Clinical Kidney Journal, 2023, vol. 16, no. 3, 422–431

https://doi.org/10.1093/ckj/sfac220
Advance Access Publication Date: 7 October 2022
CKJ Review

CKJ REVIEW

Home dialysis in older adults: challenges and solutions

Henry H.L. Wu [1], Ajay P. Dhaygude[2], Sandip Mitra[3] and Karthik K. Tennankore[4]

[1]Renal Research Laboratory, Kolling Institute of Medical Research, Royal North Shore Hospital & The University of Sydney, St Leonards, NSW, Australia, [2]Department of Renal Medicine, Lancashire Teaching Hospitals NHS Foundation Trust, Preston, UK, [3]Department of Renal Medicine, Manchester Academy of Health Sciences Centre, Manchester University Hospitals, Manchester, UK and [4]Dalhousie University and Nova Scotia Health, Dickson Building, 5820 University Avenue, Halifax, Nova Scotia, Canada

Correspondence to: Henry H.L. Wu; E-mail: honlinhenry.wu@health.nsw.gov.au

ABSTRACT

There is a rising demand for dialysis in the older population given the increased numbers of older adults living with chronic kidney disease (CKD) progressing to kidney failure. Home dialysis, i.e. peritoneal dialysis (PD) and home hemodialysis (HHD), has been available for decades, but more recently there has been a rapid increase in home dialysis utilization as patients and clinicians consider its practical and clinical advantages. For older adults, incident home dialysis utilization more than doubled and prevalent home dialysis growth nearly doubled over the past decade. Whilst its advantages and recent rise in popularity are evident, there are numerous barriers and challenges that are important to consider prior to initiating older adults on home dialysis. Some nephrology healthcare professionals do not view home dialysis as an option for older adults. Successful delivery of home dialysis for older adults may be made even more difficult by physical or cognitive limitations, concerns around dialysis adequacy, and treatment-related complications, as well as challenges relating to caregiver burnout and patient frailty that are unique to home dialysis and older adults. Ultimately, it would be important for clinicians, patients and their caregivers to define what constitutes a 'successful therapy' to ensure treatment goals are aligned towards each individual's priorities of care, considering the complex challenges that surround an older adult receiving home dialysis. In this review, we evaluate some of the key challenges surrounding the delivery of home dialysis to older adults and propose potential solutions based on updated evidence to overcome these challenges.

LAY SUMMARY

There are a greater number of older people living with chronic kidney disease progressing to kidney failure, increasing the demands of dialysis. Home dialysis uptake in older people has markedly increased over recent years, as patients, families and medical teams see multiple advantages in having dialysis at home rather than hospital or dialysis center settings. Nevertheless, there are numerous barriers and challenges in providing home-based dialysis for older people considering many may be living with other long-term illnesses in addition to kidney disease, affecting their physical and functional ability to cope with home-based dialysis. The ability to manage treatment-related complications at home could be challenging, even more so for frail, older people. Inadequate caregiver support for

Received: 20.7.2022; Editorial decision: 26.9.2022

older people undertaking home dialysis is also an important issue to consider. In this article, we discuss some of the key challenges surrounding home dialysis for older people and potential ways to overcome these challenges.

Keywords: challenges, geriatric nephrology, home dialysis, older adults, solutions

INTRODUCTION

A greater proportion of older adults diagnosed with kidney failure are being initiated on dialysis as our global population continues to expand. In the most recent European Renal Association Registry Annual Report, the incidence and prevalence of kidney replacement therapy was highest among those who were ≥75 years of age (539 and 3154 per million age-related population, respectively) [1]. Whether this increase is related to changes in eligibility or access to dialysis, improvements in outcomes for older adults, better management of comorbidities or all of the above, it is clear that the cause of increased dialysis use is multifactorial [2]. Irrespective of the underpinning reasons, dialysis is uniquely challenging for older adults, and nowhere is this more apparent than in home dialysis.

Home dialysis, i.e. peritoneal dialysis (PD) and home hemodialysis (HHD), have been available for decades. In some countries (e.g. the USA), there have been noticeable increases in home dialysis utilization for older adults, suggesting greater recognition by stakeholders that it is a viable treatment option in older people. In the latest United States Renal Data System Annual Report, incident home dialysis utilization more than doubled from 3.2% to 8.2% over the last decade for those aged 80–99 years [3]. Similarly, prevalent home dialysis growth nearly doubled from 4.2% to 7.8% [3]. While this is a positive finding, there may be an upper limit beyond which further increases are not feasible and any increase must be interpreted in the context of the baseline rate. The 2021 Australian and New Zealand Dialysis and Transplant Registry (ANZDATA) noted little to no increase in home dialysis utilization for patients aged 75 years or above between 2016 and 2020 (i.e. PD incidence increased from 13.8% to 14.0% and prevalence increased from 20.3% to 20.6%), although the incidence and prevalence in 2016 were already high [4].

The growth of home dialysis uptake amongst older adults in some countries is likely due to its practical advantages. One important reason to favor home dialysis especially in the older population is a greater flexibility in conducting dialysis sessions, which allows for more options to schedule the patient's other lifestyle activities and caregiver support around their dialysis needs. Another key advantage of home dialysis to consider in older adults is related to the better control of hemodynamic balance. Due to the slow removal of molecules, PD may achieve better cardiovascular stability whilst intensive HHD may achieve better blood pressure (BP) control during dialysis [5, 6].

Whilst these advantages are evident, there are a number of challenges that are important when considering how best to manage older adults on home dialysis. The uptake of home dialysis across Europe in patients aged 65 years or above over recent years is variable, with noticeable decline in the prevalence of patients receiving PD in several European countries [7–11]. These variations may be due to differences in clinical experience of healthcare professionals, organizational and financial factors [12, 13]. Some nephrology healthcare professionals do not view home dialysis as an option for older adults, especially those with deficits in their health. The delivery of home dialysis to older adults may be made even more difficult by physical or cognitive limitations, concerns surrounding dialysis adequacy, treatment-related complications, as well as challenges relating to caregiver burnout and living with frailty that are unique to home dialysis and older adults. Finally, despite being an option that is largely associated with comparable or improved outcomes compared with in-center hemodialysis (HD), the cumulative risk of death among older adults receiving PD remains high, and in some studies, higher than those remaining on in-center HD. Compounding these issues, one of the bigger challenges relates to the fact that there are a variety of thresholds that are used to define an 'older' person, leading to inconsistency and difficulties with comparisons. Chronological age does not equate to biological age, yet studies evaluating the feasibility and outcomes of home dialysis among older adults do not always consider frailty, fitness or functional status.

Although these challenges are of importance, they are not insurmountable. Strategies to overcome these challenges include assisted home dialysis, individualized approaches to treatment initiation or a relaxation of treatment targets to avoid treatment-associated complications. Above all, simply redefining what constitutes a 'successful therapy' may help to better ensure that we are staying aligned with what is important to patients when considering home dialysis. In this narrative review, we will describe some of the important challenges in managing older patients on home dialysis, and subsequent strategies to overcome these challenges.

PERCEPTIONS AND TREATMENT-TEAM BIASES TOWARDS OLDER ADULTS PURSUING HOME DIALYSIS

Not all practitioners view home dialysis as an option for older adults despite its potential advantages, particularly older adults with impairments that tend to accumulate with age. Nephrologists in the UK were previously surveyed about the feasibility of home dialysis and preferences for PD versus in-center HD when given a list of patient factors. Among the perceived barriers, only 9% favored PD for those >70 years of age, while 35% favored HD [14]. When considering factors that develop with age such as poor visual acuity, poor motor strength and impaired cognition, the proportion favoring PD was even lower. This perception of ineligibility is not unique to nephrologists. In an online survey of 89 nurses working across different areas in a large dialysis facility in Toronto (Canada), home dialysis nurses preferred home dialysis for those >70 years of age [15]. In contrast, nurses working at in-center HD units strongly preferred in-center HD for older patients. This suggests an unconscious bias towards eligibility which may be influenced by clinical experience and expertise. This survey was repeated more recently in a multidisciplinary group of nephrology practitioners. While there were some who were in favor of PD, in-center HD nurses

continued to prefer in-center HD for older patients, and other allied health members appear to have a neutral view on this issue [16].

In contrast to these views which may be explicit, some perceptions may be implicit against the notion that home dialysis is an option for older adults. In a survey of nephrologists in France, 298 responders were asked to comment on their preferred dialysis modality if they had kidney failure [17]. Interestingly, there were differences in survey results based on the age of the responding nephrologist. Older nephrologists preferred HD and cited dialysis efficiency as a major factor [17]. Younger nephrologists felt the opposite and cited flexibility and professional freedom as the reason. Perceptions such as these may underlie the observation that older adults are less likely to initiate chronic dialysis with PD [1–3, 18].

Whether explicit or implicit, how can bias be overcome? Providing education to patients around modality decisions that is standardized, that evaluates all options and that encourages and promotes home dialysis without preconceived bias (while focusing on patient-important values) is a valuable approach. In a prospective study of a structured pre-dialysis education program, the nephrologist's decision was but one component of the assessment [19]. Questionnaires that evaluate patient values (i.e. travel expenses, flexibility with treatment time and the ability to take up employment), the availability of an algorithmic approach to map patient values towards a dialysis modality and dialysis education programs tailored to patient needs accompanied the physician's impression [19]. Ultimately, this approach led to a higher proportion of patients expressing a preference for home dialysis and an increase in the proportion that received it. Education is helpful not just for patients, but for healthcare professionals working in nephrology as well. In a fellowship training survey, it was identified that training inadequacies existed for both PD and HHD amongst fellows. Almost 70% of fellows felt either unprepared or minimally prepared to deliver HHD and 27% for PD [20]. It is hard to be comfortable in delivering home dialysis to vulnerable groups including older adults with limited experience, and this emphasizes the importance of educating healthcare professionals. There is optimism that education initiatives may change opinions about the eligibility of older adults for home dialysis. In a survey of 89 nurses working in HD, 26% felt home dialysis could not be performed in adults >70 years of age [21]. After a continuing nurses education initiative (inclusive of a presentation on how to overcome barriers and a patient testimonial video), that proportion fell to 10% [21].

Other than these aforementioned factors, perceptions and treatment-team biases against home dialysis may also be influenced by the incumbent policy of reimbursement within a health system, with this being a major variable that limits home dialysis in many countries [22, 23]. Reimbursement schemes usually make in-center HD a more attractive dialysis modality option for service providers [23]. Unless all stakeholders recognize the chance to prioritize patient-centered dialysis over profitability, it is likely many dialysis services will continue to be predominantly provider system-centered. For one, transport costs (per patient/per week) for patients to travel for in-center HD are expenditure, which could be allocated to set up home dialysis programs to make this option more financially attractive [24, 25]. Other ways to encourage service providers to increase home dialysis utilization may include adjusting reimbursement of for-profit clinics according to strategic quality performance indicators, such as the percentage of home dialysis offered to patients [25].

PRIORITIZING AND OPTIMIZING OUTCOMES FOR OLDER ADULTS RECEIVING HOME DIALYSIS

Is prolonging survival the most important outcome for older adults?

One of the challenges that may influence provider perceptions towards home dialysis is that some studies have suggested outcomes are worse, especially amongst older adults receiving PD. It has been shown that older PD patients are at a higher risk of mortality (pooled relative risk 2.45, 95% confidence interval 1.36–4.40) versus younger PD patients [26]. When comparing across modalities, outcomes among older adults differ. In a large systematic review of incident Korean patients (≥65 years of age), the pooled hazard ratio for mortality was 1.10 (95% confidence interval 1.01–1.20) for PD versus HD and even higher for those of longer dialysis duration or with diabetes [27]. It is possible that outcomes have improved for older adults on PD in more contemporary eras. In a study from Australia and New Zealand, the adjusted risk of death was lower when comparing HHD with in-center HD for those ≥65 years of age [28]. In contrast, patients receiving PD had a higher risk of death compared with in-center HD in the earlier era (1998–2002) but a similar relative hazard for mortality in the more contemporary era (2013–17) [28]. While comparisons of mortality outcomes between dialysis modalities are frequently discussed in literature, it is clear that basing modality choice solely on anticipated survival is the incorrect approach. In the standardized outcomes in nephrology–hemodialysis (SONG-PD) study of 126 patients/caregivers, mortality was viewed as having the second highest importance score [29]. However, when looking only at those ≥55 years of age, several other factors (PD infection, fatigue, ability to travel, flexibility with time and ability to work) were viewed as being more important (Fig. 1) [29]. While a similar study in HHD is an important consideration for future study, the results of the SONG-PD study emphasize that improving survival is not the sole objective when considering home versus in-center dialysis, particularly for older adults.

Defining dialysis adequacy and goals in older adults

In contrast to mortality, it is clear that quality of life is a more important outcome. As such, dialysis adequacy should be an individualized process with both the updated 2020 International Society of Peritoneal Dialysis (ISPD) guidelines and Standardized Outcomes in Nephrology-Hemodialysis advocating for a personalized, goal-based approach to define PD and HHD adequacy in older adults [30, 31]. Such an approach would ideally take into account comorbidity burden, clinical suitability for PD or HHD, how other treatments may interact in affecting patient outcomes, the patient's preferences for dialysis modality, available caregiver support during dialysis, and treatment end-goals [30, 31]. HD delivered in the home setting can also provide additional benefits such as increased autonomy, individualization of therapy and elimination of transport (leading to increased well-being).

Optimizing the initiation of home dialysis in older adults

When an older adult decides to pursue home dialysis, it is important to consider how best to initiate therapy while taking into account the factors that both positively and negatively impact patient experience and outcomes. It has been shown that many

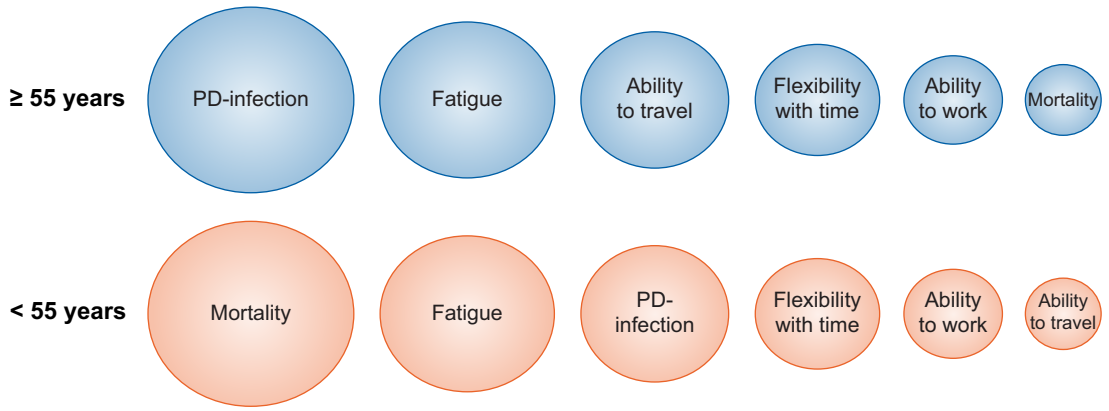

Figure 1: Select patient and provider priorities for peritoneal dialysis and their rank order of importance among respondents ≥55 years and <55 years old.

patients have concerns and fears upon initiating HHD, mainly due to the illness intrusiveness and fears of being isolated from care [32]. Finding strategies to minimize these fears may be of benefit, including the provision of respite care for those initiating HHD and individualized ways to provide support to home dialysis patients during periods of care transitions such as starting dialysis [33]. It is well established that early initiation of chronic dialysis is not beneficial for patient outcomes [34]. Therefore, most guidelines suggest deferring dialysis initiation unless indicated, based on a patient's acute/subacute clinical progression [35]. Among older adults initiating on PD, similar findings have been noted. In a recent study, the risk of mortality was relatively higher for those initiating chronic dialysis at estimated glomerular filtration rate ≥7.5 versus <5 mL/min/1.73 m^2 [36]. While this may simply be a manifestation of indication bias (i.e. patients are started on chronic dialysis at early glomerular filtration rates because of worsening health which in turn is associated with a higher mortality risk), there may be an inherent desire to start patients early to avoid unplanned transitions through HD.

To overcome this, a number of innovative strategies exist to facilitate timely home dialysis initiation in unplanned situations that may be extendable to older adults. Education initiatives directed to those in need of starting urgent in-hospital dialysis have been shown to be effective at enhancing the number of patients immediately transitioning to either PD or HHD [37, 38]. Urgent start PD (i.e. placement of a catheter and initiation of PD within 2 weeks of placement on an inpatient or outpatient basis) has also been shown to be an effective approach to improving the uptake of chronic PD, with good 1-year survival outcomes and a low risk of complications [39]. Buried PD catheters may be a strategy to establish PD access well in advance of dialysis initiation, thereby increasing the probability of a direct PD start without significant concerns on having to start HD as a bridge to PD [40]. Finally, supporting patients with referrals to transitional care units to improve their experience of initiating home dialysis may enhance the uptake of PD after an unplanned in-center HD start [41]. In HHD, a particular consideration is that training time is correlated with age. Extended training time (with a median of 75 days) needs to be considered in planning HHD infrastructure and capacity for these individuals, and may help to support HHD utilization in older adults [42]. Among those who commence on either PD or HHD, there has been emerging opinion in 'starting slowly' (especially among those with residual kidney function) to minimize the burden placed on patients and caregivers. In a recent study, 175 patients started dialysis with an incremental PD prescription (continuous ambulatory PD or automated PD with assistance) a daily PD fluid volume of ≤6 L/day and/or <7 days of PD/week. While this study was not specific to older adults, the mean age of this population was 60 ± 17 years, and outcomes were as expected for an incident cohort of PD patients initiating on full dose PD [43]. Similarly, incremental HD has garnered more attention, with observational studies demonstrating comparable or improved outcomes for those receiving incremental prescriptions (provided there are no contraindications) [44]. Not surprisingly, there are a number of upcoming clinical trials evaluating the feasibility and benefits of incremental HD when initiating dialysis (NCT04360694 and NCT04932148). Therefore, starting in a less intense fashion may be an attractive approach that allows for a graded transition to dialysis, something that intuitively would be of benefit to older adults who are faced with the potentially daunting task of commencing on long-term dialysis.

Identifying and managing treatment-related complications in older adults

Both PD and HHD are generally feasible and safe in older patients. However, infections, circulatory volume overload, BP instability and malnutrition are commonly observed (Table 1) [45–78].

PD peritonitis is the most common cause of mortality amongst PD patients aged above 65 years, accounting for approximately half of all cases of PD-related mortality [45]. Risk factors for peritonitis in older patients are numerous [46–49]. Reduced hand dexterity and eyesight with aging combined with a deterioration in cognitive function could affect performance and adherence to the aseptic demands of PD treatment, contributing to an increased risk of contamination during each exchange. Constipation is common in the general older population, and it may increase the risk of PD peritonitis by elevating the activity of bacterial intestinal translocation [50]. Recent ISPD guidelines have provided recommendations aiming to address the risk of peritonitis in older adults [51]. Daily application of topical prophylactic antibiotics such as mupirocin ointments and intermittent nasal mupirocin are recommended by ISPD to prevent exit site infections and *Staphylococcus aureus* carriage in older patients receiving PD [51]. Regular re-training of PD technique for independent patients and caregivers, and frequent re-assessment of an older patient's ability to perform PD were

Table 1: Complications and management strategies for older adults receiving home dialysis.

Complication	Suggested management strategies
PD peritonitis [45–56]	•Daily application of mupirocin ointment and intermittent nasal mupirocin as prophylactic treatment •Regular re-assessment of patient and caregiver PD technique and to advise on touch contamination risks •Prompt recognition where independent PD is no longer suitable due to cognitive and functional decline •Prevention of constipation by encouraging more fruits, vegetables and fiber intake (while monitoring for electrolyte complications) •Consideration for early acute inpatient care particularly for those who are frail and those with limited support at home •Regular review of dose-related adverse effects of antibiotics (e.g. neurotoxicity from third-generation cephalosporins and carbapenems, *Clostridium difficile* infection) and antibiotic-resistant strains of bacteria •Assistance with intraperitoneal antibiotic administration by trained community nurses or caregivers once discharged back to community
HHD vascular access infection [57–60]	•Intensive training programs prior to HHD initiation for patients and caregivers to ensure procedural technique for vascular access is of satisfactory level •Ensure there is availability of subsequent refresher training opportunities to maintain level of procedural technique for vascular access •Regular prophylactic antibiotic treatment administered intravenously may not always be in the best interests of an older patient receiving HHD
Circulatory volume overload [61–66]	•Address dialysis-specific factors to reduce risk of volume overload (i.e. for PD—optimize effluent drain volumes and membrane transport status; for HHD—ensure dialysis intensity and session frequencies is adequate to optimize volume status) •Ensure compliance towards fluid intake restrictions and maintaining a low-salt dietary intake pattern
Blood pressure instability [67–76]	•BP management should include personalized targets, avoid symptomatic or overtly low BP, considerations of goals of treatment, volume status, comorbidities and home environment •Regular home BP monitoring should be encouraged with assistance from caregivers to ensure BP measurements are done properly with automated devices
PEW, malnutrition and electrolyte abnormalities [77, 78]	•Holistic evaluation of an older patient's nutritional needs and electrolyte requirements through a combined evaluation of the patient's appetite, body weight, dietary intake and physical examination of muscle mass and body fat loss. Ensure regular biochemical tests for electrolyte and vitamin levels are being completed to guide management •Multidisciplinary care approach in the community to ensure appropriate nutrition and electrolyte supplementation when indicated, and caregivers to encourage appetite for adequate dietary intake

shown to be useful in reducing touch contamination [52]. Prompt recognition of scenarios where an older patient is not suited to perform PD independently, for example where acute cognitive and functional decline is apparent following acute stroke, is important [51]. In these circumstances, it is important to involve patients' families in the shared decision-making process, and identify means of caregiver support (and perhaps more regular community nursing assistance) during PD, or whether it would be in the patient's best interests to continue PD. Prevention of constipation should be encouraged via a healthy dietary pattern with more fruits, vegetables and fiber intake. For older patients with multiple comorbidities experiencing acute peritonitis, inpatient care until treatment response is usually advised [51]. One of the noticeable challenges related to antibiotic therapy in older patients with PD peritonitis is the susceptibility to dose-related adverse effects of antibiotics, especially neurotoxicity from third-generation cephalosporins and carbapenems [53, 54]. Older adults are also more susceptible to PD peritonitis from antibiotic-resistant strains of bacteria [55]. It is recognized that many older patients are unable to independently administer intraperitoneal antibiotic injections following a PD peritonitis episode [56]. Intraperitoneal antibiotic administration requires a good degree of manual dexterity and aseptic technique in handling sharp needles and injecting into the PD bags. For older patients with PD peritonitis who require assistance, administration of intraperitoneal antibiotic injections and PD exchange can be facilitated by a trained nurse or caregiver [56]. If intraperitoneal antibiotic treatment fails to eradicate PD peritonitis sufficiently, a shared decision-making process to consider catheter removal is needed, and the prognosis and treatment wishes of the older patient need to be considered when this step is taken.

Infective complications for older patients receiving HHD are usually related to vascular access. In particular, infection rates were higher in patients receiving HHD through central venous catheters compared with arteriovenous accesses (although buttonhole cannulation-associated infection rates were comparably higher to rates seen with central venous catheters in some studies) [57, 58]. This emphasizes the need for intensive education programs initially with subsequent refresher courses, to ensure patients and caregivers are aware of the procedural requirements in minimizing access-related infection [59]. When vascular access infection is identified, prompt confirmation with exit-site and blood cultures would be required, followed by removal of the infected access [60].

Other than infection, cardiovascular complications associated with volume overload, BP instability and myocardial stunning are major considerations for older adults receiving home dialysis. Circulatory volume overload is especially common and up to half of all patients receiving long-term home dialysis may exhibit circulatory congestion [61–63]. Numerous factors can contribute to volume overload, including PD-specific

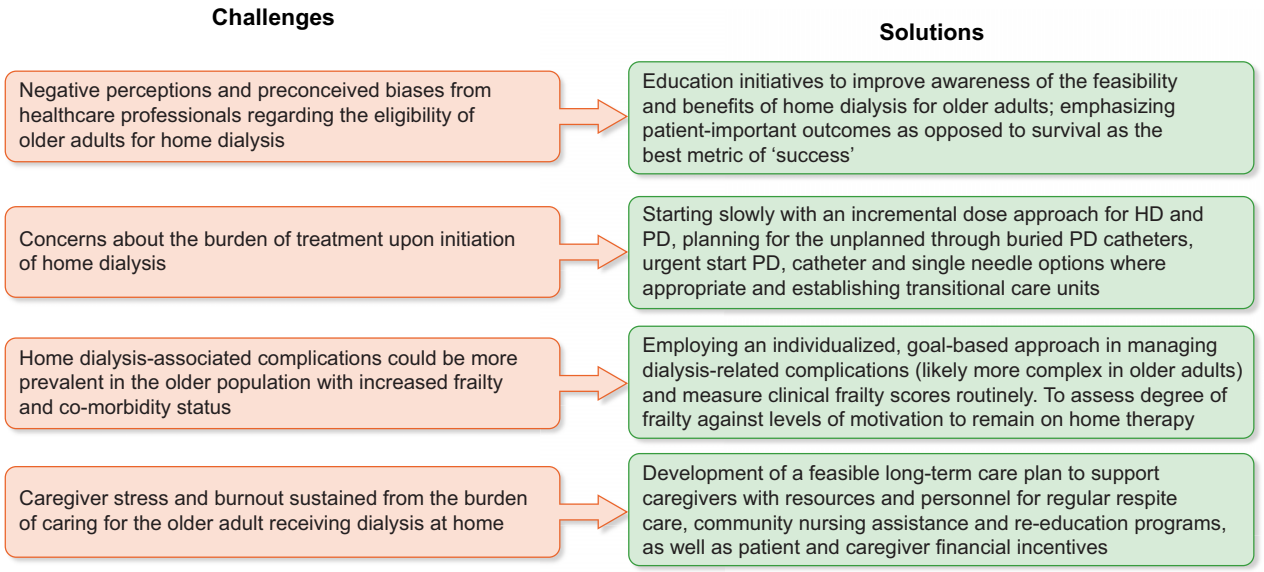

Figure 2: Summary of key challenges and solutions when managing home dialysis for older adults.

factors such as low effluent drain volumes and high membrane transport status, and HD-specific factors related to inadequate dialysis intensity and session frequency [64, 65]. These factors should be closely monitored and addressed to optimize volume control. Non-compliance to fluid intake restrictions and high-salt dietary intake are patient-specific factors of concern. For older patients, blunted taste acuity may lead to adoption of a higher salt content diet [66]. Therefore, improving salt literacy and awareness of foods with high-salt contents is essential for better low-salt intake compliance especially among older adults.

Optimizing BP control remains a challenging prospect in older patients receiving PD or HHD. The relationship between BP and mortality is complex in the dialysis population, in that either extreme is associated with a higher mortality risk [67–69]. Hypotension has been shown to have a higher association with mortality over short-term follow-up [70–72]. Older individuals with low BP at baseline are more likely to have underlying heart failure and other cardiac disease, and cardiac comorbidities most likely explain early mortality [70–72]. Evidence remains inconclusive in relation to the longer-term risks associated with hypertension for older patients receiving dialysis, with no definitive guidance regarding strict BP targets [69]. A precise, standardized method to determine intradialytic and interdialytic BP is still under debate [73]. General hypertension guidelines do not account for differences in individual cardiovascular risks for patients receiving long-term PD or HHD, especially for older adults who may be prone to complications with hypotension [74, 75]. Therefore, a universally applicable BP management strategy is not supported [69]. In contrast, BP management in older patients requiring PD or HHD should be individualized, with specific aims to avoid overly low BP along with considerations of an older individual's goals of treatment, volume status, comorbidities and home environment. Regular home BP monitoring should be encouraged with assistance from caregivers to ensure BP measurements are done properly with automated devices [69, 73, 76]. Adherence to medications that control BP is important in older patients receiving home dialysis, and would require frequent, regular counselling and education from the multi-disciplinary team.

A final complication of major importance to older patients receiving home dialysis is protein-energy wasting (PEW), malnutrition and electrolyte abnormalities. The mechanisms underlying why older patients are more susceptible to PEW, nutritional deficiency and electrolyte abnormalities are multifactorial, not limited to an individual's genetic and phenotypical features, but also contributed to by other environmental factors of aging and frailty—increased cellular mitochondrial dysfunction and oxidative stress, inflammation, reduced immunity, lifestyle, psychosocial condition, and invariably kidney failure and dialytic factors [77]. As recommended by the International Society of Renal Nutrition and Metabolism, monitoring and assessment of nutrition status is essential in the older dialysis population through a combined evaluation of the patient's appetite, body weight, dietary intake and physical examination of muscle mass and body fat loss [78]. This process should be supplemented by regular biochemical tests for electrolyte and vitamin levels to guide management [75]. Nutrition and electrolyte management in the older home dialysis population require a multidisciplinary care approach in the community and regular family support, if available, to encourage appetite and guide appropriate dietary requirements.

SUPPORTING OLDER ADULTS WHO ARE RECEIVING HOME DIALYSIS

Caregiver dependence and assisted home dialysis

The importance of caregiver support for older patients receiving home dialysis is acknowledged. There is significant symptom burden in older patients receiving home dialysis, and the wide range of symptoms is complex, multifactorial, and difficult to assess and manage [79, 80]. Older patients living at home with kidney failure usually experience multiple simultaneous symptoms and the extent of these symptoms changes during dialysis treatment [79, 81]. Whether the symptom burden is primarily physical or psychological, the presence of regular caregiver support has improved overall clinical and quality of life outcomes for older patients receiving home dialysis [82, 83].

Table 2: Strategies to overcome challenges to support growth of home dialysis in older adults.

Type of strategy	Strategies
Training	Broadly delivering educational initiatives for all home dialysis modalities to older adults, caregivers and healthcare professionals to overcome preconceived bias that home dialysis is not an option
Training	Continued promotion and delivery of home dialysis training opportunities for healthcare professionals from low uptake countries by working in collaboration with centers of excellence
Training	Developing individualized training programs for older adults. Success in this is often driven by early involvement of caregivers, highly skilled trainers and extended HHD training time. To consider retraining and refresher programs annually or as necessary
Managing	Encouraging evaluation for prioritized goals of home dialysis in each older adult at different phases of treatment, and ensuring resources and appropriately skilled multi-disciplinary personnel are available
Managing	Continued work to improve assisted care models in PD and HHD
Managing	Quality improvement initiatives aimed at minimizing symptom burden and ensuring early identification and intervention of home dialysis complications and comorbidities
Reducing attrition	Increasing collaboration with governments and industry to create financial and reimbursement schemes for robust support systems for eligible older adults and caregivers
Reducing attrition	Transition from PD to HHD through early identification of PD technique failure due to complications or inadequacy. Reappraise advance care plans on a regular basis
Reducing attrition	Identifying areas for continued innovation and improvement of current telehealth platforms such as virtual ward, digital rehabilitation programs and others to reduce attrition and improve support to patients and caregivers

Assisted PD models have displayed successful results over the previous 20 years since it was first introduced, with improved clinical outcomes for older populations receiving PD in terms of PD-associated mortality, technique survival and symptom burden [82]. In an international retrospective cohort analysis, >50% of older patients on HHD required home assistance either by the partner or by a dialysis assistant [42]. Assisted HHD is increasingly promoted for older adults, including approaches that rely on family caregivers or those that use nursing staff to provide HD for even those with advanced comorbid conditions [83, 84]. Nurse-assisted HHD is cost-effective but for both patient- and nurse-assisted HHD, it is emphasized that success is dependent on the quality of training provided for nurses and caregivers and the extent of caregiver support during HHD [85–87].

Nevertheless, sustained caregiver dependence has emerged as a challenging problem. Build-up of caregiver stress and burnout from the repetitive 'wear-and-tear' caregiver tasks is an important concern [87–91]. The prevalence of caregiver overburden when taking care of an older adult receiving dialysis is variable across published observational studies, with this being reported as high as 85% [92, 93]. Family members of older patients receiving home dialysis may require full-time employment for financial sustainability, and taking up caregiver roles and responsibilities simultaneously may lead to caregiver burnout [94]. Caregivers for older patients receiving home dialysis may also be older individuals themselves with chronic illness, and this responsibility could add further physical and psychological burden [94]. Qualitative studies reported low mood in a significant proportion of family members caring for patients on nocturnal PD and HHD [88–91]. Even if not real, perceived caregiver burnout may further impair a patient's well-being and quality of life [95]. To address these issues, it is helpful to develop a more feasible long-term care plan for both the older individual receiving home dialysis and their caregivers to reduce caregiver stress and burnout, such as having regular respite care and availability of community nursing support [91, 96]. Availability of nursing support to provide re-education programs in performing assisted dialysis could be instrumental to improve caregiver confidence and reduce anxiety, and to maintain safety standards and quality of home dialysis delivery. Initiatives to provide government-led financial support programs and digital health platforms where caregiver support networks are established could also prove useful.

Addressing frailty

The interaction of age and frailty is a natural but critically important dimension in self-care dialysis. Previous findings suggest frailty is a more representative measure of capacity to withstand demands of dialysis [97]. Home dialysis may help to mitigate geriatric syndromes, including frailty at the time of dialysis initiation, as it may reduce dialysis-related complications such as intra-dialytic hypotension, cerebral disturbances, cardiac events, malnutrition, infections, sleep disorders and psychological problems [98]. On the contrary, the presence of significant frailty may negatively affect incident uptake and dropout on home dialysis [99]. Focusing on measured frailty rather than age alone may help address some of the challenges and emerging solutions in this population [94, 97, 100, 101]. Access to dedicated pre-habilitation programs, nutrition support and rehabilitation programs delivered either face-to-face or remotely via digital interface may help prevent deterioration and drop outs and also positively impact on health outcomes and well-being on home therapies [100].

SUMMARY AND FUTURE DIRECTIONS

Home dialysis, where possible, can offer a lot more to patients even in the presence of old age and comorbidities. Extended support through assisted home dialysis care models and robust support systems may be an attractive option for the older population, to help mitigate risks and address potential complications in a timely manner. A personalized approach to dialysis care in older adults is highly desirable and is best offered in the setting of home, where a range of options exist in flexibility, prescribing, support and degree of autonomy. There are many barri-

ers and challenges to realizing this for all eligible and willing patients, and it is hopeful our review of updated evidence provides potential solutions on tackling some of the key issues surrounding home dialysis care in older adults (Fig. 2). Ultimately, home dialysis for older adults is still emerging, and in need of advancement and innovation through enabling technology, robust pathways and supportive health policy and reimbursement strategies (Table 2). Continued efforts by the global nephrology community to identify unmet needs of older adults living with kidney failure would be instrumental to provide further directions in optimizing home dialysis care for this patient population.

ACKNOWLEDGEMENTS

H.H.L.W. is supported by the Australian Government Research Training Program. S.M. is supported by the National Institute for Health Research at Manchester, UK, and Devices for Dignity MedTech & In vitro Diagnostics Co-operative, Sheffield, UK. K.K.T. has no conflicts of interest relevant to the current submission, but has conducted advisory board and consultancy work for Bayer, AstraZeneca, Otsuka, GSK and Vifor.

DATA AVAILABILITY STATEMENT

No new data were generated or analysed in support of this research.

CONFLICT OF INTEREST STATEMENT

None declared. The results presented in this paper have not been published previously in whole or part.

REFERENCES

1. Boenink R, Astley ME, Huijben JA *et al*. The ERA registry annual report 2019: summary and age comparisons. *Clin Kidney J* 2022;**15**:452–72.
2. Segall L, Nistor I, Van Biesen W *et al*. Dialysis modality choice in elderly patients with end-stage renal disease: a narrative review of the available evidence. *Nephrol Dial Transplant* 2017;**32**:41–9.
3. US Renal Data System. *USRDS 2021 Annual data report: End stage renal disease*. Vol 2021. Bethesda, MD: National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases; 2021.
4. Australian and New Zealand Dialysis and Transplant Registry. *ANZDATA 44th Annual Report 2021*. Adelaide, SA: ANZDATA Registry; 2021.
5. Ayus JC, Mizani MR, Achinger SG *et al*. Effects of short daily versus conventional hemodialysis on left ventricular hypertrophy and inflammatory markers: a prospective, controlled study. *J Am Soc Nephrol* 2005;**16**:2778–88.
6. Jefferies HJ, Virk B, Schiller B *et al*. Frequent hemodialysis schedules are associated with reduced levels of dialysis-induced cardiac injury (myocardial stunning). *Clin J Am Soc Nephrol* 2011;**6**:1326–32.
7. ERA-EDTA Registry. *ERA-EDTA Registry Annual Report 2019*. Amsterdam, The Netherlands: Department of Medical Informatics, Amsterdam UMC, AMC; 2021.
8. ERA-EDTA Registry. *ERA-EDTA Registry Annual Report 2018*. Amsterdam, The Netherlands: Department of Medical Informatics, Amsterdam UMC, AMC; 2020.
9. ERA-EDTA Registry. *ERA-EDTA Registry Annual Report 2017*. Amsterdam, The Netherlands: Department of Medical Informatics, Amsterdam UMC, AMC; 2019.
10. Guillouet S, Boyer A, Lanot A *et al*. Assessment for assisted peritoneal dialysis by peritoneal dialysis nurses: results of a cohort study. *Am J Nephrol* 2019;**50**:489–98.
11. Laplante S, Krepel H, Simons B *et al*. Offering assisted peritoneal dialysis is a cost-effective alternative to the current care pathway in frail elderly Dutch patients. *Int J Healthc Manag* 2013;**6**:27–36.
12. Bouvier N, Durand PY, Testa A *et al*. Regional discrepancies in peritoneal dialysis utilization in France: the role of the nephrologist's opinion about peritoneal dialysis. *Nephrol Dial Transplant* 2009;**24**:1293–7.
13. Ethier I, Cho Y, Hawley C *et al*. Effect of patient-and center-level characteristics on uptake of home dialysis in Australia and New Zealand: a multicenter registry analysis. *Nephrol Dial Transplant* 2020;**35**:1938–49.
14. Jassal SV, Krishna G, Mallick NP *et al*. Attitudes of British Isles nephrologists towards dialysis modality selection: a questionnaire study. *Nephrol Dial Transplant* 2002;**17**:474–7.
15. Tennankore KK, Hingwala J, Watson D *et al*. Attitudes and perceptions of nephrology nurses towards dialysis modality selection: a survey study. *BMC Nephrol* 2013;**14**:192.
16. Poinen K, Van Der Hoek M, Copland MA *et al*. Perceptions of multidisciplinary renal team members toward home dialysis therapies. *Kidney360* 2021;**2**:1592–9.
17. Lorcy N, Turmel V, Oger E *et al*. Opinion of French nephrologists on renal replacement therapy: survey on their personal choice. *Clin Kidney J* 2015;**8**:785–8.
18. van de Luijtgaarden MW, Noordzij M, Stel VS *et al*. Effects of comorbid and demographic factors on dialysis modality choice and related patient survival in Europe. *Nephrol Dial Transplant* 2011;**26**:2940–7.
19. de Maar JS, de Groot MA, Luik PT *et al*. GUIDE, a structured pre-dialysis programme that increases the use of home dialysis. *Clin Kidney J* 2016;**9**:826–32.
20. Gupta N, Taber-Hight EB, Miller BW. Perceptions of home dialysis training and experience among US nephrology fellows. *Am J Kidney Dis* 2021;**77**:713–8.
21. Phillips M, Wile C, Bartol C *et al*. An education initiative modifies opinions of hemodialysis nurses towards home dialysis. *Can J Kidney Health Dis* 2015;**2**:16.
22. Manns B, Agar JW, Biyani M *et al*. Can economic incentives increase the use of home dialysis? *Nephrol Dial Transplant* 2019;**34**:731–41.
23. Himmelfarb J, Vanholder R, Mehrotra R *et al*. The current and future landscape of dialysis. *Nat Rev Nephrol* 2020;**16**:573–85.
24. Chan CT, Wallace E, Golper TA *et al*. Exploring barriers and potential solutions in home dialysis: an NKF-KDOQI conference outcomes report. *Am J Kidney Dis* 2019;**73**:363–71.
25. Chan CT, Collins K, Ditschman EP *et al*. Overcoming barriers for uptake and continued use of home dialysis: an NKF-KDOQI conference report. *Am J Kidney Dis* 2020;**75**:926–34.
26. Jiang C, Zheng Q. Outcomes of peritoneal dialysis in elderly vs non-elderly patients: a systemic review and meta-analysis. *PLoS One* 2022;**17**:e0263534.
27. Han SS, Park JY, Kang S *et al*. Dialysis modality and mortality in the elderly: a meta-analysis. *Clin J Am Soc Nephrol* 2015;**10**:983–93.
28. Marshall MR, Polkinghorne KR, Boudville N *et al*. Home versus facility dialysis and mortality in Australia and New Zealand. *Am J Kidney Dis* 2021;**78**:826–36.

29. Manera KE, Johnson DW, Craig JC *et al*. Patient and caregiver priorities for outcomes in peritoneal dialysis: multinational nominal group technique study. *Clin J Am Soc Nephrol* 2019;**14**:74–83.
30. Brown EA, Hurst H. Delivering peritoneal dialysis for the multimorbid, frail and palliative patient. *Perit Dial Int* 2020;**40**:327–32.
31. Ju A, Unruh M, Davison S *et al*. Establishing a core outcome measure for fatigue in patients on hemodialysis: a standardized outcomes in nephrology–hemodialysis (SONG-HD) consensus workshop report. *Am J Kidney Dis* 2018;**72**:104–12.
32. Walker RC, Hanson CS, Palmer SC *et al*. Patient and caregiver perspectives on home hemodialysis: a systematic review. *Am J Kidney Dis* 2015;**65**:451–63.
33. Nadeau-Fredette AC, Chan CT, Bargman JM *et al*. Predictors of care gaps in home dialysis: the home dialysis virtual ward study. *Am J Nephrol* 2019;**50**:392–400.
34. Cooper BA, Branley P, Bulfone L *et al*. A randomized, controlled trial of early versus late initiation of dialysis. *N Engl J Med* 2010;**363**:609–19.
35. Nesrallah GE, Mustafa RA, Clark WF *et al*. Canadian Society of Nephrology 2014 clinical practice guideline for timing the initiation of chronic dialysis. *CMAJ* 2014;**186**:112–7.
36. Peng Y, Ye H, Yi C *et al*. Early initiation of PD therapy in elderly patients is associated with increased risk of death. *Clin Kidney J* 2021;**14**:1649–56.
37. Rioux JP, Cheema H, Bargman JM *et al*. Effect of an in-hospital chronic kidney disease education program among patients with unplanned urgent-start dialysis. *Clin J Am Soc Nephrol* 2011;**6**:799–804.
38. Schanz M, Ketteler M, Heck M *et al*. Impact of an in-hospital patient education program on choice of renal replacement modality in unplanned dialysis initiation. *Kidney Blood Press Res* 2017;**42**:865–76.
39. Rajora N, Shastri S, Pirwani G *et al*. How to build a successful urgent-start peritoneal dialysis program. *Kidney360* 2020;**1**:1165–77.
40. Keskar V, Biyani M, Blew B *et al*. Characteristics and outcomes of exit sites of buried peritoneal dialysis catheters: a cohort study. *Perit Dial Int* 2018;**38**:387–9.
41. Bowman BT. Transitional care units: greater than the sum of their parts. *Clin J Am Soc Nephrol* 2019;**14**:765–7.
42. Cornelis T, Tennankore KK, Goffin E *et al*. An international feasibility study of home haemodialysis in older patients. *Nephrol Dial Transplant* 2014;**29**:2327–33.
43. Yan H, Abreu Z, Bargman JM. Incremental peritoneal dialysis in incident end-stage kidney disease patients. *Perit Dial Int* 2022;**42**:387–93.
44. Jaques DA, Ponte B, Haidar F *et al*. Outcomes of incident patients treated with incremental haemodialysis as compared to standard haemodialysis and peritoneal dialysis. *Nephrol Dial Transplant* 2022; doi: 10.1093/ndt/gfac205 (online ahead of print).
45. Sakacı T, Ahbap E, Koc Y *et al*. Clinical outcomes and mortality in elderly peritoneal dialysis patients. *Clinics* 2015;**70**:363–8.
46. Perl J, Fuller DS, Bieber BA *et al*. Peritoneal dialysis–related infection rates and outcomes: results from the Peritoneal Dialysis Outcomes and Practice Patterns Study (PDOPPS). *Am J Kidney Dis* 2020;**76**:42–53.
47. Kwan BC, Chow KM, Ma TK *et al*. Automated peritoneal dialysis in Hong Kong: there are two distinct groups of patients. *Nephrology* 2013;**18**:356–64.
48. Wu H, Ye H, Huang R *et al*. Incidence and risk factors of peritoneal dialysis-related peritonitis in elderly patients: a retrospective clinical study. *Perit Dial Int* 2020;**40**:26–33.
49. Taskapan H, Tam P, LeBlanc D *et al*. Peritoneal dialysis in the nursing home. *Int Urol Nephrol* 2010;**42**:545–51.
50. Kosmadakis G, Albaret J, Da Costa Correia E *et al*. Constipation in peritoneal dialysis patients. *Perit Dial Int* 2019;**39**:399–404.
51. Li PK, Chow KM, Cho Y *et al*. ISPD peritonitis guideline recommendations: 2022 update on prevention and treatment. *Perit Dial Int* 2022;**42**:110–53.
52. Buena T, Tregaskis P, Elliott M. Peritoneal dialysis home visits: a review of timing, frequency and assessment criteria. *Ren Soc Australas J* 2018;**14**:70–7.
53. Lacroix C, Kheloufi F, Montastruc F *et al*. Serious central nervous system side effects of cephalosporins: a national analysis of serious reports registered in the French Pharmacovigilance Database. *J Neurol Sci* 2019;**398**:196–201.
54. Alves C, Mendes D, Marques FB. Fluoroquinolones and the risk of tendon injury: a systematic review and meta-analysis. *Eur J Clin Pharmacol* 2019;**75**:1431–43.
55. Salzer WL. Peritoneal dialysis-related peritonitis: challenges and solutions. *Int J Nephrol Renovasc Dis* 2018;**11**:173–86.
56. Szeto CC. Peritoneal dialysis-related infection in the older population. *Perit Dial Int* 2015;**35**:659–62.
57. Mustafa RA, Zimmerman D, Rioux JP *et al*. Vascular access for intensive maintenance hemodialysis: a systematic review for a Canadian Society of Nephrology clinical practice guideline. *Am J Kidney Dis* 2013;**62**:112–31.
58. Lok CE, Sontrop JM, Faratro R *et al*. Frequent hemodialysis fistula infectious complications. *Nephron Extra* 2014;**4**:159–67.
59. Gupta A, Zimmerman D. Complications and challenges of home hemodialysis: a historical review. *Semin Dial* 2021;**34**:269–74.
60. Akoh JA. Vascular access infections: epidemiology, diagnosis, and management. *Curr Infect Dis Rep* 2011;**13**:324–32.
61. Wang AYM, Lam CK, Yu CM *et al*. Troponin T, left ventricular mass, and function are excellent predictors of cardiovascular congestion in peritoneal dialysis. *Kidney Int* 2006;**70**:444–52.
62. de Jager DJ, Grootendorst DC, Jager KJ *et al*. Cardiovascular and noncardiovascular mortality among patients starting dialysis. *JAMA* 2009;**302**:1782–9.
63. Loutradis C, Sarafidis PA, Ferro CJ *et al*. Volume overload in hemodialysis: diagnosis, cardiovascular consequences, and management. *Nephrol Dial Transplant* 2021;**36**:2182–93.
64. Tzamaloukas AH, Saddler MC, Murata GH *et al*. Symptomatic fluid retention in patients on continuous peritoneal dialysis. *J Am Soc Nephrol* 1995;**6**:198–206.
65. Canaud B, Chazot C, Koomans J *et al*. Fluid and hemodynamic management in hemodialysis patients: challenges and opportunities. *J Bras Nefrol* 2019;**41**:550–9.
66. Stevens JC, Cain WS. Changes in taste and flavor in aging. *Crit Rev Food Sci Nutr* 1993;**33**:27–37.
67. Li Z, Lacson E, Jr, Lowrie EG *et al*. The epidemiology of systolic blood pressure and death risk in hemodialysis patients. *Am J Kidney Dis* 2006;**48**:606–15.
68. Goldfarb-Rumyantzev AS, Baird BC, Leypoldt JK *et al*. The association between BP and mortality in patients on chronic peritoneal dialysis. *Nephrol Dial Transplant* 2005;**20**:1693–701.

69. Flythe JE, Chang TI, Gallagher MP *et al*. Blood pressure and volume management in dialysis: conclusions from a Kidney Disease: Improving Global Outcomes (KDIGO) controversies conference. *Kidney Int* 2020;**97**:861–76.
70. Sulowicz W, Radziszewski A. Pathogenesis and treatment of dialysis hypotension. *Kidney Int* 2006;**70**:S36–9.
71. Reeves PB, McCausland FR. Mechanisms, clinical implications, and treatment of intradialytic hypotension. *Clin J Am Soc Nephrol* 2018;**13**:1297–303.
72. Udayaraj UP, Steenkamp R, Caskey FJ *et al*. Blood pressure and mortality risk on peritoneal dialysis. *Am J Kidney Dis* 2009;**53**:70–8.
73. Sarafidis PA, Mallamaci F, Loutradis C *et al*. Prevalence and control of hypertension by 48-h ambulatory blood pressure monitoring in haemodialysis patients: a study by the European Cardiovascular and Renal Medicine (EURECA-m) working group of the ERA-EDTA. *Nephrol Dial Transplant* 2019;**34**:1542–8.
74. Whelton PK, Carey RM, Aronow WS *et al*. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *J Am Coll Cardiol* 2018;**71**:e127–248.
75. Williams B, Mancia G, Spiering W *et al*. 2018 ESC/ESH guidelines for the management of arterial hypertension: the task force for the management of arterial hypertension of the European Society of Cardiology (ESC) and the European Society of Hypertension (ESH). *Eur Heart J* 2018;**39**:3021–104.
76. Wang AYM, Brimble KS, Brunier G *et al*. ISPD cardiovascular and metabolic guidelines in adult peritoneal dialysis patients part I–assessment and management of various cardiovascular risk factors. *Perit Dial Int* 2015;**35**:379–87.
77. Kim JC, Kalantar-Zadeh K, Kopple JD. Frailty and protein-energy wasting in elderly patients with end stage kidney disease. *J Am Soc Nephrol* 2013;**24**:337–51.
78. Ikizler TA, Cano NJ, Franch H *et al*. Prevention and treatment of protein energy wasting in chronic kidney disease patients: a consensus statement by the International Society of Renal Nutrition and Metabolism. *Kidney Int* 2013;**84**:1096–107.
79. Li H, Xie L, Yang J *et al*. Symptom burden amongst patients suffering from end-stage renal disease and receiving dialysis: a literature review. *Int J Nurs Sci* 2018;**5**:427–31.
80. Almutary H, Bonner A, Douglas C. Which patients with chronic kidney disease have the greatest symptom burden? A comparative study of advanced CKD stage and dialysis modality. *J Ren Care* 2016;**42**:73–82.
81. Nixon AC, Wilkinson TJ, Young HM *et al*. Symptom-burden in people living with frailty and chronic kidney disease. *BMC Nephrol* 2020;**21**:411.
82. Giuliani A, Karopadi AN, Prieto-Velasco M *et al*. Worldwide experiences with assisted peritoneal dialysis. *Perit Dial Int* 2017;**37**:503–8.
83. Tennankore KK, Kim SJ, Chan CT. The feasibility of caregiver-assisted home nocturnal hemodialysis. *Nephron Clin Pract* 2012;**122**:17–23.
84. Reddy NC, Korbet SM, Wozniak JA *et al*. Staff-assisted nursing home haemodialysis: patient characteristics and outcomes. *Nephrol Dial Transplant* 2007;**22**:1399–406.
85. Bamforth RJ, Beaudry A, Ferguson TW *et al*. Costs of assisted home dialysis: a single-payer Canadian model from Manitoba. *Kidney Med* 2021;**3**:942–50.
86. Schreiber MJ, Chatoth DK, Salenger P. Challenges and opportunities in expanding home hemodialysis for 2025. *Adv Chronic Kidney Dis* 2021;**28**:129–35.
87. Walker RC, Hanson CS, Palmer SC *et al*. Patient and caregiver perspectives on home hemodialysis: a systematic review. *Am J Kidney Dis* 2015;**65**:451–63.
88. Kang A, Yu Z, Foo M *et al*. Evaluating burden and quality of life among caregivers of patients receiving peritoneal dialysis. *Perit Dial Int* 2019;**39**:176–80.
89. Rioux JP, Narayanan R, Chan CT. Caregiver burden among nocturnal home hemodialysis patients. *Hemodial Int* 2012;**16**:214–9.
90. Gilbertson EL, Krishnasamy R, Foote C *et al*. Burden of care and quality of life among caregivers for adults receiving maintenance dialysis: a systematic review. *Am J Kidney Dis* 2019;**73**:332–43.
91. Tao X, Chow SK, Zhang H *et al*. Family caregiver's burden and the social support for older patients undergoing peritoneal dialysis. *J Renal Care* 2020;**46**:222–32.
92. Parlevliet JL, Buurman BM, Pannekeet MM *et al*. Systematic comprehensive geriatric assessment in elderly patients on chronic dialysis: a cross-sectional comparative and feasibility study. *BMC Nephrol* 2012;**13**:30.
93. Goto NA, Van Loon IN, Boereboom FT *et al*. Association of initiation of maintenance dialysis with functional status and caregiver burden. *Clin J Am Soc Nephrol* 2019;**14**:1039–47.
94. Wu HHL, Nixon AC, Dhaygude AP *et al*. Is home hemodialysis a practical option for older people? *Hemodial Int* 2021;**25**:416–23.
95. Suri RS, Larive B, Hall Y *et al*. Effects of frequent hemodialysis on perceived caregiver burden in the Frequent Hemodialysis Network trials. *Clin J Am Soc Nephrol* 2014;**9**:936–42.
96. Bennett PN, Schatell D, Shah KD. Psychosocial aspects in home hemodialysis: a review. *Hemodial Int* 2015;**19**:S128–34.
97. Johansen KL, Chertow GM, Jin C *et al*. Significance of frailty among dialysis patients. *J Am Soc Nephrol* 2007;**18**:2960–7.
98. Cornelis T, van der Sande FM, Kooman JP. Balancing transition to dialysis: the urgent need for more intensive hemodialysis. *Kidney Int* 2013;**83**:967–8.
99. Auguste BL, Chan CT. Home dialysis among elderly patients: outcomes and future directions. *Can J Kidney Health Dis* 2019;**6**:2054358119871031.
100. Brar R, Whitlock R, Komenda P *et al*. The impact of frailty on technique failure and mortality in patients on home dialysis. *Perit Dial Int* 2019;**39**:532–8.
101. van Loon IN, Goto NA, Boereboom FT *et al*. Frailty screening tools for elderly patients incident to dialysis. ' 2017;**12**:1480–8.