increased treatment frequency (four or more sessions per week) and relatively low UFRs (≤8 ml/hour per kg). Two-day gaps between consecutive treatments should be avoided, although local issues pertaining to staffing and economics may preclude TCU operations on weekends. Other goals may include blood flow rate of 300–400 ml/min (27) and standardized Kt/V of 2.3 (28).

Obtaining the assent of patients, physicians, nurses, healthcare system partners (including primary care physicians, hospital discharge planners, and acute dialysis staff), and allied dialysis organizations is critical to the success of the TCU program. Importantly, cherry-picking patients for the TCU is unlikely to be a good clinical or economic strategy.

Trial Run Programs: Promoting HHD in Prevalent Patients

Whereas TCU programs can be leveraged to introduce incident patients with ESKD to HHD, trial run (TR) programs can be leveraged to introduce intensive HHD to all appropriate prevalent patients with ESKD. Table 1 includes phenotypes of patients who could benefit from the opportunity to dialyze more frequently with HHD equipment. Patients can participate in TR programs for up 2 weeks. This duration allows patients an opportunity to experience some of the physical benefits (*e.g.*, shorter postdialysis recovery time) of more frequent HD and to see the simplicity of equipment that is designed for use at home. TR programs offer an excellent time to educate patients about technical and practical aspects of HHD. Table 3 displays a sample curriculum. HD prescriptions in a TR program should be like those in TCU programs, with biases favoring increased treatment frequency, shorter session duration, and lower ultrafiltration intensity. Patients who participate in TR programs may quickly report feeling better and having more energy (29).

In the United States, TR programs are most often operated in facilities that include one or two treatment stations featuring the HHD machine of choice. Patient care technicians and nurses who ordinarily work in the dialysis facility can be trained to operate home equipment, but education is typically provided by the home therapies team. If space is available, the TR program can be operated in the home therapies unit or as part of a TCU. It is important that the home therapies team carefully supervise the effects of changing the HD prescription, with attention to volume status, BP, and vascular access health. Patients may

Table 4. Approaches to introducing home hemodialysis concepts and technology to patients with ESKD, their family members, and healthcare professionals

Group	Educational Program	Duration	Educators
Patients	TCU	3–5 wk	TCU staff (RNs, LPNs, PCTs) and HT nurse
	TR	1–2 wk	TR staff (RNs, LPNs, PCTs) and HT nurse
Family members	1-h program about HHD and equipment	1–2 appointments	Social worker and HT nurse
IHD RNs, LPNs, and PCTs	2-h program about HHD and equipment	During IHD orientation	IHD educator and HT nurse
Dietitians and social workers	1-h program about HHD and equipment	During IHD orientation	IHD educator and HT nurse
Nephrologists	1-h program about HHD and equipment	During IHD orientation	HT nurse

TCU, transitional care unit; RN, registered nurse; LPN, licensed practical nurse; PCT, patient care technician; HT, home therapies; TR, trial run; HHD, home hemodialysis; IHD, in-facility hemodialysis.

need to discontinue antihypertensive medications to avoid hypotensive episodes. During a patient's time in the TR program, the nephrologist and nurse should review the home environment, the patient's work schedule (if the patient is employed), the presence and capability of any potential care partner, and the patient's lifestyle preferences, so that the patient and family members can make an informed choice about initiating HHD training. Work schedules and care partner status may necessitate additional discussion about therapy adaptations.

Addressing Barriers to HHD

A systematic approach to addressing patient and provider barriers to HHD adoption is essential to facilitating HHD growth. Important barriers include fear of HHD equipment, fear of self-cannulation, anxiety about the safety of HHD, perceived impracticality of HHD, and the lack of critical mass (*i.e.*, patient volume) in a home therapies unit. Continually educating patients, families, and staff is important. Table 4 identifies approaches to educating these parties.

Given the limited health literacy of some patients on dialysis (30), fear of HHD equipment is a real challenge for patients and family members (31). Even dialysis provider staff who are unfamiliar with HHD may harbor or express anxiety about equipment. It is important that patients undergo treatment with the HHD machine of choice in TCU and TR programs. Without this experience, patients may naively assume that HHD is possible only if conventional equipment is installed in the home. Fear of self-cannulation is another substantial problem for patients who are initiating HHD (32). Interventions to address this fear include hand holding, topical analgesia, peer modeling, relaxation techniques, and hypnotherapy (33). Self-cannulation can be taught in the TCU, thereby allowing patients and staff to focus on learning about HHD during HHD training.

Following the efforts of the "Fistula First" and "Fistula First Catheter Last" coalitions, many home dialysis programs permit HHD only with an arteriovenous fistula. This policy is often justified by a claim of uncertain safety of HHD with a central venous catheter. However, associations of vascular access type and mortality risk are similar in patients on HHD and patients on IHD (34–36). The Kidney Disease Outcomes Quality Initiative Clinical Practice Guideline for Vascular Access: 2019 Update has recommended that patients and nephrologists create an ESKD life plan, including vascular access choice (37). The update notes there is inadequate evidence about relative risks of clinical outcomes to recommend a vascular access type in prevalent patients with ESKD, thereby facilitating the adoption of a new strategy for vascular access in patients who wish to select HHD. Approximately 20% of patients on HHD in the United States use a central venous catheter (36). A patient who does not have a functioning arteriovenous access can initiate HHD with a catheter, initiate treatment in the home setting, and subsequently learn how to cannulate.

Studies indicate that >25% of patients on dialysis in the United States are either unmarried or widowed (38). It is plausible that many of these patients lack a care partner and are discouraged from pursuing HHD. However, HHD without a care partner is not uncommon in other high-income countries (39). The nephrologist should have a discussion with the interested patient about the risks of "solo" therapy—which have been evaluated by the US FDA and explicitly cleared with one machine—and the dialysis provider should employ safety provisions for patients who choose to dialyze without a partner. Some patients, with or without a partner, may perceive their residence as an impractical site for HHD. Identifying solutions for supply delivery and storage is necessary.

There is also a need for a critical mass of patients on HHD in the training unit for the home dialysis program to be successful. Patient volume improves quality of training and follow-up in home dialysis programs. A regional HHD training unit can facilitate critical mass (40). Ultimately, both nephrologists and dialysis providers should adopt an approach of finding barriers to HHD and offering resources to resolve those barriers. An "open door" to HHD will allow programs to reach a critical mass.

Table 5. Patient characteristics to consider in selection of either peritoneal dialysis or home hemodialysis as an initial home dialytic modality

Type of Dialysis	Medical Indications	Psychosocial Determinants	Possible Barrier
Peritoneal dialysis	Residual renal function	Full-time employment, including childcare at home	Homelessness
	Edema	Desire to travel	Uncontrolled anxiety or psychosis
	Suboptimal BP	Phobia of needles	Poor hand dexterity, despite adaptations
	Mild LV hypertrophy	Transportation problems	Active inflammatory bowel disease
	Right-sided heart failure	Awaiting living donor kidney transplant	History of complex abdominal surgeries
	History of heart failure hospitalization(s)	Body image concerns regarding vascular access	Anuria and BSA >2.0 m^2
Home hemodialysis	Urine volume <250 ml/d and serum phosphorus >8.0 mg/dl	Full-time employment, including childcare at home	Homelessness
	Ultrafiltration rate >13 ml/kg per h with thrice-weekly IHD	Desire to travel	Uncontrolled anxiety or psychosis
	Uncontrolled hypertension	Transportation problems	Phobia of needles
	Moderate LV hypertrophy	Desire control of treatment schedule	Increased frailty
	Right-sided heart failure	Body image concerns regarding PD catheter or distended abdomen	Blind or severely visually impaired
	Obesity, possibly with obstructive sleep apnea and/or use of CPAP		

Characteristics were adapted from the Method to Assess Treatment Choices for Home Dialysis (MATCH-D) tool (https://home-dialysis.org/match-d; Medical Education Institute, Madison, WI). LV, left ventricular; BSA, body surface area; IHD, in-facility hemodialysis; CPAP, continuous positive airway pressure.

Integrating PD with HHD

Dialytic modality selections should reflect thoughtful evaluation and informed consent. For patients who initiate dialysis in the home, selection of another modality in the future is likely (41). Preparing patients to make these selections is an important task for nephrologists. Patients must always understand that poorly managed health will render life goals more difficult to achieve. Nephrologists should guide patients toward sequencing dialytic modalities to achieve the highest quality-adjusted survival, considering the patient's life goals. The nephrologist's obligation is to recommend a course of action, but the recommendation should be accompanied by an explanation of reasons for the treatment selection or change, the anticipated benefits, and the possible risks, as well as the risks that are associated with declining the recommendation. Both medical and emotional states of the patient should be considered when selecting an initial modality (*e.g.*, PD) and transitioning from one modality to another (*i.e.*, from PD to HHD) at an appropriate time.

Although cumulative time with any dialytic modality depends on intercurrent events and provider-specific factors, the median duration of PD in incident patients with ESKD ranges from 2 to 4 years (42). The median duration of HHD is comparable (41). Patient factors to consider when recommending either PD or HHD as the initial home dialysis modality are displayed in Table 5.

In most patients with ESKD, including incident patients who undergo dialysis at home, one type of kidney replacement therapy will not be effective during the entirety of a patient's life. The concept of an integrated home dialysis model leverages the patient's home as the preferred site of disease management (43). The sequence proposes that patients initiate dialysis with PD and, when a transition point is reached, shift to HHD, instead of IHD. On average, patients who experience PD technique failure may benefit from switching to HHD (44). However, home-to-home transitions have been rare. Table 6 displays the three phases of a structured integrated home dialysis model: the modality response phase, the intermediate response phase, and the transition point phase. Home-to-home transitions can be timed to coincide with changes in residual renal function, ventricular mass, and mineral and bone disease.

Conclusions

Despite excellent treatment of uremia, quality-adjusted survival of patients on dialysis is lagging. Poor management of volume is a probable culprit. Due to its inherent customizability, HHD is an effective modality for limiting interdialytic gaps and reducing ultrafiltration intensity. To promote growth of home dialysis generally and HHD specifically, HHD should be repeatedly offered during a patient's life. TCU programs can be leveraged to introduce HHD concepts and equipment to incident patients with ESKD undergoing HD; TR programs can be likewise leveraged in prevalent patients on HD. PD and HHD can be integrated to increase the likelihood of home-to-home transitions. With this multipronged approach, HHD can be a key to improving patient health for those on dialysis.

Disclosures

M. Carver reports employment at Fresenius Medical Care North America. J. Glickman reports being on the medical advisory board of Cricket Health, speaker honorarium from Home Dialysis University, and authorship of UpToDate content. M. Kraus reports employment at Fresenius Medical Care North America. R. Lockridge reports speaker honoraria from DaVita Kidney Care,

Table 6. Phases of an integrated home dialysis model that uses peritoneal dialysis as the first modality

Early Response Phase	Intermediate Response Phase	Transition Point Phase
"No-harm" prescription	Decreasing residual renal function	Urine volume <250 ml/d with progressive LV hypertrophy
Preserve residual renal function	Increasing serum phosphorus	Phosphorus >6.0 mg/d or uncontrolled SHPT
Optimize volume control	Edema	Ultrafiltration failure
Control BP	Poorly controlled BP	Uncontrolled hypertension, with BP >150/90 mm Hg
Achieve nutritional balance	Worsening LV hypertrophy, per echocardiogram	Loss in lean body mass
Design care to avoid hospitalizations	Gradual decrease in functional status	Weight gain >15 kg
	More than one episode of peritonitis during the first year	Uncontrolled hyperglycemia and/or HbA1c >7%
	Hospitalization rate >1.5 admissions per year	Recurrent peritonitis during the first year
	Total Kt/V <1.7	Total Kt/V <1.7, despite multiple prescription changes

In the early response phase, patients are generally stable and only minor adjustments to the peritoneal dialysis prescription are needed to achieve listed medical goals. In the intermediate response phase, listed signs of clinical deterioration may require more substantial changes to the peritoneal dialysis prescription and may signal an approaching transition to home hemodialysis. Finally, in the transition phase, serious adverse events signal an imminent need for transition to home hemodialysis. LV, left ventricular; SHPT, secondary hyperparathyroidism; HbA1c, hemoglobin A1c.

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R. Lockridge, P. Tailor, and E. Weinhandl conceptualized the study; M. Carver, J. Glickman, B. Miller, R. Lockridge, and E. Weinhandl reviewed and edited the manuscript; and M. Kraus, M. Schreiber, L. Spry, P. Tailor, and E. Weinhandl wrote the original draft.

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