



Optimization of Dialysis Modality Transitions for Improved Patient Care

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Benoit Imbeault^{1,2}  and Annie-Claire Nadeau-Fredette^{1,3}

Abstract

Purpose of review: Initial and subsequent modality decisions are important, impacting both clinical outcomes and quality of life. Transition from chronic kidney disease to dialysis and between dialysis modalities are periods where patients may be especially vulnerable. Reviewing our current knowledge surrounding these critical periods and identifying areas for future research may allow us to develop dialysis strategies beneficial to patients.

Sources of information: We searched the electronic database PubMed and queried Google Scholar for English peer-reviewed articles using appropriate keywords (non-exhaustive list): dialysis transitions, peritoneal dialysis, home hemodialysis, integrated care pathway, and health-related quality of life. Primary sources were accessed whenever possible.

Methods: In this narrative review, we aim to expose the controversies surrounding home-dialysis first strategies and examine the evidence underpinning home-dialysis first strategies as well as home-to-home and home-to-in-center transitions.

Key findings: Diverse factors must be taken into consideration when choosing initial and subsequent dialysis modalities. Given the limitations of available data (and lack of convincing benefit or detriment of one modality over the other), patient-centered considerations may prime over suspected mortality benefits of one modality or another.

Limitations: Available data stem almost exclusively from retrospective and observational studies, often using large national and international databases, susceptible to bias. Furthermore, this is a narrative review which takes into account the views and opinions of the authors, especially as it pertains to optimal dialysis pathways.

Implications: Emphasis must be placed on individual patient goals and preferences during modality selection while planning ahead to achieve timely and appropriate transitions limiting discomfort and anxiety for patients. Further research is required to ascertain specific interventions which may be beneficial to patients.

Abrégé

Contexte motivant la revue: Les décisions entourant le choix de la modalité de dialyse initiale et subséquente sont importantes puisqu'elles ont des répercussions sur les résultats cliniques et la qualité de vie du patient. La transition entre la période l'insuffisance rénale chronique et l'amorce de la dialyse, de même que les périodes de transition entre différentes modalités de dialyse sont des moments où les patients sont particulièrement vulnérables. L'évaluation des données probantes entourant ces périodes et la définition de futurs axes de recherche pourraient contribuer à l'optimisation des soins aux patients.

Sources: Nous avons identifié dans PubMed et Google Scholar les articles révisés par les pairs et rédigés en anglais répondant aux mots-clés appropriés (liste non exhaustive): dialysis transitions (transitions en dialyse), peritoneal dialysis (dialyse péritonéale), home hemodialysis (hémodialyse à domicile), integrated care pathway (schéma de soins intégrés), et health-related quality of life (qualité de vie liée à l'état de santé). Dans la mesure du possible, les sources principales ont été consultées.

Méthodologie: Dans notre revue narrative, nous souhaitons exposer les controverses entourant les stratégies initiales de dialyse à domicile et examiner les données probantes qui sous-tendent les stratégies de dialyse à domicile d'abord, mais également les transitions « de domicile à domicile » et « de domicile à centre ».

Principaux résultats: Plusieurs facteurs sont à considérer au moment de choisir les modalités de dialyse initiale et subséquente. Compte tenu des limites imposées par le manque de données disponibles (et de l'absence d'arguments convaincants quant aux avantages ou désavantages d'une modalité par rapport à une autre), les facteurs axés sur les patients sont susceptibles de l'emporter sur les avantages présumés de l'une ou l'autre modalité sur le taux de mortalité.

Limites: Les données disponibles proviennent presque exclusivement d'études rétrospectives et observationnelles, lesquelles ayant souvent eu recours aux vastes bases de données nationales et internationales, et sont donc sujettes à l'introduction de biais. En outre, il s'agit d'une revue narrative qui tient compte du point de vue des auteurs, particulièrement en regard des schémas de dialyse optimaux.



Conclusion: Au moment de choisir la modalité de dialyse, il importe d'accorder une importance aux objectifs et préférences du patient, tout en planifiant la réalisation de transitions opportunes et appropriées, afin de limiter l'inconfort et l'anxiété du patient. D'autres études sont nécessaires pour définir les interventions susceptibles de bénéficier aux patients.

Keywords

dialysis transitions, controversies in dialysis, home-dialysis, integrated care pathway, peritoneal dialysis, home hemodialysis

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Why is this review important?

In an era where policymakers are promoting a home dialysis-first strategy to manage end-stage renal disease, reflecting upon the basis for such recommendations and subsequent impacts on patients is essential. This review examines the controversies and evidence underpinning home dialysis-first strategies, as well as home-to-home and home-to-in-center transitions, allowing us to propose optimal dialysis pathways for patients.

What are the key messages?

There is no unique 'best' dialysis modality for a patient but rather a combination of different modalities over time creating an optimal dialysis pathway. Though we emphasize the importance of individualizing modality selection, we propose optimal dialysis pathways favouring home dialysis modalities whenever possible.

Introduction

Choice of the optimal dialysis modality is central to patients' experience on renal replacement therapy (RRT). The best dialysis modality is influenced by various factors including health care system, dialysis center expertise, economic restrictions, patient demographics, comorbidities, frailty, and others. Often, there is no unique "best" dialysis modality for a patient but rather a combination of different modalities over time creating an optimal dialysis pathway. Patients' needs, resources, and objectives may vary through time, influencing their current or future dialysis choices. Given that most patients will require several modality changes during their life on RRT,¹ optimizing treatment pathways to offer the best RRT at the right time for the right patient is

crucial. An individualized dialysis sequence may prove to be beneficial for both clinical and patient-centered outcomes, especially in an era where policymakers are promoting home-dialysis first policies.

Overall, international registry data show that though mortality rates on dialysis have been decreasing over the last decade,^{1,2} they remain quite high at more than 10-fold that of the general population.³ Attempts to identify periods of increased vulnerability have shown that transitions from chronic kidney disease (CKD) to RRT and between RRTs are especially challenging. Through this review, we will critically discuss the current data and potential controversies surrounding home dialysis modality transitions.

Transition From Chronic Kidney Disease to Renal Replacement Therapy: Home-Dialysis First for All?

The period surrounding dialysis initiation is known to be associated with the highest mortality. Using data from the Dialysis Outcomes and Practice Patterns Study (DOPPS), Bradbury et al⁴ showed that mortality was highest in the first 120 days following initiation of dialysis. Early mortality was associated with older age, use of a catheter, hypoalbuminemia, hypophosphatemia, cancer, and congestive heart failure. Conversely, the authors showed a 50% decrease in mortality associated with pre-dialysis nephrology care. Two other studies^{5,6} found very similar associations, with mortality risk at its highest in the first two months and falling to prevalent levels at approximately 6 months. It appears that the period surrounding dialysis initiation is critical and a phase where timely interventions, such as home dialysis modality education, could improve outcomes.

¹Division of Nephrology, Maisonneuve-Rosemont Hospital, Montreal, QC, Canada

²Division of Nephrology, University Health Network, Toronto, ON, Canada

³Research Center, Maisonneuve-Rosemont Hospital, Montreal, QC, Canada

Corresponding Author:

Annie-Claire Nadeau-Fredette, Division of Nephrology, Maisonneuve-Rosemont Hospital, 5415 l'Assomption Blvd., Montreal, QC, Canada H1T 2M4.

Email: ac.nadeau-fredette@umontreal.ca

Should Peritoneal Dialysis Always be the First Dialysis Modality?

There are multiple theoretical advantages to initiating RRT with peritoneal dialysis (PD), including preservation of residual renal function^{7,8} and potential vascular accesses. Quality of life may also favor PD given its potential for preservation of lifestyle, independence (and hospital avoidance), travel ease, and flexible schedules. Despite these characteristics of PD, quality of life data have been inconsistent with studies showing superior,⁹ equal,^{10,11} or inferior¹² health-related quality of life scores compared to conventional hemodialysis (CHD). More data are needed to assess the influence of dialysis modality on patient-centered outcomes such as quality of life.¹³ Incremental dialysis, with a progressive increase in PD dwell number (continuous ambulatory peritoneal dialysis) or day-dry abdomen (nocturnal intermittent peritoneal dialysis) and non-daily PD, is a promising avenue to improve dialysis patients' quality of life. Conflicting data have been reported in studies comparing mortality in PD versus CHD cohorts. Several retrospective studies¹⁴⁻¹⁶ have shown a relative mortality benefit for patients starting dialysis on PD, especially in the first year and in patients requiring more than one modality over time. However, a recent study by Wong et al¹⁷ found a lack of the early PD survival advantage, and rather equal overall survival with PD and HD when comparing a subgroup of patients who were equally eligible for both CHD and PD at the start. The reduced survival of CHD patients in previous studies may have been driven by a selection bias with a greater proportion of more vulnerable patients in this group who were not eligible for PD. Similarly, it has previously been shown that the apparent survival advantage of PD is driven mostly by increased mortality in patients on CHD dialyzing with central venous catheters (CVC).¹⁸ As PD has advantages beyond putative improved survival, it remains a promising option for eligible patients (Figure 1).

A PD-first strategy to dialysis initiation has been promoted by many regulatory bodies. A caveat to this approach is high attrition rates seen in the first year after initiation in some studies. In a study by Guo and Mujais¹⁹ which included >30 000 incident US PD patients, about 20% of PD patients were transferred to HD during the first year. A more recent US cohort study showed similar results, with 21% of PD patients switching to CHD within their first year of PD.²⁰ In contrast, only 6.3% of French PD patients²¹ transitioned away from PD in the first 6 months. Often, early technique failure is driven by catheter-related complications while later technique failure may be related to infectious and psychosocial issues. Identifying patients at high-risk for early technique failure is imperative. A recent Australia and New Zealand (ANZDATA) registry study²² identified the following factors: age over 70, body mass index (BMI) less than 18.5, diabetes, ischemic heart disease, cerebrovascular disease, peripheral vascular disease, prior RRT, late referral to nephrology service, and being cared for in a smaller center.

In the aforementioned French cohort,²¹ CHD prior to PD, allograft failure, and early peritonitis were associated with more technique failure whereas being treated by an experienced center (more than 20 new patients per year) was protective. Although this highlights the importance of pre-dialysis care and experience of the PD team, the other risk factors may be non-modifiable. In patients without a strong personal inclination toward PD as initial modality, accumulation of multiple risk factors for technique failure, especially if compounded by psychosocial issues, may make for a more challenging PD candidate. These patients should likely be supported by an experienced team and followed more closely if oriented to PD. In all cases, we should stay away from being dogmatic about a PD-first approach, but rather encourage PD as a first modality whenever possible for the patient and dialysis center dyad.

Is Peritoneal Dialysis Only for Independent Patients?

Assisted PD (aPD) is an emerging modality where (mostly older or comorbid) patients who wish to do PD but cannot because of physical, social, or cognitive limitations can do so with help from PD-trained home nursing staff. Models for its implementation vary from country to country, with Canada and many European countries favoring an approach using aPD with once to twice daily nursing visits for cyclor setup and connection at night (with or without independent disconnection in the morning), and France favoring CAPD with 3 to 4 nursing visits per day.²³ Observational data have shown that both quality of life¹⁰ and hospitalization rates²⁴ for aPD patients are comparable to CHD patients, all the while exhibiting superior treatment satisfaction.¹⁰ Furthermore, caregiver burden of aPD as compared to self-care PD does not seem to be increased.²⁵

Not only is aPD well-tolerated by patients and their caregivers, but clinical outcomes are very reassuring as well. This is true for destination-aPD, where patients require assistance for long-term treatment, and respite-aPD, where patients transition to aPD from self-care PD for a short period of time only (ie, in the context of an acute illness) or receive support through aPD at time of PD initiation while gaining experience and confidence toward their ability to perform independent PD. In an aPD study from British Columbia,²⁶ both mortality and technique survival was comparable between PD modalities. As an added benefit, though aPD costs approximately 15 000 CAD dollars more than self-care PD per year, it remained cost-effective when compared to switching these patients to CHD.

Home Hemodialysis as the First Dialysis Modality

A minority of patients initiate home hemodialysis (HHD) immediately at start of RRT and, in many programs, patients will transition through CHD first. HHD requires investing

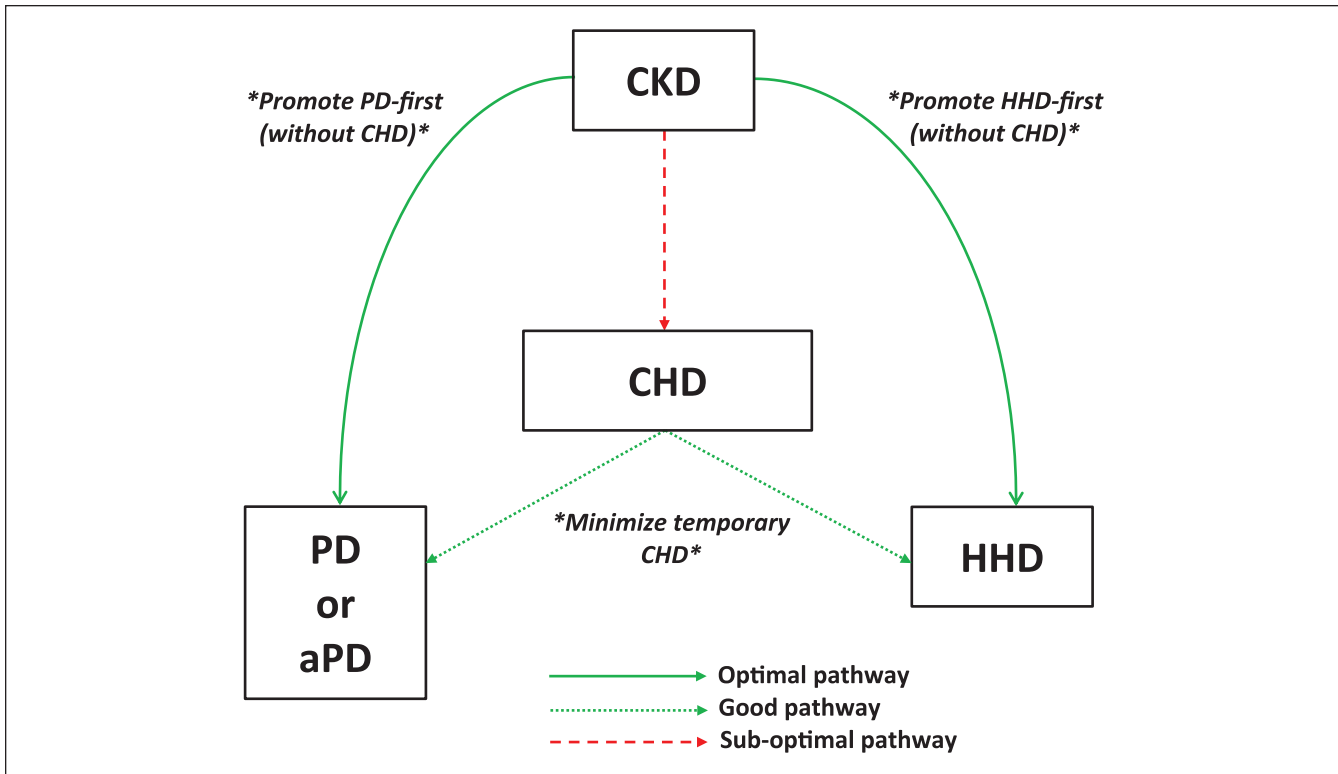


Figure 1. Proposed optimal pathway for initiating home dialysis.

Note. CKD = chronic kidney disease; CHD = conventional hemodialysis; HHD = home hemodialysis; PD = peritoneal dialysis; aPD = assisted peritoneal dialysis.

more time and resources early on, for both the treating center and the patient. This is highlighted by the fact that cost-neutrality with respect to CHD is only achieved after 12.6 months on HHD.²⁷ Patient preferences are likely to dominate the choice to initiate dialysis with HHD. HHD has generally been associated with improved quality of life in kidney-related domains compared to CHD, although study results were not always significant.²⁸⁻³² Of note, the frequent hemodialysis network (FHN) trial,²⁹ a randomized controlled trial comparing nocturnal HHD and CHD, did not find a statistically significant difference in quality of life between the conventional and nocturnal HHD groups. Nonetheless, both groups improved their quality of life during follow-up and a large proportion of the conventional HD patients received their dialysis treatments at home. Technique failure can come at great cost, and identifying at-risk patients while improving delivery of HHD by the treating center is important. Recently, Perl and colleagues³³ showed that HHD technique failure in Canada has been increasing in the most recent era, most likely due to expansion of recruitment criteria and an influx of older and more vulnerable patients as experience with the technique grew. Data from the Northern Albertan Renal program³⁴ showed that patients who failed HHD consumed more health-care resources in the last 6 months of HHD and ultimately had higher mortality after switching to another modality. In a recent Canadian multicenter study, Pauly and

colleagues³⁵ found that home HD center was an independent predictor of technique failure. It seems clear, then, that processes of care are important and should be the subject of further research.

Initiating RRT with HHD influences hospitalization rate. Suri and colleagues,³⁶ using a prevalent dialysis cohort from the United States Renal Data System (USRDS), showed that though there was no difference in hospitalization rate between HHD and CHD, cardiovascular hospitalizations were lower with HHD. Conversely, infectious and access hospitalizations were higher for the HHD cohort.

What is the best first home dialysis modality?

One of the most common clinical questions about home dialysis modality is the debate about the benefit (or not) of HHD over PD. Specific data on this subject are scarce and remain susceptible to residual confounding. Two large database studies from the United States³⁷ and Australia/New Zealand³⁸ have compared mortality and technique failure on PD and HHD. In the ANZDATA study, which included 10 710 incident PD and 706 incident HHD patients, HHD was associated with lower mortality (hazard ratio [HR], 0.47; 95% confidence interval [CI], 0.38-0.59) and technique failure (HR, 0.34; 95% CI, 0.29-0.40).³⁸ Results were consistent in different subgroups, including age, race, and diabetic status.

Patients in this study were started on home dialysis less than 90 days after initiation of RRT. Ultimately, however, results were limited by lack of adjustment for psychosocial and economic factors. Furthermore, inclusion of patients initiated on home dialysis very early after RRT start may have selected a subgroup of highly motivated HHD patients and the study results may not apply to all HHD cohorts. The study from Weinhandl et al³⁷ also showed lower risk of mortality and technique failure with short-daily HD using NxStage compared to PD (HR, 0.80 and 0.63, respectively) in a US cohort. However, in this study, the mean duration ESRD (end-stage renal disease) before home dialysis initiation was approximately 44 months in both groups, which likely represents a subgroup of “dialysis survivors” and may have influenced outcomes knowing that mortality risk is highest early after starting RRT. In the subgroup of patients who initiated either modality within the first six months of ESRD, mortality risk was similar with PD and HHD, and the HHD technique failure benefit was attenuated. Recently, a registry study of dialysis patients from Sweden³⁹ also showed higher survival with HHD compared to PD and CHD, although the HHD cohort included in this study was very small, limiting the generalizability of its findings. Furthermore, subsequent graft survival was not influenced by dialysis modality. In addition, these three studies did not include data on vascular access and residual renal function, which may have influenced outcomes. Overall, current data suggest a potential mortality benefit from initiation of dialysis with HHD and likely a technique survival benefit, although these studies held limitations as highlighted above.

The optimal initial dialysis modality for any given patient goes beyond considerations of mortality and technique survival, especially in light of the quality of available evidence. Patient preferences and quality of life should weigh heavily in the initial and subsequent modality choice.

Home-to-home transition; when PD ending is not a “failure”

The transition from PD to HHD is intuitively the most desirable. It allows patients already accustomed to a home modality to remain independent while taking advantage of long-term HHD benefits such as increased solute clearance and optimal volume control. Unfortunately, PD to HHD transitions are relatively infrequent, accounting for only 5.4% of incident PD patient with technique failure in an ANZDATA study.⁴⁰ In a single-center Canadian report, 16% (12/75) of all PD failures were eventually transferred to HHD.⁴¹ More recently, the Ontario Renal Network Home Dialysis Attrition Task Force published data regarding their experience with PD to HHD transitions between 2010 and 2016.⁴² Province-wide, 14% of patients with PD technique failure transitioned to HHD. Of note, Ontario has previously implemented a Home First Strategy, where the home-to-home strategy is preferred if a kidney transplant is unavailable, though this is no longer the case.

A recurrent clinical question for patients and nephrologists is whether PD followed by HHD is equivalent to a HHD first strategy. This dialysis pathway has been referred to as the *Integrated Home Dialysis Model*. The largest available study looking to answer this question comes from the Australia and New Zealand Dialysis and Transplant Registry.⁴³ In this cohort, 156 of 10 710 patients on incident PD transitioned to HHD within less than 180 days of PD ending. Men, obese patients, and patients with longer PD vintage were more likely to transition to HHD compared to facility-HD. Mortality risk and home dialysis technique failure were similar for patients who transitioned from PD to HHD and those treated directly with HHD at dialysis initiation.

These results were consistent to those of a smaller single-center Ontario study where HHD patients had similar patient and technique survival with and without previous exposure to PD.⁴⁴ Recently, a US study identified that 3.6% of all new HHD patients using NxStage transitioned from PD to HHD. Patients who transferred to HHD had a lower mortality risk than a matched cohort transferred to in-center HD.⁴⁵

These results favor broader use of the home-to-home transition for patients failing PD (Figure 2). Nonetheless, unanswered questions include the optimal timing for such transition and the need to adequately plan those transfers whenever possible. Of note, patients in the ANZDATA study had a median time on PD of 2.3 years before their transfer to HHD while ESRD duration was 4.3 years before HHD start in the US study.⁴³

Is it ever too late to start home dialysis?

Peritoneal dialysis

It is well recognized that a small but significant number of patients who ultimately start PD will transition through CHD first. Reasons for this delay include patient preference, modality indecision, logistical limitations (e.g. PD catheter placement), unplanned dialysis initiation (“crash-starts”), and lack of pre-dialysis nephrology follow-up. Canadian registry data have shown that, compared to PD-first patients, patients transferred from CHD had higher mortality⁴⁶ and experience more technique failure⁴⁶ and peritonitis.⁴⁷ Mortality risk and technique failure was mostly increased in the first year after the switch.

Patients who fail CHD due to vascular access issues or cardiovascular disease may represent a subgroup more likely to do well after transitioning to PD. In a Chinese study⁴⁸ specifically assessing this group, there was no statistically significant differences in technique failure or mortality between patients transferred to PD and a matched cohort initiated directly on PD. Overall, patients transferred to PD due to “CHD technique failure” will likely have different (poorer) outcomes than those transferred due to personal choices and should be followed accordingly.

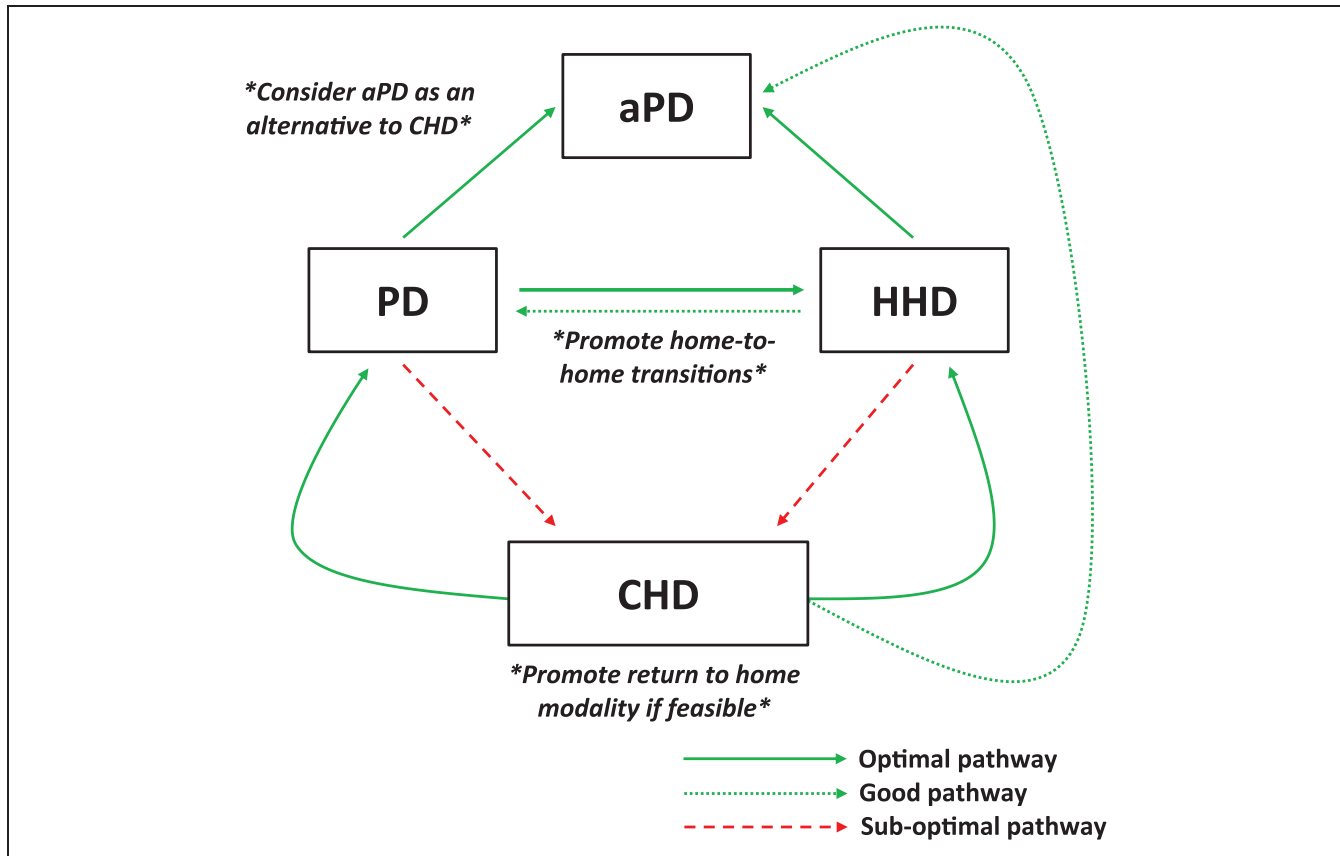


Figure 2. Proposed optimal pathway for home dialysis ending.

Note. CKD = chronic kidney disease; CHD = conventional hemodialysis; HHD = home hemodialysis; PD = peritoneal dialysis; aPD = assisted peritoneal dialysis.

Time on CHD has been associated with the loss of residual kidney function, which, in turn, is known to influence survival on PD.^{49,50} While it may never be too late to transfer a patient to PD for lifestyle and quality-of-life considerations, efforts should be made to promptly identify PD candidates in order to minimize unnecessary time on HD and thus preserve residual kidney function.

Transitioning anuric patients to PD poses a particular dilemma, as it is well recognized that residual kidney function is linked to survival on PD.^{49,51-54} Unfortunately, there is a paucity of data regarding transition to PD in this vulnerable patient population. The EAPOS (European Automated Peritoneal Dialysis Outcomes Study) prospective multicenter study⁵⁵ demonstrated the feasibility of performing APD in anuric patients. At 2 years, patient survival was 78% and technique survival was 62%. Baseline ultrafiltration <750 mL per day predicted poor survival, and daily ultrafiltration positively correlated with survival in this population. This correlation was reaffirmed in the NECOSAD (Netherlands Cooperative Study on the Adequacy of Dialysis) study⁵⁶ and in a more recent retrospective Chinese cohort.⁵⁷ Of note, baseline transport status and creatinine clearance on PD did not correlate with survival in the EAPOS study.⁵⁵

Home hemodialysis

There is little data regarding the timing of transition to HHD and subsequent outcomes. Generally, most HHD patients have a significant CHD vintage before transferring to HHD.^{58,59} In a systematic review of daily hemodialysis (including HHD) by Suri et al,⁶⁰ mean time on CHD before transition to daily HHD ranged from 2 to 11 years, and there was no signal toward negative clinical outcomes with longer CHD vintage. Studies including prevalent cohorts should, however, be interpreted with caution because these patients may be considered “survivors” and prone to the Neyman (selective survival) bias.⁶¹ HHD candidates should also be oriented to the HHD training unit as soon as possible since it is common belief that interest toward any home modality may attenuate as patients get used to their current therapy.

Peritoneal Dialysis to Conventional Hemodialysis—A Frequent and Hazardous Transition

The switch from PD to CHD is the most frequent transition in dialysis, notwithstanding transplantation. Most patients who switch from PD to CHD do so permanently. In an

ANZDATA study, 24% of patients returned to PD after 30 days on CHD, while only 3% did so after 180 days on CHD.⁶² Exploring clinical outcomes for this dialysis pathway is essential. A prospective cohort study of American PD patients⁶³ showed that patients switching from PD to CHD had a similar mortality risk than those who stayed on PD. Mortality risk after transfer to HD may be influenced by the cause of PD technique failure. In an ANZDATA study,⁶⁴ patients transferred to CHD due to inadequate dialysis or mechanical complications had lower mortality risk after transition to CHD than those with infectious causes of PD technique failure. In contrast, transfer to CHD due to social reasons was associated with an increased mortality risk once transferred. Globally, mortality after transition to CHD can be as high as 25% if the transition is unplanned.⁶⁵

This is mirrored in international data from the INTEGRATED group which showed that mortality is highest during the first month after the switch to CHD with a subsequent decline and plateau after 3 to 4 months.^{66,67} This data may help us identify those patients who are likely to survive beyond the first months of CHD after transition, and pay particular attention to interventions which may improve their outcomes.

Planning arteriovenous fistula (AVF) or graft creation in patients failing PD may allow them to start hemodialysis with a functioning vascular access. As in the general CHD population, PD patients transferred to CHD and dialyzed with a CVC are considered at higher risk of morbidity and mortality as compared to patients who either remain on PD or CHD patients dialyzed via an AVF.⁶⁸ Recently, a case-control study attempted to identify predictors of negative outcomes in PD patients and proposed a risk score to guide placement of a vascular access. In this small cohort, Kt/V < 1.7, low albumin, a peritonitis episode, and PD-related hospitalizations were associated with greater risk of transfer to CHD, which appears consistent with previous literature.⁶⁹ The authors suggested that combination of two risk factors, ≥ 4 hospitalizations, and exhaustion or loss of autonomy should warrant AVF creation. Of note, in this study, placement of AVF during PD was not associated with PD failure, which may be related to practice patterns in this center or indicate that, unfortunately, clinicians are not good at predicting PD failure. Generally, creation of a permanent vascular access at the start of PD as a “back-up” plan is not advised. A small report of 24 patients in whom an AVF was created at time of PD catheter insertion found that only 3 patients (12.5%) were started on CHD using the AVF.⁷⁰ This is similar to older data from the United Kingdom where 9% of PD patients with an AVF used this access to start CHD.⁷¹ Overall, identifying the optimal time for access creation and transition to CHD where time on PD is maximized while complications and crash-transitions are minimized remains key and should be explored in future research.

Conclusion

Overall, diverse factors must be taken into consideration when choosing initial and subsequent dialysis modalities.

Given the limitations of available data (and lack of convincing benefit or detriment of one modality over the other), patient-centered and health system-level considerations may prime over suspected mortality benefits of one modality or another. Emphasis must be placed on individual patient goals and preferences while planning ahead to achieve timely and appropriate transitions limiting discomfort and anxiety for patients. The proposed integrated care pathway where PD is initiated first with timely transition to HHD should likely be suggested to patients if their goals and preferences align, acknowledging the limitations of the current data.

Ethics Approval and Consent to Participate

No patient consent or ethics approval was required for this narrative review.

Consent for Publication

The authors have consented publication of this article.

Availability of Data and Materials

No additional data or materials are available for this review. Please contact corresponding author with any requests.

Declaration of Conflicting Interests

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ORCID iD

Benoit Imbeault  <https://orcid.org/0000-0001-8614-8126>

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