



A GUIDEBOOK ON

HOME HAEMODIALYSIS

FOR THE NEPHROLOGY CARE TEAM

Editor Joana Fontes
Reviewer Pablo Molina



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A Guidebook on Home Haemodialysis for the Nephrology Care Team

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This EDTNA/ERCA initiative aims to provide a comprehensive resource presenting the most up-to-date knowledge on Home Haemodialysis for the Nephrology Care Team.

This book has been specifically developed as a practical guide for healthcare professionals working across the spectrum of nephrology practice.

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ABBREVIATIONS

AI: Artificial Intelligence

AKI: Acute Kidney Injury

AV: Arteriovenous

AVFs: Arteriovenous Fistulas

AVGs: Arteriovenous Grafts

BDA KDSG: British Dietetic Association Kidney Dietitian Specialist Group

BH: Buttonhole

BMI: Body Mass Index

CKD: Chronic Kidney Disease

COREQ: COnsolidated criteria for REporting Qualitative research

CRBSI: Catheter-related Bloodstream Infection

CVC: Central Venous Catheter

DOPPS: Dialysis Outcomes and Practice Patterns Study

EDTNA/ERCA: European Dialysis & Transplant Nurses Association /
European Renal Care Association

ERA: European Renal Association

ESKD: End-Stage Kidney Disease

ESRD: End-Stage Renal Disease

EuroPD: European Peritoneal Dialysis

FDA: Food and Drug Administration

GIRFT: Getting It Right First Time

GDPR: General Data Protection Regulation

HD: Haemodialysis

HHD: Home Haemodialysis

HIV: Human Immunodeficiency Virus

IBW: Ideal Body Weight

ICT: Information and Communication Technology

IHDC: International Home Dialysis Consortium

IKA: Irish Kidney Association

ISN: International Society of Nephrology

ISPD: International Society for Peritoneal Dialysis

KDQOL-36™: Kidney Disease Quality of Life Instrument - 36 items

KDOQI: Kidney Disease Outcomes Quality Initiative

KRT: Kidney Replacement Therapy

LMWH: Low Molecular Weight Heparin

MIS: Malnutrition Inflammation Score

NHS: National Health Service

PCC: Person-Centred Care

PD: Peritoneal Dialysis

PDCA: Plan-Do-Check-Act

PEW: Protein-Energy Wasting

POCUS: Point-Of-Care Ultrasound

PPE: Personal Protective Equipment

QRP: Quick Response Plan

RCA: Root Cause Analysis

RFID: radio-frequency identification prescription card

RKF: Residual Kidney Function

SGA: Subjective Global Assessment

SOPs: Standard Operating Procedures

spKt/V: Single-pool Kt/V

stdKt/V: Standard Kt/V

TSC: Trisodium Citrate

UF: Ultrafiltration

USA: United States of America

UK: United Kingdom

VA: Vascular Access

VND: Venous Needle Dislodgment

WHO: World Health Organisation

Foreword

In recent years, there has been a global increase in HHD. As healthcare professionals, it is our responsibility to advocate and provide the best possible care for our patients.

HHD requires patient and carer training programs, that are tailored to each individual, supported by specialized staff who help patients to acquire the skills and competency needed to ensure safety throughout the entire process. During these training sessions, healthcare professionals build lifelong bonds with patients and their families. These connections often remain with us all our lives, and the trust established during this journey sustains the ongoing support that we can provide to our patients and their families.

The patient centred care approach empowers patients with the knowledge, confidence and ability to effectively perform HHD by themselves. It provides rewarding experiences of self-efficacy, independence and flexibility to fit treatment around their daily routines and leads to greater satisfaction with life. This is what makes our work so meaningful.

Another advantage of HHD emerged during the COVID-19 pandemic. HHD became an important strategy to help keep patients safe, as there was no need for them to travel to outpatients' HD centres. This significantly reduced the patients' exposure to the SARS-CoV-2 virus, other infections and hospitalizations.

Alongside technological advances in HD monitor software development, patients undergoing HHD have increasingly been supported by telehealth tools and by video-call appointments (virtual appointments). These innovations help ensure professional support is continuously available to both patients and carers, while reducing the burden of traveling to the hospital or HD centre for routine appointments. However, the importance of physical examinations and blood tests performed in face-to-face appointments should never be overlooked. For this reason, regular in-centre or hospital visits remain an essential component of patient care.

This guidebook will provide us with the best practices for training and supporting our patients and caregivers in HHD. Its purpose is to deliver high-quality, evidence-based information and care to patients living with chronic kidney disease.

From a historical perspective, this guidebook will explore the development of HHD worldwide and provide an in-depth understanding of the fundamental concepts underpinning contemporary HHD practice. Topics addressed include home assessment, environmental preparation, the benefits and challenges associated with HHD, principals of HHD prescription, vascular access management and the self-care model that supports patient autonomy and independence. This guidebook will also examine the educational and training programmes delivered by nurses to patients and caregivers, with emphasis on competency development, patient empowerment and ongoing support. In addition, key elements of patient safety and risk management will be discussed, alongside legal and ethical concerns relevant to home based dialysis care. Psychological aspects, nutritional management and the patient experience will be explored and provide a holistic perspective on how to establish and manage a safe, effective, patient-centred HHD programme.

Each chapter is written by experts from different healthcare contexts and takes us on a journey through their specialist knowledge of what is most important to us: **our patients**.

The Editor:

Joana Fontes, EDTNA/ERCA HD Consultant

Chapter 1

History of Home Haemodialysis

Learning objectives

- To describe the origins and mechanisms of HD
- To chronologically summarize the historical development of HHD
- To evaluate the future of HHD in light of current evidence and technological advances

Introduction

Since its inception, HHD has enabled patients to receive treatment in the comfort of their own homes, offering substantial advantages in terms of both clinical outcomes and quality of life. Interest in this treatment modality has fluctuated markedly over the years, influenced by technological innovations, the rising uptake of PD, changes in healthcare policy, and evolving approaches to patient-centred care. In this context, an understanding of the historical trajectory of HHD is of considerable importance for appreciating the origins of current practice and for evaluating potential future developments.

What is Dialysis? The Historical Development of Dialysis Therapy

In the field of chemistry, the term “dialysis” was introduced to the literature in the mid-19th century (1861) by the Scottish chemist Thomas Graham to describe the separation of crystalloid and colloid substances in liquids via the diffusion of crystalloids through a semi-permeable membrane (vegetable parchment).^{1,2} By the turn of the twentieth century, the concept of dialysis began to be explored in the medical field. These early studies laid the foundation for HD, the clinical technique by which toxic solutes are removed from the blood. Between 1913 and 1915, John Abel and colleagues conducted experiments in dogs using a “vividiffusion apparatus” consisting of 16 collodion membrane tubes housed within a glass cylinder, through which hirudin-anticoagulated blood was circulated to remove waste products via diffusion.³

In 1923, Heinrich Necheles increased the dialysate contact area by interposing supporting plates between layers of sheep peritoneal membrane, a material chosen for its expansibility.⁴ However, after encountering significant difficulties and disappointing outcomes, he ultimately abandoned his work in 1928. The first recorded clinical use of dialysis in humans was conducted in 1924 by Georg Haas, who treated a uraemic patient in Germany for 15 minutes.⁵ In this trial, blood was passed through collodion tubes arranged in eight parallel cylinders and brought into contact with an exchange fluid to test the safety of the dialysis procedure. Again, the anticoagulant used was hirudin, which was isolated from the heads of leeches in 1884 by the pharmacologist John Haycraft following his observation that individuals bitten by leeches exhibited markedly prolonged bleeding times.¹

In 1928, Georg Haas replaced the hirudin used in his earlier experiments with heparin, a safer and more effective anticoagulant, thereby preventing clotting within the extracorporeal circuit and enabling dialysis to be performed safely for longer durations.¹ The development of dialysis equipment and suitable membranes progressed in parallel. In 1937, William Thalhimer recognised that cellophane, a form of cellulose hydrate used in the sausage industry, possessed diffusion characteristics suitable for use as a dialysis membrane.^{2,4}

Development of the Artificial Kidney: Willem Kolff

Willem Kolff played a leading role in the development of modern haemodialysis, pursuing his work despite the adverse conditions of the Second World War. His interest in developing an artificial kidney began in 1938 after witnessing the death of a young patient due to renal failure. This experience prompted him to devise methods for removing uraemic toxins from the blood.³ In a later publication, he wrote that “the patient could have been saved if only 20 g of urea could have been removed from his blood every day”, reflecting his view that removing uraemic toxins and excess body fluid with a device could prolong life.^{3,5} By 1939 Kolff, together with his colleague Robert Brinkman, had developed artificial kidney prototypes that functioned in the laboratory but were not yet suitable for clinical use. These early prototypes utilised cellophane membranes and metal drum systems. Following the occupation of the Netherlands in 1940, Kolff relocated his research to Kampen, where he continued his

experiments despite having limited resources. During this period, the foundations of the first functional systems were laid using cellophane tubes intended for sausage casings and components salvaged from recycled materials.³

In 1943, with the assistance of engineer Hendrik Berk, Kolff developed the 'rotating drum kidney,' which is regarded as the first functioning artificial kidney. The apparatus consisted of long cellophane tubes wound around a drum to provide a large surface area for exchange. The walls of the tubing functioned as a semipermeable membrane, allowing toxins within the patient's blood to diffuse into the surrounding dialysate. Initially, Kolff conducted a preliminary experiment using 250 mL of blood with a urea concentration of 200 mg/dL inside a cellophane casing measuring 5 cm in diameter. After immersing the casing in a saline-filled vessel and agitating it, he observed that most of the urea was removed within 5 minutes. This experiment demonstrated that an effective artificial kidney would require approximately 20 metres of cellophane tubing.

The low-concentration saline solution used as the dialysate was contained in a large tank, within which the drum was rotated.^{3,5} Fluid removal was achieved by adding sugar to the dialysate to increase osmotic pressure. However, this occasionally resulted in membrane damage and hyperglycaemia.^{4,5} Kolff's device was used experimentally on patients with end-stage renal failure in the Netherlands during the Second World War. Between March 1944 and July 1945, the device was used to treat 15 patients, but none of these initial attempts was successful, and none of the patients survived.^{3,5} However, on 11 September 1945, a 67-year-old woman in a coma due to hepatorenal syndrome was successfully dialysed. She regained consciousness following treatment and survived for a considerable period thereafter. This case was regarded as the first compelling evidence that dialysis could be lifesaving in acute renal failure.^{3,4}

Kolff continued to refine the apparatus despite his early failures. Between 1951 and 1956, he provided 61 dialysis sessions in his own office using a 4-drum artificial kidney device. These treatments were conducted under the supervision of medical residents, without the assistance of dialysis technicians or nurses. Each session lasted a total of six hours, with the dialysate changed every two hours. To minimise the margin of error in dialysis fluid preparation and the procedure itself, Kolff clearly defined each clinician's role.

For example, while the resident preparing the dialysate added potassium at 5.0, 3.7, 2.5, or 0 mEq/L (depending on the patient's serum potassium level) to a standard premixed dialysate (sodium 138, chloride 103, bicarbonate 35, calcium 5, and magnesium 1.5 mEq/L) and counted the empty bags, another resident would mix a few drops of the patient's blood with dialysate in a small test tube and centrifuge it. The absence of haemolysis during this process indicated that the concentration was correct. A third resident would taste the dialysis fluid to assess its salinity, as an osmometer was not available.⁵

In the late 1950s, the parallel-plate dialyser developed by Fredrik Kiil gained prominence for providing a lower priming volume and large surface area. The Cuprophane membrane used in this system allowed the passage of larger molecules, and the device's ability to operate without a blood pump offered a cost advantage.⁴ The subsequent production of the disposable twin-coil kidney facilitated fluid removal by hydrostatic pressure. In the following years, dialysis treatments were performed using this device. To adequately serve the increasing number of patients during those years, two dialysis technicians were hired.

In Seattle in 1960, Belding Scribner recognised that permanent vascular access was essential to sustaining repeated dialysis treatments in patients with chronic renal failure.³⁻⁵ In response to this need, he collaborated with engineer Wayne Quinton to develop a plastic AV shunt, which was placed between the radial artery and cephalic vein in the forearm, allowing long-term vascular access.⁵ This innovation led to the successful treatment of his first patient, Clyde Shields, and enabled the initiation of chronic dialysis therapy. However, the limited resources for providing dialysis in the early 1960s raised significant ethical dilemmas regarding patient selection. A panel established at the Seattle Artificial Kidney Centre, publicly known as the 'Life or Death Committee', determined which patients would receive treatment. These decisions were based not only on an evaluation of the patients' medical condition but also their social, economic, and demographic profiles.² This holds historical importance as an early example of the intersection between ethics and medical practice in the implementation of dialysis.

While the improved access and comfort-enhancing modalities of modern dialysis clearly demonstrate remarkable progress in the

field, the prospect of portable artificial kidneys becoming a reality in the coming years offers further promise.

The History of Home Haemodialysis

In 1961, a patient in London was able to set up his own machine and initiate treatment, demonstrating the feasibility of HHD.⁴ To leave the patient's hands free, the first leg shunt was created. The outcomes of this patient, reported in 1964, showed that HHD could be performed successfully given appropriate patient selection.⁴ In USA during the 1960s, the rising mortality attributable to CKD, the shortage of dialysis centres, and the high cost of treatment necessitated the establishment of home dialysis programmes. According to 1975 data from the National Dialysis Registry, 12,977 patients were receiving chronic dialysis treatment, of whom 3,712 were on HHD. As a result of these developments, comprehensive HHD programmes were established in USA and in UK, enabling personalised treatment and greater patient reach without the need to expand hospital capacity.⁴

The Historical Trajectory of Home Haemodialysis: Causes of Decline and the Dynamics of Its Current Resurgence

Developed in the 1960s, HHD garnered attention for improving patient survival, quality of life, blood pressure control, and rehabilitation prospects, particularly when performed overnight, three times a week. Furthermore, its cost-effectiveness enabled the treatment of more patients despite limited resources.⁶ In the early 1970s, it was widely practised in several countries, most notably the USA and New Zealand. More than 30% of patients in USA and over half of patients in Australia and New Zealand were being treated at home.⁷ (Fig 1 and 2). Until the early 1980s, HHD remained a popular modality in countries such as UK and USA due to insufficient hospital capacity, long treatment durations, and the economic advantages of home-based therapy.⁸

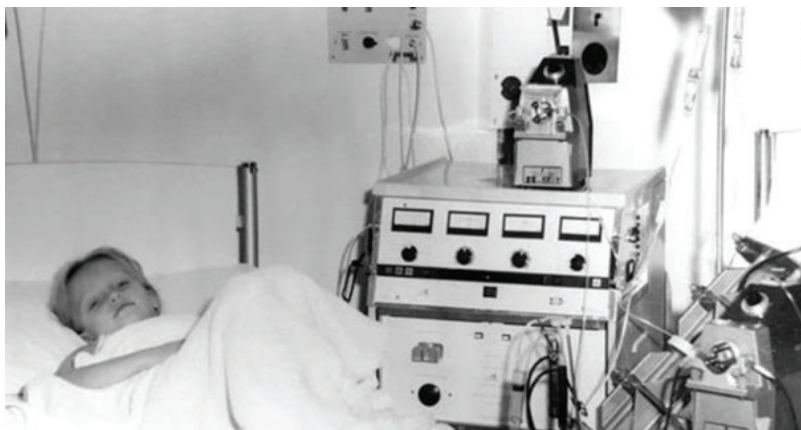


Fig 1: Home and in-centre haemodialysis patient. © 1975 Kidney Care UK. Used with permission.

Reference: <https://kidneycareuk.org/kidney-disease-information/treatments/dialysis-80-years-of-the-artificial-kidney/>

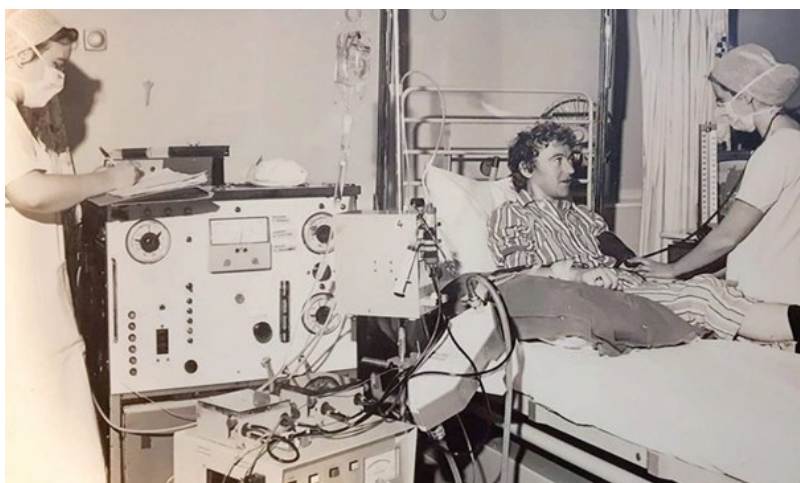


Fig 2: Single-needle wrist fistula in a patient. © 1970 Kidney Care UK. Used with permission.

Reference: <https://kidneycareuk.org/kidney-disease-information/treatments/dialysis-80-years-of-the-artificial-kidney/>

However, beginning in the 1970s, various structural and systemic changes led to a marked decline in its utilisation. In USA, the establishment of the Medicare ESRD Programme increased access to dialysis services but also led to the rapid proliferation of for-profit, in-centre dialysis centres. Reimbursement policies favouring in-centre HD diminished the economic appeal of home treatment. During this period, healthcare providers' experience with HHD decreased and the patient profile shifted as a result of rising age, comorbidity and notably, the rising prevalence of diabetes.^{7,8,9} In addition to the proliferation of community-based dialysis centres, peritoneal dialysis became safe and feasible with the advent of the Tenckhoff catheter, bringing alternative home therapies to the foreground.

The development of more efficient dialysis machines which enabled treatment schedules to be reduced to three shorter sessions per week, further eroded the relative advantages of home therapy.^{7,10-12} Consequently, HHD increasingly became a less preferred option and was even regarded in some circles as obsolete.¹⁰ A similar decline was observed in Europe, particularly in the UK, where HHD rates fell from over 15% in 1975 to less than 5% during the 1990s. By 2005, the prevalence of HHD in USA had plummeted to under 1%.⁷ The establishment of centre-based HD as the standard of care in the 1980s and 1990s, coupled with the limited support and educational resources available for home programmes and the changing patient demographic, accelerated this downturn.¹³

Starting in the 2000s, however, interest in HHD began to resurge. This revival has been driven by a growing body of evidence demonstrating favourable impacts on patient outcomes and quality of life, as well as more supportive healthcare policies and technological advancements. In particular, from the mid-1990s onwards, the increased prominence of HHD at annual dialysis conferences, the establishment of educational and research platforms for clinicians, and improved funding for related research all contributed to the renewal of knowledge and expertise among healthcare professionals. Furthermore, the development of safe, portable, and user-friendly dialysis machines has enhanced the feasibility of home-based treatment.^{7,8,11} In USA, the number of patients receiving HHD rose from 4,500 in 2009 to over 6,000 in 2012, and increased approximately threefold between 2007 and 2020.^{11,14}

Structured educational and support programmes also gained importance during this period. Initiatives such as WellBound, founded in 2002, have empowered patients to make informed choices regarding their home dialysis options, with a substantial proportion of patients receiving such education shown to opt for home-based therapies.⁹ Early patient education, peer support, and growing proficiency of clinical teams in this field are among the key factors driving greater uptake of home therapies.⁹ Alongside technological advances, the development of safety mechanisms (such as blood leak sensors and pressure monitoring systems) and improved management of vascular access have further enhanced the safety of HHD.⁸ Telehealth applications, flexible training models, and financial support mechanisms are also contributing to the sustained viability of home therapy.¹⁵

Although the use of HHD increased in Europe between 2012 and 2021, its prevalence remains low at approximately 5.8%. There is notable variation between countries, with marked increases in some while utilisation remains limited in others.¹⁶ Conversely, interest in the US maintains an upward trend due to its clinical efficacy, quality-of-life benefits, and cost advantages.⁹

At present, although HHD offers advantages over in-centre haemodialysis in terms of quality of life, flexibility, and employment opportunities, its uptake remains limited. This is attributable to multidimensional factors, including a lack of awareness, perceived technical difficulty (particularly regarding cannulation), inadequate self-efficacy and self-confidence, fear of lacking medical supervision at home, the associated burden on patients and carers, socioeconomic barriers, and inadequacies within the home environment.^{15,17} Nevertheless, current evidence suggests that, with appropriate policies, education, and investment in technology, HHD has the potential to become a more widespread, patient-centred, and cost-effective treatment option.¹⁵

The Future and Importance of Home Haemodialysis

HHD safely and effectively provides frequent and prolonged treatment, offering an important alternative to traditional centre-based dialysis. High-frequency and convective haemodiafiltration contribute to the more effective clearance of middle and large molecules and to a reduction in post-dialysis fatigue. Self-care HD and integrated care models (e.g., Transformation in Renal Dialysis Services

[TRenDS])⁸ create important opportunities for patient empowerment, engagement with therapy, and long-term sustainability.

Technological advances, user-friendly home machines, and enhanced safety mechanisms are improving the safety of the procedure, while the threat of infectious diseases such as COVID-19 has underlined the importance of HHD and the need for out-of-centre treatment models.⁸ Nevertheless, the prevalence of HHD remains limited. This can be attributed to several barriers, including a shortage of trained home dialysis nurses, the dominance of centre-based dialysis infrastructure, and the fact that current devices are often large, technically complex, and difficult to operate.¹⁴

The literature emphasises that these limitations can only be overcome through the development of smaller, portable, and more user-friendly systems. In particular wearable artificial kidney systems have been under investigation for a considerable time as a potential alternative to traditional dialysis. Although they have not yet entered clinical use, their successful development has the potential to radically transform the way dialysis treatment is administered.¹⁴

Conclusion

Historically, HHD experienced a period of initial interest, followed by decline and a subsequent resurgence. This trajectory was driven by shifts in healthcare policy, technological advancements, and evolving patient profiles. Although reimbursement systems, a bias towards in-centre therapy, and the development of alternative dialysis modalities limited its use in the past, this modality has regained prominence as a result of current technological innovations, heightened clinical awareness, educational programmes, and research funding. Nevertheless, the fact that utilisation rates remain limited indicates that structural and socioeconomic barriers persist. Ultimately HHD offers substantial opportunities in terms of both clinical efficacy and patient-centred care but achieving its widespread and sustainable use requires further improvement of technological, educational, and systemic support frameworks.

References

1. Jacobs C. La suppléance de la fonction rénale par l'hémodialyse. Un siècle et demi d'histoire [Renal replacement therapy by hemodialysis: an overview]. *Nephrol Ther.* 2009;5(4):306–312. French. doi:10.1016/j.nephro.2009.03.001.
2. Mayo Clinic. The history of the end-stage renal disease program. Rochester, MN: Mayo Clinic Press; 2026. Available from: <https://mcpress.mayoclinic.org/research-innovation/the-history-of-the-end-stage-renal-disease-program/> (accessed 22 Mar 2026).
3. Sharma N, Khav E, Elahmadi A, Ong J, Parag S. Dr. Willem Kolff: The Father of the Artificial Kidney. *Cureus.* 2024;16(9):e69098. doi:10.7759/cureus.69098.
4. Thomas N. The History of Haemodialysis. In: Fortnum D, Casal Garcia MC, editors. *Home Haemodialysis-A Nurses Guide to Implementing Best Practice in Home Haemodialysis*. 1st ed. Sweden: EDTNA/ERCA; 2017. p.29–38.
5. Nakamoto S. Reflections on My Lifetime Teacher: Dr. Willem J. Kolff. *Artif Organs.* 2018;42:115–126. doi:10.1111/aor.13114.
6. Blagg CR. The renaissance of home hemodialysis: where we are, why we got here, what is happening in the United States and elsewhere. *Hemodial Int.* 2008;Suppl 1:S2–S5. doi:10.1111/j.1542-4758.2008.00287.x.
7. Trinh E, Chan CT. The Rise, Fall, and Resurgence of Home Hemodialysis. *Semin Dial.* 2017;30(2):174–180. doi:10.1111/sdi.12572.
8. Mitra S, Kharbanda K, Ebah L. Home haemodialysis: Providing opportunities to reimagine haemodialysis care. *Nephrol Ther.* 2021;17S:S60–S63. doi:10.1016/j.nephro.2020.03.005.
9. Moran J. The resurgence of home dialysis therapies. *Adv Chronic Kidney Dis.* 2007;14(3):284–289. doi:10.1053/j.ackd.2007.03.005.
10. Agar JW. International variations and trends in home hemodialysis. *Adv Chronic Kidney Dis.* 2009;16(3):205–214. doi:10.1053/j.ackd.2009.02.007.
11. Naso A, Scaparrotta G, Naso E, Calò LA. Intensive Home Hemodialysis: An Eye at the Past Looking for the Hemodialysis of the Future. *Artif Organs.* 2015;39(9):736–740. doi:10.1111/aor.12458.
12. Perl J, Chan C. Home Hemodialysis, Daily Hemodialysis, and Nocturnal Hemodialysis: Core Curriculum 2009. *Am J Kidney Dis.* 2009;54:1171–1184.
13. Mitra S, Brady M, O'Donoghue D. Resurgence in home haemodialysis: perspectives from the UK. *NDT Plus.* 2011;Suppl 3:iii1–iii3. doi:10.1093/ndtplus/sfr133.
14. Rivara MB, Himmelfarb J. From Home to Wearable Hemodialysis: Barriers, Progress, and Opportunities. *Clin J Am Soc Nephrol.* 2024;19(11):1488–1495. doi:10.2215/CJN.0000000000000424.
15. Walker RC, Howard K, Morton RL. Home hemodialysis: a comprehensive review of patient-centered and economic considerations. *Clinicoecon Outcomes Res.* 2017;9:149–161. doi:10.2147/CEOR.S69340.
16. Slon-Roblero MF, Stel VS, Sanchez-Alvarez E, Manrique Escola J, Fraga Dias BJ, Añón AS, et al. Trends in home dialysis over the last decade in

- Europe: an ERA Registry study. *Nephrol Dial Transplant*. 2026;41(3):457–475. doi:10.1093/ndt/gfaf171.
17. Ishani A, Slinin Y, Greer N, MacDonald R, Messana J, Rutks I, et al. Comparative Effectiveness of Home-Based Kidney Dialysis Versus In-Center or Other Outpatient Kidney Dialysis Locations – A Systematic Review [Internet]. Washington (DC): Department of Veterans Affairs (US); 2015 Apr. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK344414/>

Chapter 2

Home Haemodialysis

Learning objectives

- To understand what is involved in HHD
- To recognise the importance of home safety assessments and risk mitigation, as well as the technical aspects and support networks involved, including clinical, caregiver and peer support
- To understand the benefits and challenges of HHD compared with in-centre HD
- To reflect on future perspectives regarding HHD

Introduction

HHD has re-emerged internationally as an important form of renal replacement therapy, aligned with contemporary principles of patient-centred care, personalised treatment and shared decision-making.^{1,2} The renewed interest in this modality has been driven by advances in technology, an increasing emphasis on home-based healthcare delivery and the growing need for a sustainable healthcare system.

Historically, haemodialysis has predominantly been delivered in hospitals or satellite dialysis units. However, there is an increasing body of evidence suggesting that home-based treatment could be a clinically effective and patient-centred alternative for certain individuals.^{3,4}

Several international studies have found a link between HHD and improved patient-reported outcomes. These include an enhanced quality of life, greater flexibility in treatment, a better sense of control and an increased ability to maintain employment or family responsibilities.^{1,6} Furthermore, the clinical benefits observed in specific patient groups include enhanced blood pressure control, improved volume management, reduced post-dialysis recovery time and increased phosphate clearance, particularly with more frequent or prolonged treatment regimens.^{7,9} Lastly, HHD enables treatment to be integrated into patients' daily lives, offering greater flexibility and autonomy, and encouraging their involvement in disease management.^{1,5}

Despite the recognised advantages of HHD, its implementation remains highly variable across healthcare systems.¹⁰ The uptake of HHD is influenced by organisational factors, healthcare funding models, publicity/marketing, professional expertise, infrastructure availability, patient education pathways and sociocultural attitudes towards self-management.¹¹ International recommendations increasingly advocate that individuals approaching kidney replacement therapy should receive structured education on all available treatment options, including home-based ones.^{2,12} It has been recognised that early education about treatment options is an important factor in ensuring informed treatment selection and long-term satisfaction with treatment.

Nevertheless, the successful implementation of HHD requires careful planning and multidisciplinary coordination. Essential components of sustainable HHD programmes include patient selection, structured training, home safety assessment, clinical experience and knowledge, technical support and risk mitigation strategies.¹³

The aim of this chapter is to provide a practical, technical, organisational and safety overview of HHD, emphasising the most relevant aspects to Nephrology Care Team.

What is involved?

- Home safety assessment and risk mitigation

The home environment is an essential factor to consider when assessing eligibility. Prior to programme initiation, adequate physical space, electrical safety, plumbing suitability and storage capacity for consumables should be assessed.¹³ A structured evaluation of the domestic environment should be conducted to ensure that the necessary requirements are met. The assessment process aims to minimise risks related to treatment and establish conditions that support the provision of safe, sustainable, and effective home-based care.

Water Supply and Quality

Water quality is one of the most critical safety considerations in HHD, particularly when treatment systems require water purification through reverse osmosis.¹⁹ Since dialysis fluid comes into indirect

contact with blood, inadequate water quality can expose patients to serious microbiological or chemical risks.¹⁸ The assessment should include the following:

- The suitability of water sources
- The adequacy of the water pressure
- Compatibility with treatment equipment
- Protocols for ongoing monitoring protocols

International standards emphasise the importance of continuous quality assurance, preventive maintenance, as well as regular microbiological and chemical surveillance of dialysis fluids.^{19,22}

Electrical Safety

An electrical safety assessment is essential prior to the installation of home dialysis equipment. The domestic electrical system must be able to safely support dialysis-related devices and comply with the relevant technical standards.¹³ The following should be taken into consideration when carrying out the assessment:

- The adequate electrical capacity (for the system to function properly)
- Ensuring that sockets are placed safely
- Grounding of equipment is essential
- Minimise the risk of accidental electrical hazards

When necessary, electrical modifications should be performed by qualified professionals.

Physical Environment and Space Requirements

To ensure the safe performance of treatments and the appropriate storage of materials, there must be adequate physical space. Ideally, the treatment environment should provide:

- A space that is clean and organised
- Appropriate ventilation
- Adequate lighting

- Sufficient room for equipment operation, ensuring that there is no obstruction and that it can be used effectively
- Safe access to emergency communications

Storage capacity should also be assessed, as HHD commonly requires regular delivery of consumables and dialysis-related materials.²⁰ While some homes may require structural adjustments, technological advances and smaller equipment designs have removed many environmental barriers.³

Communication and Emergency Planning

Reliable communication systems are essential for emergency management and patients should have immediate access to them. These can include:

- Telephone or mobile communication
- Clinical support contacts
- Technical assistance pathways

Emergency contingency planning involves having clear escalation plans in place for managing equipment malfunctions, vascular access complications, unexpected symptoms, and interruptions to treatment.¹³

Waste Management and Infection Prevention

HHD produces potentially hazardous healthcare waste, which include needles, blood-contaminated materials, and single-use dialysis supplies.²³ Patients and caregivers should receive clear training on how to manage this waste safely, to ensure legal compliance and a safe workplace. Safety courses on clinical waste will explain how to store, separate, and dispose of all hazardous and non-hazardous materials, for example:

- Secure disposal of sharp objects
- Appropriate segregation of clinical waste (blood lines, dialysers, wipes, dressings, tape, plasters, etc.)
- Infection prevention measures
- Environmental cleaning procedures

Although local healthcare systems may differ in their waste collection pathways, clear protocols are essential to ensure safety and environmental responsibility.¹⁸ Haemodialysis waste represents a considerable risk, it must be disposed of safely and in accordance with the law. The sustainability of HHD programmes depends on effective risk prevention strategies that combine patient preparation, technical reliability, professional support, and continuous monitoring.^{2,13} Even though home treatment offers greater autonomy, structured safety mechanisms are still necessary to minimise complications and maintain patient confidence.

- Technical aspects and equipment

Safe and effective HHD depends on the availability of reliable equipment adapted for home use.¹³ Significant advances in haemodialysis technology have facilitated the expansion of home-based treatment by improving usability, portability, automation, and safety mechanisms.

Modern HHD machines are designed to support simplified operation while maintaining treatment accuracy and safety. Features such as user-friendly interfaces, automated priming systems, integrated alarms, and guided treatment pathways may reduce technical complexity experienced by patients and caregivers.³

Technological developments have enabled the increasing integration of digital systems into HHD programmes. Features such as data transmission, automated session recording, and remote technical support can enhance monitoring capabilities and facilitate communication between patients and nephrology teams.²¹

Despite these advances, access to technology varies considerably between healthcare systems, so implementation strategies must be adaptable to local infrastructure and resources.

The specific equipment required depends on the treatment modality and local infrastructure, but commonly includes:

- HD machine/monitor
- Water treatment systems
- Dialysers and extracorporeal circuits (blood lines)
- Cannulation material

- Monitoring equipment: weight scales and blood pressure devices
- Cleaning and infection control supplies

In many settings, reverse osmosis water purification systems are essential for ensuring the quality of treated water.¹⁹ However, technological innovation has led to the innovation of systems that use pre-prepared dialysate solutions or require less complex water treatment infrastructure, thereby reducing the technical barriers to implementation.³

Reliable logistics systems are essential for programme sustainability. This requires regular home delivery of consumables, adequate storage capacity, inventory management, and maintenance planning are required to minimise treatment interruption.²⁰

Storage requirements may present a practical challenge, particularly in a smaller living space. Patients and families often require guidance on organisation, stock rotation, and the appropriate environmental conditions for storing consumables.

- Support: technical, clinical, caregiver & peer support networks

Technical Support and Equipment Maintenance

Reliable technical assistance is essential to minimise interruptions and to ensure equipment performance. Preventive maintenance schedules should include the following:

- Equipment inspection
- Water system monitoring
- Technical troubleshooting
- Replacement of malfunctioning components

Implementing rapid-response pathways could minimise treatment disruption and boost patient's confidence in home-based care.²⁰

Clinical Support Systems

Continuous clinical support is recognised internationally as a vital component of HHD programmes.² Centres should provide:

- Dedicated telephone support
- Personalised follow-up
- Access to nephrology team
- Rapid clinical advice for complications
- Structured follow-up pathways

Professional accessibility contributes to clinical safety, patient reassurance, and long-term treatment adherence.¹⁶

Telemedicine and Remote Monitoring

Advances in digital health technologies have enabled remote monitoring to become an increasingly important part of the HHD programmes, particularly during the COVID-19 pandemic.²¹ Telemedicine strategies include:

- Transmission of dialysis session data
- Remote review of treatment parameters
- Virtual clinical appointments
- Automated alerts for abnormal findings

Remote monitoring can help to identify complications earlier, encourage adherence to treatment and improve communication between patients and healthcare teams.^{14,21} However, its implementation can vary considerably depending on the infrastructure, digital literacy, and the resources available in the different healthcare systems of each country.

Caregiver & Peer Support Networks

For some patients, caregivers play a vital supportive role in HHD treatment. However, the burden on caregivers should be proactively recognised. The long-term responsibilities of caregiving can lead to emotional distress, fatigue, and anxiety concerning potential treatment complications.²⁴ Healthcare teams should consider:

- Caregiver education
- Ongoing mental & emotional support

- Periodic assessment and reassessment of caregiver burden, in collaboration with the renal psychologist
- Integrated care plan: a holistic approach that addresses both physical symptoms, and psychological distress. This care plan should be co-developed and reviewed during routine multidisciplinary meetings
- Temporary alternatives where required

Home treatment can sometimes lead to feelings of isolation and a lack of confidence. However, these issues might be alleviated through peer support networks and patient communities.²⁴

- Challenges and barriers

Fear of Self-Cannulation and Treatment Responsibility

For many patients, the anxiety associated with self-cannulation is a significant psychological obstacle to HHD.¹⁶ Treatment acceptance may be influenced by concerns regarding needle insertion, equipment handling, and complication management. Collaborative training containing a structured program of education, supervised practice, and psychological support is essential for developing the confidence of patients or caregivers. Sometimes, patients need cognitive behaviour therapy, to help them manage their stress and regain confidence and control.

Health Literacy and Confidence

Differences in health literacy may influence patients' understanding of treatment procedures and their confidence in their ability to effectively self-manage their condition.¹⁷ It is known that low health literacy is related to poor health outcomes. This is why educational strategies should be tailored to the needs of patients and caregivers, recognising that successful adaptation depends not only on technical competence, but also on knowledge and emotional readiness. Specific educational techniques and support plans can help to achieve this.

Housing and Environmental Constraints

The feasibility of a programme may be affected by domestic infrastructure. For example: space limitations, unsuitable plumbing,

inadequate electrical systems and storage difficulties may reduce eligibility for home treatment.¹³ While technological developments have reduced some practical barriers, environmental suitability remains a fundamental concern.

Caregiver Burden

Treatment-related responsibilities can add to the emotional and physical burden of caregivers when their involvement is necessary.²⁴

The fear of complications, the demands of long-term treatment and changes in family dynamics may all influence the well-being of caregivers. Therefore, ongoing professional support and caregiver education are essential components of sustainable HHD programmes.

Ageing and Clinical Complexity

The increasing age and burden of comorbidities in dialysis populations may reduce the proportion of patients who are considered suitable for autonomous home treatment.¹⁵ Nevertheless, eligibility should be assessed on a case-by-case basis, and older age alone should not automatically preclude consideration of HHD.

Benefits and challenges of home haemodialysis compared with in-centre haemodialysis

Compared with conventional in-centre haemodialysis, HHD has been associated with a range of advantages across clinical, organisational, and patient-reported outcome measures.^{1,2} However, successful implementation also requires recognition of potential limitations and barriers that may affect suitability and long-term sustainability.

- **Potential Benefits**

Greater Autonomy and Treatment Flexibility

One of the principal advantages of HHD is the flexibility for patients to integrate treatment into their daily lives.^{1,6} Home treatment can provide greater freedom in scheduling dialysis, which can facilitate employment, education, family responsibilities, and social participation. Patients often report greater autonomy and a better sense of independence, especially when treatment schedules can be tailored to their needs.²

Improved Quality of Life

Several studies suggest that HHD may contribute to improved patient-reported quality of life compared with conventional in-centre treatment.^{1,5} Reduced travel requirements, greater familiarity of the home environment, and increased adaptability may contribute positively to emotional well-being and treatment satisfaction. They may also experience reduced post-dialysis fatigue and shorter recovery periods, particularly when more frequent or extended dialysis schedules are used.^{8,9}

Clinical Benefits

Reported clinical advantages in selected populations include:

- Improved blood pressure control
- Better body volume management
- Enhanced phosphate and potassium clearance
- Reduced cardiovascular stress
- Improved symptom control^{7,9}

More frequent or longer dialysis schedules performed at home may more closely replicate physiological kidney function, although treatment prescription should remain tailored to patient's clinical needs.¹

Healthcare System Benefits

In some healthcare systems, HHD may contribute to reduced demand for in-centre dialysis capacity and greater treatment flexibility.²⁰ Home-based care may also reduce transport requirements and facilitate more personalised care pathways. However, implementation costs, organisational readiness, and infrastructure availability can differ considerably between healthcare systems and should be interpreted within local contexts.

Future perspectives and practical reflection

The future development of HHD will likely depend on continued technological innovation, improved educational pathways, and greater integration of patient-centred approaches within renal replacement therapy programmes.²

International recommendations increasingly advocate early education regarding dialysis modality options, ideally before dialysis is initiated.^{2,12} Structured pre-dialysis education programs can help to improve informed decision-making and increase awareness of home-based therapies.

Raising awareness of environmental concerns could encourage more people to choose HHD over in-centre haemodialysis. Publicising this greener option will also prompt countries to recognise its importance and hopefully create national strategies to regulate and finance it.

Technological advances are also likely to influence future implementation. Smaller machines, simplified setup processes, remote monitoring systems, digital communication platforms, and telemedicine may reduce barriers to home treatment and strengthen patient safety.²¹ However, successful implementation will continue to depend on careful patient selection, structured training, professional expertise, and sustainable organisational models. Although HHD delivery models vary internationally, practical clinical experience consistently highlights the importance of multidisciplinary collaboration, continuous support, and rigorous safety processes in sustaining home-based treatment programmes.

Conclusion

HHD is an important and increasingly recognised form of renal replacement therapy. It offers a patient-centred alternative to conventional in-centre dialysis for individuals who are suitable candidates.^{1,2}

Successful implementation requires careful multidimensional patient assessment with structured training, safe home environments, reliable technical infrastructure, and robust clinical support systems.¹³ Risk mitigation strategies, caregiver support, and ongoing reassessment are all fundamental to ensuring the sustainability of treatment and patient engagement.

Despite the ongoing challenges, such as the complexity of treatment, environmental limitations, health literacy barriers, and the burden on caregivers, technological innovation and a growing focus on personalised care are driving the international development of HHD.²¹

In order to support informed treatment decisions and ensure the safe delivery of educational programmes, Nephrology Teams must understand the practical, technical, and organisational aspects of HHD. As healthcare systems evolve, HHD is likely to remain a vital component of future kidney replacement therapy pathways, particularly given that the healthcare models are increasingly prioritising patient autonomy, and flexibility, as well as the awareness of the in-centre haemodialysis environmental impact.

References

1. Walker RC, Howard K, Tong A, Palmer SC. Introduction to home dialysis: fundamentals and beyond. *Clin J Am Soc Nephrol*. 2023;18(10):1553–1564.
2. Perl J, Brown EA, Chan CT, Couchoud C, Davies SJ, Kazancioğlu R, et al. Home dialysis: conclusions from a Kidney Disease: Improving Global Outcomes (KDIGO) Controversies Conference. *Kidney Int*. 2023;103(5):842–858.
3. El Shamy O, Abra G, Chan C. Patient-centered home hemodialysis: approaches and prescription. *Clin J Am Soc Nephrol*. 2024;19(4):517–524.
4. Himmelfarb J, Ikizler TA. Hemodialysis. *N Engl J Med*. 2010;363(19):1833–1845.
5. Oreopoulos DG, Thodis E, Passadakis P, Vargemezis V. Home dialysis as a first option: a new paradigm. *Int Urol Nephrol*. 2009;41(3):595–605.
6. Rubin HR, Fink NE, Plantinga LC, Sadler JH, Kliger AS, Powe NR. Patient ratings of dialysis care with peritoneal dialysis vs haemodialysis. *JAMA*. 2004;291(6):697–703.
7. Chertow GM, Levin NW, Beck GJ, Daugirdas JT, Eggers PW, Kliger AS, et al. In-center haemodialysis six times per week versus three times per week. *N Engl J Med*. 2010;363(24):2287–2300.
8. Tennankore KK, Na Y, Wald R, Chan CT, Perl J. Short daily-, nocturnal-, and conventional-home haemodialysis have similar patient and treatment survival. *Kidney Int*. 2018;93(1):188–194.
9. Marshall MR, Byrne BG, Kerr PG, McDonald SP. Associations of haemodialysis dose and session length with mortality risk in Australian and New Zealand patients. *Kidney Int*. 2016;90(4):914–922.
10. European Renal Association (ERA). ERA Registry Annual Report 2022. Amsterdam: European Renal Association; 2022.
11. Abra GE, Weinhandl ED, Hussein WF. Setting up home dialysis programmes: now and in the future. *Clin J Am Soc Nephrol*. 2023;18(11):1490–1496.
12. European Dialysis and Transplant Nurses Association. Guidelines for home haemodialysis training and safety. EDTNA/ERCA; 2021.
13. Kidney Disease: Improving Global Outcomes (KDIGO). Clinical practice guideline for dialysis adequacy. *Kidney Int Suppl*. 2020;10(1):1–115.
14. Jacquet S, Trinh E. The potential burden of home dialysis on patients and caregivers: a narrative review. *Can J Kidney Health Dis*. 2019;6:2054358119893335.
15. Kuroda S, Yabe H, Nagata A, Imoto C, Oida M, Kadoshima Y, et al. Medical and nursing interventions influence a caregiver's willingness to continue home haemodialysis: a multicentre cross-sectional survey. *Ren Replace Ther*. 2024;10(1):37.
16. Murray MA, Brunier G, Chung JO, Craig LA, Mills C, Thomas A, et al. A systematic review of factors influencing decision-making in adults living with chronic kidney disease. *Patient Educ Couns*. 2009;76(2):149–158.

17. International Organization for Standardization. ISO 23500-3:2024. Preparation and quality management of fluids for haemodialysis and related therapies. Geneva: ISO; 2024.
18. Centers for Disease Control and Prevention. Dialysis safety: preventing infections in dialysis settings. Atlanta: CDC; 2022.
19. European Committee for Standardization. EN ISO 23500-3:2024. Water quality for haemodialysis and related therapies. Brussels: CEN; 2024.
20. European Renal Association. Home haemodialysis: position statement. *Nephrol Dial Transplant*. 2020;35(6):1–8.
21. International Society for Hemodialysis. ISH guidelines for haemodialysis. *Hemodial Int*. 2019;23(S1):S1–S105.
22. National Institute for Health and Care Excellence. Renal replacement therapy and conservative management. NICE guideline NG107. London: NICE; 2018.
23. Direção-Geral da Saúde. Normas de controlo de infeção em unidades de diálise. Lisboa: DGS; 2019.
24. Grajales-García DP, Lara-Prado JI, Feria-Ramírez JA, Pazos-Pérez F, Mendez-Landa CE, Lopez Cabrera Y, et al. Caregiver burnout and risk of complications in home dialysis. In: *Peritoneal Dialysis in the Modern Era*. London: IntechOpen; 2024.

Chapter 3 (part 1)

Prescription of Home Haemodialysis

Learning objectives

- To identify appropriate candidates for HHD based on clinical, psychosocial, and environmental factors
- To describe structured training programmes and competencies required for safe and effective HHD
- To define eligibility criteria and specific clinical indications where HHD provides added benefit

Introduction

HHD is increasingly recognised as an effective and patient-centred renal replacement therapy for people with CKD. Technological advances improved clinical outcomes, and policy support have contributed to renewed interest in HHD programmes.¹

Compared with conventional in-centre haemodialysis, HHD offers greater flexibility, improved haemodynamic stability, and enhanced quality of life.^{2,3,4} European registry data demonstrate that although HHD utilisation has increased, overall uptake remains low, representing approximately 5–6% of kidney replacement therapy prevalence.⁵ However, successful implementation depends critically on the appropriate selection of people with ESKD, as well as robust education and training frameworks.

This chapter explores key principles of patient selection, training strategies, eligibility criteria, and specific indications for HHD, with a focus on European clinical practice and multidisciplinary nursing care.

Patient Selection for Home Haemodialysis

General Principles

Most patients in the pre-dialysis stage are medically eligible for HHD, and selection should be based on shared decision-making that incorporates patient preferences, quality of life, personal goals,

clinical characteristics, family support, and the home environment.⁶ Selection for HHD should be individualized and based on a comprehensive assessment of medical, functional, cognitive, and psychosocial factors.^{7,8} Historically, HHD was limited to highly motivated individuals; however, contemporary practice supports a more inclusive approach, recognizing that many barriers are modifiable through education, structured training, and targeted support strategies.¹

A 2025 systematic review identified key elements associated with successful HHD implementation:

- **Home environment adequacy** – physical space and availability of appropriate electrical and plumbing infrastructure
- **Self-care ability** – the patient's capacity to perform dialysis-related procedures
- **Social support** – availability of a caregiver or care partner
- **Patient capability** – cognitive function, manual dexterity, and motivation⁹

The optimal approach involves a multidisciplinary evaluation including a nephrologist, social worker, and dialysis nurse.¹⁰

Clinical Criteria

There are few absolute medical contraindications to HHD. Suitable candidates typically include individuals with:

- **Stable cardiovascular status**

Although cardiovascular stability is desirable, patients with established cardiovascular disease (including heart failure) may benefit from HHD. HHD avoids cycles of hypervolaemia and rapid ultrafiltration that contribute to myocardial stunning, even in the absence of overt hypotension. Studies demonstrate that HHD is associated with a lower risk of hospitalization for heart failure and improvement in left ventricular ejection fraction in patients with left ventricular dysfunction.^{11,12}

- **Reliable vascular access (arteriovenous fistula or graft preferred)**

The arteriovenous fistula is generally the preferred access for HHD because of superior long-term patency and lower infection risk.^{13,14} AVGs are acceptable but may limit the feasibility of buttonhole cannulation. Tunnelled central venous catheters may be used temporarily during maturation of the permanent vascular access - however, they are associated with a higher risk of infection, thrombotic and veno-occlusive complications, and catheter displacement, and should therefore be avoided as a long-term access whenever possible.

- **Suitability for more frequent or longer dialysis sessions**

In general, more frequent and/or longer dialysis sessions are associated with better haemodynamic tolerance due to lower ultrafiltration rates and smoother fluid and solute removal. However, the potential benefits of more intensive dialysis schedules should be balanced with individual patient preferences, lifestyle, and overall clinical context. Intensive regimens (short daily or long nocturnal schedules) provide significant cardiovascular benefits, including reduction in left ventricular mass, improved blood pressure control, and lower ultrafiltration rates, thereby reducing episodes of intradialytic hypotension.^{11,15,16}

- **Absence of uncontrolled psychiatric illness or severe cognitive impairment**

Controlled psychiatric disease is not a contraindication to HHD. Depression and anxiety are common among patients with kidney failure receiving dialysis (with a reported prevalence of 22.8–39.3% for depression) but can be effectively treated with selective serotonin reuptake inhibitors and cognitive behavioural therapy.¹⁷ An observational study demonstrated that adaptive coping strategies are significantly associated with longer technique survival in home dialysis (explaining 16% of the variance in duration of home therapy), suggesting that psychological interventions may facilitate successful

treatment maintenance.¹⁸ Patients with mild-to-moderate cognitive impairment may perform HHD with adequate caregiver support; in contrast, severe cognitive impairment, advanced dementia, or uncontrolled psychiatric disease that compromises treatment safety represent absolute contraindications, particularly for independent HHD.^{19,20} Relative contraindications to HHD may include:

- **Advanced frailty with functional dependence**

Frailty is common among patients with chronic kidney disease and is associated with poorer quality of life, as well as increased risks of hospitalization and mortality.²¹ However, frailty is not an absolute contraindication to HHD. Older and frail patients may benefit from HHD when adequate caregiver support is available. It is essential to define individualized treatment goals aligned with each patient's priorities and overall care objectives. A matched cohort study published in 2021 demonstrated comparable or improved survival with HHD compared with in-centre haemodialysis, even among older patients with a greater comorbidity burden.²²

- **Unstable angina or severe arrhythmias**

Unstable angina and uncontrolled severe arrhythmias represent relative contraindications that require clinical stabilization before initiation of HHD. However, following stabilization, these patients may benefit from HHD because of reduced haemodynamic fluctuations compared with conventional in-centre haemodialysis.^{11,12}

- **Frequent intradialytic complications**

Frequent intradialytic complications—particularly intradialytic hypotension—may initially limit eligibility for HHD, especially during the training phase, when clinical stability is essential to ensure patient safety and treatment autonomy. However, after clinical stabilization and completion of the training process, HHD may become an effective strategy to reduce the occurrence of intradialytic hypotension rather than representing a contraindication to its use.

Intradialytic hypotension occurs in up to 30% of conventional in-centre haemodialysis sessions and is associated with myocardial injury and the development of transient regional wall motion abnormalities. Longer HHD sessions (>4 hours), particularly when performed more frequently during the week, allow lower ultrafiltration rates and smaller reductions in systolic blood pressure and are associated with a lower incidence of dialysis-induced regional wall motion abnormalities.²³ More importantly, eligibility criteria should remain flexible and inclusive. Contemporary guidance supports offering home dialysis to all well-informed individuals without contraindications, with efforts focused on identifying and overcoming modifiable barriers.⁶

Psychosocial and Cognitive Factors

Successful implementation of HHD depends not only on clinical eligibility but also on the patient's or caregiver's active and sustained engagement in treatment. At this stage of the evaluation process, particular attention should be given to the patient's motivation, confidence, and willingness to assume an active role in therapy management.²⁴

Key aspects to consider include:

- willingness to participate actively in treatment-related procedures
- confidence in performing dialysis-related tasks independently (or with supervision when required)
- ability to integrate HHD into daily routines
- availability of a trained caregiver when necessary

Fear of self-cannulation, anxiety related to potential complications, and the perception of increased responsibility for treatment management represent some of the most frequently reported patient-related barriers to HHD implementation. These factors should be addressed proactively through structured therapeutic education programs, progressive supervised training, psychological support when indicated, and contact with patients already established in home dialysis programs.²⁵ It is also important to recognize that patient empowerment is a dynamic process that develops throughout the educational pathway and training period. With appropriate support, many patients who are initially hesitant progressively gain confidence and autonomy over time.¹

Home Environment Assessment

Environmental barriers to home haemodialysis (HHD) are common but are often modifiable with appropriate institutional support.¹ A structured home assessment is essential and should ideally include a home visit performed by a social worker or dialysis nurse, allowing direct evaluation of environmental conditions and identification of practical solutions to modifiable barriers.²⁶ The assessment should evaluate:

1. Adequate space for equipment and consumables

Lack of space has been identified as the second most commonly perceived barrier by patients and caregivers in a national survey conducted in the United States.²⁷ Space requirements vary significantly depending on the technology used:

- **Conventional HHD machines** – require dedicated space for equipment (dialysis machine and water treatment system), storage of consumables (dialyzers, bloodlines, and solutions), and a preparation workspace.
- **Modern portable systems (e.g., Physidia[®], NxStage System One[®])** – substantially more compact, with reduced storage requirements and no complex water treatment infrastructure, facilitating implementation in homes with space limitations.^{26,28}

Additionally, adequate consumables storage capacity is required, including space for approximately 1–2 weeks of supplies (dialyzers, bloodlines, needles, dressings, and solutions), stored in a clean, dry area protected from extreme temperatures.

2. Access to clean water, electricity, hygiene and infection control conditions

Reliable access to clean water and electricity is essential for safe HHD delivery and should be verified during the home assessment. Adequate hygiene conditions are critical to prevent infectious complication: specific training in aseptic technique, hand hygiene, vascular access care, and early recognition of signs of infection is essential to minimize risk of infection.⁴

3. Storage capacity and waste disposal logistics

Adequate storage capacity and appropriate waste disposal logistics should be ensured to support safe and sustainable long-term treatment at home.

Care Partner Considerations

While some systems allow independent HHD, many programmes require a trained care partner. This role includes:

- Assisting with cannulation and monitoring
- Supporting emergency management
- Sharing treatment responsibilities

Caregiver burden must be assessed carefully, as it can influence long-term technique sustainability.²⁹ Emerging models such as assisted HHD, where trained personnel provide support at home, may help overcome these barriers and expand access. Facilitators include education, peer support, assisted dialysis models, and telemedicine, all of which can improve uptake and sustainability.

Domain	Barriers	Potential Interventions
Patient-level	Fear, limited knowledge, perceived lack of safety	Structured education, peer support, simulation training
Environmental	Limited space, housing constraints, infrastructure issues	Home adaptation, technical support, portable systems
Care partner	Lack of caregiver, burden and burnout	Assisted HHD programmes, caregiver training and support
Healthcare system	Limited expertise, inadequate education programmes, poor access to support services	Staff training, development of HHD programmes, telemedicine and multidisciplinary care

Figure 1 - Barriers and Potential Interventions for HHD.

Training for Home Haemodialysis

Principles of training

Training is a cornerstone of safe HHD and should be structured, individualized, and competency based. The success of an HHD program depends largely on a robust patient safety framework and the risk tolerance - the degree of clinical risk the organization is willing and able to accept when determining patient eligibility - of the home dialysis program. Dialysis treatments require operators to perform dozens of steps repeatedly and reliably within a complex procedure - in HHD, these operators are the patients themselves or their caregivers, making attention to safety and risk mitigation essential.³⁰ There is no universal consensus across HHD programs regarding optimal training schedules or methods, and individual programs typically adopt approaches based on local experience. However, several evidence-based principles are consistently recognized.³¹

Factors influencing training duration include:

- **Prior self-care experience** – patients with previous self-care experience, particularly including self-cannulation, generally require shorter training periods
- **Comorbidity burden** – higher modified *Charlson Comorbidity Index* scores are associated with longer training duration
- **Age** – older patients may require additional training sessions

Training should be delivered by experienced renal nurses and supported by a multidisciplinary team.

Pre-training education

Pre-training education is essential to prepare both patients and caregivers for the learning process.^{4,5} During this phase, the following elements should be addressed:

- establishing realistic expectations regarding the training process and daily life with HHD
- assessing individual learning styles to personalize the educational approach
- identifying and addressing psychological barriers (e.g., fear of self-cannulation and anxiety)
- involving caregivers and family members in the educational process

Intensive supervised training

This represents the core phase of the training program, during which patients acquire the essential technical competencies required for independent treatment.²⁸ Training structure typically includes:

- **Duration** – typically 4–8 weeks (variable according to learning pace)
- **Frequency** – daily or near-daily sessions during the training period
- **Staffing ratio** – ideally 1:1 (nurse-to-patient)
- **Setting** – a dedicated training unit designed to simulate the home environment

Training should cover a structured set of procedural steps that must be performed repeatedly and reliably:

a) Equipment operation

- assembly and dismantling of the extracorporeal circuit
- dialysis machine programming
- system preparation and priming
- alarm management and troubleshooting
- equipment maintenance and cleaning

b) Self-cannulation of vascular access

Self-cannulation is frequently identified as one of the main barriers to HHD adoption. Required competencies include:

- pre-cannulation access assessment (inspection, auscultation, and palpation)
- cannulation techniques:
 - **rope ladder technique** – systematic rotation of cannulation sites
 - **buttonhole technique** – use of established subcutaneous tracts with blunt needles
- strict adherence to aseptic technique

- management of complications (e.g., infiltration, haematoma, bleeding)
- safe needle removal and achievement of haemostasis

Selection of cannulation technique should be individualized.^{32,33} The buttonhole technique may facilitate self-cannulation for some patients but is associated with an increased infection risk and requires specific training for tract creation and maintenance.

c) Emergency management

Emergency management training is critical because adverse events, although relatively infrequent, may have serious consequences, including significant morbidity, technique failure, or death.³⁴

Essential competencies include:

- needle or bloodline disconnection – recognition and immediate response
- air embolism – prevention, recognition, and management
- intradialytic hypotension – recognition, intervention, and prevention
- bleeding – control and indications for seeking urgent assistance
- equipment failure – troubleshooting and backup procedures
- basic cardiopulmonary resuscitation training for both patients and caregivers

d) Monitoring

- recording dialysis and vital parameters
- monitoring body weight and fluid balance
- recognizing warning signs requiring clinical attention
- maintaining effective communication with the clinical team

e) Non-technical skills

Non-technical competencies are equally important for successful independent dialysis and include problem-solving and decision-

making skills, development of self-efficacy and confidence, and stress and anxiety management. These skills are critical because fear and uncertainty represent major barriers to independent home dialysis.

Competency assessment should be standardized and documented. Ongoing reassessment is recommended to ensure long-term treatment safety.

Transition to home

The transition from the training environment to the home requires careful planning.²⁶ During this stage, several key elements must be ensured:

- installation and testing of dialysis equipment in the home environment
- verification of infrastructure requirements (water supply, electricity, and drainage)
- organization of consumables storage
- establishment of a reliable supply delivery system
- confirmation of emergency contacts and availability of 24-hour support

The first treatments performed at home require intensified support during the early transition period.³⁵ This support can be optimized through several key components:

- **home visits by the HHD nurse** – direct observation of the first home treatments
- **frequent telephone contact** – daily or near-daily follow-up during the initial phase
- **24-hour availability** – access to a support line for clinical questions and emergencies
- **remote telemonitoring, when available** – telemedicine and remote monitoring have become central components of modern HHD programs, improving safety, reducing patient isolation, and enhancing confidence in treatment delivery.^{1,3}

Ongoing support

Training does not end at initiation. Continuous support includes:

- Regular follow-up (in-person or via telehealth)
- Remote monitoring of treatment data
- Access to 24-hour technical and clinical support

Role of the renal nurse

Renal nurses play a central role in HHD programmes which includes:

- Patient assessment and selection
- Delivery of education and training
- Competency evaluation
- Ongoing clinical and psychosocial support
- Coordination of multidisciplinary care

Shortage of experienced staff is a recognised barrier to HHD expansion, reinforcing the importance of specialised nursing training and workforce development.

Specific Indications for Home Haemodialysis

HHD may be particularly advantageous in specific clinical scenarios:

1. Cardiovascular Disease

More frequent or prolonged dialysis improves:

- Blood pressure control
- Left ventricular hypertrophy
- Volume management

These benefits are especially relevant for people with resistant hypertension or heart failure.^{1,8}

2. Poor Tolerance to Conventional Haemodialysis

Individuals experiencing:

- Intradialytic hypotension
- Post-dialysis fatigue
- Long recovery times

may benefit from shorter and more frequent HHD sessions.¹

3. Younger and Working Individuals

HHD provides:

- Flexible scheduling
- Greater independence
- Improved ability to maintain employment or education

4. Preference for Nocturnal Dialysis

Some individuals may particularly benefit from or prefer nocturnal HHD schedules, which allow longer treatment times with lower ultrafiltration rates, improved haemodynamic tolerance, greater daytime freedom, and potentially better dialysis adequacy and quality of life. This option may be especially attractive for active or working patients seeking greater flexibility and a treatment schedule better integrated into daily life.

5. Pregnancy or Preconception Planning

Intensive dialysis regimens, often feasible at home, are associated with improved maternal and foetal outcomes.

6. Remote or Rural Residence

HHD reduces travel burden and improves access to care for people living far from dialysis centres.

7. Preference for Autonomy and Quality of Life

Patient preference remains a central indication. Shared decision-making is essential, and individuals should be offered HHD as a standard option.

Conclusion

HHD represents a safe, effective, and increasingly accessible modality for people with ESKD. Appropriate patient selection requires a holistic assessment encompassing clinical, psychosocial, and environmental domains.

Structured, nurse-led training programmes are essential to ensure competence, safety, and long-term success. Importantly, eligibility criteria should be flexible and inclusive, with a focus on overcoming modifiable barriers.

HHD is particularly beneficial in individuals requiring intensive dialysis, those with cardiovascular instability, and those seeking greater autonomy. Expanding access to HHD in Europe will depend on improved education, workforce development, policy support, and integration of telemedicine, alongside a continued shift towards person-centred care.

References

1. Yeung K, Chan CT. It's time for home hemodialysis to be treated as an established dialysis modality—A call to action! *Nephrol Self Assess Program*. 2026;24(5):285–288. doi: 10.58483/nsap.00322025.
2. Chan CT, Blankestijn PJ, Dember LM, Gallieni M, Harris DCH, Lok CE, et al. Dialysis initiation, modality choice, access, and prescription: conclusions from a Kidney Disease: Improving Global Outcomes (KDIGO) Controversies Conference. *Kidney Int*. 2019;96(1):37–47. doi: 10.1016/j.kint.2019.01.017.
3. Rivara MB, Mehrotra R. Home dialysis. *N Engl J Med*. 2020;383(10):999–1008.
4. Walker RC, Howard K, Morton RL. Home hemodialysis: a comprehensive review of patient-centered and economic considerations. *Clinicoecon Outcomes Res*. 2017;9:149–161. doi: 10.2147/CEOR.S69340.
5. Slon-Roblero MF, Stel VS, Sanchez-Alvarez E, et al. Trends in home dialysis over the last decade in Europe: an ERA Registry study. *Nephrol Dial Transplant*. 2026;41(3):457–475. doi: 10.1093/ndt/gfaf171.
6. Perl J, Brown EA, Chan CT, Couchoud C, Davies SJ, Kazancioğlu R, et al. Home dialysis: conclusions from a Kidney Disease: Improving Outcomes (KDIGO) Controversies Conference. *Kidney Int*. 2023;103(5):842–858. doi: 10.1016/j.kint.2023.01.006.
7. Mendu ML, Divino-Filho JC, Vanholder R, Mitra S, Davies SJ, Jha V, et al. Expanding utilization of home dialysis: an action agenda from the First International Home Dialysis Roundtable. *Kidney Med*. 2021;3(4):635–643. doi: 10.1016/j.xkme.2021.04.004.
8. Brown EA, Jha V; Steering Committee. Introducing the International Home Dialysis Consortium. *Kidney Int Rep*. 2023;8(7):1277–1280. doi: 10.1016/j.ekir.2023.04.019.
9. Ting R, Borkum M, Ni LT, Levin A. Patient screening and assessment for home dialysis therapies: a scoping review. *Perit Dial Int*. 2025;45(1):7–16. doi: 10.1177/08968608241266130.
10. Bonenkamp AA, Reijnders TDY, van Eck van der Sluijs A, Hagen EC, Abrahams AC, van Ittersum FJ, et al. Key elements in selection of pre-dialysis patients for home dialysis. *Perit Dial Int*. 2021;41(5):494–501. doi: 10.1177/08968608211023263.
11. Sarnak MJ, Auguste BL, Brown E, Chang AR, Chertow GM, Hannan M, et al. Cardiovascular effects of home dialysis therapies: a scientific statement from the American Heart Association. *Circulation*. 2022;146(11):e146–e164. doi: 10.1161/CIR.0000000000001088.
12. Reaves AC, Weiner DE, Sarnak MJ. Home dialysis in patients with cardiovascular diseases. *Clin J Am Soc Nephrol*. 2024;19(12):1646–1655. doi: 10.2215/CJN.0000000000000410.
13. Chan RJ, Chan CT. Vascular access considerations in home hemodialysis. *Clin J Am Soc Nephrol*. 2024;19(8):1036–1044. doi: 10.2215/CJN.0000000000000499.

14. Lok CE, Huber TS, Lee T, Shenoy S, Yevzlin AS, Abreo K, et al. KDOQI clinical practice guideline for vascular access: 2019 update. *Am J Kidney Dis.* 2020;75(4 Suppl 2):S1–S164. doi: 10.1053/j.ajkd.2019.12.001.
15. Cheetham MS, Ethier I, Krishnasamy R, Cho Y, Palmer SC, Johnson DW, et al. Home versus in-centre haemodialysis for people with kidney failure. *Cochrane Database Syst Rev.* 2024;4(4):CD009535. doi: 10.1002/14651858.CD009535.pub3.
16. Ok E, Demirci C, Asci G, Yuksel K, Kircelli F, Koc SK, et al. Patient survival with extended home hemodialysis compared to in-center conventional hemodialysis. *Kidney Int Rep.* 2023;8(12):2603–2615. doi: 10.1016/j.ekir.2023.09.007.
17. Knehtl M, Petreski T, Piko N, Ekart R, Bevc S. Polypharmacy and mental health issues in the senior hemodialysis patient. *Front Psychiatry.* 2022;13:882860. doi: 10.3389/fpsy.2022.882860.
18. Nearhos J, Van Eps C, Connor J. Psychological factors associated with successful outcomes in home haemodialysis. *Nephrology.* 2013;18(7):505–509. doi: 10.1111/nep.12089.
19. Wu HHL, Dhaygude AP, Mitra S, Tennankore KK. Home dialysis in older adults: challenges and solutions. *Clin Kidney J.* 2023;16(3):422–431. doi: 10.1093/ckj/sfac220.
20. Saeed F, Jawed A, Gazaway S, Hall RK, Klein-Fedyshin M, Bowling B, et al. Supporting shared decision-making in life-altering kidney therapy decisions for older adults: a review. *JAMA Intern Med.* 2025;185(12):1479–1488. doi: 10.1001/jamainternmed.2025.5554.
21. Chan GCK, Kalantar-Zadeh K, Ng JK, Tian N, Burns A, Chow KM, et al. Frailty in patients on dialysis. *Kidney Int.* 2024;106(1):35–49. doi: 10.1016/j.kint.2024.02.026.
22. Yeung EK, Polkinghorne KR, Kerr PG. Home and facility haemodialysis patients: a comparison of outcomes in a matched cohort. *Nephrol Dial Transplant.* 2021;36(6):1070–1077. doi: 10.1093/ndt/gfaa358.
23. Lai AC, Bienstock SW, Sharma R, Skorecki K, Beerkens F, Samtani R, et al. A personalized approach to chronic kidney disease and cardiovascular disease: JACC review topic of the week. *J Am Coll Cardiol.* 2021;77(11):1470–1479. doi: 10.1016/j.jacc.2021.01.028.
24. Walker RC, Hanson CS, Palmer SC, Howard K, Morton RL, Marshall MR, et al. Patient and caregiver perspectives on home haemodialysis: a systematic review. *Am J Kidney Dis.* 2015;65(3):451–463. doi: 10.1053/j.ajkd.2014.10.020.
25. Helali BAN, Eliwa SM, Nosir FAAES, Adam Mohamed SS. Impact of a psychoeducational nursing program on self-efficacy and psychological adjustment in hemodialysis patients. *Sci Rep.* 2025;15(1):19568. doi: 10.1038/s41598-025-04052-x.
26. Gupta N. Strategic planning for starting or expanding a home haemodialysis program. *Adv Chronic Kidney Dis.* 2021;28(2):143–148. doi: 10.1053/j.ackd.2021.02.005.

27. Reddy YNV, Kearney MD, Ward M, Burke RE, O'Hare AM, Reese PP, et al. Identifying major barriers to home dialysis (the IM-HOME study): findings from a national survey of patients, care partners, and providers. *Am J Kidney Dis.* 2024;84(5):567–581.e1. doi: 10.1053/j.ajkd.2024.04.007.
28. Bieber SD, Young BA. Home haemodialysis: core curriculum 2021. *Am J Kidney Dis.* 2021;78(6):876–885. doi: 10.1053/j.ajkd.2021.01.025.
29. Jacquet S, Trinh E. The potential burden of home dialysis on patients and caregivers: a narrative review. *Can J Kidney Health Dis.* 2019;6:2054358119893335. doi: 10.1177/2054358119893335.
30. Thomas N, editor. *Renal Nursing: Care and Management of People with Kidney Disease.* 5th ed. London: Wiley Blackwell; 2019.
31. Platnich JM, Pauly RP. Patient training and patient safety in home haemodialysis. *Clin J Am Soc Nephrol.* 2024;19(8):1045–1050. doi: 10.2215/CJN.0000000000000416.
32. Bermudez MC, El Shamy O. Self-cannulation for home haemodialysis: a review of current practices and implementation approaches. *Curr Opin Nephrol Hypertens.* 2025 Oct 15. doi: 10.1097/MNH.0000000000001121.
33. Agarwal AK, Boubes K, Haddad NF. Essentials of vascular access for home haemodialysis. *Adv Chronic Kidney Dis.* 2021;28(2):164–169. doi: 10.1053/j.ackd.2021.06.008.
34. Chan DT, Faratro R, Chan CT. The impact of simulation-based teaching on home haemodialysis patient training. *Clin Kidney J.* 2015;8(5):594–598. doi: 10.1093/ckj/sfv067.
35. More KM, Tennankore K. Quality assurance and preventing serious adverse events in the home haemodialysis setting. *Adv Chronic Kidney Dis.* 2021;28(2):170–177. doi: 10.1053/j.ackd.2021.02.007.

Chapter 3 (part 2)

Prescription of Home Haemodialysis

Learning objectives:

- To understand the principles guiding the prescription of HHD
- To identify the key parameters that can be individualised when prescribing HHD
- To recognise specific clinical situations in which intensive HHD may be particularly beneficial

Introduction

Since the introduction of dialysis as a KRT, defining the optimal dialysis dose has been a key objective in reducing morbidity and mortality. Traditionally, dialysis adequacy has been assessed using urea kinetics, with urea clearance as the main surrogate marker of treatment efficacy. However, this approach has important limitations, and it is now widely recognised that adequacy cannot be fully explained by urea clearance alone.¹⁻³

A broader perspective has emerged, incorporating not only solute removal but also volume management, preservation of RKF, cardiovascular protection, and quality of life. This shift has been reinforced by the KDIGO Controversies conference held in 2018,³ which promotes a more patient-centred approach to defining dialysis adequacy. Recognising that “adequacy” may be perceived differently by clinicians and people living with kidney disease, current practice emphasises shared decision-making. This approach—often referred to as goal-directed dialysis—involves individualising treatment goals and dynamically reassessing them over time according to both clinical evolution and patient priorities.³

This paradigm is particularly well suited to HHD, where the inherent flexibility to adjust treatment frequency, duration, and timing enables dialysis to be tailored to the individual's life, instead of requiring the individual to adapt to the treatment.⁴

This chapter outlines the key principles of HHD prescription, with the aim of optimising clinical outcomes while maximising patient autonomy and quality of life.

A. Prescribing Home Haemodialysis

The concept of an “optimal” HD regimen remains challenging to define, and a single prescription is unlikely to be appropriate for all individuals. Instead, HD should be individualised, moving away from a “one-size-fits-all” approach towards a personalised and dynamic model of care that integrates patient goals and preferences while maintaining standards of quality and safety.^{2,3}

HD prescription should consider clinical status, RKF, comorbidities, and individual preferences, while allowing adjustment of key parameters such as frequency, duration, blood and dialysate flow rates, dialyser characteristics, and dialysate composition. Although these variables can be modified in in-centre HD, HHD offers substantially greater flexibility, enabling closer alignment with both clinical needs and lifestyle considerations.^{5,6}

There is no standardised HHD prescription. While thrice-weekly HD remains the most common regimen in dialysis centres, largely due to logistical constraints, HHD supports more frequent and/or longer schedules. Increased treatment frequency is a key component, associated with improved phosphate control, better blood pressure and volume management, regression of left ventricular hypertrophy, enhanced haemodynamic tolerance, and improved patient-reported outcomes, including recovery time and quality of life.⁷⁻¹¹ Survival with long nocturnal HD may approach that of deceased-donor kidney transplantation.¹²⁻¹⁴

A major advantage of HHD is the ability to avoid prolonged interdialytic intervals, particularly the 72-hour “weekend gap” (Figure 1), which is associated with increased cardiovascular risk.^{15,16} Regimens of at least four sessions per week or alternate-day schedules are therefore recommended when feasible.

However, treatment intensification requires careful monitoring and must be balanced against potential risks, including vascular access complications, hypophosphataemia, possible loss of RKF, and caregiver burden.¹⁷⁻¹⁹ Consequently, it should be approached as a highly individualised strategy, ensuring that potential clinical benefits are carefully weighed against the patient’s specific circumstances and aligned with their life goals.¹⁵

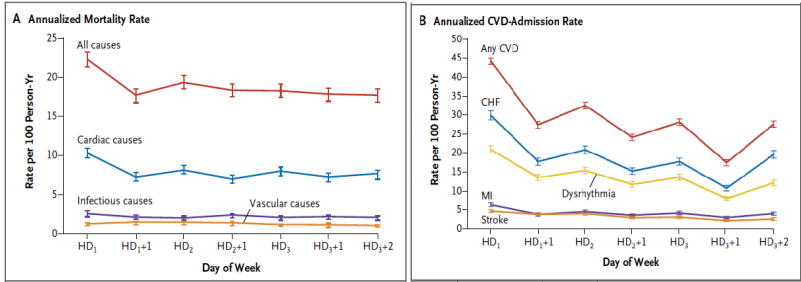


Figure 1: Annual rates of mortality (A) and hospital admissions (B) due to cardiovascular causes according to the different days of the week for dialysis.

Finally, technological advances have further facilitated HHD through the development of compact, user-friendly, and often portable systems. When solute clearance is evaluated using Kt/V, stdKt/V should be used to reflect cumulative weekly clearance, rather than relying on single-session metrics such as spKt/V (Figure 2)²⁰. However, it is important to recognise that dialysis adequacy is a broader concept and should not be defined solely by Kt/V, as previously discussed.

Overall, HHD represents a flexible, individualised approach in which adequacy is a dynamic process that evolves with clinical status and patient priorities. Accordingly, continuous reassessment and adaptation of the prescription are essential to ensure high-quality care.

Volume cleared (spKt/V) by treatment frequency²⁰

Example for spKt/V of 2.3

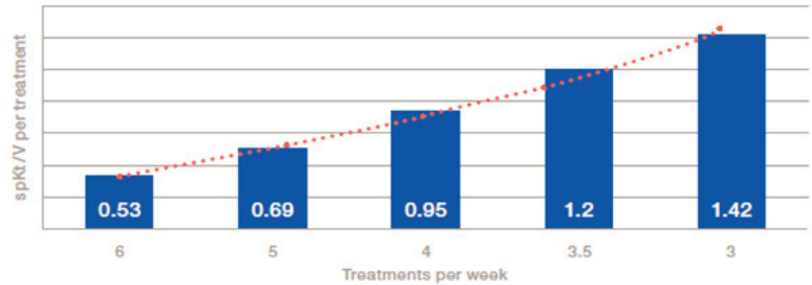


Figure 2: The figure above represents the volume cleared per treatment to achieve a standardized stdKt/V of 2.3. Note that standardized Kt/V is not a linear function of single pool Kt/V.²¹

Different options regarding available prescriptions for HHD

Modality	Sessions per week	Session duration (h)	QB (mL/min)	QD (mL/min)(L/session)	Base (mmol/L)	K+ (mmol/L)	Ca2+ (mmol/L)	PO4 added
Traditional Conventional	3	3–5	300–400	500–800	HCO ₃ , 28–35	2	1.25	None
Traditional short daily	5–6	2.5–3.5	350–400	350–500	HCO ₃ , 28–35	2	1.25	None
Traditional nocturnal	4–6	6–8	250–300	300	HCO ₃ , 28–35	3	1.5–1.75	20–30% of time
Alternate-night nocturnal	3.5	6–8	250–300	300–500	HCO ₃ , 28–35	2	1.25	Rare
Low-flow dialysate short daily	5–7	2–3.5	300–400	20–30 L per session	Lactate, 40–45 or HCO ₃ 35	1–2	1.5	None
Low-flow dialysate nocturnal	4–6	6–8	200–300	30–60 L per session	Lactate, 40–45	2	1.5	None
Low-flow Alternate-night nocturnal	3.5	6–8	200–300	30–60 L per session	Lactate, 40–45	2	1.5	Rare

Table 1: Adapted from: Lockridge R, Cornelis T, Van Eps C. Prescriptions for HHD. *Hemodial Int.* 2015;19 Suppl 1:S112–27.²²

B. Home Haemodialysis prescription according to the available device

Most HD devices can be used in the home setting; however, dedicated HHD systems have been developed to simplify treatment delivery. These devices are typically smaller, portable, and often operate with low dialysate flow rates, facilitating their use outside the hospital environment.²³

Traditional HD monitors, by contrast, require fixed water treatment systems and, when used at home, necessitate reverse osmosis installation. While prescription principles remain similar to in-centre HD, the home setting allows greater flexibility to increase treatment frequency and/or duration and to avoid prolonged interdialytic intervals.

The growing availability of low-flow dialysis systems represents a major development in HHD. These systems differ from conventional monitors in dialysate flow, solute clearance, and treatment metrics, requiring adapted prescription strategies. Currently, the main low-flow systems include NxStage and Physidia S3.

Given their relatively recent introduction, this chapter includes a dedicated section outlining their characteristics and providing practical guidance for their appropriate prescription, which is essential to ensure adequate dialysis delivery and optimal patient outcomes.

1. Prescribing HHD with the Physidia S3 System

The Physidia S3 is a HHD monitor developed in France and has been available in Europe since 2013. It is specifically designed for home use, combining ease of operation with prescription safety through an RFID prescription card. The system also integrates Bluetooth-enabled blood pressure monitoring and advanced connectivity, enabling automatic capture and transmission of treatment and haemodynamic data. Through a secure digital platform (with an approximate 5-minute delay), clinicians can remotely supervise sessions, review automated reports, and maintain continuous clinical oversight, enhancing patient safety, reducing the need for in-person visits, and facilitating communication between the patient and the healthcare team.

The Physidia S3 allows a high degree of prescription flexibility, including adjustment of treatment duration, frequency, buffer composition (bicarbonate or lactate), and dialyser selection, as it is not limited by fixed cartridges.

A distinctive feature of the system is self-convective HD (SeCoHD®), which combines diffusive and convective solute transport without the need for external substitution fluid or a conventional water treatment system. This is achieved through the PhysiFlow® cassette, using a pneumatic push–pull mechanism to generate dialysate flow and precisely control fluid balance. This approach enhances the clearance of middle- and large-molecular-weight toxins, reduces uraemic symptoms, and minimises haemoconcentration, thereby lowering coagulation risk. In addition, dynamic ultrafiltration control adapts to changes in venous pressure, improving treatment safety and precision.

As mentioned before, treatment delivery is governed by the programmed RFID card, ensuring adherence to the prescribed regimen. Although this limits real-time patient adjustments, flexibility can be maintained by providing multiple prescription cards tailored to different treatment scenarios.

Overall, the Physidia S3 represents an advanced and adaptable HHD platform that combines prescription flexibility, safety, and remote clinical oversight.



Figure 3: Physidia S3 Monitor. © 2026 Physidia - Tous droits réservés. Used with permission.

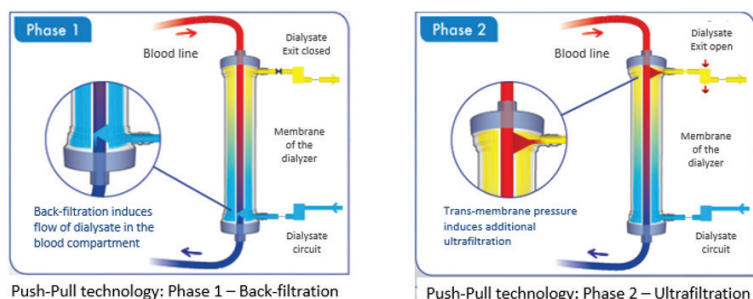


Figure 4: Convective transfer of molecules via the Self-Convective HemoDialysis (SeCoHD®) system, which consists of HD with controlled internal convection.

1.1 Characteristics of the dialysate with the Physidia S3 system

The system operates using sterile, pre-prepared, ready-to-use 5-L dialysis fluid bags, eliminating the need for on-site fluid production. It allows the use of two types of buffer solutions, selected according to patient-specific needs: lactate-based solutions in single-compartment bags or bicarbonate-based solutions in double-compartment bags.

a. Lactate

For lactate-buffered dialysis, several formulations are available, with the most commonly used containing 1.5 mmol/L of potassium (STL1550E) (Table 3).



Figure 5. Lactate bag.

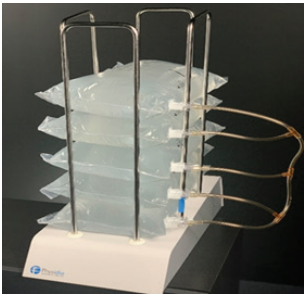


Figure 6. Lactate support.

REF	Lactate (mmol/l)	Na+ (mmol/l)	K+ (mmol/l)	Ca2+ (mmol/l)	Mg2+ (mmol/l)	Cl- (mmol/l)	Glucose (mmol/l)
STL1550E	40	140	1,5	1,5	0,5	105,5	5,55

Table 3. Composition of dialysis fluid using lactate as the buffer.

b. Bicarbonate

For bicarbonate-buffered dialysis, double-compartment bags are used, allowing the preparation of fresh bicarbonate-based dialysate at the time of treatment. Different formulations are available, typically with potassium concentrations of 1.0 or 1.5 mmol/L (Table 4).



Figure 7. Bicarbonate bag.

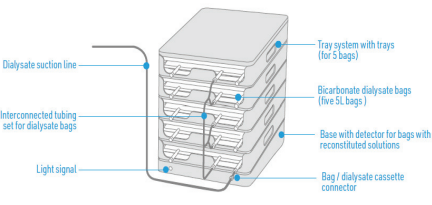


Figure 8. Bicarbonate trays.

	HCO3- (mmol/l)	Na+ (mmol/l)	K+ (mmol/l)	Ca2+ (mmol/l)	Mg2+ (mmol/l)	Cl- (mmol/l)	Glucose (mmol/l)	Osmolarity (mosmol/l)
HMB35/1,5	35	140	1,5	1,5	0,5	110,5	5,55	294,6

Table 4. Composition of dialysis fluid using bicarbonate as buffer (1,5 mmol/l K and 1 mmol/l K).

1.2 Prescription parameters for the Physidia S3 system

Overall, the Physidia S3 system is a HHD platform designed to facilitate safe, flexible, and efficient dialysis in the home setting. Its use of pre-prepared sterile dialysate bags eliminates the need for a water treatment system, simplifying logistics and improving accessibility. Prescription is individualized through an RFID card, ensuring accurate and reproducible delivery of therapy. In Table 5 we summarize some key principles when prescribing HHD with this device.

Parameter	Recommendation	Clinical rationale
Treatment frequency	5–7 sessions/week Avoid ≥2 consecutive days without dialysis	Reduces interdialytic weight gain and uraemic toxin fluctuations; improves haemodynamic stability, LVH regression, survival, and hospitalisation rates
Session duration	2–3 hours/session	Optimal balance between solute clearance and lifestyle; diminishing returns beyond early phase; allows safer ultrafiltration
Blood flow (QB)	250–350 mL/min	Limited impact on small-solute clearance in low-flow systems; ≥250 mL/min improves fibre rheology and reduces clotting risk
Dialysate flow (QD)	150–200 mL/min	Low-flow design reduces fluid requirements; adequate stdKt/V (>2.1) achievable depending on frequency
Dialysate temperature	35–36°C	Improves haemodynamic stability and reduces intradialytic hypotension
Ultrafiltration rate (UFR)	<7–10 mL/kg/h	Minimises myocardial stunning and cardiovascular risk
Convection (reinjection volume)	0–3 L/h (as tolerated)	Enhances middle- and large-molecule clearance via SeCoHD®

Parameter	Recommendation	Clinical rationale
Bolus	150–200 mL 2–5 per session Safety interval: 1–5 min	Used for hypotension management or circuit washing; rapid repetition possible in acute events
Priming volume	600–2000 mL (standard ~1200 mL)	Depends on dialyzer/lines; fluid discarded to waste to ensure circuit quality
Heparin	Prefer no heparin in short daily HDD If needed: initial low molecular weight heparin (LMWH) dose	Minimises bleeding risk while maintaining circuit patency
Dialyzer type	Any compatible dialyzer	System allows flexible dialyzer selection according to patient needs
Dialysis fluid type	Bicarbonate or lactate Adjust K ⁺ concentration individually	Allows personalization of electrolyte and buffer composition (Table 6).

Table 5. Summary key points regarding the prescription parameters for HDD with Physidia S3 System.

Available formulations

	Bicarbonate K1	Bicarbonate K1.5	Lactate K1.5
HCO₃⁻ / C₃H₆O₃⁻	35 mmol/L	35 mmol/L	40 mmol/L
Na⁺	140 mmol/L	140 mmol/L	140 mmol/L
K⁺	1 mmol/L	1.5 mmol/L	1.5 mmol/L
Ca₂⁺	1.5 mmol/L	1.5 mmol/L	1.5 mmol/L
Mg₂⁺	0.5 mmol/L	0.5 mmol/L	0.5 mmol/L
Cl⁻	110.5 mmol/L	105.5 mmol/L	110 mmol/L
Glucose	1 g/L	1 g/L	1 g/L
Osmolarity	294.6 mOsmol/L	294.6 mOsmol/L	294 mOsmol/L

Table 6. Composition of dialysis fluid with Physidia.

After establishing the prescription, a formal calculation of stdKt/V using validated tools is strongly recommended (Table 7) to ensure that the delivered dialysis dose meets adequacy targets for frequent HD regimens. This approach enables accurate assessment of cumulative weekly clearance, particularly in schedules that differ from conventional thrice-weekly HD. As discussed above, assessment should be multidimensional, integrating quantitative measures

such as stdKt/V with clinical evaluation (including volume control, haemodynamic stability, metabolic management, nutritional status, treatment tolerance, and quality of life) and ongoing monitoring, to ensure that dialysis is not only effective but also safe, well tolerated, and aligned with individual patient goals.

Estimated dialysis dose

Estimation of the dialysis dose based on treatment parameters

Patient				Treatment			Calculation		
Gender	Age	Weight (kg)	Height (cm)	Frequency (sessions/week)	Session Time (min)	Dialysate Flow (ml/min)	Session Kt/V	std Kt/V	Bags
M	60	80	175	6	120	180	0.50	2.40	5
M	60	80	175	5	150	180	0.63	2.38	6
M	60	80	175	5	180	150	0.65	2.44	6
M	60	80	175	6	180	150	0.65	2.94	6

Table 7. Example of tables for calculating the estimation of dialysis dose according to treatment parameters. This shows examples of the most commonly used prescriptions to individualize treatment, based on a clearance target according to standard Kt/V (StdKt/V).

2. HHD Prescription with the NxStage System One

The NxStage System One is a HHD platform developed in the USA and has been available in Europe since 2010. It is specifically designed for home use, requiring no fixed water treatment installation, and is more compact and user-friendly than conventional HD monitors.

The system allows two options for dialysate preparation: on-site generation using tap water processed through a dedicated filtration system and mixed with an acid concentrate, or the use of pre-prepared bags of ultrapure lactate-based dialysate. This flexibility facilitates its use across different home environments.

Prescription with the NxStage System One follows a structured, software-guided approach, supported by the proprietary “Dosing Calculator”, a tool developed by the manufacturer to guide system-specific prescription, which assists clinicians in individualising treatment parameters to achieve adequacy targets while accommodating patient-specific clinical characteristics and lifestyle needs.

2.1 Dosing Calculator Software

The NxStage Dosing Calculator (<https://dosingcalculator.nxstage.com>) is a proprietary tool specifically designed to support HHD prescription

using the NxStage System One. Based on validated algorithms and patient-specific inputs, it generates treatment options that achieve a predefined dialysis dose, facilitating the selection of regimens aligned with both clinical targets and patient lifestyle.

To generate these prescriptions, a set of individual patient parameters must be entered into the calculator (Table 9). These include total body water (estimated using the Watson formula or entered directly), target weekly standard Kt/V (stdKt/V), blood flow rate (QB), haematocrit, and weekly ultrafiltration volume. Additional parameters include maximum ultrafiltration rate, minimum treatment hours per week, and options to include or exclude thrice-weekly regimens. The calculator also allows adjustments such as rounding dialysate volumes to standard bag capacities and accounting for saline flushes within the ultrafiltration target.

Once all parameters have been entered, the calculator generates an “Options Table” (Table 8), which displays a range of treatment regimens that meet the prescribed adequacy target while respecting the defined clinical constraints. These options vary in terms of treatment frequency (sessions per week), session duration, and dialysate volume per session.

All regimens presented achieve the target stdKt/V and comply with the specified limits for ultrafiltration, treatment time, and frequency. This structured approach supports the selection of an appropriate dialysis schedule tailored to the patient’s clinical needs while allowing flexibility in treatment planning.

The availability of multiple equivalent regimens allows dialysis to be adapted to the patient’s and caregiver’s lifestyle without compromising adequacy targets. This flexibility represents a key advantage of the system, supporting a patient-centred approach in which treatment can be adjusted while consistently maintaining the prescribed dialysis dose.

The Dosing Calculator should be regarded as a supportive tool that facilitates prescription. However, it does not replace clinical judgement. The final prescription must always be determined by the treating physician, who is responsible for selecting the regimen that best aligns with the patient’s clinical condition, needs, and circumstances.

Treatment Option Results						
Treatment Options			Treatment Parameters			
Treatments/ Week	Duration (hr)	Volume (L)	Target stdKt/V	Single Pool Kt/V	DFR (L/hr)	DFR (ml/min)
7	2:30	20	2.5	0.51	8.0	133
7	2:10	25	2.5	0.52	11.5	192
6	5:00	20	2.5	0.55	4.0	67
6	2:30	25	2.5	0.62	10.0	167
5	5:50	25	2.5	0.69	4.3	71
5	3:20	30	2.5	0.75	9.0	150
2 on, 1 off	4:20	30	2.5	0.79	6.9	115
4	4:20	40	2.5	1.01	9.2	154
4	4:10	50	2.5	1.02	12.0	200
Every Other Day	5:00	50	2.5	1.24	10.0	167

Table 8: “Options Table” provided by the Dosing Calculator to guide different treatment regimens with the NxStage SystemOne (<https://dosingcalculator.nxstage.com>).

Information required to use the NxStage Dosing Calculator

Parameter	Input / Options	Description
Total Body Water	Watson formula or direct entry	Estimated via Watson equation (age, weight, height, sex; ≥18 years) or entered directly in litres
Target stdKt/V	User-defined	Defines desired weekly dialysis dose; determines treatment options generated
Blood flow (QB)	According to vascular access	Reflects achievable blood flow based on access characteristics
Haematocrit	Whole number (no %)	Current patient haematocrit value
Weekly UF volume	L/week	Total planned ultrafiltration over one week
Maximum UF rate	L/h	Sets upper safety limit for ultrafiltration rate
Minimum hours/week	User-defined	Minimum weekly dialysis time required
Allow 3 sessions/week	Yes / No	Includes or excludes thrice-weekly regimens

Parameter	Input / Options	Description
Round to nearest SAK	Yes / No	Rounds volumes (35,45,55 L → 40,50,60 L) to match standard bag capacities
Include saline wash in UF	Yes / No	Adds ~280 mL per session to UF target to account for saline flush

Table 9. Summary key points regarding the information required to use the NxStage Dosing Calculator.

2.2 Characteristics of the dialysate with the NxStage System One

A key feature of the NxStage System One is the flexibility in dialysate delivery, allowing the use of two main approaches: pre-prepared, ready-to-use dialysis fluid bags (5-L RFP bags) or on-site dialysate production using tap water processed through the PureFlow SL purification system (PAK), which is then mixed with an acid concentrate (SAK) to generate dialysis fluid.⁶

Both approaches offer different formulations in terms of potassium and lactate concentrations, enabling individualisation of dialysate composition according to patient-specific clinical needs. These options are available for both premixed dialysate (RFP) Table 10 and on-site generated dialysate (SAK) Table 11.



Premixed dialysate bag formulations

Constituents	RFP-204	RFP-205	RFP-207	RFP-209	RFP-211
Lactate	40 mmol/L	35 mmol/L	45 mmol/L	45 mmol/L	40 mmol/L
Potassium	1 mmol/L	3 mmol/L	1 mmol/L	2 mmol/L	2 mmol/L
Sodium			140 mmol/L		
Calcium	1.5 mmol/L	1.5 mmol/L	1.5 mmol/L	1.5 mmol/L	1.75 mmol/L
Magnesium			0.5 mmol/L		
Chloride	105 mmol/L	112 mmol/L	100 mmol/L	101 mmol/L	106.5 mmol/L
Glucose			1.1 g/L		
Osmolarity (calculated)	294 mOsmol/L	298 mOsmol/L	294 mOsmol/L	296 mOsmol/L	296 mOsmol/L

All RFP-2XX fluids are packaged in 5.0 litre bags and will typically have up to 1.5% overfill.

Table 10: Different options for premixed dialysate bags with the NxStage SystemOne. Not all concentrates are available in all countries.²¹

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Dialysate concentrates

The PureFlow SL System prepares batches of dialysate in the following formulations and volumes:

Constituents	SAK-301/401	SAK-302/402	SAK-303/403	SAK-304/404	SAK-305/405	SAK-306/406	SAK-307/407
Lactate	45 mmol/L	40 mmol/L	45 mmol/L	45 mmol/L	45 mmol/L	45 mmol/L	40 mmol/L
Potassium	1 mmol/L	1 mmol/L	1 mmol/L	2 mmol/L	1 mmol/L	2 mmol/L	1 mmol/L
Sodium				140 mmol/L			
Calcium	1.5 mmol/L	1.5 mmol/L	1.5 mmol/L	1.5 mmol/L	1.5 mmol/L	1.5 mmol/L	1.5 mmol/L
Magnesium				0.5 mmol/L			
Chloride	100 mmol/L	105 mmol/L	100 mmol/L	101 mmol/L	100 mmol/L	101 mmol/L	105 mmol/L
Glucose				100 mg/dL			
Batch size	60 L	60 L	50 L	60 L	40 L	50 L	50 L

Table 11: Different dialysis fluid options with PureFlow for the NxStage SystemOne. Not all concentrates are available in all countries.²¹ NxStage System One Monitor© 2026 Fresenius Medical Care -All rights Reserved. Used with permission.

An important consideration when prescribing HD with the NxStage System One is that the dialysate calcium concentration is fixed, with only one formulation currently available (calcium 3 mEq/L or 1.5 mmol/L). Therefore, modulation of calcium balance cannot be achieved by adjusting dialysate composition. When a reduction in calcium exposure is required, this must be addressed by modifying treatment parameters—such as decreasing the dialysate volume per session or reducing treatment frequency—thereby lowering total calcium load delivered through dialysis.

Another key aspect of the NxStage System One is that dialysate uses lactate, rather than bicarbonate, as the buffer. Two formulations are available (lactate 40 and 45 mEq/L), allowing individualisation according to the patient’s acid–base status. Adjustment of acid–base balance is therefore achieved by selecting the appropriate lactate concentration: if serum bicarbonate levels are suboptimal with lactate 40 mEq/L, a switch to lactate 45 mEq/L may be considered, and vice versa. In cases where bicarbonate levels remain insufficient despite the higher lactate concentration, additional strategies—such as oral bicarbonate supplementation or adjustment of dialysate flow—may be required.

Serum bicarbonate using the NxStage system	Lactate dialysate concentration using the NxStage system	
	40 mmol/L	45 mmol/L
< 22 mmol/L	Consider 45 mmol/L	Recommended
22–26 mmol/L	Recommended	Recommended
> 26 mmol/L	Recommended	Consider 40 mmol/L

Table 12: Recommended lactate concentrations based on serum bicarbonate levels.²¹

It is important to note that lactate-based dialysate relies on hepatic metabolism for conversion to bicarbonate. Therefore, in patients with impaired lactate metabolism (e.g. advanced liver disease, post-liver transplantation, or lactic acidosis), the use of lactate-buffered solutions is contraindicated, as it may lead to persistent metabolic acidosis. In such cases, this system is not appropriate, and alternative options should be considered, including traditional haemodialysis systems or other portable low-flow devices capable of delivering bicarbonate-based dialysate.

In practice, prescription with the NxStage System One is guided by the Dosing Calculator, which generates treatment options based on patient-specific parameters and predefined adequacy targets. The resulting regimens—varying in frequency, session duration, and dialysate volume—allow treatment to be individualised while ensuring that prescribed dialysis targets are consistently achieved.

In addition to the parameters requested by the Dosing Calculator, additional considerations must be taken into account when adjusting the prescription.

Parameter	Recommendation	Clinical notes
Blood flow (QB)	300–350 mL/min (adjust to vascular access)	Should be adapted to access performance and patient tolerance
Maximum UF rate	<7–10 mL/kg/h	Higher rates associated with haemodynamic instability and cardiovascular risk
Circuit priming	Saline solution	Used for priming and for intradialytic boluses if hypotension occurs

Parameter	Recommendation	Clinical notes
Anticoagulation	Prefer no heparin in short daily HHD; LMWH if needed	Frequent short sessions often allow heparin-free dialysis
Dialyser type	Integrated cartridge (e.g. PUREMA H)	No individual dialyser selection possible
Dialysate composition	Lactate-based with variable K+	Adapted to patient metabolic and electrolyte needs
Dialysate delivery	PureFlow or pre-prepared bags	Choice depends on home logistics and patient preference

Table 13: Additional Prescription Considerations for HHD with NxStage.²¹

C. Prescription of HHD in special situations

D.1 Obesity and low-flow dialysate systems

In individuals with obesity, no major adaptations are usually required when prescribing haemodialysis with traditional monitors. However, when low-flow dialysate systems are used, specific considerations are necessary to ensure that an adequate solute clearance is achieved.

In this population, urea-based Kt/V may underestimate the true delivered dialysis dose. This is because adipose tissue increases total body weight, and therefore the calculated distribution volume (V), without a proportional increase in total body water, which is the compartment where urea is distributed. As a result, adequacy calculations based on Kt/V may be inaccurate. For this reason, current recommendations suggest using measured total body water (e.g. via bioimpedance), ideal body weight, or alternative metrics such as body surface area when estimating solute clearance.²⁴

In clinical practice, when prescribing with low-flow systems:

- **Total body water** should be entered manually based on measured values rather than estimated from body weight.
- **Treatment intensity** (in terms of frequency and/or duration) often needs to be increased to achieve adequate solute clearance

D.2 Haemodynamic Instability

Intradialytic hypotension is a common complication in HD and is associated with increased morbidity and mortality. It results from an imbalance between effective circulating blood volume and the haemodynamic response, typically occurring when the ultrafiltration rate exceeds the plasma refill rate during the dialysis session.^{10,25} Patients with autonomic or baroreceptor dysfunction (e.g. diabetes or advanced age), as well as those with underlying cardiac disease (such as left ventricular hypertrophy or ischaemic heart disease), have a reduced capacity to compensate for ultrafiltration and are therefore at higher risk.²⁶

Haemodynamic instability remains challenging to manage with conventional HD regimens. More intensive strategies—by increasing treatment frequency and/or prolonging session duration—can improve tolerance by reducing interdialytic weight gain and allowing lower ultrafiltration rates (Figure 6).²⁷ In this context, home HHD represents an attractive option, as it enables treatment individualisation and facilitates these adjustments with minimal impact on quality of life. Notably, nocturnal HHD is particularly effective in improving haemodynamic stability, as extended treatment duration allows more gradual fluid removal and lower ultrafiltration rates. This modality will be discussed in more detail in the following section.

A key factor contributing to volume imbalance and difficulty in achieving adequate ultrafiltration is inaccurate dry weight assessment, together with excessive interdialytic weight gain. For patients undergoing HHD, these aspects should be clearly addressed during training, ensuring that patients understand their importance and are able to adjust treatment accordingly.

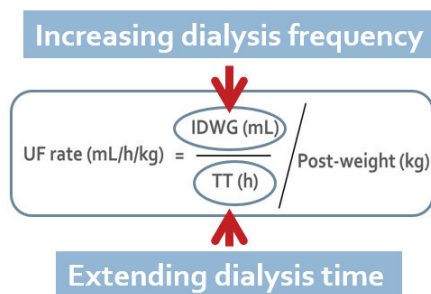


Figure 6: Formula explaining the parameters related to the ultrafiltration rate during a HD session. Changes in frequency or duration can alter this ultrafiltration rate to improve the patient's haemodynamic tolerance.

Although intradialytic hypotension remains a relevant risk in the home setting, it can be significantly reduced through appropriate education. Ensuring that both patients and caregivers understand the underlying principles and are trained to recognise and manage hypotensive episodes during treatment, is essential for the safe delivery of HHD.

If haemodynamic instability cannot be adequately controlled at home despite appropriate preventive and corrective measures, transition to in-centre HD should be considered to prioritise patient safety.^{19,28}

Suggestions for managing patients with hemodynamic instability

Dry weight	Daily adjustment
Frequency	6–7 days
Ultrafiltration	Set a maximum UF per session. Ultrafiltration rate < 7–10 mL/kg/h
Dialysate temperature	35,5 °C
Dialysis fluid	Adjust electrolytes (Avoid low levels of magnesium and calcium)
Adjust sodium profile	When possible
Online HD	When possible
Nocturnal HD	When possible

Suggestions for managing patients with hemodynamic instability

Other measures	Dialysis in the supine position Do not eat during the session Consider a preventive saline bolus in selected patients with low blood pressure, even if asymptomatic, to reduce the risk of severe hypotension
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Table 14: Parameters to consider when prescribing patients with poor haemodynamic tolerance.

D.3 HD and Pregnancy

Pregnancy is uncommon in women receiving dialysis due to fertility-related complications associated with kidney disease. However, when it occurs, it represents a major clinical challenge given the high rates of maternal and foetal morbidity and mortality.²⁹⁻³² Optimal outcomes require close interdisciplinary management involving nephrologists, obstetricians, nutritionists, neonatologists, and specialised nursing staff.

In this context, more intensive HD regimens have been associated not only with improved fertility but also with a higher likelihood of achieving full-term pregnancy and favourable maternal and foetal outcomes.³⁰

Given the need for substantially increased dialysis intensity, HHD provides a particularly advantageous setting, allowing escalation of dialysis dose while minimising the impact on quality of life.³³

The main considerations for HD prescription during pregnancy are summarised in Table 15.

Specific Prescription Parameters During Pregnancy

Weekly dialysis hours	> 36 hours per week
Frequency	6–7 days
Hemodynamic tolerance	Avoid hypotension (< 120/70 mmHg) Ultrafiltration rate < 5 ml/kg/h
Volume control	Maintain post-dialysis BP < 140/90 mmHg

Specific Prescription Parameters During Pregnancy	
Potassium in dialysis fluid	3 mEq/L
Calcium in dialysate	3 mEq/L (1.5 mmol/L)
Anticoagulation	Unfractionated heparin if required

Table 15: Parameters to consider when prescribing during pregnancy.

In addition to dialysis prescription, close monitoring of anaemia is essential, including the use of erythropoiesis-stimulating agents (ESAs) and, when required, intravenous iron to maintain haemoglobin levels between 10 and 11 g/dL. Nutritional status should also be carefully assessed, along with the potential need for phosphorus and magnesium supplementation.³⁴

Following pregnancy, the patient should transition to the dialysis regimen that best aligns with her clinical condition and individual circumstances. In this context, shared decision-making is essential to reassess and adapt dialysis options according to the patient's needs, circumstances, and life goals, with the aim of optimising long-term outcomes alongside life participation and quality of life.^{3,5}

D.4 Home Nocturnal HD

Nocturnal HHD has demonstrated multiple clinical, biochemical, and quality-of-life benefits. These advantages are primarily driven by the substantial increase in treatment duration per session, resulting in greater weekly dialysis time. This leads to enhanced clearance of uraemic toxins with more complex kinetics than urea—such as phosphorus and β 2-microglobulin—as well as improved haemodynamic stability through lower ultrafiltration rates and enhanced plasma refill. In addition, increased dialysis frequency and duration have been associated with reduced sympathetic activity, improved inflammatory profile, and enhanced myocardial function.^{27,35,36}

Clinically, nocturnal HHD is associated with excellent haemodynamic tolerance, improved blood pressure control—often with a reduced need for antihypertensive therapy—and regression of left ventricular hypertrophy, largely driven by improved volume control and lower ultrafiltration rates.^{37,38} It also provides superior phosphate control, frequently reducing the need for phosphate binders,³⁶ along with

improvements in selected domains of quality of life³⁹ and encouraging survival outcomes comparable to those observed in deceased-donor kidney transplant recipients.¹²

In terms of patient selection, nocturnal HHD is particularly suitable for individuals requiring improved volume control, those with significant interdialytic weight gain or poor haemodynamic tolerance, and patients with inadequate phosphate control. Importantly, by shifting treatment to nighttime, it frees daytime hours from dialysis, thereby enhancing patients' ability to participate in daily activities and making it an attractive option for improving quality of life.⁴⁰

Nocturnal HD can be performed using conventional haemodialysis monitors. When considering low dialysate flow systems, this modality is currently feasible only with the NxStage system,⁴¹ as the Physidia S3 is not designed for this type of prescription.

Key prescription considerations include:

- Time and frequency: typically, 6–8 hours per session, aligned with sleep, on alternate days or according to patient needs.
- Blood and dialysate flow: generally lower than in conventional or short daily regimens.
- Anticoagulation: adjusted to prevent circuit clotting; in Europe, a single initial dose of low-molecular-weight heparin is commonly used.
- Dialysate composition: higher potassium concentrations may be required, with dietary adjustments to prevent hypokalaemia.
- Phosphate management: monitoring is essential to avoid hypophosphataemia; supplementation may be required depending on the system used.
- Safety: the use of monitoring systems (e.g. blood leak and dialysate leak detectors) is essential.

Key concepts

Key Concepts Prescription for HHD:

- There is no single optimal dialysis regimen. Dialysis prescription should be individualised and dynamic, recognising that different

patients—and even the same patient over time—may require adjustments according to changes in clinical condition, general health, lifestyle, and personal preferences.

- Intensive dialysis regimens provide important clinical benefits. Increasing treatment frequency and/or duration is associated with improved volume control, enhanced haemodynamic stability, better toxin clearance, and improved quality of life. However, these regimens are often difficult to implement in-centre due to logistical, organisational, and economic constraints.
- HHD provides an optimal setting for personalised care.
- It offers greater flexibility in treatment schedules, allowing dialysis to be adapted to the patient's life rather than the reverse. This approach is associated with improved clinical outcomes, increased patient autonomy, and greater overall satisfaction.
- Technological advances have facilitated the expansion of HHD.
- Modern systems, particularly those based on low dialysate flow, simplify treatment delivery and improve accessibility. However, their lower per-session clearance requires adapted prescription strategies, typically involving increased frequency and/or longer treatment duration to achieve weekly adequacy targets (standard Kt/V).
- Prescription with low-flow systems requires specific expertise.
- A clear understanding of system-specific parameters and limitations is essential to ensure adequate dialysis dose and safe treatment delivery, highlighting the importance of appropriate training for both clinicians and patients.
- HHD is particularly valuable in complex clinical situations.
- In conditions such as pregnancy, haemodynamic instability, persistent volume overload, or refractory metabolic disturbances, more intensive dialysis is often required. In these scenarios, HHD represents a key therapeutic option, enabling optimisation of clinical and biochemical outcomes while preserving quality of life.

References:

1. Curran SP, Chan CT. Intensive hemodialysis: Normalizing the “Unphysiology” of conventional hemodialysis? *Semin Dial.* 2011;24(6):607-613. doi:10.1111/j.1525-139X.2011.01010.x
2. Perl J, Dember LM, Bargman JM, et al. The Use of a Multidimensional Measure of Dialysis Adequacy—Moving beyond Small Solute Kinetics. *Clinical Journal of the American Society of Nephrology.* 2017;12(5):839-847. doi:10.2215/CJN.08460816
3. Chan CT, Blankestijn PJ, Dember LM, et al. Dialysis initiation, modality choice, access, and prescription: conclusions from a Kidney Disease: Improving Global Outcomes (KDIGO) Controversies Conference. *Kidney Int.* 2019;96(1):37-47. doi:10.1016/j.kint.2019.01.017
4. François K, Ghazan-Shashi S, Chan CT. Modalities and prescribing strategies in intensive home hemodialysis: a narrative review . *Minerva urologica e nefrologica.* 2015;67(1):75-84.
5. El Shamy O, Abra G, Chan C. Patient-Centered Home Hemodialysis: Approaches and Prescription. *Clinical Journal of the American Society of Nephrology.* 2024;19(4):517-524. doi:10.2215/CJN.0000000000000292
6. Perl J, Brown EA, Chan CT, et al. Home dialysis: conclusions from a Kidney Disease: Improving Global Outcomes (KDIGO) Controversies Conference. In: *Kidney International.* Vol 103. Elsevier B.V.; 2023:842-858. doi:10.1016/j.kint.2023.01.006
7. Copland M, Komenda P, Weinhandl ED, McCullough PA, Morfin JA. Intensive Hemodialysis, Mineral and Bone Disorder, and Phosphate Binder Use. *American Journal of Kidney Diseases.* 2016;68(5):S24-S32. doi:10.1053/j.ajkd.2016.05.024
8. Garg AX, Suri RS, Eggers P, et al. Patients receiving frequent hemodialysis have better health-related quality of life compared to patients receiving conventional hemodialysis. *Kidney Int.* 2017;91(3):746-754. doi:10.1016/j.kint.2016.10.033
9. Bakris GL, Burkart JM, Weinhandl ED, McCullough PA, Kraus MA. Intensive Hemodialysis, Blood Pressure, and Antihypertensive Medication Use. *American Journal of Kidney Diseases.* 2016;68(5):S15-S23. doi:10.1053/j.ajkd.2016.05.026
10. Morfin JA, Fluck RJ, Weinhandl ED, Kansal S, McCullough PA, Komenda P. Intensive Hemodialysis and Treatment Complications and Tolerability. *American Journal of Kidney Diseases.* 2016;68(5):S43-S50. doi:10.1053/j.ajkd.2016.05.021
11. Tennankore KK, Chan CT, Curran SP. Intensive home haemodialysis: benefits and barriers. *Nat Rev Nephrol.* 2012;8(9):515-522. doi:10.1038/nrneph.2012.145
12. Nishio-Lucar AG, Bose S, Lyons G, Awuah KT, Ma JZ, Lockridge RS. Intensive Home Hemodialysis Survival Comparable to Deceased Donor Kidney Transplantation. *Kidney Int Rep.* 2020;5(3):296-306. doi:10.1016/j.ekir.2019.12.019

13. Pauly RP, Gill JS, Rose CL, et al. Survival among nocturnal home haemodialysis patients compared to kidney transplant recipients. *Nephrology Dialysis Transplantation*. 2009;24(9):2915-2919. doi:10.1093/ndt/gfp295
14. Ethier I, Cho Y, Hawley C, et al. Multicenter registry analysis comparing survival on home hemodialysis and kidney transplant recipients in Australia and New Zealand. *Nephrology Dialysis Transplantation*. 2021;36(10):1937-1946. doi:10.1093/ndt/gfaa159
15. Foley RN, Gilbertson DT, Murray T, Collins AJ. Long Interdialytic Interval and Mortality among Patients Receiving Hemodialysis. *New England Journal of Medicine*. 2011;365(12):1099-1107. doi:10.1056/NEJMoa1103313
16. Fotheringham J, Sajjad A, Stel VS, et al. The association between longer haemodialysis treatment times and hospitalization and mortality after the two-day break in individuals receiving three times a week haemodialysis. *Nephrology Dialysis Transplantation*. 2019;34(9):1577-1584. doi:10.1093/ndt/gfz007
17. Lockridge RS, Moran J. Hemodialysis at Home Series Editors: Bertrand L. Jaber and John Moran: Short Daily Hemodialysis and Nocturnal Hemodialysis at Home: Practical Considerations. *Semin Dial*. 2008;21(1):49-53. doi:10.1111/j.1525-139X.2007.00369.x
18. Skeat L, Masterson R, Tjijto AC, Karschimkus C, Toussaint ND. Residual kidney function in nocturnal vs conventional haemodialysis patients: a prospective observational study. *Int Urol Nephrol*. 2020;52(4):757-764. doi:10.1007/s11255-020-02419-9
19. Pauly RP, Eastwood DO, Marshall MR. Patient safety in home hemodialysis: Quality assurance and serious adverse events in the home setting. *Hemodialysis International*. 2015;19(S1):S59-S70. doi:10.1111/hdi.12248
20. Roblero MFS, Rubio MAB, González-Moya M, et al. Experience in Spain with the first patients in home hemodialysis treated with low-flow dialysate monitors. *Nefrología (English Edition)*. 2022;42(4):460-470. doi:10.1016/j.nefro.2022.11.004
21. Therapy Handbook NxStage® Hemodialysis Treatment.
22. Lockridge R, Cornelis T, Van Eps C. Prescriptions for home hemodialysis. *Hemodialysis International*. 2015;19(S1). doi:10.1111/hdi.12279
23. Diaz-Buxo JA, Zeller-Knuth CE, Rambaran KA, Himmele R. Home hemodialysis dose: Balancing patient needs and preferences. In: *Blood Purification*. Vol 39. S. Karger AG; 2015:45-49. doi:10.1159/000368944
24. Daugirdas JT, Depner TA, Inrig J, et al. KDOQI Clinical Practice Guideline for Hemodialysis Adequacy: 2015 Update. *American Journal of Kidney Diseases*. 2015;66(5):884-930. doi:10.1053/j.ajkd.2015.07.015
25. Kim TW, Chang TI, Kim TH, et al. Association of Ultrafiltration Rate with Mortality in Incident Hemodialysis Patients. *Nephron*. 2018;139(1):13-22. doi:10.1159/000486323
26. Shringi S, Shah AD. The cardiovascular unphysiology of thrice weekly hemodialysis. *Curr Opin Nephrol Hypertens*. Lippincott Williams and Wilkins. 2025;34(1):69-76. doi:10.1097/MNH.0000000000001037

27. Sarnak MJ, Augustine BL, Brown E, et al. Cardiovascular Effects of Home Dialysis Therapies: A Scientific Statement From the American Heart Association. *Circulation*. Lippincott Williams and Wilkins. 2022;146(11):E146-E164. doi:10.1161/CIR.0000000000001088
28. Platnich JM, Pauly RP. Patient Training and Patient Safety in Home Hemodialysis. *Clinical Journal of the American Society of Nephrology*. 2024;19(8):1045-1050. doi:10.2215/CJN.0000000000000416
29. Oliverio AL, Hladunewich MA. End-Stage Kidney Disease and Dialysis in Pregnancy. *Adv Chronic Kidney Dis*. 2020;27(6):477-485. doi:10.1053/j.ackd.2020.06.001
30. Hladunewich MA, Hou S, Odutayo A, et al. Intensive Hemodialysis Associates with Improved Pregnancy Outcomes. *Journal of the American Society of Nephrology*. 2014;25(5):1103-1109. doi:10.1681/ASN.2013080825
31. Hladunewich M, Schatell D. Intensive dialysis and pregnancy. *Hemodialysis International*. 2016;20(3):339-348. doi:10.1111/hdi.12420
32. Ankawi G, Tangirala N, Jesudason S, Hladunewich MA. Pregnancy in Patients Receiving Home Dialysis. *Clinical Journal of the American Society of Nephrology*. 2025;20(2):292-300. doi:10.2215/CJN.0000000000000437
33. Bajpai D, Mangalgi S, Verma P, Shah S. Pregnancy in women on home dialysis: Your questions answered. *Perit Dial Int*. Published online October 28, 2025. doi:10.1177/08968608251389274
34. Copur S, Berkkan M, Basile C, Cozzolino M, Kanbay M. Dialysis in Pregnancy: An Update Review. *Blood Purif*. S. Karger AG. 2023;52(7-8):686-693. doi:10.1159/000531157
35. Sarafidis P, Faitatzidou D, Papagianni A. Benefits and risks of frequent or longer haemodialysis: weighing the evidence. *Nephrology Dialysis Transplantation*. 2021;36(7):1168-1176. doi:10.1093/ndt/gfaa023
36. Malavade TS, Dey A, Chan CT. Nocturnal Hemodialysis: Why Aren't More People Doing It? *Adv Chronic Kidney Dis*. W.B. Saunders. 2021;28(2):184-189. doi:10.1053/j.ackd.2021.04.003
37. Roumeliotis A, Roumeliotis S, Chan C, Pierratos A. Cardiovascular Benefits of Extended-Time Nocturnal Hemodialysis. *Curr Vasc Pharmacol*. 2020;19(1):21-33. doi:10.2174/1570161118666200401112106
38. Rocco M V., Lockridge RS, Beck GJ, et al. The effects of frequent nocturnal home hemodialysis: the Frequent Hemodialysis Network Nocturnal Trial. *Kidney Int*. 2011;80(10):1080-1091. doi:10.1038/ki.2011.213
39. Culleton BF, Walsh M, Klarenbach SW, et al. Effect of Frequent Nocturnal Hemodialysis vs Conventional Hemodialysis on Left Ventricular Mass and Quality of Life. *JAMA*. 2007;298(11):1291. doi:10.1001/jama.298.11.1291
40. Suri RS, Kliger AS. When is more frequent hemodialysis beneficial? *Semin Dial*. 2018;31(4):332-342. doi:10.1111/sdi.12688
41. Molina P, Galván E, Porcar L, Alba A, Hernandis A, Pascual P, et al. Nocturnal home hemodialysis with low-flow dialysate: a report of the first two cases in Spain. *Nefrologia (Engl Ed)*. 2026;46(1):501405. doi:10.1016/j.nefro.2026.501405.

Chapter 4

Vascular Access

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Learning objectives

- To examine the specific requirements and challenges of vascular access management within the home environment, prioritising patient safety, and independence
- To demonstrate that the critical role of self-cannulation is a key factor in patient empowerment and long-term access survival in HHD
- To provide a comprehensive overview of cannulation techniques, specifically the "BH" and "rope ladder" methods, and their clinical implications for the patient undergoing HHD
- To highlight the importance of meticulous adherence to access care to mitigate the risks of complications and access failure

Introduction

HHD offers distinct clinical and lifestyle benefits, including improved blood pressure control, regression of left ventricular hypertrophy, and superior phosphorus management. Despite these advantages, VA remains the primary source of clinical vulnerability in this modality. The successful implementation of HHD is therefore fundamentally dependent on the establishment and maintenance of a robust and reliable VA.¹⁻⁴

In the home setting, stewardship of VA shifts from the clinical team to the person with ESKD and, where appropriate, their care partner. This represents a fundamental change from the in-centre haemodialysis model, with important implications for training, monitoring and safety (Table 1). This transition requires not only technical competence but also confidence, engagement, and a significant psychological adjustment. Consequently, nephrology nursing practice evolves from the execution of clinical tasks to a strategic role focused on education, mentorship, surveillance and risk mitigation, supporting individuals to safely manage their VA as a key component of their independence.^{1,3-6}

This chapter provides an overview of VA management in HHD, incorporating current evidence and the person-centred principles advocated by the EDTNA/ERCA.^{1,2}

Modality Feature	In-Centre HD	HHD
Primary Operator	Nursing/Technician staff	Person with CKD or Care Partner
Treatment Frequency	Usually 3 times weekly	4 to 7 times weekly or nocturnal
Cannulation Expert	Rotating clinical staff	Consistent single operator (the patient)
Monitoring	Intermittent clinical observation	Daily self-assessment (Look, Listen, Feel)
Safety Infrastructure	Direct clinical supervision	Reliance on technology (alarms) and training

Table 1- Comparison of Access Management Contexts.

1. Integrated Planning of Vascular Access

A notable evolution in vascular access philosophy has been the shift from a normative ‘Fistula First’ perspective to an individualised and dynamic approach focused on integrated vascular access planning, tailored to the clinical profile of the person with ESKD. The 2019 KDOQI Clinical Practice Guidelines emphasise that the choice of access must align with the person's overall goals, lifestyle, and long-term trajectory of renal replacement therapy.^{7–9}

1.1. The concept of the life-plan

The ESKD Life-Plan is a documented, long-term map that considers the person's current and future needs, including the potential for kidney transplantation, peritoneal dialysis, or different haemodialysis regimens. For the HHD nurse, this means participating in a multidisciplinary team that evaluates the person's manual dexterity, visual acuity, cognitive status, and social support before selecting an access type.^{8,10}

The "ViP ACCeS"¹¹ framework is used to guide this planning:

- **Vessel Preservation:** Protecting the non-dominant arm from venepuncture and intravenous lines from the early CKD stages.
- **Access Creation:** Selecting the most appropriate site (usually distal-to-proximal) and type based on vessel mapping.

- **Contingency Planning:** Establishing a "Plan B" if the primary access fails to mature or complications arise.
- **ESKD Succession:** Planning the next VA or modality shift to ensure continuous, high-quality therapy.

1.2. Selecting access for the home environment

The home setting presents unique challenges that influence the choice of VA. While an AVF is preferred due to its low infection risk and longevity, an AVG may be considered if native vessels are unsuitable. CVCs, while generally discouraged as a first choice, are recognised as a necessary alternative for some HHD patients, particularly those with significant needle phobia or limited life expectancy, where the burden of surgical revisions outweighs the benefits.^{3,6,10}

The key characteristics, advantages, and limitations of the different vascular access options for HHD are summarised in Table 2.

Access Type	Primary Advantages	Primary Disadvantages
AVF (Native)	Longest survival; lowest infection/thrombosis rates; patient empowerment through self-cannulation.	Requires 6-8 weeks' maturation; technical skill required for sharp needle insertion.
AVG (Synthetic)	Predictable anatomy; easy to palpate; shorter maturation (days for early-cannulation types).	Higher risk of stenosis/thrombosis; higher infection risk than AVF.
CVC (Tunnelled)	No needles required; immediate use; simpler connection process for those with limited dexterity.	Highest infection and mortality risk; potential for central venous stenosis.

Table 2 - Arteriovenous Access vs. Central Venous Catheters in HHD.

2. Overcoming barriers to self-cannulation

Self-cannulation is often identified as the primary barrier to the uptake and retention of HHD. The prospect of inserting needles into one's own arm can be terrifying, leading to high levels of anxiety and potential withdrawal from HHD training.^{1,3}

2.1. Psychological barriers: trypanophobia and anxiety

Trypanophobia (fear of needles) and haemophobia (fear of blood) are common in the CKD population. Nursing interventions should focus on desensitisation and gradual exposure. The process begins with the person simply being "present" during cannulation without the pressure to perform. This advances to handling the equipment, touching the needle to the skin (without insertion), and finally participating in the procedure.^{12–14}

2.2. Cognitive and behavioural interventions

The HHD nurse acts as a mentor, using techniques such as "*Imaginal Exposure Therapy*", where the nurse describes the procedure while the person visualises it, rating their anxiety on a scale of 0 to 10. Peer support is also invaluable; hearing from other people with CKD who have mastered self-cannulation can transform the mindset from "*I could never do that*" "*If they can do it, I can do it*".^{1,3}

2.3. The tandem-hand technique

The "Tandem-Hand" (or handholding) technique is a cornerstone of cannulation training.¹ This method involves the nurse placing their hand over the person's hand to guide the needle, providing a sense of security and control.^{12,15–17}

The key steps of the Tandem-Hand technique include:

- **Preparation:** The nurse stabilises the hand by resting the heel of the hand on the person's arm, providing a solid base.
- **Phase 1:** The person places their thumb and forefinger behind the nurse's fingers. They "squeeze" to feel the nurse's movements as the needle enters the skin and vessel.
- **Phase 2:** Once the person is comfortable with the sensation, the positions are reversed. The person holds the needle, and the nurse places their fingers behind the person's fingers to provide a "safety net" and guide the angle.
- **Phase 3:** The person performs the insertion with only verbal guidance from the nurse, eventually progressing to independent cannulation.

2.4. Technology-assisted cannulation

POCUS is an emerging tool that can facilitate cannulation, particularly in AVFs with deep or difficult-to-palpate veins. Nurses can use POCUS to map the vessel's depth and course, marking the skin with a surgical marker to provide a visual "roadmap" for the person with CKD. POCUS provides detailed information on vascular morphology and structure, enabling nurses to optimise care planning and support patient education for self-cannulation. This may reduce the number of failed attempts and infiltration events, building the person's confidence during the learning phase.^{18–21}

3. Cannulation techniques in HHD: evidence and practice

In the context of HHD, VA cannulation requires assessment of the VA, selection of the puncture site, and preparation of both the person with ESKD and the materials. The cannulation technique must be performed with precision to ensure treatment efficacy and reduce complications. The choice of cannulation technique significantly impacts the health and longevity of the access, especially in frequent HHD where the access is punctured 5 to 7 times per week.^{3,22,23}

3.1. The Rope ladder technique

The rope ladder is considered the clinical standard for arteriovenous access. It involves rotating needle sites along the entire length of the vessel at each session.

- **Pros:** Minimal scar tissue formation; lowest infection risk.
- **Cons:** Requires a long, straight segment of vessel; technically more challenging for self-cannulators who must reach different areas of the arm; always requires sharp needles.^{3,14,24,47}

3.2. The Buttonhole technique

The BH technique (or constant-site method) involves inserting the needle into the exact same spot, at the same angle and depth, at every session. This creates a "tunnelled track" of scar tissue.

- **Pros:** Once established (usually after 8–10 sessions with sharp needles), blunt needles can be used, which significantly reduces pain and the risk of mis cannulation or infiltration. It is ideal for short or tortuous fistulas.

- **Cons:** Significantly higher risk of local and systemic infections if aseptic technique is not followed meticulously.^{1,3,14,25}

3.3. The BH controversy and infection prevention

While BH facilitates self-cannulation, recent literature alerts nurses to an increased risk of *Staphylococcus aureus* bacteraemia. The HDD nurse must enforce a rigorous aseptic protocol:

- **Thorough Cleaning:** Washing the access arm with soap and water is mandatory.
- **Scab Removal:** The scab must be completely removed before cannulation using a sterile blunt needle or a dedicated scab remover. Leaving even a small portion of the scab can introduce bacteria into the bloodstream.
- **Dual Disinfection:** The site should be disinfected *before* scab removal and *after* the scab is gone.
- **Topical Prophylaxis:** The application of 2% mupirocin or Polysporin triple ointment to the site after needle removal has been shown to reduce BH-related infections.^{1,6,12,26,27}

3.4. Cannulation support

To accelerate BH formation and facilitate easier entry, polycarbonate pegs (e.g., BioHole® plugs) can be used.¹ These sterile "thumbtacks" are inserted into the needle site after dialysis to maintain the track until the next session, preventing scab formation and ensuring the track remains patent.^{12,28,29}

4. Management of central venous catheters at home

Although AV access is preferred, approximately 24% of HDD patients in some European cohorts use a CVC. In the home setting, the CVC requires high-level nursing protocols to prevent catastrophic complications such as air embolism and catheter-related bloodstream infection.^{3,24,30}

4.1. CVC hygiene and dressing protocols

Aseptic handling is non-negotiable. Nurses must train people with CKD to:

- **Use PPE:** Wear a mask and clean gloves whenever the catheter hubs are accessed to prevent contamination from respiratory droplets.
- **Hub disinfection:** Perform a "friction scrub" of the catheter hub, connection surfaces, and limbs for at least 30 seconds using 2% chlorhexidine in 70% alcohol.
- **Transparent dressings:** Use transparent, semi-permeable dressings to allow for continuous monitoring of the exit site for signs of infection (erythema, discharge).^{1,3,24,31}

4.2. Closed-connector technology

The use of needleless, closed-connector devices (e.g., Tego) is highly recommended for people performing independent HHD with a CVC. These devices create a mechanically closed system that remains in place throughout treatment, reducing the risk of air embolism during connection and disconnection and minimising the frequency of hub manipulation.^{24,31,32}

4.3. Locking protocols: citrate vs. heparin

To maintain patency, CVCs must be "locked" after each treatment.

- **Heparin:** Traditional standard but carries risks of systemic anticoagulation if it leaks from the tip. Lower concentrations are recommended.
- **Trisodium citrate:** TSC at 4% is increasingly preferred. It provides local anticoagulation and has broad antimicrobial properties. Studies have shown that TSC may reduce catheter-related bacteraemia by over 70% compared to heparin.^{1,3,33}

4.4. Troubleshooting catheter dysfunction

People on HHD must be trained to recognise and troubleshoot flow issues. Definitions of dysfunction include the inability to maintain blood flows of >300ml/min. Simple positional changes or flushing of saline using a "push-pull" motion can often clear a fibrin sheath or positional occlusion. For persistent thrombus, the use of thrombolytics like alteplase is the standard intervention, often requiring a visit to the clinical centre.^{3,34,35}

5. Education and training strategies for the home patient

Training for HHD is a structured educational process that typically lasts 2 to 6 weeks. The nurse's primary objective is to build the person's "self-efficacy", the belief in their own ability to manage a complex medical procedure safely.^{1,34}

5.1. Adapting to adult learning styles

The HHD nurse should tailor teaching strategies to the individual's needs using the VAK (Visual, Auditory, Kinaesthetic) model:

- **Visual learners** benefit from clear diagrams, checklist-based manuals, and videos.
- **Auditory learners** require detailed verbal walk-throughs and the opportunity to "teach back" the concepts.
- **Kinaesthetic learners** (the majority in dialysis) need maximum hands-on time, practicing on models before transitioning to their own access.^{36,37}

5.2. The progressive training models

Training should follow a logical progression from observation to total independence. The initial week focuses on general operations and hand hygiene, while subsequent weeks introduce machine setup, cannulation, and troubleshooting.^{1,36,37} A suggested framework for progressive HHD training is presented in Table 3.

Training Phase	Focus Area	Learning Objective
Observation	Dialysis environment	Reduced anxiety; familiarisation with equipment.
Participation	Hand hygiene; self-assessment	Master the basics of infection control and monitoring.
Technical	Machine stringing/priming	Proficiency in treatment set-up and safety checks.
Access Mastery	Self-cannulation/CVC scrub	Precision and aseptic technique in access handling.
Crisis Management	Troubleshooting alarms	Ability to respond calmly and appropriately to alerts.
Independence	Full simulation	Confidence to perform a complete treatment independently.

Table 3 - Framework for Progressive HHD Training.

5.3. The nurse as a mentor

The HHD nurse must relinquish the traditional "control" of the procedure to the person with CKD. This involves providing constructive feedback, praising successes, and treating errors as valuable learning opportunities. Regular auditing of the person's technique, even after they have gone home, is essential to prevent "procedural drift" and ensure long-term safety.

6. Surveillance, maintenance, and complication management

In the HHD context, VA surveillance assumes a fundamentally different character from in-centre practice. Rather than episodic professional assessment, VA surveillance becomes a daily, person-led clinical activity, supported by structured education and clearly defined escalation pathways. This shift places the person with ESKD as the primary sentinel for early VA dysfunction.³⁸

Routine surveillance relies on the systematic application of the "Look, Listen, and Feel" approach before each treatment:

- **Look:** Check for signs of infection (redness, swelling, pus) or skin changes over aneurysms. Shiny or thin skin over a bulge is a warning sign of potential rupture.
- **Listen:** Use a stethoscope or place the ear near the access to hear the "whooshing" bruit. A whistling sound or high-pitched bruit indicates potential stenosis.
- **Feel:** Palpate for the "thrill" (vibration). The absence of a thrill may indicate that the access has clotted (thrombosis), requiring immediate emergency intervention.

Consistent deviation from baseline findings must prompt immediate communication with the home dialysis team, as delayed intervention remains a principal contributor to access thrombosis and loss.^{39,40}

Scientific literature demonstrates that self-care by people with ESKD in relation to VA, through complication prevention and monitoring of signs and symptoms, is crucial for optimising treatment effectiveness and improves quality of life. Persons undertaking HHD must avoid constrictive clothing, jewellery, or activities that compromise venous return. Skin hygiene, particularly in buttonhole cannulation, constitutes a cornerstone of infection prevention. Importantly, pharmacological strategies aimed at improving VA patency, including antiplatelet or

anticoagulant therapies, have not demonstrated clinical benefit and are not recommended solely for VA preservation.^{5,38,41}

Continuous surveillance is the most effective strategy to prevent access failure. People on HHD must be trained to function as the primary monitors of their access status. Clear protocols must be established for emergencies such as post-dialysis bleeding or accidental needle dislodgement.^{1,37}

6.1. Venous needle dislodgement

VND is a potentially life-threatening complication that occurs when the venous needle becomes unintentionally dislodged from the vascular access while the blood pump continues to return blood outside the body. This can lead to a loss of a substantial proportion of the person's blood volume within minutes.

- **Risk Factors:** Restlessness, muscle cramps, and covering the access with blankets are significant risks, especially during nocturnal HHD.
- **Prevention:** Secure taping using the Chevron/Butterfly technique and ensuring bloodlines are looped loosely to avoid tugging.
- **Safety Technology:** The use of moisture/blood leak detectors (e.g., Redsense) is strongly recommended in HHD, providing an audible alarm if any blood is detected at the needle site.^{42,43}

Preventive strategies include meticulous taping techniques, avoidance of excessive tubing tension, and the routine use of venous pressure alarms. Where available, blood leak detection systems integrated into dialysis machines or external sensors provide an additional layer of protection, particularly during unattended nocturnal treatments. Importantly, the person and any care partner must demonstrate competence in recognising abnormal machine alarms and unexplained drops in venous pressure, which may precede overt dislodgement.^{5,44,45}

6.2. Emergency response and escalation protocols at home

A defining requirement of safe HHD is the existence of clear, rehearsed emergency protocols. These protocols must be embedded within training programmes and reinforced through simulation and periodic reassessment.^{1,5}

In the event of suspected VND or uncontrolled bleeding, the immediate priorities are cessation of blood flow, direct manual compression of the access site, and activation of emergency medical services when bleeding cannot be promptly controlled. Persons performing HHD must be trained to distinguish expected post-dialysis oozing from pathological haemorrhage, particularly in the context of anticoagulation or recent access intervention.^{1,44}

Equally critical is the management of VA dysfunction. Persistent difficulty achieving prescribed blood flow rates, recurrent alarms, or prolonged haemostasis after needle removal should not be managed empirically at home. These signs frequently reflect underlying stenosis or structural compromise and warrant urgent specialist assessment. Delayed referral remains a recognised contributor to thrombosis and access abandonment in HHD populations.^{3,5}

6.3. Long-term access preservation under high-frequency cannulation

High-frequency cannulation, inherent to most HHD prescriptions, imposes unique mechanical and biological stress on vascular access. This reality necessitates a proactive preservation strategy that integrates cannulation technique selection, site rotation discipline, and continuous education.¹

The rope ladder technique remains the preferred default due to its lower infection risk and reduced localised trauma. However, in persons with limited cannulation length or anatomical constraints, BH cannulation may represent the only feasible option to sustain independent dialysis. In such cases, strict adherence to aseptic protocols, including complete scab removal, dual-phase skin disinfection, and post-dialysis topical antimicrobial prophylaxis, is non-negotiable. Deviations from protocol have been consistently associated with increased rates of *Staphylococcus aureus* bacteraemia.^{6,46}

Access preservation also depends on maintaining a strong therapeutic alliance between the home dialysis team and the person performing HHD. Regular remote or in-person review of cannulation technique, combined with structured audits and checklist-based reinforcement, reduces procedural drift and sustains long-term access viability.^{3,5}

Conclusion

VA in HHD is a dynamic and multifaceted challenge that lies at the intersection of surgical precision, clinical protocols, and patient psychology. The successful HHD nurse must be proficient in all three domains. By adopting the ESKD Life-Plan, nurses can ensure that access choices are not only clinically appropriate but also sustainable and empowering for the person with CKD.

The transition to home-based care requires a rigorous commitment to education and safety. From overcoming the psychological barriers of self-cannulation using the tandem-hand technique to implementing robust CVC infection prevention and VND safety protocols, the goal remains the same: to protect the "lifeline" and support the highest possible quality of life for people managing kidney disease at home.

References

1. Goovaerts T. Vascular Access for Home Haemodialysis. In: Home haemodialysis: a nurse's guide to implementing best practice in home haemodialysis [Internet]. 1st ed. Malmö, Sweden: European Dialysis and Transplant Nurses Association / European Renal Care Association (EDTNA/ERCA); 2017. p. 1–118. Available from: <https://books.google.com/>
2. Glickman AJD, Chan C. Choosing home hemodialysis for end-stage kidney disease. 2026;1–12.
3. Roncon C, Levin N. Hemodialysis vascular access and peritoneal dialysis access. Contributions to nephrology. Basel- Switzerland on: Karger; 2004. 1–485 p. PubMed PMID: 14719382.
4. Bieber SD, Young BA. Home Hemodialysis: Core Curriculum 2021. American Journal of Kidney Diseases. 2021;78(6):876–85. doi:10.1053/j.ajkd.2021.01.025 PubMed PMID: 34518031.
5. Glickman AJD, Chan C. Choosing home hemodialysis for end-stage kidney disease. UpToDate. 2026;1–12.
6. Agarwal AK, Boubes KY, Haddad NF. Essentials of Vascular Access for Home Hemodialysis. Adv Chronic Kidney Dis. 2021;28(2):164–9. doi:10.1053/j.ackd.2021.06.008 PubMed PMID: 34717863.
7. Lok CE, Rajan DK. KDOQI 2019 Vascular Access Guidelines: What Is New. Semin Intervent Radiol. 2022 Feb 1;39(1):3–8. doi:10.1055/s-0041-1740937 LK - https://catalyst.library.jhu.edu/discovery/openurl?institution=01JHU_INST&vid=01JHU_INST:JHU&date=2022&aulast=Lok&issue=1&aufull=Lok%20C.E.&coden=SIRAE&isbn=&spage=3&title=Seminars%20in%20Interventional%20Radiology&aunit=C.E.&title=KDOQI%202019%20Vascular%20Access%20Guidelines:%20What%20Is%20New&aufirst=Charmaine%20E.&sid=EMBASE&sid=EMBASE&volume=39&pages=3-8&aunit1=C&issn=10988963&stitle=Semin.%20Intervent.%20Radiol.&epage=8&aunitm=E&id=doi:10.1055%2Fs-0041-1740937

8. Lok CE, Huber TS, Lee T, Shenoy S, Yevzlin AS, Abreo K, et al. KDOQI Clinical Practice Guideline for Vascular Access: 2019 Update. *American Journal of Kidney Diseases*. 2020 Apr 1;75(4):S1–164. doi:10.1053/j.ajkd.2019.12.001https://catalyst.library.jhu.edu/discovery/openurl?institution=01JHU_INST&vid=01JHU_INST:JHU&date=2020&aulast=Lok&issue=4&aufull=Lok%20C.E.&coden=AJKDD&isbn=&spage=S1&title=American%20Journal%20of%20Kidney%20Diseases&aunit=C.E.&title=KDOQI%20Clinical%20Practice%20Guideline%20for%20Vascular%20Access:%202019%20Update&aufirst=Charmaine%20E.&sid=EMBASE&sid=EMBASE&volume=75&pages=S1-S164&aunit1=C&issn=15236838&stitle=Am.%20J.%20Kidney%20Dis.&epage=S164&aunitm=E%20PubMed%20PMID:%20327-78223.&id=doi:10.1053%2Fj.ajkd.2019.12.001
9. Lok CE, Yuo T, Lee T. Hemodialysis Vascular Access: Core Curriculum 2025. *American Journal of Kidney Diseases*. 2025;85(2):236–52. doi:10.1053/j.ajkd.2024.05.021 PubMed PMID: 39625430
10. Lok CE, Rajan DK. KDOQI 2019 Vascular Access Guidelines: What Is New. *Semin Intervent Radiol*. 2022;39(1):3–8. doi:10.1055/s-0041-1740937 LK - https://catalyst.library.jhu.edu/discovery/openurl?institution=01JHU_INST&vid=01JHU_INST:JHU&date=2022&aulast=Lok&issue=1&aufull=Lok%20C.E.&coden=SIKRAE&isbn=&spage=3&title=Seminars%20in%20Interventional%20Radiology&aunit=C.E.&title=KDOQI%202019%20Vascular%20Access%20Guidelines:%20What%20Is%20New&aufirst=Charmaine%20E.&sid=EMBASE&sid=EMBASE&volume=39&pages=3-8&aunit1=C&issn=10988963&stitle=Semin.%20Intervent.%20Radiol.&epage=8&aunitm=E&id=doi:10.1055%2F041-1740937
11. Lok C, Yuo T, Lee T. Hemodialysis Vascular Access: Core Curriculum 2025. *American Journal of Kidney Diseases*. 2024;XX:1–17. doi:10.1053/j.ajkd.2024.05.021
12. Mott S. The Art of Teaching Buttonhole Self-Cannulation. *Home Dialysis Central* [Internet]. 2011 [cited 2026 Feb 7];1–8. Available from: <https://homedialysis.org/documents/pros/ButtonholeCannulation.pdf>
13. Jayanti A, Foden P, Wearden A, Morris J, Brenchley P, Mitra S. Self-cannulation for haemodialysis: Patient attributes, clinical correlates and self-cannulation predilection models. *PLoS One*. 2015 May 19;10(5). doi:10.1371/journal.pone.0125606 PubMed PMID: 25992775.
14. Furlan A, Pinto B, Miriunis C, Morris I, Matos JF, Peralta R. Vascular access cannulation and care - A nursing best practice guide for arteriovenous graft [Internet]. 1 edition. (EDTNA/ERCA) E dialysis and transplant nurses association/European renal care association, editor. Lucerne - Switzerland: Imprenta Tomás Hermanos; 2016. 192 p. Available from: https://www.researchgate.net/publication/319483290_Vascular_Access_Cannulation_and_Care_A_Nursing_Best_Practice_Guide_for_Arteriovenous_Graft/link/5abcd9250f7e9bfc04565957/download
15. Ward FL, Faratro R, McQuillan RF. Self-cannulation of the vascular access in home hemodialysis: Overcoming patient-level barriers. *Semin Dial*. 2018 Sep 1;31(5):449–54. doi:10.1111/sdi.12708 PubMed PMID: 29750827.

16. Bermudez MC, El Shamy O. Self-cannulation for home hemodialysis: a review of current practices and implementation approaches. *Curr Opin Nephrol Hypertens.* 2026;35(1):94–100. doi:10.1097/MNH.0000000000001121 PubMed PMID: 41117182.
17. Mott S, Moore H. Using 'Tandem Hand' Technique to Facilitate Self-Cannulation in Hemodialysis. *Nephrology Nursing Journal* [Internet]. 2009;36(3):313–7. Available from: https://www.researchgate.net/publication/26657839_Using_'Tandem_Hand'_technique_to_facilitate_self-cannulation_in_hemodialysis
18. Kruger Gomes L, Patel H, Agrawal N, Vin Y. Point of Care Ultrasound of the Hemodialysis Vascular Access. *POCUS Journal.* 2022;7(Kidney):105–9. doi:10.24908/pocus.v7ikidney.15348
19. Iglesias R, Vallespín J, Ibeas J. HANDBOOK ON ULTRASOUND FOR VASCULAR ACCESS EXAMINATION From the Specialist to the Nurse. 2018.
20. Sousa CN, Ozen N, Teles P, Kisbet T, Ozen V. Ultrasound for the Arteriovenous Fistula. In: Sousa C, Teles P, editors. *Arteriovenous Fistula Management.* Springer Nature Switzerland; 2025. p. 71–80. doi:10.1007/978-3-032-04771-7_8
21. Pinto R, Barros J, Ferreira R, Alves P, Sousa R, Oliveira L, et al. Advancing arteriovenous fistula needling: The role of physical exam and doppler ultrasound. *J Ren Care.* 2024 Dec 8;50(4):426–34. doi:10.1111/jorc.12505 PubMed PMID: 38850083.
22. Sousa CN, Ozen N, Teles P. Cannulation Methods for the Arteriovenous Fistula. In: Sousa C, Ozen N, Teles P, editors. *Arteriovenous Fistula Management.* Cham: Springer Nature Switzerland; 2025. p. 51–61. doi:10.1007/978-3-032-04771-7_6
23. Pinto R, Duarte F, Mata F, Sousa C, Salgueiro A, Fernandes I. Arteriovenous fistula cannulation in hemodialysis: Constructing and validating a decision-making model. *Revista de Enfermagem Referencia.* 2023 Jan 1;6(2). doi:10.12707/RVI22021
24. Faratro R, Jeffries J, Nesrallah GE, Macrae JM. The care and keeping of vascular access for home hemodialysis patients. *Hemodialysis International.* 2015 Apr 1;19(S1):S80–92. doi:10.1111/hdi.12242 LK - https://catalyst.library.jhu.edu/discovery/openurl?institution=01JHU_INST&vid=01JHU_INST:JHU&date=2015&aulast=Faratro&issue=S1&aufull=Faratro%20R.&coden=HIENA&isbn=&spage=S80&title=Hemodialysis%20International&aunit=R.&title=The%20care%20and%20keeping%20of%20vascular%20access%20for%20home%20hemodialysis%20patients&aufirst=Rose&sid=EMBASE&sid=EMBASE&volume=19&pages=S80-S92&aunit1=R&issn=15424758&stitle=Hemodial.%20Int.&epage=S92&aunitm=%20PubMed%20PMID:%2025925828.&id=doi:10.1111%2Fhdi.12242
25. Grudzinski A, Mendelssohn D, Pierratos A, Nesrallah G. A systematic review of buttonhole cannulation practices and outcomes. *Semin Dial.* 2013;26(4):465–75. doi:10.1111/sdi.12116

26. Funaro L, Borzumati M, Vio P, Bonvegna F, Mancini E, Ametrano P, et al. Buttonhole cannulation technique: Pros and cons. *Nephrology Dialysis Transplantation*. 2015;30:iii584. doi:10.1093/ndt/gfv198.50 LK-https://catalyst.library.jhu.edu/discovery/openurl?institution=01JHU_INST&vid=01JHU_INST:JHU&date=2015&aualast=Funaro&issue=&aufull=Funaro%20L.&coden=&isbn=&spage=iii584&title=Nephrology%20Dialysis%20Transplantation&aunit=L.&atitle=Buttonhole%20cannulation%20technique:%20Pros%20and%20cons&aufirst=Loredana&sid=EMBASE&sid=EMBASE&volume=30&pages=iii584-&aunit1=L&issn=09310509&style=Nephrol.%20Dial.%20Transplant.&epage=&aunitm=&id=doi:10.1093%2Fndt%2Fgv198.50
27. Muir CA, Kotwal SS, Hawley CM, Polkinghorne K, Gallagher MP, Snelling P, et al. Buttonhole cannulation and clinical outcomes in a home hemodialysis cohort and systematic review. *Clinical Journal of the American Society of Nephrology*. 2014;9(1):110–9. doi:10.2215/CJN.03930413 PubMed PMID: 24370768.
28. King J. Buttonhole tunnel tract creation with the biohole® buttonhole Device. Buttonhole Cannulation: Current Prospects and Challenges. 2015;186(2006):21–32. doi:10.1159/000431165 PubMed PMID: 26283556.
29. Fielding C, Cain P, Debling P, Ross J, Drysder D, Swain A, et al. Clinical practice recommendations for the use of buttonhole cannulation. *Journal of Kidney Care*. 2016;1(4). doi:<https://doi.org/10.12968/jokc.2016.1.4.186>
30. BC Renal. Vascular Access Guideline [Internet]. 2024. p. 1–7. Hemodialysis Central Venous (CVC): Discontinuance of Dialysis. Available from: www.bcrenal.ca/health-professionals/clinical-resources/vascular-access
31. Aragon MA, El Shamy O, Zheng S, Chertow GM, Glickman J, Weinhandl E, et al. Vascular Access for Home Hemodialysis: A Perspective on Tunneled Central Venous Catheters at Home. *Kidney Med*. 2025;7(1):100916. doi:10.1016/j.xkme.2024.100916
32. Brunelli SM, Njord L, Ehunt A, Sibbel SP. Use of the tego needlefree connector is associated with reduced incidence of catheter-related bloodstream infections in hemodialysis patients. *Int J Nephrol Renovasc Dis*. 2014;7:131–9. doi:10.2147/IJNRD.S59937
33. Mai H, Zhao Y, Salerno S, Li Y, Feng Y, Ma L, et al. Citrate versus heparin lock for prevention of hemodialysis catheter-related complications: updated systematic review and meta-analysis of randomized controlled trials. *Int Urol Nephrol*. 2019;51(6):1019–33. doi:10.1007/s11255-019-02150-0 PubMed PMID: 31012037.
34. BC Renal Hemodialysis Committee. Hemodialysis guideline - Nursing management of complications during hemodialysis [Internet]. Victoria - Canada; 2021 Jan. Available from: www.bcrenal.ca
35. Bander S, Woo K. Overview of central catheters for acute and chronic hemodialysis access - Uptodate. Collins KA, editor. Upto [Internet]. Kathryn A Collins (Editor); 2018. 1–15 p. Available from: https://www.uptodate.com/contents/central-catheters-for-acute-and-chronic-hemodialysis-access/print?topicRef=1906&source=see_link

36. Chan RJ, Chan CT. Vascular Access Considerations in Home Hemodialysis. *Clinical Journal of the American Society of Nephrology*. 2024;19(8):1036–44. doi:10.2215/CJN.0000000000000499 LK - https://catalyst.library.jhu.edu/discovery/openurl?institution=01JHU_INST&vid=01JHU_INST:JHU&date=2019&aualast=Abreo&issue=1&aufull=Abreo%20K.&coden=JVAOA&isbn=&spage=7&title=Journal%20of%20Vascular%20Access&aunit=K.&title=Physical%20examination%20of%20the%20hemodialysis%20arteriovenous%20fistula%20to%20detect%20early%20dysfunction&aufirst=Kenneth&sid=EMBASE&sid=EMBASE&volume=20&pages=7-11&aunit1=K&issn=17246032&stitle=J.%20Vasc.%20Access&epage=11&aunitm=%20PubMed%20PMID:%2029627998.&id=doi:10.1177%2F1129729818768183
37. Rioux JP, Marshall MR, Faratro R, Hakim R, Simmonds R, Chan CT. Patient selection and training for home hemodialysis. *Hemodialysis International*. 2015 Apr 1;19(S1):S71–9. doi:10.1111/hdi.12254 PubMed PMID: 25925826.
38. Allon M. Overview of hemodialysis arteriovenous fistula maintenance and thrombosis prevention - UpToDate. UpToDate [Internet]. 2018;1–17. Available from: https://www.uptodate.com/contents/overview-of-hemodialysis-arteriovenous-fistula-maintenance-and-thrombosis-prevention?search=h modialyse&source=search_result&selectedTitle=1~150&usage_type=default&display_rank=1
39. Abreo K, Amin BM, Abreo AP. Physical examination of the hemodialysis arteriovenous fistula to detect early dysfunction. *Journal of Vascular Access*. 2019;20(1):7–11. doi:10.1177/1129729818768183 LK -
40. Umar R, Akram M, Naeem H, Rehman F, Ali N, Aslam S, et al. Diagnostic Accuracy of Physical Examination for Detecting Arteriovenous Fistula Stenosis in Haemodialysis Patients. *J Liaquat Uni Med Health Sci* July. 2025;18:1–9. doi:10.22442/jlumhs.2025.01282
41. Sousa CN, Ozen N, Teles P. Self-care Behaviours with the Arteriovenous Fistula. In: Sousa C, Ozen N, Teles P, editors, *Arteriovenous Fistula Management*. Cham: Springer Nature Switzerland; 2025. p. 81–92. doi:10.1007/978-3-032-04771-7_9
42. Frinak S, Kennedy J, Zasuwa G, Passalacqua KD, Yee J. Detection of Hemodialysis Venous Needle Dislodgment Using Venous Access Pressure Measurements: A Simulation Study. *Kidney360*. 2023;4(4): E476–85. doi:10.34067/KID.0000000000000093 PubMed PMID: 36960959.
43. Speranza-Reid J, Brouwer-Maier D, Cruz CM, Inglese M. Venous Needle Dislodgement and Access-Bloodline Separation. *Nephrol Nurs J*. 2021;48(4):347–65. doi:10.37526/1526-744x.2021.48.4.347 PubMed PMID: 34463464.
44. Chan DYF, Dobson S, Barber T. Hemodialysis taping styles and their effect on reducing the chance of venous needle dislodgement. *Semin Dial*. 2021 May 1;34(3):218–23. doi:10.1111/sdi.12944 PubMed PMID: 33336846.
45. Van Waeleghem JP, Chamney M, Lindley EJ, Panc rova J, Jean-Pierre Van Waeleghem, Melissa Chamney, et al. VENOUS NEEDLE DISLODGE MENT: HOW TO MINIMISE THE RISKS. *J Ren Care*. 2008 Dec 19;34(4):163–8.

doi:10.1111/j.1755-6686.2008.00047.x

46. MacRae JM, Ahmed SB, Atkar R, Hemmelgarn BR. A randomized trial comparing buttonhole with rope ladder needling in conventional hemodialysis patients. *Clinical Journal of the American Society of Nephrology*. 2012 Oct 5;7(10):1632–8. doi:10.2215/CJN.02730312 PubMed PMID: 22822010.
47. Sousa C, Teles P, Ribeiro O, Sousa R, Lira M, Delgado E, et al. How to Choose the Appropriate Cannulation Technique for Vascular Access in Hemodialysis Patients. *Ther Apher Dial*, (2023) pp. 27(3):394-401. Chapter 1

Chapter 5

Home Therapies Training Team – Education and Training Programme

Learning objectives

- To critically understand the role of the home therapies training team in supporting people receiving HHD
- To analyse educational, communicative, and psychosocial strategies that underpin successful HHD training programmes
- To apply person-centred care principles to enhance self-management, confidence, and adherence in HHD

Introduction

HHD is increasingly recognised as a key modality within kidney replacement therapy, offering improved autonomy, flexibility, and quality of life compared to in-centre haemodialysis.^{1,2} However, despite these benefits, uptake remains limited globally, partly due to the complexity of treatment and the demands placed on individuals and their families.³ The transition from hospital-based to home-based dialysis represents a fundamental shift in care delivery. Responsibility for treatment moves from healthcare professionals to the individual and their support network.⁴ This shift requires not only technical competence but also confidence, motivation, emotional resilience, and sustained support.⁴ Central to this transition is the home therapies training team, typically led by nephrology nurses.⁴ The team is responsible for delivering a structured education and training programme that enables safe and effective dialysis at home.⁵ Importantly, training is not limited to skill acquisition but involves PCC, shared decision-making, and self-management support.⁶ The home dialysis literature highlights that a successful HHD programme requires involvement of the person in decision-making, treatment, and management of illness and health, alongside active involvement of relatives and continuous professional support.⁶ This chapter explores the key components of an effective HHD training programme, emphasising the role of the home therapies training team in delivering holistic, PCC.

Continuous Support

Continuous support is a fundamental component of safe and sustainable HHD care.⁷ While the initial training programme equips individuals with the technical knowledge and skills needed to perform dialysis at home, the transition to independent treatment represents a critical period that requires ongoing professional support.⁵

In the context of HHD, continuous support should be understood as part of a long-term partnership between healthcare professionals and the individual receiving care. Rather than representing a shift from dependence to independence, home dialysis reflects a model of shared responsibility in which both parties remain actively engaged.⁸ Evidence suggests that individuals receiving dialysis at home continue to rely on healthcare professionals for reassurance, guidance, and clinical oversight, even after completing training.⁸ This support is typically delivered through a combination of approaches, including access to specialist advice outside standard hours, regular follow-up consultations, and the use of telehealth solutions that allow remote monitoring and communication.⁶ In some cases, home visits may also be required to assess the treatment environment or provide additional guidance.⁵ Furthermore, peer support initiatives and engagement with other individuals undergoing home dialysis can contribute to confidence and normalisation of the experience.⁹

From a nursing perspective, continuous support involves ongoing assessment of both clinical competence and psychosocial wellbeing (Table 1). Nephrology nurses play a key role in identifying early signs of complications, addressing emerging concerns, and adapting support to meet changing needs over time.⁵ In doing so, they contribute to maintaining safety, promoting confidence, and supporting long-term adherence to treatment.

Components of continuous support	Nursing implications
24-hour access to specialist advice	Monitor competence over time
Regular follow-up consultations	Identify early signs of complications
Telehealth monitoring and digital communication	Provide reassurance and reinforcement
Home visits when necessary	Adapt support to evolving needs
Peer and caregiver support systems	

Table 1. Components of Continuous Support in HHD and Associated Nursing Implications.

Effective Communication with People and Families

Communication is central to all aspects of HHD training and care. It forms the foundation for learning, supports shared understanding, and enables individuals to engage actively in their treatment.⁵ In the context of home-based dialysis, where individuals assume a high level of responsibility, effective communication is essential for both safety and confidence.⁵

As illustrated in Figure 1, a person-centred approach to communication requires healthcare professionals to engage with individuals as partners in care. This involves listening to the person's narrative, understanding their values, preferences, and concerns, and incorporating these into care planning.^{6,10} Communication is therefore not limited to the provision of information but represents an ongoing dialogue that supports mutual understanding and shared responsibility.¹¹

The Gothenburg PCC framework¹⁰ provides a useful structure for this approach. It highlights three key elements: listening to the individual's narrative, establishing a partnership between the individual and healthcare professionals, and documenting care within a shared health plan.^{6,10} These elements emphasise the importance of recognising the individual as an expert in their own life and integrating this perspective into clinical care.

Family members often play a significant role in HHD and should be included in communication wherever appropriate.¹² Their involvement may include supporting treatment tasks, provide emotional support, and contribute to decision-making processes.⁸ However, caregiving responsibilities can also a significant burden on relatives, resulting in physical and emotional strain. Therefore, it is essential for healthcare professionals to acknowledge and address the needs of relatives as an integral part of the care process.¹³

To support effective communication, nephrology nurses should adopt strategies that enhance understanding and engagement. These include the use of clear and accessible language, avoiding unnecessary technical terminology, and applying teach-back methods to confirm comprehension.¹⁴ The use of written and visual educational materials can reinforce learning, while structured

conversations can help guide complex discussions.¹⁵ Including family members in these conversations contributes to a more holistic and comprehensive approach to care.¹²

Effective communication contributes to improved understanding, increased confidence, and greater engagement in treatment. It also plays a crucial role in promoting adherence and ensuring that individuals feel supported in managing dialysis at home.⁸

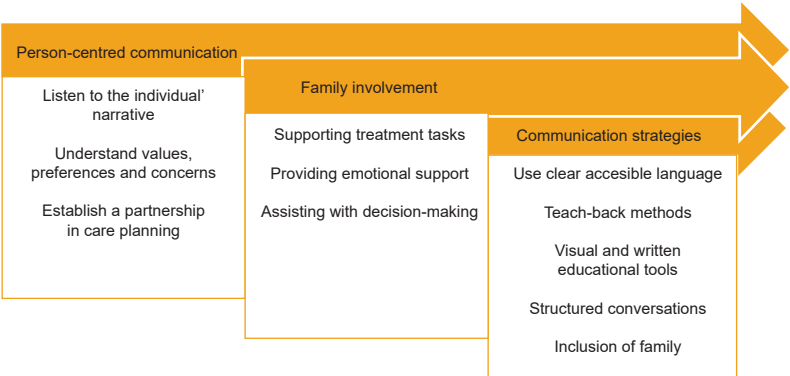


Figure 1. *Person-Centred Communication and Family Involvement in HHD.*

Training People and Caregivers: Best Practices

The education and training programme for HHD is a structured yet adaptable process that aims to equip individuals and, where relevant, their caregivers with the knowledge, skills, and confidence required to perform dialysis safely at home.⁵ While training programmes may vary between centres, several core principles underpin best practice.^{5,15}

Phase	Content	Nursing Role
Preparation	Education, modality choice	Facilitate shared decision-making
Early training	Machine setup, hygiene	Demonstrate and supervise
Skill acquisition	Cannulation, troubleshooting	Coach and assess
Consolidation	Independent dialysis	Evaluate readiness

Phase	Content	Nursing Role
Home transition	Real-life application	Support and monitor
Follow-up	Long-term care	Continuous education

Table 2. Structured HHD Training Pathway and Nursing Roles.

Training should be individualised, recognising that individuals differ in their learning pace, cognitive abilities, emotional readiness, and social circumstances.⁵ A flexible approach allows healthcare professionals to tailor the programme to the needs of each individual, thereby enhancing both learning outcomes and overall experience.¹⁵

Experiential learning plays a central role in HHD training.⁵ Individuals benefit from actively performing tasks under supervision, allowing them to develop practical competence and confidence.¹⁵ As illustrated in Table 2, training typically progresses in a stepwise manner, beginning with observation, followed by supervised practice, and ultimately leading to independent performance.^{5,15} This gradual transition supports both skill acquisition and psychological adaptation.

Consistency within the training team is also important.¹⁵ Working with a small group of dedicated nurses can enhance continuity, build trust, and improve communication. In addition, the use of structured educational materials, including written guides, visual aids, and digital resources, can support learning and provide ongoing reference after training is completed.¹⁵

Caregivers, when involved, should be included in training to ensure that they feel confident in their supportive role.⁸ This inclusion not only enhances safety but also helps to reduce anxiety and uncertainty for both the individual and their family.¹²

Overall, effective training programmes are those that combine structure with flexibility, technical instruction with emotional support, and individualised learning with consistent professional guidance.^{5,15}

Building Confidence and Self Efficacy in People

Confidence and self-efficacy are essential for successful HHD (Table 3). Self-efficacy refers to an individual's belief in their ability to perform specific tasks and manage challenges.¹⁶ In the context of HHD, this includes not only performing dialysis procedures but

also recognising complications, making decisions, and managing treatment within the context of daily life.

The development of self-efficacy is closely linked to the training process.⁵ Individuals who feel confident in their abilities are more likely to engage with treatment, adhere to prescribed regimens, and manage unexpected situations effectively. Conversely, low confidence may lead to anxiety, avoidance behaviours, and reduced adherence.

Nephrology nurses play a central role in fostering self-efficacy. This can be achieved through gradual skill development, allowing individuals to build competence step by step. Positive reinforcement and constructive feedback are important in supporting progress, while simulation and repetition help to consolidate learning.¹⁷ Encouraging individuals to actively participate in problem-solving further strengthens their sense of control and capability.

Self-management in HHD extends beyond technical tasks to include managing symptoms, adapting to lifestyle changes, and coping with emotional challenges.¹⁸ Supporting self-efficacy therefore requires a holistic approach that addresses both practical and psychological aspects of care.

Self-efficacy in HHD	Self-management in HHD	Supporting Strategies in HHD
Willingness to initiate treatment	Managing treatment	Gradual skill development
Ability to manage complications	Managing life roles	Positive feedback
Long-term adherence	Managing emotional responses	Simulation training
Self-management framework		Problem-solving exercises
		Encouragement of autonomy
		Evidence perspective

Table 3. *Self-Efficacy, Self-Management, and Supporting Strategies in HHD.*

Shared Decision Making and Motivation

Shared decision making and motivation are key approaches that support engagement and autonomy in HHD.¹⁹

Motivation in the context of home haemodialysis (HHD) can be understood through the lens of self-determination theory, which emphasises the importance of supporting an individual's intrinsic motivation through the fulfilment of three basic psychological needs: competence, autonomy, and relatedness.²⁰ Rather than focusing solely on resolving ambivalence, this approach highlights how healthcare professionals can create conditions that enable individuals to feel capable, self-directed, and supported in their treatment journey.^{19,20} Supporting competence involves ensuring that individuals develop the knowledge and skills required to perform dialysis safely and effectively. Through structured education, supervised practice, and constructive feedback, nephrology nurses can help individuals build confidence in their ability to manage treatment and respond to challenges. Promoting autonomy requires recognising the individual as an active decision-maker in their care. This includes providing meaningful choices, encouraging participation in decision-making, and respecting personal values and preferences. When individuals experience a sense of ownership over their treatment, they are more likely to engage with and adhere to HHD. Fostering relatedness involves establishing trusting and supportive relationships between healthcare professionals, individuals, and their families.⁸ Feeling understood, respected, and supported enhances motivation and contributes to a sense of security in managing treatment at home. By addressing these three dimensions, nephrology nurses can support sustained motivation and engagement in HHD, facilitating not only adherence to treatment but also a more positive and empowering experience of living with kidney disease.

Shared decision-making involves collaboration between healthcare professionals and the individual receiving care (Figure 2). It integrates clinical knowledge with the individual's values, preferences, and circumstances to arrive at decisions that are both informed and meaningful.²¹ In HHD, shared decision-making is particularly important when choosing dialysis modality and adapting treatment over time.⁶

Together, these approaches support a shift from provider-led care to a partnership model, where individuals are actively involved in decisions about their treatment.⁶ This not only enhances satisfaction but also contributes to improved adherence and long-term outcomes.

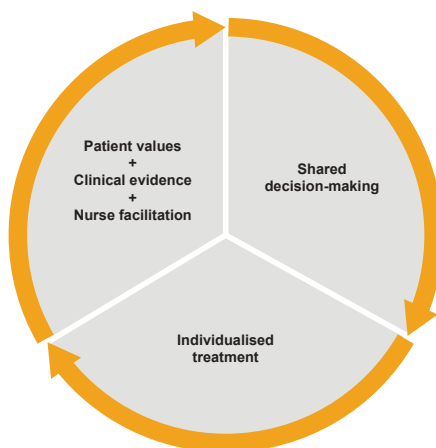


Figure 2. *Shared Decision Making Model in HHD.*

Psychological and Emotional Support Strategies

The transition to HHD involves significant psychological and emotional adjustment. These challenges and support strategies are summarised in Table 4. Individuals may experience anxiety related to performing treatment independently, fear of complications, or concerns about the impact on their daily life and relationships.²²

Providing psychological support is therefore an integral part of the training programme and ongoing care.^{5,6} Nephrology nurses should be attentive to emotional cues and create a supportive environment in which individuals feel comfortable expressing their concerns. Active listening, empathy, and reassurance are essential components of this process.²³ In some cases, referral to specialised psychological services may be required. Peer support, whether through formal programmes or informal connections, can also provide valuable opportunities for individuals to share experiences and gain perspective.

Supporting caregivers is equally important, as they may experience emotional strain and uncertainty in their role.¹³ Addressing the needs of both individuals and their families contributes to a more sustainable and supportive home care environment.

Psychological challenges	Support strategies
Anxiety	Emotional assessment
Fear of complications	Active listening
Treatment burden	Counselling referrals
Role changes	Peer support
	Family support

Table 4. *Psychological Challenges and Support Strategies in HHD.*

Addressing People Concerns and Treatment Adherence

The factors influencing engagement with HHD are complex and cannot be fully understood from a healthcare professional perspective alone. While concerns such as treatment complexity, risk of complications, and responsibility for care are often highlighted by professionals, emerging evidence suggests that these do not always reflect the priorities or lived experiences of individuals receiving dialysis.²⁴ Recent findings indicate a clear discrepancy between patients and kidney professionals in how barriers to home dialysis are perceived. Whereas professionals tend to emphasise issues such as patient reluctance, social isolation, and the burden of responsibility, patients more often highlight structural and practical challenges, including access to support, communication with the care team, technological limitations, and financial or organisational barriers. At the same time, patients frequently identify independence and flexibility as key motivations for choosing home dialysis, even when the transition initially feels overwhelming.²⁴

Importantly, patient experiences suggest that adaptation to HHD is a dynamic process rather than a one-time decision.²⁵ For some individuals, early experiences of insecurity or feeling overwhelmed may gradually give way to increased confidence and a sense of mastery over time, particularly when consistent support is available. This aligns with previous research demonstrating that the anticipated experience of home dialysis may differ significantly from the lived experience, highlighting the importance of ongoing support and realistic expectations.²⁵

From a clinical perspective, this underscores the need to move away from assumptions about “typical patient concerns” and instead adopt a more exploratory and person-centred approach. Rather than

pre-emptively addressing perceived barriers, healthcare professionals should actively engage in dialogue to understand each individual's priorities, preferences, and contextual challenges.¹⁰ Providing clear, honest, and tailored information remains essential, but it should be grounded in the individual's own concerns and experiences. Demonstration of procedures, discussion of potential challenges, and development of contingency plans can support confidence when these are aligned with what the individual perceives as relevant.¹⁵ Equally important is ensuring accessible and responsive communication channels, as timely support has been identified by patients as a key factor in feeling safe when managing dialysis at home.⁶

Engagement with HHD is influenced by multiple interacting factors, including access to resources, perceived support, individual motivation, and the quality of the relationship with healthcare professionals. A strong therapeutic relationship, characterised by trust, continuity, and responsiveness, remains central.⁶ However, this relationship should be understood as a partnership in which the individual's perspective is actively sought, acknowledged, and integrated into care.¹⁰ By recognising the potential gap between professional assumptions and patient experiences, the home therapies training team can better tailor education and support. This approach not only enhances engagement and adherence but also contributes to a more person-centred and sustainable model of home dialysis care.

Conclusion

The home therapies training team plays a central role in enabling individuals to successfully undertake HHD. Through a comprehensive education and training programme, supported by effective communication, psychological care, and continuous professional engagement, individuals can develop the confidence and competence required to manage dialysis at home. A person-centred approach is fundamental to this process, ensuring that care is tailored to the individual's needs, preferences, and circumstances. By fostering partnership, supporting self-management, and addressing both practical and emotional challenges, nephrology teams can enhance both the experience and outcomes of home-based dialysis.

References

1. A. A. Bonenkamp, M. K. van Gelder, A. C. Abrahams, et al., "Home Haemodialysis in The Netherlands: State of the Art," *Netherlands Journal of Medicine* 76, no. 4 (2018): 144–157.
2. J. Antoun, D. J. Brown, D. J. W. Jones, et al., "Exploring Patients' Experiences of the Impact of Dialysis Therapies on Quality of Life and Wellbeing," *Journal of Renal Care* 49, no. 1 (2023): 15–23.
3. Perl J, Brown EA, Chan CT, Couchoud C, Davies SJ, Kazancioğlu R, et al. Home dialysis: conclusions from a kidney disease: improving global outcomes (KDIGO) controversies conference. *Kidney Int.* 2023;103(5):842–58.
4. Lynch F, Masani N, Carson J, Halinski C. Direct Transition from Hospital to Home Dialysis: Revolutionizing Home Dialysis Training. *Nephrol Nurs J.* 2024 Mar-Apr;51(2):143-152.
5. Rioux JP, Marshall MR, Faratro R, Hakim R, Simmonds R, Chan CT. Patient selection and training for home hemodialysis. *Hemodial Int.* 2015 Apr;19 Suppl 1:S71-9.
6. Nygaard-Andersen B, Torbjørnsen A, Hougaard PF, Leonardsen AL, Wolf A, Finderup J. Home-Based Dialysis and Person-Centered Care: A Scoping Review. *Nephron.* 2025;149(8):463-478.
7. Poinen K, Mitra S, Quinn RR. The integrated care model: facilitating initiation of or transition to home dialysis. *Clin Kidney J.* 2024 Jun 5;17(Suppl 1):i13-i20.
8. Finderup J, Jensen JD, Lomborg K. Shared decision-making in dialysis choice has potential to improve self-management in people with kidney disease: A qualitative follow-up study. *J Adv Nurs.* 2021 Apr;77(4):1878-1887.
9. Rizzolo K, Golestaneh L. The Role of Peer Support for Minoritized Individuals With Kidney Disease. *Kidney Int Rep.* 2024 Jan 18;9(3):497-500.
10. Britten N, Ekman I, Naldemirci Ö, Javinger M, Hedman H, Wolf A. Learning from Gothenburg model of person centred healthcare. *BMJ.* 2020 Sep 1;370:m2738.
11. Annelie J S, Lena H, Sandra, Mariela AM, Ewa CL, Inger K H. The COMCARE Framework for Person-Centred Communication-A Practical Caring Framework. *Scand J Caring Sci.* 2025 Sep;39(3):e70074.
12. Finderup J, Deeke M, Agerskov H, Bonner A. Beyond the Individual: Toward a Family-Centered Understanding of Dialysis Caregiving. *Am J Kidney Dis.* 2026 Apr;87(4):511-513.
13. Driehuis E, Peters SCE, Roeterdink AJ, Vogels TJFM, Goto NA, Broese van Groenou MI, de Wildt R, Dekker FW, van Jaarsveld BC, Abrahams AC; DOMESTICO Study Group. Trajectories of Experiences and Health-Related Quality of Life of Informal Caregivers of Home and In-Center Dialysis Patients: A Multicenter Longitudinal Cohort Study. *Am J Kidney Dis.* 2026 Apr;87(4):517-528.e1.
14. Payton J. Improving Communication Skills within the Nephrology Unit. *Nephrol Nurs J.* 2018 May-Jun;45(3):269-280.

15. Knudsen KK, Adrian CV, Jensen MH, Ilsøe S, Rugaard J, Poulsen SE, Kjærgaard KD, Funderup J. Developing and Evaluating a Home Hemodialysis Training Program-A Quality Improvement Study. *Hemodial Int*. 2025 Oct;29(4):496-506.
16. Bandura A. Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*. 1977;84(2):191–215.
17. Chao CT, Wu MY, Hung KY, Wu MS, Liang JC. Interprofessional Differences in Multidimensional Self-Efficacy Associated With Professional Performance in Nephrology During Case-Based Learning. *Kidney Int Rep*. 2024 Jan 12;9(4):877-887.
18. Lorig KR, Holman H. Self-management education: history, definition, outcomes, and mechanisms. *Ann Behav Med*. 2003 Aug;26(1):1-7.
19. Funderup J, Bjerre T, Soendergaard A, Nielsen ME, Zoffmann V. DEVELOPING LIFE SKILLS IN HAEMODIALYSIS USING THE GUIDED SELF-DETERMINATION METHOD: A QUALITATIVE STUDY. *J Ren Care*. 2016 Jun;42(2):83-92.
20. Ryan RM, Deci EL. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *Am Psychol*. 2000 Jan;55(1):68-78.
21. Bekker HL, Winterbottom AE, Gavaruzzi T, Funderup J, Mooney A. Decision aids to assist patients and professionals in choosing the right treatment for kidney failure. *Clin Kidney J*. 2023 Sep 13;16(Suppl 1):i20-i38.
22. Hanson CS, Chapman JR, Craig JC, Harris DC, Kairaitis LK, Nicdao M, Mikaheal M, Tong A. Patient experiences of training and transition to home haemodialysis: A mixed-methods study. *Nephrology (Carlton)*. 2017 Aug;22(8):631-641.
23. Concepcion Bachynski J, Duhn L, Costa IG, Camargo-Plazas P. Breaking Through the Glass Ceiling-Having That Conversation: A Constructivist Grounded Theory Study Exploring the Experiences of Nephrology Nurses' Practice in Kidney Supportive Care in Canada. *Can J Nurs Res*. 2026 Jun;58(2):141-155.
24. Torbjørnsen A, Nygaard-Andersen B, Kiani K, Leonardsen ACL, Wolf A, Pripp AH, Hougaard PF, Funderup J. Factors influencing home dialysis choice in Scandinavia: a cross-sectional study. Manuscript submitted for publication.
25. Rygh E, Arild E, Johnsen E, Rumpsfeld M. Choosing to live with home dialysis-patients' experiences and potential for telemedicine support: a qualitative study. *BMC Nephrol*. 2012 Mar 19;13:13.

Chapter 6

Safety and Risk Management in Home Haemodialysis

Learning objectives

- To identify the main clinical, technical and human-factor risks associated with HHD, and the strategies used to prevent them.
- To describe how to train and support people receiving HHD and care partners to recognise and manage emergencies and common complications safely at home.
- To explain the role of communication and a structured quality assurance programme (including incident reporting and continuous improvement) may improve safety in HHD programmes.

Introduction: Safety in the Home Context

HHD has re-emerged over the past two decades as a highly effective and increasingly utilised modality of kidney replacement therapy. Clinical benefits associated with HHD include improved blood pressure control, enhanced phosphate management, greater treatment flexibility and improved quality of life and survival outcomes compared with conventional in-centre HD.¹⁻³ However, HD is a complex medical treatment that carries inherent risks, and HHD shifts care from a supervised clinical environment to the domestic setting. In this new context, the person receiving dialysis and where applicable their care partner, assumes responsibilities that in a dialysis centre would normally be undertaken by nursing staff. These responsibilities include continuous observation of the treatment, management of equipment and consumables, responding to alarms and making timely decisions during unexpected situations.^{4,5}

This shift does not simply change the location of care; it fundamentally reshapes the concept of patient safety. Whereas in in-centre HD safety systems rely on professional oversight, rapid access to medical intervention and multilayered institutional protocols, in the HHD setting safety depends on the competence, vigilance and preparedness of the person with ESKD and where applicable, their care partner. For nephrology nurses, this represents a transition from direct procedural supervision to a role centred on education, empowerment, ongoing support, and risk anticipation.⁵⁻⁷

Risk refers to the probability that an adverse event may occur during any stage of the treatment process. An adverse event is any unintended or unexpected incident that may have clinical, technical, or environmental consequences, potentially compromising the safety of the person receiving dialysis, the care partner, or the home setting. Risk management in HHD aims to minimise the likelihood of such events and reduce their impact should they occur. A rapid response plan must also be in place to manage adverse events promptly and safely. People performing HHD should know exactly what to do in the event of bleeding, hypotension, equipment malfunction, or other emergencies. Evidence from large observational cohorts suggests that serious procedure-related adverse events in HHD are uncommon. Reported life-threatening event rates range between approximately 0.04 and 0.06 per 1,000 treatments. Nevertheless, although rare, events such as catastrophic blood loss due to needle dislodgement, air embolism or severe technical error may have fatal consequences. The low frequency but potentially high severity of such events highlights the importance of proactive prevention in home dialysis safety.^{8,9}

Safety in HHD should therefore be conceptualised not merely as the absence of complications, but as the outcome of a structured, anticipatory, and collaborative risk management strategy. It is shaped by the interaction between the individual, the home setting, the healthcare team, and the dialysis equipment. Relationships based on mutual trust, effective communication and shared accountability are essential components of safe home treatment. For nephrology nurses, this means moving beyond technical competencies alone. It requires preparing individuals to recognise potential hazards, critically assess their clinical significance, and respond in a timely and appropriate manner. Key components of safe practice in HHD are outlined in **Box 1**. When systematically integrated into routine clinical practice, these elements strengthen risk prevention, enhance quality of care, and contribute to the long-term sustainability of HHD programmes.⁴⁻⁹

- Careful selection and structured assessment of the person receiving HHD and, where relevant, their care partner
- Comprehensive, competency-based training
- Verification of correct equipment function and environmental safety
- Strict adherence to clinical and technical protocols
- Ongoing monitoring of treatment parameters
- Clear communication pathways and continuous access to professional support
- Implementation of infection prevention and complication management measures
- Systematic recording and analysis of incidents to support continuous improvement

Box 1. *Key Components of Safe Practice in HHD.*

Comprehensive risk management is therefore not a separate activity, but an integral and ongoing component of high-quality HHD care. Developing a strong safety culture requires organisational commitment and active participation from all stakeholders. For nursing teams, promoting a culture of safety in HHD requires continuous education, supportive follow-up, constructive feedback, and the reinforcement of safe practices. In practical terms, this means fostering an environment in which patient safety is recognised as a shared priority, open communication is encouraged, incident reporting is free from blame, learning from errors and near misses is routine, and continuous improvement is embedded in daily practice. Safety in HHD is best understood as a dynamic system integrating human factors, technology, environment, and organisational culture.⁵⁻⁷ This chapter explores how these elements interact and outlines practical strategies to strengthen safety in HHD programmes.

Training People for Safe Home Haemodialysis

Patient Selection and Home Environment Assessment as a Safety Strategy in HHD

The selection and assessment of a candidate for HHD should not be viewed as a purely administrative step, but rather as a fundamental component of preventive care. A structured evaluation transforms a potentially vulnerable domestic environment into a safe therapeutic

space. Careful assessment allows the multidisciplinary team to identify the conditions necessary for safe and autonomous practice. It enables the design of a personalised training plan, adaptation of technical resources to individual needs and the establishment of follow-up mechanisms that reinforce safety throughout the therapeutic process. This approach strengthens patient protection, optimizes healthcare resources and promotes more person-centred humane care.^{6,7}

Patient selection for home haemodialysis should go beyond clinical stability and include evaluation of the home environment, support network, motivation, learning capacity and level of commitment, as these factors directly influence adherence and the safe self-management of treatment. Although no universally accepted inclusion and exclusion criteria exist for HHD, patient selection should involve a multidisciplinary assessment—typically including nephrologists, nephrology nurses and, when appropriate, psychologists—to determine whether the patient can safely assume responsibility for home treatment. Given the high level of autonomy required, this evaluation is essential to ensure both patient safety and program success (**Figure 1**).¹⁰

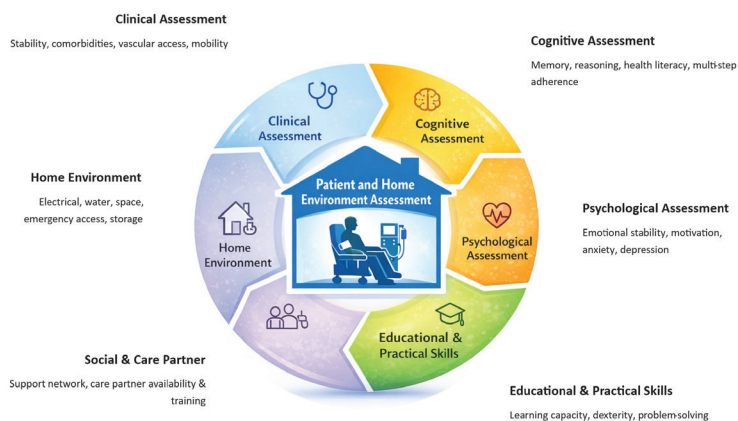


Figure 1. Patient Selection and Comprehensive Home Environment Evaluation for HHD.

Clinical Assessment

Clinical stability is a prerequisite for safe HHD.¹⁰ Assessment should include:

- Overall clinical stability
- Identification of comorbidities that may interfere with treatment performance
- Type and condition of vascular access and its suitability for independent management
- Functional status and mobility

The Charlson Comorbidity Index may be used as a supportive tool to assess comorbidity burden and risk profile. However, clinical judgement remains central to decision-making.

Cognitive Assessment

The individual must be able to understand instructions, make informed decisions, and maintain adherence to treatment.^{10,11} Key aspects include:

- Executive functions (memory, attention, reasoning)
- Ability to follow multi-step procedures
- Capacity to respond appropriately to unexpected situations
- Health literacy

Assessment tools may include structured interviews, behavioural observation during training sessions and, where appropriate, cognitive screening tools such as the Trail Making Test. Practical demonstrations during training often provide valuable insight into real functional capacity.

Psychological Assessment

Psychological status can significantly influence treatment adherence and safety.^{11,12} Evaluation should explore:

- Emotional stability
- Motivation to assume self-care responsibilities
- Attitude towards treatment-related responsibility

- Presence of anxiety, depression, or other psychological conditions

Direct conversation, structured interviews and validated anxiety or depression scales may be used when indicated. The objective is not to exclude patients unnecessarily, but to identify support needs and tailor follow-up appropriately.

Educational and Practical Skills Assessment

HHD requires the acquisition of theoretical knowledge and practical skills.¹³ Assessment should consider:

- Learning capacity
- Manual dexterity
- Ability to understand and apply technical instructions
- Problem-solving skills

Exploring occupational background, hobbies or previous technical experience (e.g. manual work, DIY activities, reading habits, structured games) may provide additional insight into autonomy and cognitive habits. Observational assessment during training is often the most reliable indicator of readiness.¹³

Social and Care Partner Assessment

The social environment plays a critical role in safety and treatment success. Evaluation should include:

- Availability of a committed care partner when the individual unable to function independently
- Existence of a broader support network
- Family understanding of treatment demands

Where a care partner is required, their motivation, availability, and willingness to participate in training must be confirmed. Safety cannot rely on an unprepared or reluctant support person.⁷

Home Environment Assessment

The domestic environment must be compatible with safe treatment delivery.¹⁴ Assessment should include:

- Electrical and water installations compatible with dialysis equipment
- Adequate space, lighting, and ventilation
- Structural and environmental safety for machine installation
- Access to emergency medical services
- Availability of telephone or telematic communication
- Dedicated storage space for consumables

Evaluation may be conducted through a structured interview, a home visit or reviewing photographs when an in-person assessment is not feasible.¹⁴ **Table 1** illustrates an example of how HHD can be safely integrated into the domestic environment.

Component	Requirements for Safe Home Haemodialysis
Patient Area	Approximately 5 m ² of dedicated space with adequate lighting and ventilation. Sufficient room for a reclining chair and dialysis monitor. Access to water supply and drainage where required.
Equipment Placement	Stable surface for the dialysis monitor. Clear visibility of the screen and alarms. Safe positioning of tubing to avoid tension or accidental disconnection.
Storage of Consumables	Dedicated cabinet or shelving for materials required for each session. Separate storage space for weekly or bulk supplies. Clean, dry, and organised area.
Waste Management	Sharps container located within the treatment area. Safe disposal of consumables according to local regulations. Non-recyclable disposable materials discarded with household waste when appropriate.
Utilities and Infrastructure	Compatible electrical installation. Adequate water supply and drainage. Reliable power source. Access to telephone or internet connection for communication with the renal team.
Emergency Preparedness	Clear access pathways. Emergency contact information readily available. Adequate space to manage complications if required.

Table 1. Example of a Suitable HHD Space.

Education and Patient Empowerment

Education and patient empowerment are closely linked and represent a cornerstone of safety in HHD. Education in this context does not consist merely of transmitting information; it involves supporting individuals in acquiring the knowledge, practical skills, and confidence necessary to perform treatment safely and independently.^{13,16,17}

During the learning process, the most appropriate educational strategies should be selected for each individual. Teaching methods must be adapted to cognitive abilities, learning pace, previous experience, and personal circumstances. Practical demonstrations, supervised repetition, written materials, visual aids, and digital resources may all contribute to effective learning. Training should not be understood as a single event, but as a continuous process. It must evolve alongside the person's clinical condition and adapt to technological and therapeutic developments.^{15,16} Ongoing education should include key aspects such as troubleshooting common incidents, safe use of emergency devices, recognition of warning signs and appropriate communication with the reference centre.^{11,17}

However, empowerment goes beyond technical instruction. It involves integrating knowledge into daily practice, developing autonomy, strengthening self-confidence and assuming an active and responsible role in treatment. Empowerment enables the person receiving HHD to move from being a passive recipient of care to becoming an informed and engaged participant in their own health management.¹⁸⁻²⁰ For education to translate into genuine empowerment, it must be supported by a strong therapeutic relationship. This relationship should be based on empathy, open two-way communication, and active listening. Nephrology nurses play a leading role in building this relationship, creating a safe space where questions can be asked without fear, and difficulties can be discussed openly.^{13,16}

Patient-centred care further consolidates this therapeutic bond. Recognising the individual as the protagonist of their health journey—respecting their values, emotions, and personal circumstances—creates an emotionally supportive context that enhances participation and engagement. In this framework, empowering the person receiving HHD involves enabling them to make informed decisions, consistently adhere to established protocols, recognise potential risks, respond appropriately to unexpected situations, and actively

engage in their own self-care. This transformation has a direct impact on safety. Increased competence and confidence reduce the likelihood of human error, improve adherence to treatment, and foster a proactive attitude towards risk prevention.²⁰ Empowerment is therefore not only an ethical principle of person-centred care, but also a measurable safety strategy in HHD.¹⁸⁻²⁰

The Care Partner as an Additional Safety Layer

The care partner is an important agent in patient safety within the home setting. Their role extends beyond emotional accompaniment and is adjusted according to the level of autonomy and independence of the person receiving HHD. Depending on individual capabilities, the care partner's involvement may range from technical assistance and clinical observation to emergency management and communication with the healthcare team. Their support should be flexible and responsive to the patient's evolving needs and functional capacity.⁷ These actions contribute directly to the prevention of complications and the strengthening of the therapeutic environment. The practical contributions of the care partner to treatment safety are outlined in **Table 2**.^{7,21}

Function	Role and Contribution to Safety
Technical assistance and supervision of treatment	Support with specific procedural steps when required, such as assisting with central venous catheter connection, maintaining hygiene and aseptic technique, and preparing materials.
Management of adverse events	Recognition of early symptoms and prompt response to complications such as hypotension or bleeding due to accidental disconnection. A trained care partner reduces response time and, when necessary, contacts the nephrology team or emergency services according to established protocols.
Reduction of stress and anxiety	Support in establishing stable treatment routines and providing emotional reassurance. A calmer patient is more likely to tolerate treatment well and less likely to make errors related to anxiety or distraction.
Contribution to session documentation	Assistance in recording treatment parameters and relevant clinical observations to enhance traceability and continuity of care.
Support in the educational process	Reinforcement of procedural understanding and safety measures, consolidating learning and strengthening adherence.

Table 2. Key Functions of the Care Partner in HHD.

Minimum Competencies of the Care Partner

When a care partner is involved, it is important to ensure that they are committed and included in the training process from the outset of the HHD programme.^{7,21} Their preparation should be structured, supervised, and periodically reinforced to maintain competence and confidence over time. To function effectively as an additional safety layer, the care partner should demonstrate the ability to:

- Safely interrupt the dialysis session and perform blood return when required
- Assist with needle removal in patients with an AVF
- Apply effective compression to a bleeding puncture site
- Position a hypotensive patient appropriately, initiate first-line measures and contact emergency services if indicated
- Use established communication systems to contact the nephrology team

While the involvement of a care partner represents an important additional safety layer, it should not be considered an absolute requirement in all cases. Serious adverse events in HHD are uncommon when patients are carefully selected and appropriately trained.^{4,8,9} In highly motivated individuals who demonstrate excellent technical competence, consistent adherence to protocols and strong situational awareness, fully autonomous (unassisted) HHD may be safely performed. Requiring the constant presence of a care partner in every case could unintentionally exclude individuals who live alone, lack family support or prefer not to involve relatives in their treatment (for example, choosing to dialyse independently while a partner is at work).^{3,22} Therefore, the decision regarding assisted or autonomous dialysis should be individualised, based on structured assessment, documented competency and shared agreement within the multidisciplinary team. Ensuring safety in HHD requires balancing rigorous risk management with respect for patient autonomy and equitable access to home therapy.²²

Equipment Selection as a Safety Strategy in Home Haemodialysis

The selection of dialysis equipment is a critical component of safety in HHD. The use of monitors specifically designed for the home setting enhances safety by reducing the occurrence of adverse events,

particularly those associated with technical and human error.⁸ Key design and safety features of HHD equipment are summarised in **Table 3**. Equipment intended for HHD should prioritise simplified operation and error prevention. Intuitive interfaces, integrated automatic safety systems and rigorous monitoring of dialysate and water quality reduce reliance on manual technique and minimise the risk of incorrect handling. In the home setting, the dialysis machine itself functions as a primary safety barrier; therefore, essential features such as clear visual and audible alarms, air detection within the extracorporeal circuit, dialysate temperature control and automatic shutdown mechanisms are fundamental. Additional functionalities—including remote data transmission, integrated educational resources, energy-efficient design, and ease of cleaning—further enhance safety, support patient autonomy, and facilitate the integration of treatment into daily life.^{3,8,21}

Additional Considerations for Nocturnal Home Haemodialysis

Safety Domain	Design Features
Design Simplification	Intuitive user interfaces that reduce the probability of programming errors, incorrect connections, and inappropriate responses to alarms.
Integrated Automatic Safety Systems	Automated priming, self-diagnostic functions, leak detection, and other built-in safeguards that reduce dependence on manual technique.
Dialysate and Water Control	Continuous monitoring systems that ensure correct conductivity and treatment parameters.
Essential Safety Barriers in the Home Setting	Clear and easily interpretable visual and audible alarms. Air detection within the extracorporeal circuit. Continuous monitoring of dialysate temperature. Automatic shutdown in the event of critical malfunction.
Additional Recommended Features	Automatic data recording and remote connectivity enabling real-time or periodic transmission of treatment data to the nephrology team. Integrated user manuals and digital educational resources to support patient autonomy. Energy-efficient operation and low noise levels to enhance domestic suitability. Ease of cleaning and maintenance to reduce infection risk.

Table 3. *Design and Safety Features of Equipment for HHD.*

In nocturnal HHD, additional safety measures are recommended due to the increased vulnerability associated with treatment during sleep. Prolonged overnight sessions may delay recognition of bleeding or

disconnection events. For this reason, vascular access site blood leak detectors and connection monitoring systems should be incorporated as additional safety barriers.²² These devices trigger audible alarms when blood or moisture is detected around the vascular access or extracorporeal circuit. Reports of severe bleeding events in HHD have identified needle dislodgement during nocturnal treatment as a critical risk factor, reinforcing the importance of dedicated leak detection systems. When nocturnal HHD is performed autonomously, careful preparation and confidence in the system are essential. Comprehensive training, adherence to clear protocols and dependable safety technology provide reassurance and support safe practice. With appropriate patient selection, well-designed safeguards and clearly defined emergency procedures, extended or overnight treatments can be undertaken safely and with confidence.²²

Strict Adherence to Standardised Clinical and Technical Protocols

Rigorous adherence to clinical and technical protocols is fundamental to ensuring safety in HHD.¹¹ These standardised procedures, grounded in evidence-based practice, reduce variability, prevent complications and transform the home into a safe therapeutic environment.^{23,24} During the training process, individuals receive structured instruction on the protocols governing treatment at home. These include clear guidance on equipment handling, hygiene practices, infection prevention, troubleshooting common incidents and the use of emergency devices. Protocols also define communication pathways with the reference centre, clinical follow-up schedules, and recommended actions in unexpected situations. By following standardised procedures, errors related to improvisation or uncertainty are minimised, and effective responses to complications are facilitated.²⁵ Clinical and technical standardisation ensures comprehensive follow-up, early detection of complications and continuity of care, covering both patient monitoring and the operational management of dialysis equipment (**Table 4**). Adherence to protocols also reinforces patient empowerment by providing a clear and structured framework for action.^{11,24,25}

Clinical Standardisation	Technical Standardisation
Periodic evaluation of overall health status – Regular laboratory monitoring – Monitoring of vital signs, dry weight, and nutritional status	Appropriate equipment selection – Selection of home haemodialysis monitors and related systems by the healthcare team

Clinical Standardisation	Technical Standardisation
Vascular access surveillance – Correct handling of the vascular access – Strict infection prevention measures – Monitoring for signs of thrombosis, dysfunction, or infection	Structured training and competency assessment – Evaluation of physical, cognitive, and emotional capacity – Intensive training in machine operation and vascular access management
Management of complications – Identification and response to hypotension, bleeding, access dysfunction, technical errors, and warning symptoms	Home installation verification – Assessment of electrical, water and environmental conditions – Installation of water treatment systems when required
Emotional and educational support – Reinforcement of empowerment – Clarification of doubts and review of practices	Standardised connection and disconnection procedures – Preparation and priming of the extracorporeal circuit – Safe vascular access connection and disconnection
Documentation and traceability – Daily recording of sessions and incidents – Continuous communication with the healthcare team	Equipment maintenance and incident reporting – Daily cleaning and periodic disinfection – Alarm checks and calibration – Communication with technical support services

Table 4. *Standardised Clinical and Technical Protocols in HHD.*

Managing Common Complications at Home

HHD introduces specific safety challenges derived from the shift of care from a supervised clinical environment to the patient's home.^{4,8,9} Although continuous professional observation is not present, well-structured programmes demonstrate that serious adverse events remain uncommon when appropriate training, monitoring and quality assurance systems are implemented. In this context, the management of complications must be proactive rather than reactive. Anticipation of potential adverse events, early recognition of warning signs and predefined response strategies are essential components of safe practice. The main risk domains in HHD, together with their

prevention and response principles, are summarised in **Table 5**.²⁶

Domain	Typical Events	Prevention Strategies	Immediate Response Principles
Vascular access-related events	- Needle dislodgement - Line disconnection - Access bleeding - Difficult cannulation - Access dysfunction - Local infection	- Structured cannulation training and periodic reassessment - Secure Luer-lock connections - Appropriate needle fixation - Use of blood leak detection systems - Routine monitoring of pressures and flows - Strict aseptic technique	- Stop blood pump immediately - Clamp lines - Apply direct pressure to bleeding site - Assess haemodynamic status - Activate emergency plan if significant blood loss occurs - Contact dialysis team
Cardiovascular instability	- Intradialytic hypotension - Presyncope - Muscle cramps - Symptomatic hypertension	- Individualised ultrafiltration limits (≤ 10 ml/kg/h) - Optimisation of antihypertensive therapy - Careful dry weight assessment - Gradual adaptation during training - Education on salt and fluid restriction	- Stop or reduce ultrafiltration - Place patient supine - Administer fluid bolus if indicated - Reassess vital signs - Contact healthcare team if symptoms persist or recur

Domain	Typical Events	Prevention Strategies	Immediate Response Principles
Infection	- Local access infection - Exit-site inflammation - Fever - Suspected bloodstream infection	- Repeated hand hygiene training - Use of gloves and masks - Sterile connection technique - Routine access inspection - Automated machine disinfection - Water quality monitoring - Early reporting of symptoms	- Stop dialysis if clinically unstable - Assess temperature and symptoms - Obtain medical advice promptly - Initiate emergency care if systemic signs are present
Technical complications	- Alarm misinterpretation - Circuit misconnection - Priming or rinse-back errors - Dialysate leak - Equipment malfunction	- Comprehensive equipment training - Standardised checklists - Automated priming and self-diagnostic systems - Periodic retraining - Avoidance of improvisation - Remote support access	- Stop blood pump - Clamp circuit if required - Do not attempt untrained repairs - Contact technical support or dialysis unit - Activate emergency services if patient instability occurs

Domain	Typical Events	Prevention Strategies	Immediate Response Principles
Human factors	- Omission of protocol steps - Incorrect connections - Failure to respond to alarms - Fatigue-related errors - Cognitive or visual limitations	- Structured training and competency assessment - Use of checklists - Simulation exercises - Periodic cognitive and functional evaluation - Monitoring for patient or caregiver burnout - Supportive follow-up	- Pause treatment if uncertainty arises - Follow predefined protocol - Seek guidance from dialysis team - Avoid improvisation - Escalate care if patient safety is compromised

Table 5. Common complications in HHD: risk domains, prevention, and immediate response.

Vascular Access–Related Events

VA remains the cornerstone of safe HD delivery. In the home setting, frequent self-cannulation and repeated manipulation of the access introduce variability that may increase the risk of both mechanical and infectious complications.²⁷ Local infections may arise from subtle deviations in aseptic techniques. Variability in cannulation angle, incomplete hand hygiene, inconsistent mask use, or improper removal of crusts in buttonhole technique may progressively compromise access integrity. For this reason, periodic face-to-face reassessment of cannulation techniques is strongly recommended, even in experienced patients. Mechanical complications—including haematomas, stenosis, infiltration, or progressive dysfunction—may be more difficult to identify early at home. Structured surveillance through regular review of arterial and venous pressures, blood flow trends and patient-reported difficulties facilitates timely intervention.^{26,27}

Catastrophic bleeding due to needle dislodgement or line disconnection represents one of the most feared complications in HHD. Although rare, such events are typically associated with human error rather than device malfunction. Secure fixation of needles, correct Luer-lock connections and consistent adherence to protocol significantly reduce this risk. Importantly, patients must be trained not only in prevention but also in immediate haemorrhage control and emergency activation procedures.^{4,8,26}

Cardiovascular Instability

Intradialytic hypotension remains one of the most common treatment-related complications across all dialysis modalities. In HHD, its occurrence is influenced by interdialytic weight gain, cardiovascular comorbidity, and the accuracy of dry weight assessment. Current programmes emphasise strict ultrafiltration control, with predefined hourly removal limits and individualised prescriptions. During the initial training phase, anti-hypertensive therapy is often reassessed and progressively adjusted. Patients are educated to recognise early symptoms—such as dizziness, visual disturbance, or nausea—and to act promptly according to predefined protocols. While severe haemodynamic collapse is rare in the home setting, early symptom recognition and structured response pathways remain critical for maintaining safety and patient confidence.^{21,26}

Infection Prevention

Infectious complications continue to be a major safety concern in dialysis care. In HHD, both the vascular access and the domestic environment may become potential sources of contamination. Strict hand hygiene, correct preparation of the access site, avoidance of contact with sterile connectors and routine inspection of the exit site or puncture areas are fundamental measures. Advances in dialysis technology—including automated disinfection cycles and improved monitor reliability—have contributed to reducing infection rates. However, consistent human behaviour remains the determining factor. Structured education, periodic reinforcement, and prompt communication with the dialysis team at the first sign of infection are essential to prevent systemic complications.⁹

Technical Complications

Technical complications may arise from incorrect connections, alarm misinterpretation, priming or rinse-back errors, or equipment malfunction.⁸ Although modern HHD monitors incorporate integrated self-diagnostic systems and automatic safety mechanisms, most severe technical events reported in the literature are linked to deviations from established procedures. This highlights the importance of avoiding improvisation and reinforcing standardised checklists. Any incident, however minor, should trigger structured review and retraining when necessary.^{23,25,26} As a practical preventive measure, a structured pre-connection checklist may function as the final safety barrier before starting treatment (**Box 2**). By formalising self-verification immediately prior to connection, this tool reduces cognitive overload, reinforces protocol adherence, and mitigates human-factor risk.

“My Safe Dialysis” Pre-Connection Safety Checklist

This structured checklist should be completed before each session to minimise preventable technical and human-factor errors.

1. Environment and Personal Status

- ☐ **General wellbeing assessment:** Absence of fever, hypotension, dizziness or other unusual symptoms.
- ☐ **Support availability:** Care partner present if required, or immediate access to telephone.
- ☐ **Workspace safety:** Clean, organised area free from pets, distractions or contamination risks.
- ☐ **Utilities verification:** Stable electricity and water supply; adequate room temperature.

2. Equipment and Machine Verification

- ☐ **Expiry check:** Dialyser and lines within valid expiry dates.
- ☐ **Package integrity:** Sealed, dry and correctly stored materials.
- ☐ **Prescription accuracy:** Dialyser type, concentrates and consumables correspond to medical prescription.
- ☐ **Machine self-test:** Dialysis monitor has successfully completed all internal safety checks.

3. Hygiene and Vascular Access Assessment

- ☐ **Hand hygiene:** Proper hand washing performed; alcohol-based hand gel available.
- ☐ **Access preparation:** Fistula washed with soap and water or catheter cleaned according to protocol; mask worn.
- ☐ **Access assessment:** Presence of fistula thrill; absence of infection signs; catheter patency confirmed.
- ☐ **Final antisepsis:** Antiseptic applied with correct contact and drying time respected.

4. Critical Safety Final Check

- ☐ **Emergency materials available:** Clamps and sterile gauze within immediate reach.
- ☐ **Emergency algorithm visible:** Rapid Response Plan and contact list clearly accessible.
- ☐ **Programming verification:** Weight and treatment parameters confirmed according to prescription.

Human Factors

Human factors represent a transversal domain that influences all other categories of complications.^{11,17} Fatigue, anxiety, progressive cognitive decline, visual impairment, or caregiver burnout may gradually compromise adherence to protocols. Errors may manifest as omitted steps, incorrect connections, failure to respond appropriately to alarms or unauthorised modification of prescribed treatment parameters. These situations underscore the need for periodic cognitive and functional reassessment throughout the duration of the home programme.²⁶

Overall, serious adverse events in structured HHD programmes are uncommon, as consistently shown in experienced cohorts.^{4,8,9} However, maintaining this safety profile requires more than the absence of complications: it depends on the systematic integration of technical safeguards, rigorous and ongoing training, and sustained clinical oversight led by the nursing team. In the home setting, safety is dynamic and must be actively reinforced through continuous education, periodic reassessment of patient and caregiver competencies, early recognition of warning signs and prompt, protocol-driven responses to any deviation from expected parameters. Within this framework, the nursing team plays a central role in empowering patients and care partners to recognise and manage acute emergencies effectively, ensuring that autonomy is always accompanied by structured support and professional supervision.²⁶

Coordination with Health Care Providers and Emergency Services

In HHD, the person receiving treatment is not only a recipient of care but also an **active participant** in the delivery of therapy.¹⁸ By performing clinical procedures, making real-time decisions, and applying preventive measures, patients directly contribute to their own safety. This active role carries responsibility: applying training rigorously, reporting any incident without delay and engaging in the continuous improvement of care processes. For this reason, a structured communication protocol between the patient and the nephrology team is essential.²⁵

Communication pathways should be clearly defined from the outset of the programme and include multiple channels, such as scheduled

in-person reviews, remote follow-up through telemonitoring systems, secure email communication, and regular telephone contact. Continuous exchange of information enables the clinical team—particularly the nursing team—to review treatment data, detect early deviations from expected parameters and implement timely corrective actions. Evidence from established HHD programmes highlights that structured follow-up and accessible professional support are key components of patient safety. Communication must be reciprocal. Patients and care partners should feel empowered to ask questions, clarify uncertainties and report concerns without fear of criticism. The language used by professionals should be adapted to the individual's level of health literacy, respectful and empathetic, thereby reinforcing trust and therapeutic alliance. A culture of openness and psychological safety encourages transparent reporting of incidents and near misses, which in turn strengthens overall programme safety.^{11,25,26}

Telephone communication remains a cornerstone of remote support but may present challenges in interpretation. To improve clarity and reduce misunderstandings, healthcare professionals should:

- Speak at a measured pace
- Use brief but frequent pauses
- Provide periodic summaries and recapitulations
- Ask and answer questions clearly and concretely
- Deliver instructions in logical sequence
- Conclude the call in a structured manner
- Complement verbal instructions with written information whenever possible

In the event of an adverse occurrence, rapid, open and non-judgemental communication is critical.¹⁵ Patients should be encouraged to describe what happened, including potential contributing factors, without fear of blame. Such transparency is only achievable when a respectful and supportive communication culture has been established in advance.^{25,26}

Technological tools can further reinforce communication pathways. The use of devices with Bluetooth connectivity and remote data transmission capabilities allows real-time or near-real-time

monitoring of treatment parameters. While technology does not replace human interaction, it complements and strengthens the relationship between patients and the nephrology team by enhancing oversight, responsiveness, and reassurance. Ultimately, HHD should be understood as autonomous but never isolated care. Continuous, structured, and empathetic communication ensures that patients remain supported, supervised and safely always connected to their clinical team.^{11,21}

Incident Reporting and Continuous Improvement

Safety in HHD requires systematic measurement, analysis, and comparison of outcomes. Clearly defined safety and quality indicators enable programmes to evaluate performance, identify areas for improvement, and ensure that treatment delivered at home meets the same standards as hospital-based dialysis. Continuous monitoring of these indicators is fundamental to adverse event prevention and quality assurance.^{11,17,25,26} A structured incident reporting system is central to this process. All adverse events, near misses and protocol deviations should be documented in detail, including their type, severity, contributing factors, immediate actions taken and clinical outcome. This structured documentation supports root cause analysis, facilitates continuity of care, and enables the identification of recurrent risk patterns such as vascular access infections, haemodynamic instability, technical failures or human error. In this context, a structured continuous improvement plan is proposed, integrating both systematic data collection and the implementation of corrective and preventive actions. Proactive identification of risks and continuous monitoring of processes allow strategies to be adapted to the real needs of the programme and patient population.^{25,26}

However, data collection alone is insufficient. Information must be actively analysed and translated into measurable improvements. Continuous improvement in HHD programmes can therefore be organised using the PDCA cycle, illustrated in **Figure 2**. This framework ensures that safety initiatives are not reactive but systematic: incident analysis informs planning; implemented changes are evaluated through structured audits and indicator monitoring; and effective measures are standardised and embedded into routine practice.^{23,25}

Plan

- Identify risks and priority areas for improvement in quality and safety based on systematic analysis of recorded incidents.
- Review incident logs and analyse key safety indicators such as vascular access infection rates, intradialytic hypotension episodes and critical technical alarms.
- Define clear, measurable objectives (e.g. reduce vascular access infections by 20% within six months).
- Design targeted protocols, safety checklists and preventive strategies tailored to identified risks.

Do

- Implement planned modifications in clinical practice and operational procedures.
- Introduce enhanced safety routines (e.g. double verification of vascular access preparation, reinforced hand hygiene protocols).
- Provide updated training for healthcare professionals and patients.
- Distribute educational materials and integrate structured checklists into routine sessions.
- Ensure consistent documentation of all sessions and safety measures.

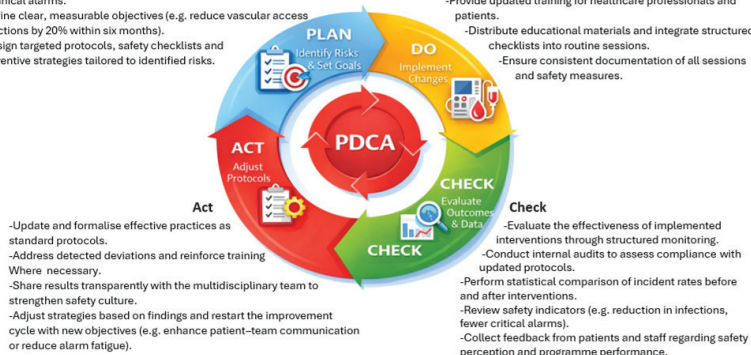


Figure 2. Continuous Improvement Cycle (Plan–Do–Check–Act) applied to HHD Programmes.

Beyond strengthening safety, this approach fosters a culture of continuous learning. The improvement plan should include continuous education for both healthcare professionals and patients, regular updates of clinical protocol, incorporation of technological tools for incident recording and analysis, and the promotion of open communication among all stakeholders. In this way, interventions become not only effective but sustainable over time, ensuring the progressive enhancement of HHD care. Under the leadership of the nursing team, this evolving process transforms individual incidents into opportunities for shared learning and long-term programme development.²⁶

Rapid Response Plan for Adverse Events

The Rapid Response Plan for Adverse Events is designed to ensure prompt management of unexpected incidents during HHD. It uses a structured, severity-based algorithm to classify events into Green, Yellow and Red levels, supporting safe and proportionate decision-making home setting. This framework provides clear guidance for action and communication without replacing professional medical care. The algorithm depicted in Figure 3 presents a stepwise approach to the management of acute complications in the home

setting, guiding immediate and safe decision-making while facilitating timely contact with the nephrology team or emergency services.^{11,25}



Figure 3. Immediate Response Algorithm for Complications in HDD.

The severity-based escalation framework is summarised in **Table 6** and distinguishes between incidents that can be managed independently, situations requiring remote professional guidance, and true medical emergencies demanding immediate activation of external emergency services. This structured differentiation allows patients and care partners to calibrate their response according to clinical severity. Minor technical incidents (Green Level) may be resolved using training and troubleshooting guides, provided that they do not compromise patient stability. Persistent clinical or technical events (Yellow Level) require interruption of treatment when appropriate and prompt contact with the HDD team for professional guidance. Major emergencies (Red Level) demand immediate interruption of the extracorporeal circuit and activation of emergency services.²⁶

Severity Level	Risk Profile	Examples	Immediate Actions
● Green Level Minor Technical Incident	- Interruption of session without clinical compromise. - Patient able to resolve independently using training and technology safeguards.	- Low dialysate inlet pressure - Blood pressure cuff reading error - Missing consumables - Positional or clamp-related pressure alarms	1. Silence alarm and read message 2. Follow Visual Troubleshooting Guide 3. Resume session if resolved 4. Record event in daily log 5. Escalate if unresolved after two attempts
● Yellow Level Persistent Clinical or Technical Incident	- Safety compromised but no immediate life-threatening risk. - Requires professional clinical judgement.	- Persistent hypotension or dizziness - Muscle cramps not resolving - Dysfunctional vascular access - Recurrent alarms - Medication administration errors	1. Stop blood pump if needed 2. Apply trained corrective measures 3. Assume safe position 4. Contact HHD Unit or technical support 5. Decide on continuation or termination
● Red Level Major Emergency	- Immediate risk to life, limb, or vascular access. - Requires urgent interruption and emergency activation.	- Line disconnection with blood loss - Chest pain - Loss of consciousness - Seizures - Needle dislodgement with bleeding - Loss of extracorporeal circuit	1. Emergency stop or clamp lines immediately 2. Perform manual blood return if safe 3. Activate emergency services 4. Inform care partner 5. Notify HHD Unit after stabilisation

Table 6. Severity-Based Escalation Model for Adverse Events in HHD.

The key objectives of the rapid response plan are to:

- Facilitate early recognition of abnormal or potentially dangerous situations
- Ensure immediate and structured communication with the reference team
- Establish safe initial actions that can be performed at home
- Promote systematic recording and analysis of incidents to strengthen programme safety

The rapid response plan is introduced from the beginning of the training process and reinforced throughout follow-up.²⁶ During training, individuals must develop the ability to recognise warning signs, interpret alarm warnings, and apply appropriate corrective measures. Practical simulations are essential to consolidate competence, particularly for Yellow and Red Level scenarios.¹¹ Patients should clearly understand:

- Which symptoms or alarm signals require immediate action
- How to apply basic initial measures while awaiting professional support
- Which communication channels to use for urgent incidents
- The criteria for attending a healthcare facility or activating emergency services

To facilitate access to essential information at home, the nursing team may provide:

- Printed or digital guidance documents
- Visual flowcharts summarising the response pathway
- Clearly structured 24/7 contact lists for the nephrology team and emergency services

These materials function as structured cognitive supports, helping patients maintain clarity and confidence under stress.^{4,8}

For effective integration into routine practice, it is recommended to:

- Display emergency contact information in a visible and easily accessible location

- Maintain an organised and safe treatment area to allow prompt and efficient action
- Periodically review educational materials and emergency resources to ensure they remain updated and accessible

When consistently embedded into daily practice and reinforced through ongoing nursing supervision, the severity-based rapid response model strengthens patient autonomy while preserving a secure and reliable connection with the healthcare team. In this way, preparedness becomes an integral and dynamic component of safety in HHD.²⁶

Quality and Safety Assurance Framework

A structured quality and safety assurance framework is essential to ensure that HHD programmes remain safe, consistent, and sustainable over time. Although serious adverse events in well-established programmes are uncommon, their potential severity requires systematic oversight, continuous monitoring, and organisational learning. This framework can be conceptualised using Donabedian's Structure–Process–Outcome model, adapted to the home dialysis setting (Figure 4). In HHD, patient safety emerges from the interaction between robust structural safeguards, standardised care processes, and measurable outcomes.^{1,5,23}

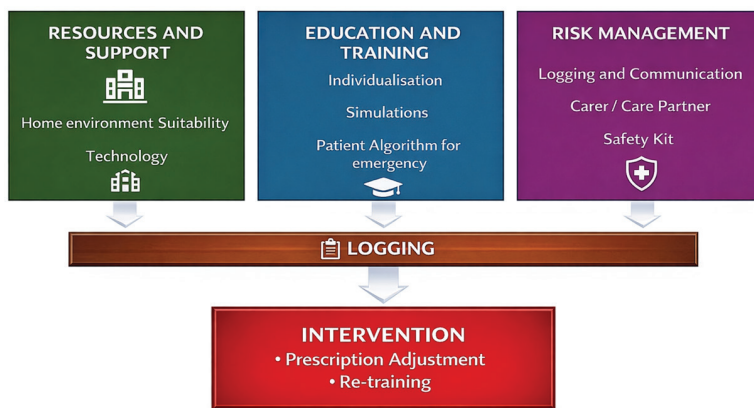


Figure 4. Structured Quality and Safety Assurance Framework for HHD.

Structural Dimension: Resources and Support

Structural elements define the foundational conditions required for safe home treatment before dialysis even begins. These include:

- Certification of the training centre and documented competencies of nurse educators
- Structured assessment of home suitability, including electrical, plumbing and communication systems
- Selection of dialysis technology incorporating advanced biosafety systems (air detection, blood leak sensors, pressure monitoring) and ergonomic, user-friendly interfaces

These safeguards establish a safe therapeutic environment and reduce dependence on improvisation.

Process Dimension: Education and Risk Control

Process measures represent the primary safety filter in HHD. They include:

- Risk-based patient selection using clinical, psychosocial, and functional assessment
- Competency-based training, including mandatory simulation of critical incidents (e.g., accidental disconnection, severe hypotension, power failure, machine malfunction)
- Implementation of a clearly defined QRP, supported by visual aids and accessible emergency contacts
- Ongoing nursing-led monitoring through periodic in-person or remote home audits

Standardisation of these processes minimises variability, strengthens adherence and reduces preventable risk.^{17,18}

Safety Governance: Incident Culture and Critical Risk Management

Transforming shared responsibility into operational safety requires a structured and transparent incident culture. All adverse events and near misses should be systematically recorded and analysed using RCA.^{8,28,29} A structured incident log template may facilitate consistent documentation, trend identification, and reflective review (**Table 7**).

		DATE	ACTIONS	CONSE- QUENCES	OUTCOMES
TECHNICAL ISSUES	Monitor malfunction				
	Water contamination				
	Medication error				
	Air in circuit				
	Blood Leak				
	Others				
MEDICAL COMPLICATIONS	Hypotension (Low BP)				
	Muscle cramps				
	Blood loss				
	Infection				
	Catheter dysfunction				
	Absence of thrill (arteriovenous fistula)				
	Extravasation (Infiltration)				
	Minor bleeding				
	Major haemorrhage				
	Air embolism				
	Chest pain / Headache / Dyspnoea				
	Clotted extracorporeal circuit				
	Oedema				
	Others				

		DATE	ACTIONS	CONSE- QUENCES	OUTCOMES
OTHERS / PSYCHOSOCIAL	Non-adherence to treatment regimen				
	Cannulation anxiety				
	Caregiver strain / Overload				
	Memory lapses / Omissions				
	Other issues				

Table 7. Structured Incident Log Template for Safety Monitoring in HHD.

Near misses are particularly valuable, as they provide opportunities for corrective action before patient harm occurs and allow early identification of latent system vulnerabilities.

Additional safety reinforcement strategies include:

- Assessment of caregiver stress and burnout as potential risk factors for safety degradation.
- Provision of structured visual support resources (“Safety Kit”), including emergency algorithms, 24/7 contact lists, troubleshooting guides and backup material stock

A non-punitive reporting environment that actively encourages transparency strengthens organisational learning, reinforces nursing oversight, and enhances programme resilience over time.²⁸

Outcome Dimension: Documentation and Quality Indicators

Outcome monitoring enables objective evaluation of programme performance. Clearly defined safety indicators allow benchmarking and early detection of deviations. Parameters such as vascular access infection rates, intradialytic hypotension, thrombosis, ultrafiltration rates, extracorporeal circuit loss, technique retention,

and adverse event-related hospitalisations provide measurable insight into safety performance. A selection of safety-related quality indicators commonly applied in HHD programmes is presented in

Table 8.^{28,30}

Domain	Indicator	Target
Training	Days of training	< 40 days
Vascular access	Autologous AVF rate	≥ 80%
Vascular access	Permanent CVC rate	< 20%
Infection	CRBSI	0 episodes /1,000 tunnelled CVC days
Thrombosis	Access thrombosis rate	< 0.15 episodes/patient- year at risk
Haemodynamic stability	Intradialytic hypotension	< 5% of dialysis sessions
Ultrafiltration safety	UF rate	< 10 ml/kg/h
Circuit safety	Extracorporeal clotting	< 1% of dialysis sessions
Cannulation safety	Puncture/extravasation problems	< 10% of dialysis sessions

Table 8. *Selected Safety-Related Quality Indicators in HHD.*

Through structured governance, regular audit and data-driven evaluation, quality assurance transforms isolated clinical events into continuous organisational learning. In this way, safety in HHD becomes an ongoing commitment embedded within programme culture rather than a static achievement.²⁸

Conclusion

HHD is a highly effective and patient-centred modality of kidney replacement therapy, but its safe delivery in the home setting requires a structured and proactive approach. As care shifts from the supervised clinical environment to the patient's home, safety becomes a shared responsibility grounded in preparation, competence, and coordinated support.

Safe practice in HHD relies on careful patient and home assessment, structured education, appropriate equipment selection, adherence to standardised protocols and clear communication pathways. Early recognition and management of complications, supported by defined

response plans and continuous access to the nephrology team, are essential components of this framework.

Within this model, the nursing team plays a central and leading role. Nurses are pivotal in patient selection, education, competency assessment, ongoing supervision, and the promotion of a culture of safety based on trust, open communication, and continuous reinforcement of best practices. Through structured follow-up, incident review and quality monitoring, nursing leadership ensures that safety is maintained over time and adapted to the evolving needs of patients. In this way, HHD can be delivered safely and sustainably, empowering patients while maintaining high standards of clinical governance and professional oversight.

References

1. Ferreira AC, Mateus A. Home dialysis: advantages and limitations. *Clin Kidney J.* 2024;17(7):sfae180. doi:10.1093/ckj/sfae180.
2. Bieber SD, Young BA. Home hemodialysis: core curriculum 2021. *Am J Kidney Dis.* 2021;78(6):876-885. doi:10.1053/j.ajkd.2021.01.025.
3. Slon Roblero MF, Bajo Rubio MA, González-Moya M, Calviño Varela J, Pérez Alba A, Villaro Gumpert J, et al. Experience in Spain with the first patients in home hemodialysis treated with low-flow dialysate monitors. *Nefrologia (Engl Ed).* 2021;S0211-6995(21)00144-2. doi:10.1016/j.nefro.2021.07.001.
4. Pauly RP, Eastwood DO, Marshall MR. Patient safety in home hemodialysis: quality assurance and serious adverse events in the home setting. *Hemodial Int.* 2015;19 Suppl 1:S59-S70.
5. Tran E, Karadjian O, Chan CT, Trinh E. Home hemodialysis technique survival: insights and challenges. *BMC Nephrol.* 2023;24:205.
6. Virtanen H, Tuominen R, Kiukainen S, Koskinen J, Koskeniemi J, Laulaja J, et al. Experiences of safety among patients receiving home dialysis therapies. *J Ren Care.* 2019;45(4):223-231.
7. Walker RC, Howard K, Morton RL. Patient and caregiver perspectives on home hemodialysis: a systematic review. *Am J Kidney Dis.* 2015;65(3):451-463.
8. Tennankore KK, d'Gama C, Faratro R, Fung S, Wong E, Chan CT. Adverse technical events in home hemodialysis. *Am J Kidney Dis.* 2015;65(1):116-121.
9. Gupta A, Zimmerman D. Complications and challenges of home hemodialysis: a historical review. *Semin Dial.* 2021;34(4):269-274.
10. Rioux JP, Marshall MR, Faratro R, Hakim R, Simmonds R, Chan CT. Patient selection and training for home hemodialysis. *Hemodial Int.* 2015;19(Suppl 1):S71-9. doi:10.1111/hdi.12254.
11. Platnich JM, Pauly RP. Patient training and patient safety in home hemodialysis. *Clin J Am Soc Nephrol.* 2024;19(8):1045-1050.

12. Ting R, Borkum M, Ni LT, Levin A. Patient screening and assessment for home dialysis therapies: a scoping review. *Perit Dial Int.* 2025;45(1):7-16. doi:10.1177/08968608241266130.
13. Guerraoui A, Galland R, Belkahla-Delabruyere F, Didier O, Berger V, Sauvajon P, et al. Design of therapeutic education workshops for home haemodialysis in a patient-centered chronic kidney diseases research: a qualitative study. *BMC Nephrol.* 2022;23(1):53.
14. Reddy YNV, Kearney MD, Ward M, Burke RE, O'Hare AM, Reese PP, Lane-Fall MB; IM-HOME Advisory Board. Identifying major barriers to home dialysis (the IM-HOME study): findings from a national survey of patients, care partners, and providers. *Am J Kidney Dis.* 2024;84(5):567-581.e1. doi:10.1053/j.ajkd.2024.04.007.
15. Anderson RM, Funnell MM. Patient empowerment: myths and misconceptions. *Patient Educ Couns.* 2010;79(3):277-282.
16. Lundström UH, Meeus G, Aronsen T, Clause AL, Finderup J, Finne PJ, et al. Increasing the adoption of home dialysis through improved advanced kidney care patient education: a call for action. *Clin Kidney J.* 2025;18(4):sfaf087.
17. Auguste BL, Girsberger M, Kennedy C, Srithongkul T, McGrath-Chong M, Bargman J, et al. Are adverse events in newly trained home dialysis patients related to learning styles? A single-centre retrospective study from Toronto, Canada. *BMJ Open.* 2020;10(1):e033315
18. Hou Y, Zhang Y, Wang Y, Liu X, Li Y, Li X. Relationships between social capital, patient empowerment, and self-management of patients undergoing hemodialysis: a cross-sectional study. *BMC Nephrol.* 2022;23(1):71.
19. Bravo P, Edwards A, Barr PJ, Scholl I, Elwyn G, McAllister M, et al. Conceptualising patient empowerment: a mixed methods study. *BMC Health Serv Res.* 2015;15:252.
20. Ortiz Martínez N, Delgado Quintana F, Sáenz Trallero D, Nosti Lagunas M, Sánchez Sánchez S, Ibañez Navarro A. Empoderamiento del paciente: revisión bibliográfica. *Ocronos.* 2024;7(12):80.
21. Rajkomar A, Farrington K, Mayer A, Walker D, Blandford A. Patients' and carers' experiences of interacting with home haemodialysis technology: implications for quality and safety. *BMC Nephrol.* 2014;15:195.
22. Molina P, Galván E, Porcar L, Alba A, Hernandis A, Pascual P, et al. Nocturnal home hemodialysis with low-flow dialysate: a report of the first two cases in Spain. *Nefrología (Engl Ed).* 2026;46(1):501405.
23. Arenas Jiménez MD, Ferre G, Álvarez-Ude F. Strategies to increase patient safety in hemodialysis: application of the modal analysis system of errors and effects (FMEA system). *Nefrología.* 2017;37(6):608-621.
24. Arenas Jiménez MD, Macía-Heras M. Safety on haemodialysis: teamwork paradigm. *Nefrología (Engl Ed).* 2018;38(1):1-3.
25. BC Renal. Best practices: home hemodialysis programs. Vancouver (BC): Provincial Health Services Authority; 2017. Available from: https://www.bcrenal.ca/resource-gallery/Documents/Best_Practices-Home_Hemodialysis_Programs.pdf

26. Painter D. Preventing home dialysis complications. *Am J Nurs.* 2021;121(1):57–63.
27. Chan RJ, Chan CT. Vascular access considerations in home hemodialysis. *Clin J Am Soc Nephrol.* 2024;19(8):1036–1044.
28. More KM, Tennankore K. Quality assurance and preventing serious adverse events in the home hemodialysis setting. *Adv Chronic Kidney Dis.* 2021;28(2):170-177. doi:10.1053/j.ackd.2021.02.007.
29. Wong B, Zimmerman D, Reintjes F, Courtney M, Klarenbach S, Dowling G, Pauly RP. Procedure-related serious adverse events among home hemodialysis patients: a quality assurance perspective. *Am J Kidney Dis.* 2014;63(2):251-258. doi:10.1053/j.ajkd.2013.07.009.
30. Komenda P, Chan C, Pauly RP, Levin A, Copland M, Pierratos A, Sood MM; CAN-SLEEP Investigators: CANadian Slow Long Nightly ExtEnded Dialysis Programs. The evaluation of a successful home hemodialysis program: establishing a prospective framework for quality. *Clin Nephrol.* 2009;71(5):467-474.

Chapter 7

Home Haemodialysis and Psychological Aspects

Learning objectives

- To be able to summarize the concept of HHD and its current role in kidney replacement therapy
- To understand the principles and psychological aspects of independent and assisted HHD training
- To recognize psychosocial aspects of HHD
- To identify psychological support strategies to improve adaptation and quality of life in HHD patients

Introduction

HHD is increasingly recognised as a preferred, cost-effective KRT. It improves patient survival and quality of life compared to in-centre, hospital-based HD. It can offer greater independence, flexibility, and convenience for the patient and their family. It also reduces the risk of infections, which was especially relevant during the Covid pandemic.^{1,2,3}

The medical benefits for patients include improvement in blood pressure control, less hospital admissions, and better mental health. The patients have the flexibility to set their schedules at home to suit themselves. With the ability to do more frequent, longer, or even nocturnal HD sessions it can also reduce cardiovascular stress. However, globally the uptake for HHD remains low. This is due to a number of factors. To complete treatment without lack of infrastructure, water and power is not possible. As the cost of equipment is high, the expenses are not always covered by medical insurance, or government policy. For the patient there can be a lack of confidence in their ability, for example, the anxiety around self-cannulation. Where there is a caregiver, there is the possibility of stress, care, and the responsibility of being in that position.^{4,5,6,7,8}

The ISN and the ISPD have formed the IHDC to promote home dialysis globally. In May 2025 the WHO have adopted a resolution in relation to kidney health. The IHDC's mission is to align with these goals, by applying the same standards of home-based dialysis access to affordable kidney care. The aim is to move from hospital

HD (3 sessions a week) to all home-based options. The knock-on effect will be improving patient outcomes and reducing the cost and burden on healthcare systems.^{2,3,9,10,11}

Home haemodialysis independently or with assistance - training

The psychosocial aspects of HHD can significantly influence a patient's positive treatment outcome. While HHD offers flexibility and an improved quality of life, it also presents challenges. The fundamental issues for patients include anxiety, depression, social isolation, and the burden of managing treatment. There is also concern about unexpected outcomes during HD. When a patient has assistance from someone in managing their treatment, such as a spouse, parent, sibling, friend, or caregiver, they may also find the routine burdensome. This can lead to the patient returning to the hospital or satellite HD unit for treatment.¹²

Training programmes for HHD typically take 3-5 weeks to complete, and the training is usually completed in-centre, at the hospital. It is essential to teach patients to cannulate their access with confidence, in order to manage their HHD treatment independently. This process helps them see themselves as a 'self-care provider,' sometimes with the support of a 'care partner.' Patients may experience anxiety related to self-cannulating, and potential complications during HHD. While in-centre support exists, the responsibility ultimately rests with the patient and/or care partner at home. It is crucial that training and support are tailored to each individual; some patients may require additional time to develop the necessary skills, which can help prevent burnout in the future. Long-term HHD patients may also face depression, an issue often under-recognized in the past. Chronic illness can significantly impact quality of life, leading to sleep disturbances, psychological stress, feelings of isolation, and sometimes a sense of being a burden to loved ones. When a patient can transition from in-centre HD to HHD, considering all these factors and with proper support, it can become a manageable routine for both the patient and their extended family.¹²

Below is a comparison between completing haemodialysis in-centre compared to choosing to do the treatment at home.

	Dialysis centre	Home
Schedule	Three treatments a week for about 4 hours. Monday, Wednesday, Friday; or Tuesday, Thursday, Saturday/Sunday.	Flexible. Three to seven short or long treatments per week at times that work best for you, including daily or nocturnal HD.
Availability	Available in most communities; may require travel in rural areas.	Becoming more widely available as smaller equipment is developed.
Machine/supplies	The clinic has the machine and supplies.	The machine and 2 - 4 weeks' worth of supplies in the home. You may need adaptations in your home to connect the machine to electricity and water.
Training	The clinic teaches about treatments, diet, liquids, medicines, lab tests, etc.	You (and a partner, if assisted HHD is planned) must attend 3 to 8 weeks of HHD training.
Diet and liquids	Strict limits on liquids, phosphorus, sodium, and potassium intake.	Fewer limits on liquids or diet, based on the amount of HD, residual kidney function, and lab tests.
Level of freedom	Less freedom on treatment days. May feel fatigued for hours after each treatment.	More freedom because you set the treatment schedule to meet the total prescribed dose. Work and travel are much easier.
Amount of work	Centre staff members do HD tasks. They can teach you to do some tasks.	You (and your partner if available) must set up, run, and clean the machine; check vital signs; track the treatments and send in forms; and order supplies.
Payment	Medicare and most other health plans cover three HD treatments a week.	Medicare covers three HD treatments a week and may cover more for medical reasons; other health plans may cover all HD treatments.

Table 1 - Dialysis Centre and HHD Comparison Chart.

The above chart is adapted from the National Institute of Diabetes and Digestive and Kidney Diseases.¹³

Psychosocial aspects and Home Haemodialysis

An international study conducted in Melbourne, Victoria, Australia, in 2015 reviewed the psychosocial aspects of HHD. Its goal was to serve as a psychosocial guide for new start-up HHD programmes.

It is important to recognise the psychosocial aspects involved when a patient completes HHD. Managing their own treatment is a significant responsibility for any kidney patient. A patient's psychosocial factors influence the success of the training program provided by the hospital they attend. To perform HHD, the patient must be physically capable of meeting all treatment requirements and executing the procedure at home. Support from a multidisciplinary team is essential. Performing HD at home can be challenging and requires proper training, education, and communication among all involved parties. There can also be financial implications in some cases, depending on the country and available government support. The hospital-based multidisciplinary team must also provide appropriate support when necessary. It is crucial that patients can contact the hospital 24/7 if needed or have access to the contact information of the equipment supplier for HHD. Successfully managing their ESKD could help patients prolong their lives and improve their quality of life.¹²

The research compared twelve countries with a total of 9382 patients. DOPPS, along with the depression screening index, found that 43% of patients attending hospital-based HHD were identified as having depression. However, nephrologists only identified 13.9% of these patients as being depressed.¹¹

Griva et al. (2010), in their study, 'An evaluation of illness, treatment perceptions, and depression in hospital versus home-based dialysis modalities,' showed that depression was significantly less common among the home HHD population at 8%, compared to hospital HHD patients, who were 42.3% more likely to experience depression.¹⁴

A study by Nearhos et al. (2013) on the psychological factors associated with successful outcomes in HHD found that these outcomes are strongly driven by psychological factors. Adaptive coping strategies can optimise a favourable outcome in continuing HDD. Patients who have 'high levels of motivation, emotional resilience, and actively engage in their self-care are successful in HHD. When a patient can also accept their diagnosis and treatment, and has strong social support networks to help manage the burden of self-care, this often leads to better outcomes.'²

Key psychological factors associated with success include:

- **Active Role and Autonomy** - Patients who take an active role in their treatment are more likely to succeed. They usually exhibit self-confidence and self-belief and a sense of control.
- **Acceptance and Coping Styles** - Successfully adapting and accepting the necessity of HHD treatment, and possessing the capacity to change and learn new coping strategies. Furthermore, being optimistic and positive is associated with longer-term success.
- **Psychological Resilience and Mental Health** – Depression, anxiety, and stress when managed and supported can contribute to better outcomes. There are studies that suggest that "denial" to a degree, can produce a protective screen, allowing the patients to manage the stress of treatment.
- **Social Support and Interaction** – Support from family, friends, and healthcare professionals that are engaged in patients' treatment mitigates emotional distress and is crucial for long-term success.
- **Cognitive and Emotional Suitability** – Patients are sometimes assessed using tools like the Jo-Pre-training Assessment Tool (JPAT). A patient's cognitive function and emotional stability can be evaluated prior to training for HHD treatment.
- **Managing Burden and Anxiety** – To avoid burnout and stopping/changing treatment, it is essential to try and manage emotional fears, complications, and anxiety related to self-needling and the maintenance of equipment for treatment.¹³

Factors such as high emotional stress, poor coping, and limited support can lead to early failure in home training or treatment, resulting in a return to in-centre HD.

A small, but relevant study in Australia by Hanson et al. (2017) aimed to give an insight into patient's perspectives on the transition to HHD. Twenty patients engaged in this study, completing a satisfaction questionnaire after commencing HHD. They also participated in 'sequential semi-structured interviews', three in total. Interview one at the start of training, interview two at the end of training, and interview three when HHD treatment commenced.

Six themes were identified from the study:

1. Reconciling fears of cannulation, for example, by repetitive practice in needling.
2. Acknowledging the rare possibility of fatal risks and put supports in place to prevent them occurring.
3. Tolerating necessary concessions.
4. Dispelling concerns of neglect.
5. Optimising the learning pathway – for example, by following a checklist.
6. Developing confidence and belief in their ability to do the treatment at home themselves.

The study concluded that training in HHD promotes confidence for patients. In several instances, it was recognised that many patients experience stress because of medical isolation, treatment responsibilities, family impositions, and financial difficulties. Therefore, it is important to address patients' on-going psychosocial concerns. By doing so it could alleviate burdens that patients and their families are experiencing while transiting to HHD.¹⁶

A systematic review of qualitative studies was undertaken by Walker et al. (2015) on patient and caregiver perspectives on HHD, only English articles were included. Twenty-four studies were looked at involving a total of 221 patients. The breakdown was as follows: HHD 109, hospital HD 97, pre dialysis 15, along with 121 eligible caregivers. The interviews looked at the possible benefits of HHD taking into consideration any fears or anxieties that they had prior to training. These included lacking confidence in ability to perform HHD, particularly self-cannulation, and a sense of being vulnerable and secluded from medical support. The last perceived concern was that HHD would place a burden on the family. Although there were concerns, primarily patients and caregivers could see the flexibility HHD would allow, and the realisation that there would be constant monitoring and communication from the support team in the hospital. There was also consideration regarding improved well-being, and better relationships, along with the opportunity to thrive. Once the apprehensions were acknowledged and discussed with patients and caregivers, the idea of HHD was considered a positive option.¹⁶

Psychological support strategies

Professional psychological support – Bennett, Schatell, and Shah recommend assessing all HHD patients (both home and in-centre) for depression before starting HHD treatment and at regular intervals afterward. This is especially important when a patient experiences a ‘change in life status,’ such as the death of someone close, ending a relationship, changes in ability to work, or ongoing hospitalisations. Having a psychologist or counsellor as part of the multidisciplinary team is beneficial for managing anxiety and/or depression, which could interfere with HHD treatment. It is also notable that in the USA, adult dialysis patients are required to complete KDQOL-36™ survey annually as part of their care plan. Research dating back to 1997, which the author believes remains relevant today, has shown that haemodialysis patients perceived functional health status can predict survival, hospitalization, and dialysis attendance compliance. DeOreo recommended using specific depression scales, such as the Beck Depression Inventory and the mental health section of the Patient Health Questionnaire-2, to screen for depression.^{17,18}

Peer psychological support – Depending on the individual, there can be a sense of isolation for some completing their HHD from home. This was recognised in research, through interviews conducted in 2013 by Tong, et al., titled "*The Beliefs and Expectations of Patients and Caregivers About Home Haemodialysis*." There are various support options outside of the hospital environment available to kidney patients. These include web-based support, local support groups, peer-to-peer, and individual support for those seeking additional assistance. Since COVID-19, more support is accessible online, which is especially helpful for those who find it difficult to travel or live in rural areas. An example is IKA, a charitable organization that offers free, online, peer-to-peer support via Zoom. They have trained patients to serve in this capacity and supervise them in all aspects of kidney treatment, including HHD, peritoneal dialysis, hospital HD, transplantation, and living donation. The organization also provides free counselling services across Ireland for patients, caregivers, and family members. Additionally, IKA has branches nationwide that hold monthly meetings for patients and families to connect. There are also online support groups established by patients themselves, where they can engage with others who have experienced or are experiencing similar journeys related to their medical treatment.^{19,20}

Multidisciplinary team support – It is important that patients have support and encouragement from their multidisciplinary nephrology team, including nurses, social workers, and psychologists or counsellors, to engage with these supports. With the assistance of the hospital nephrology team, the goal is for patients to regularly engage with their chosen supports, which helps identify any issues they are experiencing, such as early signs of burnout.

Technical Support – HD machines are modern and user-friendly. They have remote monitoring and, this allows for the patient to have a safer, independent HHD experience at home. Due to remote monitoring a care partner is not necessary in most situations.^{4,6,7}

Financial Support – This covers the cost of the home modifications that are required to install the HD machine. It also assists in the cost of utilities for example, electricity which is essential for the treatment process. Reimbursement for out-of-pocket expenses and employment-retention interventions can assist in overcoming some of the logistical barriers.¹²

Respite Care – The type of respite care required will be determined by the patient and care partner to fit their own unique situation. There is access to temporary in-centre HD treatment due to illness or difficulties managing treatment at home. This can allow patients and caregivers to have a break from managing treatment at home.²¹

Travel and Holidays – It is possible for the majority of patients on all forms of dialysis treatment including HHD to travel and go on holidays if they wish. However, good planning is required by the patient. It can take approximately eight to twelve weeks to arrange, depending on the holiday destination. This is to allow for the coordination of supplies and treatments where HD treatment has been arranged in-centre at their destination. Available slots can be limited depending on where you are travelling. Some patients on HDD may use portable machines, such as the NxStage System One or the Physidia System, which can travel with the patient. It is important that patients continue to live their lives while on treatment and taking a holiday can give an 'emotional boost'.^{22,23}

Conclusion

While HHD offers significant benefits, including increased independence, improved clinical outcomes and quality of life, for some patients and caregivers it can inflict a considerable amount of burden that is not anticipated when treatment commences at home. Successful HHD is connected to the psychological well-being of the patient, caregiver, and/or family. The "home-first" approach must be supported by a multidisciplinary team and proactive psychosocial framework.^{7,16,17,24,25}

References

1. Brown, E.A., Jha, V., Abdou, N., Bavanandan, S., Liew, A., Madero, M., Mitra, S., Nygård, H.T., Saxena, A., Schmitt, C.P., Tchokhonelidze, I., 2023. Introducing the International Home Dialysis Consortium. *Kidney International Reports* 8, 1277–1280. <https://doi.org/10.1016/j.ekir.2023.04.019>
2. Blagg, C.R., 2008. Home haemodialysis. *BMJ* 336, 3–4. <https://doi.org/10.1136/bmj.39392.575208.80>
3. Cozzolino, M., Conte, F., Zappulo, F., Ciceri, P., Galassi, A., Capelli, I., Magnoni, G., La Manna, G., 2021. COVID-19 pandemic era: is it time to promote home dialysis and peritoneal dialysis?. *Clinical Kidney Journal* 14, i6–i13. <https://doi.org/10.1093/ckj/sfab023>
4. National Kidney Foundation. (2026). Home Hemodialysis: <https://www.kidney.org/kidney-topics/home-hemodialysis>
5. Kendzia D, Lima F, Zawierucha J, Busink E, Apel C, Malyszko JS, Zebrowski P, Malyszko J. Main Barriers to the Introduction of a Home Haemodialysis Programme in Poland: A Review of the Challenges for Implementation and Criteria for a Successful Programme. *J Clin Med*. 2022 Jul 18;11(14):4166. doi: 10.3390/jcm11144166. PMID: 35887931; PMCID: PMC9321469.
6. DaVita Kidney Care. (2026). Treatment Options: Home Hemodialysis: <https://davita.com/treatment-options/home-hemodialysis>.
7. Fresenius Medical Care. (2026). Home Therapies: <https://hometherapies.freseniusmedicalcare.com>.
8. Walker RC, Howard K, Morton RL. Home hemodialysis: a comprehensive review of patient-centered and economic considerations. *Clinicoecon Outcomes Res*. 2017 Feb 16;9:149-161. doi: 10.2147/CEOR.S69340. PMID: 28243134; PMCID: PMC5317253.
9. Brown EA, Jha V, Bavanandan S, Chan CT, Davies S, Figueirido A, Liew A, Madero M, Niang A, Mehrotra R, Mitra S, Rutherford P, Saxena A, Schiller B, Schmitt CP, Tang SCW, Tchokhonelidze I. International Home Dialysis Consortium: Declaration Advocating for the Promotion of Home Dialysis Globally. *Kidney Int Rep*. 2025 Mar 14;10(6):1633-1642. doi: 10.1016/j.ekir.2025.03.012. PMID: 40630296; PMCID: PMC12231036.
10. Kidney Care UK. (2025). World Health Organisation adopts resolution on kidney health: <https://kidneycareuk.org/news-from-kidney-care-uk/who-adopts-resolution-on-kidney-health>
11. Lopes AA, Albert JM, Young EW, et al. Screening for depression in hemodialysis patients: Associations with diagnosis, treatment, and outcomes in the DOPPS. *Kidney Int*. 2004;66:2047–2053.
12. Cho Y, Rivara MB. Introduction to Home Dialysis: Fundamentals and Beyond: Fundamentals and Beyond. *Clin J Am Soc Nephrol*. 2023 Oct 1;18(10):1349-1350. doi: 10.2215/CJN.0000000000000272. Epub 2023 Jul 31. PMID: 37523307; PMCID: PMC10578627.
13. Lockridge R Jr, Weinhandl E, Kraus M, Schreiber M, Spry L, Tailor P, Carver M, Glickman J, Miller B. A Systematic Approach To Promoting Home Hemodialysis during End Stage Kidney Disease. *Kidney360*. 2020 Jul 8;1(9):993-1001. doi:

- 10.34067/KID.0003132020. PMID: 35369547; PMCID: PMC8815594.
14. National Institute of Health. National Institute of Diabetes and Digestive and Kidney Diseases. (2018). Hemodialysis: <https://www.niddk.nih.gov/health-information/kidney-disease/kidney-failure/hemodialysis>
15. Griva K, Davenport A, Harrison M, Newman S. An evaluation of illness, treatment perceptions, and depression in hospital- vs. home-based dialysis modalities. *J Psychosom Res.* 2010;69:363–370.
16. Hanson CS, Chapman JR, Craig JC, Harris DC, Kairaitis LK, Nicdao M, Mikaheal M, Tong A. Patient experiences of training and transition to home haemodialysis: A mixed-methods study. *Nephrology (Carlton).* 2017 Aug;22(8):631-641. doi: 10.1111/nep.12827. PMID: 27253517.
17. Walker RC, Hanson CS, Palmer SC, Howard K, Morton RL, Marshall MR, Tong A. Patient and caregiver perspectives on home hemodialysis: a systematic review. *American Journal of Kidney Diseases.* 2015 Mar 1;65(3):451-63.
18. Bennett PN, Schatell D, Shah KD. Psychosocial aspects in home hemodialysis: A review. 2015; DOI:10.1111/hdi.12258.
19. DeOreo PB. Hemodialysis patient-assessed functional health status predicts continued survival, hospitalization, and dialysis-attendance compliance. *Am J Kidney Dis.* 1997;30:204–212.
20. Tong A, Palmer S, Manns B, et al. The beliefs and expectations of patients and caregivers about home haemodialysis: An interview study. *BMJ Open.* 2013;3:1–14.
21. Irish Kidney Association. (2026). www.ika.ie
22. National Kidney Foundation. (2026). Travel Tips: A Guide for Kidney Patients: <https://www.kidney.org/kidney-topics/travel-tips-guide-kidney-patients>
23. Baxter. (2026). My Kidney Journey. Travelling on Dialysis: <https://ie.mykidneyjourney.com/live-well/travelling-dialysis>
24. Jacquet S, Trinh E. The Potential Burden of Home Dialysis on Patients and Caregivers: A Narrative Review. *Can J Kidney Health Dis.* 2019 Dec 18;6:2054358119893335. doi: 10.1177/2054358119893335. PMID: 31897304; PMCID: PMC6920584.
25. Matthews M, Reid J, McKeaveney C, Mullan R, Bolton S, Hill C, Noble H. Development of a psychosocial intervention to support informal caregivers of people with end-stage kidney disease receiving haemodialysis. *BMC Nephrol.* 2020 Oct 1;21(1):421. doi: 10.1186/s12882-020-02075-2. PMID: 32998706; PMCID: PMC7527291.

Chapter 8

Home Haemodialysis and Diet

Learning objectives:

- To outline how HHD influences nutritional requirements and dietary restrictions compared with conventional in-centre HD, with particular attention to protein and energy needs
- To describe practical, food-based strategies to help patients meet protein and energy requirements, while recognising common barriers such as fatigue, reduced appetite, and limited cooking capacity
- To explain phosphate management in HHD, including the impact of dialysis dose, the relationship between dietary protein and phosphate, and prioritising reduction of phosphate additives without compromising nutritional adequacy
- To support safe sodium and potassium management by focusing on practical counselling approaches, label awareness, avoidance of potassium-based salt substitutes, and recognition of non-dietary contributors to potassium imbalance
- To recognise and respond to malnutrition risk in HHD by applying structured nutritional screening and timely escalation/referral when concerns arise

Introduction

Nutritional care is a core component of safe and effective HHD. While dialysis enables the clearance of uraemic toxins and supports metabolic stability, it can also contribute to catabolism and nutrient losses—particularly protein—making adequate intake essential to reduce the risk of PEW. The dialysis prescription used in HHD (including frequency and duration) may also alter the degree of dietary restriction required for phosphate, sodium, and potassium. Advice therefore needs to be individualised and guided by biochemical trends, dialysis adequacy, and patient-reported intake. This chapter provides practical, nursing-focused guidance on supporting dietary intake in HHD, including estimating protein and energy requirements, prioritising nutritionally valuable foods while limiting additive-rich processed products, and implementing structured screening to identify malnutrition risk and trigger timely intervention.

Protein and Home Haemodialysis

People with ESKD on dialysis have increased daily protein requirements. This is due to several factors, including the fact that dialysis itself is a catabolic process, contributing to inflammation and the loss of nutrients such as protein. In maintenance dialysis populations, it has been estimated that patients may lose up to 7–8 g of protein per dialysis session.¹ Similar research in HHD patients is lacking; however, with increased dialysis hours and/or frequency, it is reasonable to consider that HHD patients may be at greater risk of cumulative protein losses.

Current KDOQI guidelines advise protein requirements of 1.0–1.2 g/kg body weight/day for HD patients.² Calculations are usually based on the “healthy” BMI range of 18.5–25.0 kg/m². Where an individual is overweight (BMI >25.0 kg/m²) or underweight (BMI <18.5 kg/m²), IBW should be used when calculating protein requirements.

When considering a patient’s protein requirements, it is also important to recognise factors that may increase needs further, such as regular physical activity (particularly weight/resistance training), acute illness or metabolic stress, and the presence of pressure sores/ulcers or wounds requiring healing. In more complex scenarios such as these, referral to a renal dietitian (where available) is recommended.

Protein can be found in both animal and plant sources. Animal sources include meat, fish, dairy, and eggs. Plant-based sources include nuts, beans, pulses (lentils, chickpeas, peas), and soya products (e.g., tofu). There is insufficient evidence to suggest which type of protein is most beneficial in HD patients; however, encouraging a variety of sources is advisable. Including a portion of protein at each meal is recommended to help individuals meet their requirements. Table 1 shows the protein content of selected foods per 100 g portion.³

Food item	Portion size	Protein content
Chicken breast (cooked)	100 g	32.0 g
Minced beef (cooked)	100 g	21.8 g
Cod (cooked)	100 g	24.6 g
Eggs (boiled)	100 g	13.0 g
Cow’s milk (whole)	100 g	3.4 g

Food item	Portion size	Protein content
Hard cheese (cheddar)	100 g	25.4 g
Cannellini beans (cooked)	100 g	7.8 g
Chickpeas (cooked)	100 g	8.4 g
Lentils (cooked)	100 g	8.1 g
Mixed nuts (unsalted)	100 g	23.8 g
Tofu	100 g	8.1 g

Table 1. Protein content of common foods (per 100 g).

High-protein foods that are also high in salt and phosphate/potassium additives should be reduced. Examples include processed meats (cured meats, sausages, packaged meats), processed cheeses, salted nuts, and processed meat “alternatives”.

When supporting patients to eat enough protein, it is important to acknowledge that daily intake may be affected by factors such as education, cooking skills, fatigue, appetite, and personal dietary preferences. It has been observed that intensive HHD regimens, particularly nocturnal HHD and short daily HHD, can be associated with improved overall intake and appetite. This may relate to more frequent removal of uraemic toxins, fewer restrictions around potassium and phosphate, and reduced reliance on medications such as phosphate binders.^{4,5}

Energy Requirements

Although energy (calories) is not lost during the dialysis process, sufficient energy intake is essential to help protect against protein–energy malnutrition. KDOQI guidelines advise total energy expenditure for dialysis patients of 25–35 kcal/kg body weight/day,² again using IBW in over- and underweight individuals. Physical activity and comorbidities such as cancer, chronic obstructive pulmonary disease, HIV, and acute illness with metabolic stress may increase energy requirements further. As above, referral to a renal dietitian is advised in more complex cases where available.

Energy is provided by all food groups, but energy-dense foods include carbohydrates (bread, potatoes, rice, pasta) and fats (butter and oils). To maximise nutritional benefit, higher-fibre carbohydrate sources should be encouraged, such as wholegrain breads and

pastas, and brown or wild rice. Fats should be included in moderation, with emphasis on unsaturated fats (plant-based oils such as olive oil) over saturated fats (animal-based fats), to support cardiovascular health.

High-energy foods that are also high in sugar and fat (e.g., cakes, pastries, biscuits, sweets, chocolate, crisps) should be eaten less often and in small amounts, in line with healthy eating guidance.

For those who are unlikely to have a transplant in the future, nutritional goals should consider quality of life alongside the likelihood of clinically meaningful benefit from dietary change. With ageing, it is also important to consider whether calorie restriction and weight loss are beneficial. For transplant candidates (or those who may receive a transplant), achieving a healthier weight can reduce the risk of diabetes and cardiovascular complications, and obesity is associated with a higher risk of delayed graft function and post-operative complications.⁶ Conversely, in older people on long-term dialysis who have limited physical activity and reliance on carers, there may be a risk of muscle loss,⁷ which can affect mobility, increase falls risk, and negatively impact overall health.

References:

1. Sahathevan S, Khor BH, Ng HM, Abdul Gafor AH, Mat Daud ZA, Mafrá D, Karupaiah T. Understanding development of malnutrition in hemodialysis patients: a narrative review. *Nutrients*. 2020;12(10):3147.
2. Ikizler TA, Burrowes JD, Byham Gray LD, Campbell KL, Carrero JJ, Chan W, Fouque D, Friedman AN, Ghaddar S, Goldstein Fuchs DJ, Kaysen GA, Kopple JD, Teta D, Wang AYM, Cuppari L. KDOQI clinical practice guideline for nutrition in CKD: 2020 update. *Am J Kidney Dis*. 2020;76(3 Suppl 1):S1–S107.
3. Public Health England. McCance and Widdowson's Composition of Foods Integrated Dataset 2021 (CoFID). London: Public Health England; 2021.
4. Ipema KJR, Struijk S, van der Velden A, Westerhuis R, van der Schans CP, Gaillard CAJM, et al. Nutritional status in nocturnal hemodialysis patients: a systematic review with meta-analysis. *PLOS One*. 2016;11(6):e0157621. doi:10.1371/journal.pone.0157621.
5. Slon Roblero MF, Bajo Rubio MA, González-Moya M, Calviño Varela J, Pérez Alba A, Villaro Gumpert J, Cigarrán S, Vidau P, García Marcos S, Abáigar Luquin P, Coll Piera E, Gascón Mariño A, Espigares MJ, Molina MD, Molina P. Experience in Spain with the first patients in home hemodialysis treated with low-flow dialysate monitors. *Nefrologia (Engl Ed)*. 2021 Aug 12:S0211-

- 6995(21)00144-2. English, Spanish. doi: 10.1016/j.nefro.2021.07.001. Epub ahead of print. PMID: 34393002.
6. Scheuermann U, Babe J, Pietsch UC, Weimann A, Lyros O, Semming K, et al. Recipient obesity as a risk factor in kidney transplantation. *BMC Nephrol.* 2022;23:37. doi:10.1186/s12882-022-02668-z.
 7. Miller SL, Wolfe RR. The danger of weight loss in the elderly. *J Nutr Health Aging.* 2008;12(7):487–491.

Phosphate

Phosphate clearance is reduced in ESKD. Someone receiving three haemodialysis sessions per week for around 4 hours per session is likely to require phosphate moderation advice. People on nocturnal HHD tend to remove more phosphate due to extended dialysis hours,⁸ so the need for dietary restriction will depend on serum levels. Given higher protein requirements in dialysis, phosphate intake can increase unavoidably because many higher-protein foods contain moderate amounts of phosphate. Phosphate binders may therefore become more important.

Sustained hyperphosphatemia is associated with vascular calcification and CKD–mineral and bone disorder. Some people are at increased risk of vascular calcification, including those taking warfarin, people with diabetes, those with a raised BMI, and those with raised phosphate and calcium levels.⁹ Poor phosphate control over time can contribute to calciphylaxis (calcific uraemic arteriopathy), a painful skin and vascular condition that can be life-limiting.

When discussing phosphate restriction, it is important to prioritise foods that are less nutritious and those where phosphate is more readily absorbed. Phosphate additives (e.g., sodium phosphate, phosphoric acid) used in products such as sausages, burgers, cola drinks, and processed cheese are more easily absorbed, so these should be targeted first. Foods such as offal (e.g., liver, kidney) are also high in phosphate, as are edible bones in fish (e.g., tinned fish). In this case, the bones can be avoided rather than the fish itself, as oily fish provides beneficial omega-3 fats. If phosphate remains raised despite these steps, phosphate binders may need to be considered, as it is important not to compromise protein intake.¹⁰

References:

8. Kuhlmann MK. Phosphate elimination in modalities of hemodialysis and peritoneal dialysis. *Blood Purif.* 2010;29(2):137–144.
9. Wu D, Lu S, Hu J, Zeng M, Wu J, Li C, et al. Calciphylaxis: ongoing challenges and treatment opportunities with mesenchymal stem cells. *J Mol Cell Biol.* 2025;17(2):mjaf009.
10. Shinaberger CS, Greenland S, Kopple JD, Van Wyck D, Mehrotra R, Kovesdy CP, et al. Is controlling phosphorus by decreasing dietary protein intake beneficial or harmful in persons with chronic kidney disease? *Am J Clin Nutr.* 2008;88(6):1511–1518.

Salt

High salt intake increases the risk of hypertension and related complications such as stroke. Salt can also increase thirst, so salt restriction is advised for people on dialysis and offers multiple benefits. In the UK, average salt intakes are around 9.5 g/day, and guidance is to reduce to 100 mmol of sodium,¹¹ equivalent to 6 g of salt per day.

Sources of salt vary by cuisine. In many European diets, salt tends to come predominantly from processed foods. In some Asian, African, Caribbean, and Chinese cuisines, more salt may be added during home cooking through salt, monosodium glutamate, and stock seasonings. Advice to reduce salt therefore needs to be tailored to the patient's usual diet and cooking practices.¹²

Herbs and spices can enhance flavour without adding sodium, so options such as basil, oregano, pepper, chilli powder, ginger, garlic, lemon juice, and vinegar can be encouraged.

If stock cubes are used, advise limiting to no more than one cube for four servings and choosing reduced-sodium options, while ensuring they do not contain potassium-based salt substitutes (often listed as potassium-containing ingredients). In dialysis populations, salt substitutes are not advised because they commonly contain potassium.

References:

11. Ikizler TA. KDOQI Clinical Practice Guideline for Nutrition in CKD: 2020 Update (vol 76, pg S1, 2020). *Am J Kidney Dis.* 2021;77(2):308.
12. Slon Roblero MF, Bajo Rubio MA, González-Moya M, Calviño Varela J, Pérez Alba A, Villaro Gumpert J, Cigarrán S, Vidau P, García Marcos S, Abáigar Luquin P, Coll Piera E, Gascón Mariño A, Espigares MJ, Molina MD, Molina P. Experience in Spain with the first patients in home hemodialysis treated with low-flow dialysate monitors. *Nefrologia (Engl Ed).* 2021 Aug 12:S0211-6995(21)00144-2. English, Spanish. doi: 10.1016/j.nefro.2021.07.001. Epub ahead of print. PMID: 34393002.

Potassium Management in Home Haemodialysis

In ESKD, potassium homeostasis becomes critically dependent on dialysis because the kidneys can no longer effectively excrete dietary potassium. In healthy individuals, the kidneys excrete approximately 90% of potassium, with the gastrointestinal tract handling the remainder. In patients on HHD, potassium balance depends on the frequency and duration of dialysis, dialysate potassium concentration, and dietary intake.

For many HHD patients, more frequent sessions allow more stable potassium removal and may reduce the need for rigid potassium restriction. However, potassium intake still requires careful assessment, particularly when pre-dialysis serum potassium values are elevated or trending upward.

Nurses play a central role in monitoring potassium balance. Regular review of laboratory values, especially pre-dialysis serum potassium, should be part of routine care. Trends above 5.5–5.8 mmol/L may indicate excessive potassium intake relative to dialysis clearance, missed treatments, or changes in home routine. Conversely, persistent levels below 3.5 mmol/L may suggest over-clearance, low dietary intake, or gastrointestinal losses.

Traditional advice often focuses on “high potassium foods,” but this can be misleading. Not all potassium sources have the same impact on serum levels. Many nutrient-dense foods—such as fruits, vegetables, legumes, and whole grains—contain potassium bound within plant cells, which is often less bioavailable than potassium salts added to processed foods (e.g., potassium chloride in salt substitutes and preservatives). This distinction is important, particularly when advising patients without routine dietetic support.

Patients should be guided to limit processed foods containing potassium additives (e.g., ready meals, processed meats, instant noodles, and salt substitutes), which can raise serum potassium due to higher bioavailability and limited nutritional benefit. In contrast, whole plant foods often provide valuable fibre, antioxidants, and micronutrients and may be included safely when serum potassium is stable (Table 2).

In addition to diet, consider non-dietary contributors to potassium imbalance, including dialysate potassium concentration, missed or shortened sessions, medications (especially RAAS inhibitors), and acid–base balance. Nurses can also support patients to keep a simple food log (e.g., 3–5 days) to identify patterns linked to potassium changes.

Education is key: support patients to interpret food labels and to distinguish naturally occurring potassium from potassium-based additives. Reinforce that the goal is balanced intake rather than blanket restriction, while prioritising overall nutritional quality. Ultimately, potassium management in HHD is dynamic and requires ongoing adjustment based on trends and context.

Food item	Reason for high potassium	Additional concerns
Crisps, instant noodles	Potassium additives	High salt/fat; low nutrients
Salt substitutes	Potassium chloride	Can significantly raise potassium
Chocolate, confectionery	Cocoa potassium	High sugar/fat
Large fruit juice servings	Natural potassium, no fibre	High sugar; lacks whole fruit benefits

Table 2. Common high-potassium, low-nutrient foods.

Screening For Malnutrition in Home Haemodialysis

Malnutrition, particularly PEW, remains a significant concern among individuals receiving maintenance HD. It is associated with increased morbidity and mortality, reduced functional capacity, and diminished quality of life. Although much of the research has focused on in-centre haemodialysis populations, the principles supporting nutritional screening are equally relevant to HHD, where patients

may have distinct patterns of intake and energy expenditure related to their treatment modality and lifestyle.

The prevalence of nutritional risk in HD populations is high. Cross-sectional studies using validated tools such as the MIS,¹³ SGA¹⁴ and disease-specific indices have reported malnutrition risk in approximately 30–45% of haemodialysis cohorts, although estimates vary depending on the tool and population studied.

Effective nutritional screening in HHD should incorporate both subjective and objective parameters. Standard indicators such as BMI may underestimate risk when used in isolation, particularly in patients with altered body composition or significant fluid fluctuation. A combined approach that includes anthropometry, dietary intake patterns, biochemical markers (e.g., albumin, prealbumin), and validated questionnaires (e.g., Mini Nutritional Assessment–Short Form, MIS, SGA)¹⁴ improves identification of individuals at risk of malnutrition and facilitates the diagnosis of PEW in the home setting.

In HHD, baseline and serial assessments of nutritional status are recommended at therapy initiation and at regular intervals thereafter (e.g., quarterly, or following significant clinical changes such as dry-weight loss, hypokalaemia, or hypophosphataemia). Early identification supports timely escalation to the medical team and referral to renal dietitians (where available) and enables targeted interventions to optimise energy and protein intake, prevent unintentional weight loss, and support overall outcomes.

Where appetite is poor, nurses can implement low-risk, food-based strategies such as encouraging small, frequent meals; advising on energy-dense choices (e.g., full-fat dairy, nourishing snacks); and supporting appropriate use of oral nutritional supplements where permitted by local guidance. Ongoing monitoring of dry weight, intake patterns, and biochemical markers is essential, with concerns escalated to the medical team when specialist dietetic input is unavailable. Once appetite improves and weight is stable, a return to a general healthy eating pattern can be considered, provided there are no ongoing medical drivers of poor intake (e.g., infection, malignancy).

Malnutrition risk may increase during repeated hospitalisations, where disrupted routines and unintentional weight loss are common. When dialysis is delivered effectively and regularly, risk may be

reduced because improved uraemic toxin clearance can help preserve appetite. Nevertheless, ongoing assessment of appetite and intake remains essential.

Monitoring dry weight (interpreted in the context of fluid balance) is a key strategy for identifying nutritional concerns. A consistent decline in dry weight may signal the need for intervention. Tools that assess appetite and intake, rather than relying solely on weight or BMI, are particularly valuable in patients with oedema or fluid shifts. Unexpected increases in fluid weight may also conceal loss of muscle or fat tissue, highlighting the importance of comprehensive monitoring.

Techniques such as bioimpedance analysis and simple functional measures, including handgrip strength, may complement routine nutritional assessment and help identify early signs of PEW.

Appetite disturbance may be driven by comorbidities such as malignancy, gastroparesis, sepsis, or the cumulative impact of frequent admissions. Social factors—including financial constraints, reliance on caregivers, or difficulty accessing food—can further compromise intake. Nutritional status can change with acute illness, treatment modifications, psychosocial stressors, or other clinical events. A structured but flexible approach to screening and follow-up supports early identification of risk and timely intervention, improving resilience and quality of life.

Treatment of Malnutrition in Home Haemodialysis

Although many patients undertaking HHD achieve good nutritional intake, some individuals may continue to struggle to meet their energy and protein requirements through diet alone. In these circumstances, oral nutritional supplements may provide a practical and acceptable adjunct to dietary counselling, particularly where appetite is poor, dietary restrictions limit food choice, or the demands of treatment contribute to fatigue or reduced meal preparation. Their use should be individualised, considering nutritional status, biochemical parameters, fluid allowance, gastrointestinal tolerance, and patient preferences. Renal-specific supplements may be appropriate where control of potassium, phosphate, or fluid intake is a concern, although standard preparations may also have a role

depending on clinical need. Oral nutritional supplements should not replace food-based strategies but may support nutritional adequacy when dietary intake remains insufficient despite tailored advice.

References:

13. Kalantar-Zadeh K, Kopple JD, Block G, Humphreys MH. A malnutrition-inflammation score is correlated with morbidity and mortality in maintenance hemodialysis patients. *American Journal of Kidney Diseases*. 2001 Dec;38(6):1251–1263. doi:10.1053/ajkd.2001.29222. PMID: 11728958.
14. Detsky AS, McLaughlin JR, Baker JP, Johnston N, Whittaker S, Mendelson RA, Jeejeebhoy KN. What is subjective global assessment of nutritional status? *JPEN J Parenter Enteral Nutr*. 1987 Jan-Feb;11(1):8–13. PMID: 3820522.

Conclusion

Dietary management in HHD should be individualised according to dialysis prescription, biochemical trends, nutritional status, and patient circumstances. While increased dialysis frequency or duration may reduce the need for some dietary restrictions, maintaining adequate protein and energy intake remains essential to prevent PEW. Practical support should focus on food-based strategies, reducing salt and phosphate/potassium additives, if indicated, and avoiding unnecessary restriction of nutritious foods. Regular screening for malnutrition, early recognition of changing intake or weight, and timely referral to renal dietitians are central to supporting safe, person-centred care and help support quality of life for people undertaking HHD.

In this chapter, we are pleased to provide further information on the work of Kidney Care UK's Kidney Kitchen. The work of this charity is greatly valued by our patients and healthcare professionals in renal area.

At Kidney Care UK, we receive more questions about how to eat well to stay well with CKD than almost any other topic.' With this in mind, Kidney Care UK worked closely with BDA KDSG to set up Kidney Kitchen in 2018. This initiative provides free recipes and dietary advice to all those living with CKD in UK.

With over 300 delicious recipes and six recipe magazines, Kidney Kitchen has something for everyone, from pasta and

dal to burgers and hotpots. The Kidney Kitchen brings together professional chefs who understand food and know how to bring flavours to life with a team of experienced kidney dietitians who modify recipes to better suit the dietary needs of people with CKD.

Anyone can enjoy eating our kidney-friendly meals every day as part of a healthy, balanced diet, safe in the knowledge that we find inventive ways to flavour each dish without adding salt! Every one of our Kidney Kitchen recipes is carefully analysed and approved by the BDA KDSG.

For more information, please scan the below QR Code from the advert, that will take you to Kidney Kitchen homepage.



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The Kidney Kitchen is all about healthy, delicious food, that you can enjoy eating every day, and at every stage of kidney disease.

Chapter 9

Home Haemodialysis Patient's Experience

Learning objectives

- To understand the impact of HHD on quality of life and patient's independence
- To identify the role of Peer Support Groups
- To recognise the importance of Advocacy

Introduction: First-Hand Story from a Patient

Receiving a diagnosis of CKD is a life-changing event, which divides life into a before and an after. Like many patients, my first understanding of dialysis was the uncertainty and fear of the unknown, with images of hospital rooms, medical appointments, and dependence on machines and healthcare professionals. The idea of long hours in dialysis centres is always associated with feelings of loss not only of time, but also of identity.

When I was told that my kidneys were failing and that dialysis would soon be part of my life, my immediate reaction was panic. I felt devastated and completely lost. To be honest, I didn't want to live like this. It was not just fear of the treatment itself, but fear of losing control of my time, my body, and my future. Like many other kidney patients, I initially assumed dialysis meant something similar to cancer treatment, adjusting my life around inflexible schedules and depending on a machine to survive.

HHD entered my life relatively late. At the start of my dialysis journey no one had told me it was an available treatment choice. Looking back perhaps the healthcare system was unintentionally disqualifying the patients before they had the opportunity to choose. It's true that the thought of managing needles, alarms, and responsibility at home was very overwhelming and intimidating. As the education and training progressed, that fear slowly transformed into confidence. What profoundly changed my perspective was realising that HHD was not about doing dialysis alone, it was about doing dialysis at home on my own terms, according to my schedule and my preferences.

The transition to HHD is not only a choice, it's a journey. Training required patience, trust in yourself, and trust in your healthcare team. But the first time I completed a session at home, I felt something I hadn't felt since my diagnosis: empowerment. I felt capable of taking care of myself and sharing responsibility for my treatment. I was no longer just a patient receiving care, I was an active participant in my own treatment. HHD helped me restore a sense of control that kidney disease had taken away.

Impact of home haemodialysis on quality of life and patient's independence

One of the most significant benefits of HHD is its impact on quality of life.¹ Flexibility and frequency are among the most important advantages, with fewer diet and fluid restrictions, in addition to improvements in clinical outcomes such as survival and reduced hospitalisations.² More frequent dialysis sessions mean fewer toxins in your body, but most importantly, you will feel less thirsty because you are able to eliminate uraemic toxins almost every day, usually requiring less medication to control phosphate and potassium. HHD allows treatment schedules to adapt to the lives of the kidney patients, rather than forcing life to adapt to the treatments. This flexibility enables patients to better manage work, family responsibilities, and social relationships, providing a real sense of independence.

From a physical perspective, more frequent dialysis sessions make the dialysis less aggressive in terms of fluid removal from your body, and allows for a huge improvement in recovery time after the dialysis sessions. Most patients experience better blood pressure control, less unpleasant symptoms, improved energy levels, and shorter recovery times.³ These clinical benefits translate directly into everyday well-being, allowing patients to remain active, and giving them the opportunity to continue their daily activities and participate more fully in life.

Being able to manage your own treatment reinforces self-esteem and diminishes the feeling of always having to be at the hospital. In my opinion, autonomy and rehabilitation, both physical and social, have been recognised as central advantages of this modality. For me, this translated into better energy levels, and the ability to take part more in family life, work, and social activities.

Independence is not just about doing the treatment by yourself, it's about dignity. HDD restores a sense of normality in your life. You can plan treatments, travel when you want with proper preparation, and make decisions based on your needs rather than healthcare system rules. This autonomy fundamentally changes how you see your kidney disease, not as a person who is ill 24/7, but as a person living with a condition and, despite its challenges, is able to deal with it.

Overcoming challenges

Despite the benefits, HDD is not without challenges. The responsibility associated with self-caring can initially feel overwhelming. Fear of making mistakes, concerns about vascular access, being afraid about needling yourself, and anxiety about managing complications are common and should never be underestimated. We need to address these challenges through a better programme design, individualised assessment, 24/7 support at home (not just technical support), and the implementation of real shared decision-making.

Another challenge is integrating dialysis sessions into your home environment. The presence of medical devices can create the feeling of bringing your kidney disease into the home, just as it is present in the hospital, acting as a constant reminder, affecting not only the patient, but also family members or caregivers. Emotional adaptation, and psychological support are really important during and after the technical training.⁴

These fears are real and completely normal. What made the difference for me was structured training, ongoing clinical support, and knowing that I was not alone. Technology, while sometimes frustrating, has also evolved to become more user-friendly and safer, reinforcing confidence over time. However, some home therapies today are not truly portable. While the equipment can be moved, it requires a large quantity of supplies, and the machines remain too heavy and bulky to be transported as cabin luggage when travelling abroad by air.

The role of peer support groups and the importance of advocacy

Peer support plays a vital role in the patient experience of HDD. Peer-to-peer programmes are an enormously powerful tool, which can help to change the behaviour and habits of newly diagnosed patients, due to the unique credibility derived from having gone

through the same process or procedure before. Connecting with other patients who are already living with HHD provides experiences that no clinical explanation can replace. Peer conversations normalise fears, share practical solutions, and reinforce confidence through shared experience. In my opinion, peer support is one of the most underestimated and underutilised interventions in HHD.⁵

Advocacy ensures that patient voices are heard in policy discussions, helping decision makers to understand the reality of the condition and care, and to design better models of care.⁶ Chronic conditions should be managed at home whenever possible, as the home environment and family support could be therapeutic elements in themselves. No one is better placed than you to manage your own condition. It promotes equity, informed choice, and recognition of outcomes that matter most to patients, such as independence, quality of life, and life participation. We usually have shared the benefits of HHD from a clinical perspective; it's time to share with policy makers the benefits from a social and humanistic perspective. As way of highlighting this humanistic approach of home therapies, patient-centred advocacy is essential for the sustainable expansion of HHD programmes worldwide.

Advocacy is not only about choice, fairness, dignity, and respect. It is about ensuring that patients are well informed, supported, and empowered to choose the therapy that best fits their lives. As patients, caregivers, clinicians, and policymakers, we share a responsibility to build healthcare systems that value not only clinical outcomes, but also outcomes that matter most to people living with kidney disease. It's important to remark that home therapies help to conciliate life and work, allowing people to maintain their jobs and economic independence. Moreover, home therapies are climate friendly and more sustainable, with less need of water, transportation, and human resources.⁷

Conclusion

HHD is more than a dialysis technique or treatment modality, it is a care framework that places the patient at the centre. From the patients' perspective, it's a model of care that restores control, dignity, quality of life and the possibility of living a fulfilling life beyond the dialysis chair in the hospital.⁸

Listening to patient experiences, empowering peer support, and working together in advocacy efforts are the best ways to shape HHD programs for our future. When patients are informed, supported, and empowered, HHD becomes not only a viable option, but a life-enhancing solution, promoting self-care, independence, quality of life and sustainability.

References

1. Finkelstein F.O. et al. At-home short daily hemodialysis improves the long-term health-related quality of life. *Kidney Int.* 2012 Sep;82(5):561-9. DOI: 10.1038/ki.2012.168.
2. Mowatt G., Vale L., MacLeod A. Systematic review of the effectiveness of home versus hospital or satellite unit hemodialysis for people with end-stage renal failure. *Int J Technol Assess Health Care.* 2004 Summer;20(3):258-68. DOI: 10.1017/s0266462304001060.
3. Bolton S. et al. Clinical Assessment of Dialysis Recovery Time and Symptom Burden: Impact of Switching Hemodialysis Therapy Mode. *Patient Relat Outcome Meas.* 2021 Nov 4;12:315-321. DOI: 10.2147/PROM.S325016.
4. Brown D.J. et al. Physical, emotional and social adjustments to home dialysis. *Med J Aust.* 1978 Mar 11;1(5):245-7. DOI: 10.5694/j.1326-5377.1978.tb112515.x.
5. Golestaneh L. et al. Peer mentorship to improve outcomes in patients on hemodialysis (PEER-HD): a randomized controlled trial protocol. *BMC Nephrol.* 2022 Mar 5;23(1):92. DOI: 10.1186/s12882-022-02701-1.
6. Watnick S. et al. System-Level Strategies to Improve Home Dialysis: Policy Levers and Quality Initiatives. *Clin J Am Soc Nephrol.* 2023 Dec 1;18(12):1616-1625. DOI: 10.2215/CJN.0000000000000299.
7. Barraclough K. A. et al. Carbon Emissions From Different Dialysis Modalities: A Life Cycle Assessment. *Am J Kidney Dis.* 2025 Oct;86(4):465-474.e1. DOI: 10.1053/j.ajkd.2025.04.019.
8. Walker RC, Howard K, Morton RL. Home hemodialysis: a comprehensive review of patient-centered and economic considerations. *Clinicoecon Outcomes Res.* 2017 Feb 16;9:149-161. DOI: 10.2147/CEOR.S69340.

Chapter 10

Establishing a Home Haemodialysis Programme

Learning objectives

- To describe the strategic, workforce, infrastructure and governance components required to establish an equitable and sustainable HHD programme
- To outline a practical pathway from modality education and referral through assessment, training, home installation, independent treatment, and ongoing support
- To identify safety, quality assurance and outcome measures that support programme growth while maintaining PCC

Introduction

HHD is not simply haemodialysis moved from a dialysis unit into a person's house. It is a different model of care that requires service redesign, clear leadership, reliable infrastructure, and a confident multidisciplinary team. When established well, HHD can offer people with kidney failure greater autonomy, flexibility, and involvement in their own treatment. It may also support more frequent or longer dialysis schedules, reduce travel burden, and contribute to capacity within in-centre HD services. There is some evidence supportive of the hypothesis that a more physiological approach of delivering dialysis may lead to improvement in several cardiovascular factors. However, the evidence base remains mixed and subject to selection bias; programmes should therefore avoid overpromising benefits and should focus on shared decision-making, individual goals, and safe delivery.¹⁻⁵

International experience shows that access to home dialysis is highly variable. KDIGO has emphasised that expansion of home dialysis requires an alignment of policy, funding, organisational structure, provider accountability, education and support.³ In England, the GIRFT renal medicine report recommended that all suitable people should be offered home dialysis and that every renal centre should work towards a minimum 20% home dialysis rate.⁴ The practical question for nephrology care teams is therefore not whether HHD is valuable, but how to build a programme that is safe, inclusive, financially sustainable and resilient.

This chapter provides a framework for establishing an HHD programme. It draws on published guidance, recent evidence, and the experience of the Wessex Kidney Centre in Portsmouth, UK, which re-established HHD after a decade without provision and developed it into one of the largest programmes reported in the EDTNA/ERCA HHD guide.^{8,9}

1. Set the programme vision and governance

A successful HHD programme starts with a clear service vision: every person approaching or receiving dialysis who may benefit from HHD should receive timely, balanced information and access to assessment. The vision should be written into the renal service strategy, linked to the dialysis capacity plan, and owned jointly by nursing, medical, technical, managerial, and lived-experience representatives. It should include both growth and quality, because increasing numbers without sufficient support can lead to treatment discontinuation, anxiety, and avoidable risk.

Governance should be established before the first person is trained. The programme should have a named clinical lead nephrologist, senior nurse lead, operational manager, technical or biomedical lead and administrative support. A steering group can oversee pathway design, business case development, risk assessment, SOPs, incident review, training records, infection prevention, prescribing, water and electrical safety, and an audit. Where possible, people already established on HHD and care partners should contribute to the pathway design, person-facing information, and quality improvement. This co-production helps ensure that the service addresses real barriers rather than assumptions made by professionals.

The initial business case should describe expected demand, current dialysis pressures, capital and revenue costs, staffing, training facilities, home installation arrangements, supplies, waste disposal, utility reimbursement where applicable, and technical support. It should also define escalation plans for clinical or technical issues, including out-of-hours advice. Early engagement with commissioners, finance, procurement, estates, infection prevention, information governance, and community services prevent delays once the programme begins.

2. Understand the population and remove avoidable barriers

The first planning task is to understand the local dialysis population. A simple baseline review should include the number of people receiving in-centre HD, PD, and conservative kidney management, people approaching KRT, travel times, vascular access status, frailty and comorbidity, home circumstances, languages spoken, and groups underrepresented in home therapies. Data from national and international renal registries (e.g. the UK Renal Registry and the ERA Registry), together with local dashboards can help benchmark the service and monitor equity over time.¹⁷

Eligibility should be based on individual assessment rather than blanket exclusion. Age, diabetes, disability, living alone, catheter access or distance from the renal centre should prompt a structured discussion about risk and support rather than automatic refusal. KDIGO and contemporary vascular access guidance support person-centred decision-making and the matching of treatment to life goals, care-partner availability and living environment.^{3,11}

Common barriers include limited knowledge of HHD, fear of emergencies, concerns about space, care-partner burden, lack of confidence, financial worries, provider assumptions and systems designed around in-centre dialysis.^{15,16} Programmes should therefore provide repeated education, peer support, home visits, flexible training, psychological support where required, and transparent discussion of costs and practicalities. People should be able to decline HHD without feeling judged and should be able to revisit the decision later.

3. Build the multidisciplinary Home Haemodialysis team

HHD requires a named team with protected time. Relying on goodwill from busy in-centre staff may work for a small pilot, but it rarely sustains growth. The core team usually includes:

- HHD lead nurse or clinical nurse specialist responsible for pathway coordination, education, competency assessment, home visits, ongoing support, and quality assurance.
- Consultant nephrologist or medical lead responsible for clinical governance, prescribing, eligibility decisions, complications, and escalation.

- Technical or biomedical support for water treatment, machine installation, maintenance, alarms, repairs, and home safety.
- Dialysis assistant or support worker to assist with education, logistics, stock, home assessments, and data collection.
- Dietitian, pharmacist, psychologist, social worker, VA team, infection prevention team, and administrative coordinator as extended members of the pathway.

The Wessex Kidney Centre reported that programme growth became difficult when the ratio exceeded 20 people on HHD per nurse, and that a ratio closer to 15:1 was more appropriate when nurses were also training new people.^{8,9} This should not be interpreted as a universal rule, but it is a useful planning benchmark. Local ratios should reflect geography, complexity, training throughput, on-call arrangements, home visits, respite provision, and administrative support.

The wider renal workforce also needs education. People receiving in-centre HD often discuss treatment choices with satellite-unit nurses, healthcare support workers, and junior doctors before meeting the HHD team. HHD awareness should therefore be included in staff induction, renal courses, shared-care programmes, VA education and regular satellite-unit updates. Staff who understand HHD are more likely to identify suitable people, answer questions honestly and avoid presenting home therapy as a last resort.

4. Develop the Home Haemodialysis pathway

A written pathway helps teams move from enthusiasm to reliable delivery. The pathway should be easy to follow and should define who does what, by when, and how progress is tracked. Figure 1 shows a practical sequence.

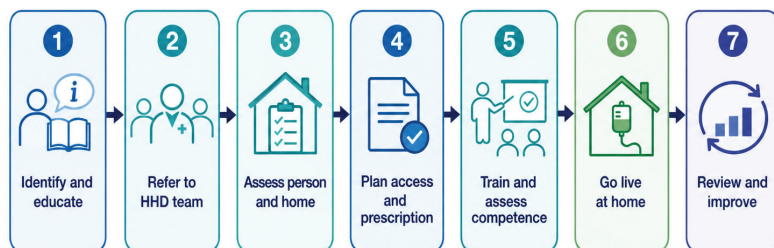


Figure 1. Example HHD programme pathway

Referral routes should include advanced kidney care clinics, in-centre HD, PD, transplant clinics, inpatient wards, and shared-care programmes. Every referral should trigger a structured HHD assessment, not an informal conversation that may be forgotten. The assessment should cover motivation, learning needs, manual dexterity, vision, cognition, language, health literacy, vascular access, haemodynamic stability, infection risk, home environment, storage, waste, electricity, water, digital connectivity, transport, care-partner involvement, and safeguarding considerations.

Home assessment should be practical and respectful. The aim is to identify what support is needed, not to judge the home. Depending on the dialysis system used, the assessment may include space for the machine and chair or bed, access to water and drainage, electricity supply, lighting, hand hygiene, clinical waste storage, stock deliveries, emergency access and telephone or digital contact. A written plan should record any adaptations, responsible person, and target date.

5. Design training for competence and confidence

Training is the heart of the programme. The goal is not simply to teach a person to press buttons, but to develop competence, confidence, and judgement. A competency-based curriculum should include treatment set-up, hand hygiene, infection prevention, access assessment, cannulation or catheter care, anticoagulation, observations, fluid management, alarm response, rinse-back, documentation, emergency actions, stock management, waste disposal and when to stop treatment and seek help.^{10,12}

Training should use adult-learning principles: demonstration, repetition, supervised practice, teach-back and gradual transfer of

responsibility. A "hands-off" approach, where the person performs each task under close supervision from the start, can build confidence and reveal learning needs early. Written guides, pictorial checklists, videos, and translated materials should be available. Care partners require their own training and competency assessment; their role should be negotiated so that they are supported rather than unintentionally overburdened.

VA planning is essential. Where a AVF or AVG is used, self-cannulation training should begin early and, where possible, before formal HHD training. This allows the person to learn in a familiar environment and at an appropriate pace. For people using catheters, training should emphasise aseptic technique, exit-site care, line security and rapid escalation of infection or flow concerns. Current VA guidance highlights the importance of shared decision-making and individualised access planning rather than a single access hierarchy for all people.¹¹

The final stage of training should include supervised treatments in the home, confirmation that equipment and supplies are in place, emergency contacts are understood, and the prescription is safe and achievable. Sign-off should be documented by the HHD team and agreed with the medical lead. Competence should be reassessed after any serious incident, long admission, change in cognition or dexterity, new access, recurrent alarms or request from the person or care partner.

6. Provide structured ongoing support

A programme is established only when people remain safely supported after training. The first month at home is particularly important. A planned contact schedule should include early telephone or video review, a home visit where required, review of treatment logs, blood results, access, stock, confidence, and care-partner wellbeing. Routine follow-up commonly includes a monthly nursing review, regular blood monitoring and quarterly medical review, adapted to local policy and individual risk.

Support should be easy to access. People should know who to call for clinical concerns, technical alarms, supply issues, VA problems, and non-dialysis emergencies. A single written escalation sheet at the machine is helpful. Technical support arrangements depend on the equipment model, but the service must specify response times

for machine failure and the process for replacement, temporary in-centre dialysis, or treatment deferral where clinically safe.

Digital tools are an important emerging component. Electronic treatment records, remote upload of machine data, virtual appointments and digital portals can reduce travel and enable earlier intervention, although they should not replace human contact. KDIGO identified telehealth, remote monitoring, and eHealth interventions as key areas for home dialysis development.³ Digital inclusion should be considered: people without reliable internet, devices or confidence using technology should receive alternative support.

7. Embed safety and quality assurance

HHD is widely recognised as a safe and effective dialysis modality when delivered through structured training, appropriate technology and ongoing professional support, but the home environment shifts greater responsibility for treatment and safety to individuals and their care partners. The person receiving dialysis, and any care partners become active members of the safety system. The programme must therefore create a culture where near misses and concerns are reported without blame and used for improvement.^{12,13}

A quality assurance framework should include current SOPs, risk assessments, competency records, water or dialysate quality processes, infection surveillance, VA monitoring, incident reporting, emergency drills, annual home reviews, equipment maintenance, stock checks, and audit of outcomes. High-priority risks include venous needle dislodgement, bleeding, access infection, catheter-related bloodstream infection, hypotension, power failure, machine alarms, water leaks, incorrect dialysate or prescription, medication errors, and carer strain. Each risk should have prevention, detection, and escalation controls.

Programmes should monitor both clinical and person-reported outcomes. Suggested measures include the number of people educated about HHD, referrals received, assessments completed, training commencements, and training completions.

Programme efficiency may be monitored through measures such as time from referral to home start and time from training completion to independent treatment. Clinical outcomes should include technique survival, reasons for discontinuation, access events, infection rates, hospital admissions, treatment adherence, and mortality. Safety indicators should encompass incidents, near misses, adverse

events, and safeguarding concerns, helping to drive continuous improvements. Workforce measures would need to include staff training completion, competence assessment, and maintenance of clinical skills.

Person-centred outcomes may include person-reported experience and outcomes, respite service utilisation, travel avoided, treatment adherence, care-partner burden, quality of life, and achievement of treatment goals.

Equity should be monitored across the pathway by age, sex, ethnicity, deprivation, socioeconomic deprivation, language, disability and geographical location to ensure fair access, participation and outcomes for all population groups.

Data should be reviewed at governance meetings and shared with the multidisciplinary team as well as people with lived experience, to promote transparency, learning and continuous service improvement.

8. Sustain and grow the programme

Growth is achieved by making HHD visible and normal within the renal service. Education should be an ongoing process and should be repeated and reinforced over time. Practical strategies could include HHD open days, peer-support events, videos of people dialysing at home, shared-care sessions, satellite-unit champions, regular feedback to consultants and ward teams, and inclusion of HHD in advanced kidney care education. Peer support can be particularly powerful because it addresses fears that professionals may underestimate, such as isolation, storage, sleep disruption, body image, travel, and the impact on family life.^{15,16}

Financial sustainability requires a realistic understanding of both the initial set-up costs and the long-term value generated by the programme. Initial costs include staff time, training, equipment, home adaptations, technical support, and supplies. Longer term benefits may include reduced demand on in-centre dialysis capacity, decreased reliance on patient transport services, greater flexibility for people who work or study, and the potential to avoid or defer costly capital expansion of dialysis facilities. The programme should work with finance teams to model local costs rather than relying only on published estimates, as reimbursement, geography and technology differ between countries.^{3,4}

Environmental sustainability should also be considered from the beginning. Home therapy changes the location of water use, electricity use, deliveries, and waste. Programmes should educate people about safe segregation of clinical and domestic waste, recycling where appropriate, stock rotation to prevent stock going over the expiry date, and reporting leaks or excessive alarms. Procurement decisions should consider not only clinical suitability and cost, but also water, energy, packaging, transport, and waste implications.

Conclusion

Establishing an HHD programme requires more than purchasing machines or identifying motivated individuals. It requires a whole-service pathway, visible leadership, trained staff, technical infrastructure, person-centred education, home assessment, competency-based training, responsive support, and continuous quality assurance. The experience of established programmes shows that growth is possible when HHD is presented as a normal dialysis option, when barriers are actively addressed, and when people and care partners are supported beyond the transition to home treatment. The measure of success is not only how many people start HHD, but whether they feel safe, informed, respected, and able to live as well as possible with kidney failure. Table 1 provides a practical implementation checklist to help centres assess readiness and guide the development of a new HHD programme.

Component	Minimum requirement	Evidence of readiness
Leadership	Named medical, nursing, operational and technical leads	Terms of reference, steering group minutes, escalation route
Pathway	Written pathway from education to home start and review	Referral form, assessment template, pathway map
Workforce	Protected HHD team time and training capacity	Staffing model, competency records, training rota

Component	Minimum requirement	Evidence of readiness
Infrastructure	Training space, equipment, supplies, waste, and utilities process	Home assessment checklist, supplier agreement, waste contract
Safety	SOPs, risk register, incident process, and emergency guidance	Approved SOPs, risk log, emergency guidance sheet
Support	Clinical and technical contacts, routine review, and respite plan	Contact sheet, review schedule, respite access
Quality	Outcome dashboard and person/care-partner feedback	Audit report, governance review, improvement plan

Table 1. Implementation checklist for a new HHD programme.

Reflective learning activity

- How would your centre identify every person who should be offered information about HHD?
- Which single barrier currently limits HHD growth in your service: workforce, training space, education, technical support, confidence, or funding?
- What three measures would you include in a monthly HHD quality dashboard?

References

1. National Institute for Health and Care Excellence. Renal replacement therapy and conservative management. NICE guideline NG107. London: NICE; 2018. Available at: <https://www.nice.org.uk/guidance/ng107> (accessed 1 May 2026).
2. National Institute for Health and Care Excellence. Guidance on home compared with hospital haemodialysis for patients with end-stage renal failure. Technology appraisal guidance TA48. London: NICE; 2002. Available at: <https://www.nice.org.uk/guidance/ta48> (accessed 1 May 2026).
3. Perl J, Brown EA, Chan CT, Couchoud C, Davies SJ, Kazancioglu R, et al. Home dialysis: conclusions from a Kidney Disease: Improving Global Outcomes (KDIGO) Controversies Conference. *Kidney Int.* 2023;103(5):842-858. doi: 10.1016/j.kint.2023.01.006.
4. Lipkin G, McKane W. Renal Medicine: GIRFT Programme National Specialty Report. London: Getting It Right First Time; 2021. Available at: https://gettingitrightfirsttime.co.uk/medical_specialties/renal-medicine/ (accessed 1 May 2026).

5. Cheetham MS, Ethier I, Jun M, Howell M, Cho Y, Wong G, et al. Home versus in-centre haemodialysis for people with kidney failure. *Cochrane Database Syst Rev.* 2024;4(4):CD009535. doi: 10.1002/14651858.CD009535.pub3.
6. FHN Trial Group; Chertow GM, Levin NW, Beck GJ, Depner TA, Eggers PW, Gassman JJ, et al. In-center hemodialysis six times per week versus three times per week. *N Engl J Med.* 2010;363(24):2287-2300. doi: 10.1056/NEJMoa1001593.
7. Rocco MV, Lockridge RS Jr, Beck GJ, Eggers PW, Gassman JJ, Greene T, et al. The effects of frequent nocturnal home haemodialysis: the Frequent Hemodialysis Network Nocturnal Trial. *Kidney Int.* 2011;80(10):1080-1091. doi: 10.1038/ki.2011.213.
8. Borman N, Atkins K. Home Programme Case Study. In: Fortnum D (ed.) *Home Haemodialysis - A Nurses Guide to Implementing Best Practice in Home Haemodialysis.* Hergiswil: EDTNA/ERCA; 2017. p.197-208.
9. UK Kidney Association. Improving access to home haemodialysis. *Kidney Quality Improvement Partnership case study: Wessex Kidney Centre.* Available at: <https://www.ukkidney.org/kquip/qi-case-studies/improving-access-home-haemodialysis> (accessed 1 May 2026).
10. Ashby D, Borman N, Burton J, Corbett R, Davenport A, Farrington K, et al. Renal Association Clinical Practice Guideline on Haemodialysis. *BMC Nephrol.* 2019;20(1):379. doi: 10.1186/s12882-019-1527-3.
11. Aitken E, Anijeet H, Ashby D, Barrow W, Calder F, Dowds B, et al. UK Kidney Association Clinical Practice Guideline on vascular access for haemodialysis. *BMC Nephrol.* 2025;26:461. doi: 10.1186/s12882-025-04374-y.
12. Pauly RP, Eastwood DO, Marshall MR. Patient safety in home haemodialysis: quality assurance and serious adverse events in the home setting. *Hemodial Int.* 2015;19 Suppl 1:S59-S70. doi: 10.1111/hdi.12248.
13. Hawley CM, Jeffries J, Nearhos J, Van Eps C. Complications of home haemodialysis. *Hemodial Int.* 2008;12 Suppl 1:S21-S25. doi: 10.1111/j.1542-4758.2008.00291.x.
14. Tran E, Karadjian O, Chan CT, Trinh E. Home haemodialysis technique survival: insights and challenges. *BMC Nephrol.* 2023;24(1):205. doi: 10.1186/s12882-023-03264-5.
15. Reddy YNV, Kriedberg C, Shi J, Clase CM, Hladunewich MA, Nesrallah G, et al. Identifying major barriers to home dialysis (the IM-HOME study): findings from a national survey of patients, care partners and providers. *Am J Kidney Dis.* 2024;84(5):567-581.e1. doi: 10.1053/j.ajkd.2024.04.007.
16. Earley A, Lydon S, Walker RC, Gannon L, Reddan D, Durack L, et al. A systematic review of the qualitative research on barriers and facilitators to home haemodialysis. *Hemodial Int.* 2025;29(4):434-441. doi: 10.1111/hdi.13266.
17. UK Kidney Association. UK Renal Registry 27th Annual Report: data to 31/12/2023. Bristol: UK Kidney Association; 2025. Available at: <https://www.ukkidney.org/audit-research/annual-report/27th-annual-report-data-31122023> (accessed 1 May 2026).

Chapter 11

Ethical and Legal Considerations in Home Haemodialysis

Learning objectives

- To understand key ethical principles underpinning HHD
- To explore the role of informed consent and shared decision-making in home-based kidney care
- To analyse ethical dilemmas and legal considerations related to privacy, data security, and telehealth

Introduction

HHD represents a shift in healthcare delivery from hospital-based treatment to care provided within the individual's home. This transition fundamentally alters the roles and responsibilities of healthcare professionals, individuals receiving care, and their families.^{1,2} While HHD offers increased autonomy, flexibility, and improved quality of life, it also introduces complex ethical and legal considerations that must be carefully addressed.³ The move to home-based care requires individuals to take on a greater degree of responsibility for their treatment. At the same time, healthcare professionals retain responsibility for ensuring safe, effective, and equitable care.⁴ This shared responsibility creates a dynamic interplay between autonomy, safety, and professional accountability.³ Ethical practice in HHD is closely linked to the principles of person-centred care, which emphasise respect for individual values, preferences, and experiences.⁵ Evidence highlights that involvement in decision-making, treatment, and management of illness is essential for successful home dialysis but also requires continuous support from healthcare professionals.³ This chapter explores key ethical and legal dimensions of HHD, focusing on informed consent and shared decision-making, ethical dilemmas in home-based care, and issues related to privacy, data security, and telehealth.⁹

Informed Consent and Shared Decision-Making

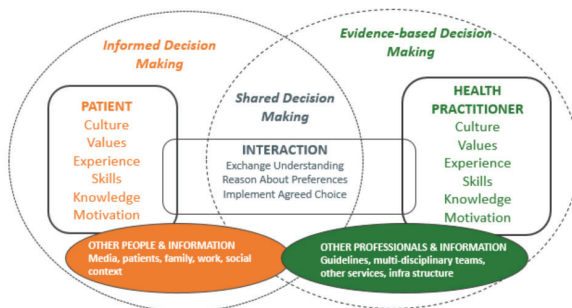
Informed consent is a fundamental ethical and legal principle in healthcare and is particularly significant in the context of HHD, where individuals assume an active role in managing their treatment.⁶

Traditionally, informed consent has been understood as the provision of information followed by a patient's agreement to a proposed intervention. However, in contemporary practice, especially in home-based care, this understanding is insufficient. Instead, informed consent should be conceptualised as a dynamic, relational, and ongoing process that is closely intertwined with shared decision-making.³

In HHD, informed decision making begins with the individual's own life context, including their values, experiences, knowledge, and motivation. Decisions about dialysis modality are not made in isolation but are shaped by personal goals, daily life, and social circumstances.⁷ Individuals must not only understand the clinical aspects of HHD but also the practical, emotional, and social implications of integrating dialysis into their everyday lives.⁷ This includes considerations related to responsibility, lifestyle changes, involvement of family members, and the potential impact on the home environment.⁸

The process of informed and shared decision-making can be understood through the MIND-IT framework (Figure 1)⁹, which illustrates how decisions are shaped through the interaction between the individual and the healthcare professional. The model emphasises that informed decision making is not solely an individual cognitive process but is embedded in a broader relational and contextual framework. On one side, the individual brings their personal values, experiences, and preferences; on the other, the healthcare professional contributes clinical knowledge, expertise, and evidence-based recommendations.⁸ Between these perspectives lies the interaction, where understanding is exchanged, preferences are explored, and decisions are negotiated.⁷

Making Informed Decisions Individually and Together (MIND-IT)



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First published in Breckenridge et al, *Nephrol Dial Transplant*. 2015. [10.1093/ndt/gfv209](https://doi.org/10.1093/ndt/gfv209)

Figure 1. Making Informed Decisions Individually and Together (MIND-IT model adapted for HDD).

Shared decision making emerges from this interaction as a collaborative process in which both parties contribute to the final decision. It involves not only the exchange of information but also the development of a shared understanding and agreement on the most appropriate course of action. Importantly, shared decision making does not imply equal knowledge but rather mutual respect and recognition of complementary expertise: the individual as an expert in their own life and the healthcare professional as an expert in clinical care.⁷

In the context of HDD, this process is particularly important because decisions are complex, preference-sensitive, and evolve over time.³ Evidence suggests that the choice of dialysis modality is not a single event, but an ongoing process influenced by changing circumstances, experiences, and priorities.^{3,10} Furthermore, recent research highlights that there may be discrepancies between what healthcare professionals perceive as important and what individuals themselves prioritise.⁸ While professionals often emphasise risks, technical complexity, or concerns about responsibility, individuals frequently prioritise independence, flexibility, and the ability to maintain everyday life.⁸ This underscores the ethical importance of ensuring that decision-making processes genuinely reflect the individual's perspective.

Family members and caregivers often play an important role in HHD decision-making, particularly when they participate in supporting treatment.¹⁰ The MIND-IT model recognises that decision-making is influenced not only by the individual and healthcare professional but also by a broader network of people and information, including family, peers, and social context.⁹ Ethical practice requires that family involvement supports, rather than overrides, the individual's autonomy. Healthcare professionals must therefore navigate these relational dynamics carefully, ensuring that the individual's voice remains central.¹¹

Another key implication of this approach is that informed consent and shared decision making must be revisited over time. As individuals gain experience with dialysis, their preferences, confidence, and circumstances may change.³ Ongoing dialogue, reflection, and adaptation are therefore essential components of ethical care in HHD. This process-oriented understanding aligns with person-centred care principles, which emphasise partnership, responsiveness, and continuity.⁵

In summary, informed consent and shared decision-making in HHD should be understood as interconnected, evolving processes that are grounded in the interaction between individuals and healthcare professionals. By adopting a relational and person-centred approach, nephrology teams can support decisions that are not only clinically appropriate but also meaningful and sustainable within the individual's life context.

Ethical Dilemmas in Home-Based Care

The transition from hospital-based dialysis to HHD introduces a range of ethical dilemmas that arise from the redistribution of responsibility, the relocation of care into the home, and the need to balance autonomy with safety.^{1,2} These dilemmas can be understood through the lens of the four fundamental principles of biomedical ethics, **autonomy, beneficence, non-maleficence, and justice**, which provide a widely accepted framework for ethical decision-making in healthcare.¹²

The principle of **autonomy** emphasises respect for the individual's right to make informed decisions about their own care. In HHD, this includes supporting individuals in choosing and managing

treatment in a way that aligns with their values, preferences, and life circumstances.¹² **Beneficence** refers to the obligation to act in the best interests of the individual by promoting wellbeing and maximising the potential benefits of treatment. In the context of HHD, this may include enabling greater flexibility, independence, and quality of life.¹² **Non-maleficence** often summarised as the duty to “do no harm” requires healthcare professionals to minimise risks and prevent harm. In home-based care, this principle is particularly relevant due to the shift of treatment into a non-clinical environment, where individuals assume responsibility for complex procedures.¹² Finally, the principle of **justice** concerns fairness and equity in access to care. In HHD, this includes ensuring that all individuals have equal opportunity to access home-based treatment, regardless of socioeconomic status, living conditions, or available support systems.¹²

These principles are not applied in isolation but often interact and, at times, come into tension with one another. Ethical dilemmas in HHD therefore arise not from a lack of guiding principles, but from the complexity of applying them in real-world contexts.

In addition to these foundational principles, contemporary healthcare practice, particularly in the context of HHD, requires attention to a set of context-specific ethical considerations that reflect the realities of care delivered outside traditional clinical environments. These include **relational ethics**, **privacy and confidentiality**, **autonomy in digital care**, and **equity in access to telehealth**.^{4,8,13,14}

Relational ethics emphasises that decision-making and care are embedded within relationships between individuals, families, and healthcare professionals. In HHD, where family members are often involved in treatment, ethical practice requires sensitivity to interpersonal dynamics, caregiver burden, and the need to maintain the individual's autonomy within a relational context. **Privacy and confidentiality** take on additional significance in home-based and digitally supported care. The home becomes a site of clinical activity, and personal health data are increasingly shared through digital platforms. Ethical practice requires safeguarding sensitive information, ensuring transparency in data use, and maintaining trust. The concept of **autonomy in digital care** extends traditional understandings of autonomy to include the individual's ability to engage with and make informed choices about the use of telehealth

and remote monitoring technologies. This includes understanding both the benefits and limitations of digital tools, as well as avoiding unintended dependency on technology. Finally, **equity in telehealth** highlights the risk that digital solutions may exacerbate existing inequalities in healthcare. Differences in digital literacy, access to technology, and socioeconomic resources can influence the ability to benefit from telehealth-supported HHD. Addressing these disparities is therefore an essential component of ethically responsible care.^{4,8,13,14} Together, these context-specific considerations complement the four core ethical principles and provide a more comprehensive framework for understanding ethical challenges in HHD.

A central ethical tension in HHD lies in the balance between respecting autonomy and ensuring safety.^{4,8,14} Individuals undertaking HHD are encouraged to take an active role in managing their treatment, which can promote independence and improve quality of life. However, healthcare professionals retain a duty of care to ensure that treatment is delivered safely. This tension may become particularly evident when individuals make choices that differ from clinical recommendations, when competence fluctuates over time, or when adherence to treatment protocols is inconsistent. Ethical practice therefore requires a nuanced and individualised approach that supports autonomy while maintaining appropriate safeguards.

The redistribution of responsibility inherent in HHD also raises ethical considerations related to burden and capacity.⁸ While home-based treatment can be empowering, it may also be experienced as demanding or overwhelming, particularly during the initial stages of adaptation. Importantly, emerging evidence suggests that healthcare professionals may overemphasise concerns related to patient reluctance or burden, whereas individuals themselves often highlight practical and structural challenges, such as access to support, communication with the care team, and organisational barriers.⁸ This discrepancy underscores the importance of grounding ethical decision-making in the individual's lived experience rather than professional assumptions.

Another important ethical dimension relates to the home as a site of care.^{4,14} Introducing dialysis into the home environment can blur the boundaries between personal and clinical spaces. For some individuals, this integration enhances comfort and flexibility, while for others it may challenge the perception of the home as a place of

rest and normality. Respecting the home as a private and meaningful space therefore requires sensitivity to individual preferences and efforts to minimise disruption to daily life.

Ethical dilemmas in HHD are also closely linked to issues of equity and access.^{4,14} Not all individuals have the same opportunities to undertake home dialysis, as factors such as housing conditions, availability of caregiver support, socioeconomic circumstances, and healthcare infrastructure can significantly influence eligibility. Ensuring equitable access requires active efforts to identify and address these structural barriers, as well as awareness of potential biases in how treatment options are presented.

These interrelated ethical considerations are summarised in Table 1, which illustrates how core ethical principles and context-specific considerations intersect with decision-making processes and clinical practice in HHD. The table highlights the need for ongoing ethical awareness and person-centred dialogue in navigating complex situations.

Category	Ethical Domain	Key Considerations in HHD	Informed Consent & SDM	Ethical Dilemmas	Nursing Implications
Core ethical principles	Autonomy	Supporting independent treatment	Ensuring informed, value-based decisions	Balancing independence and safety	Support autonomy with safeguards
	Beneficence	Promoting wellbeing	Aligning care with patient goals	Delivering optimal care at home	Tailor education and support
	Non-maleficence	Minimising harm	Communicating risks clearly	Managing risks in self-care	Reinforce safety and monitoring
	Justice	Ensuring equity	Supporting fair access	Structural inequalities	Address barriers and bias

Category	Ethical Domain	Key Considerations in HHD	Informed Consent & SDM	Ethical Dilemmas	Nursing Implications
Context-specific ethical considerations	Relational ethics	Family involvement	Including family appropriately	Caregiver burden, coercion	Support families and assess capacity
	Privacy & confidentiality	Data protection	Transparency in data use	Data breaches	Ensure secure systems
	Autonomy in digital care	Telehealth use	Consent for digital tools	Over-reliance on technology	Support digital literacy
	Equity in telehealth	Access to digital care	Inclusive participation	Digital divide	Provide alternatives

Table 1. *Ethical Considerations, Decision-Making, and Nursing Implications in HHD.*

Privacy, Data Security and Telehealth Regulation

The increasing integration of telehealth and digital technologies⁸ into HHD has introduced new ethical and legal dimensions related to privacy, data protection, and equitable access to care. While these technologies offer significant benefits in terms of accessibility, flexibility, and continuity of care⁸, they also require careful consideration to ensure that ethical standards are upheld. Telehealth is now an integral component of many HHD programmes, supporting remote monitoring, communication between individuals and healthcare professionals, symptom reporting, and ongoing education.¹⁴ These developments have the potential to enhance safety and reduce the need for hospital visits. However, they also involve the collection, storage, and transmission of sensitive personal health data, raising important questions about confidentiality and data security.

Protecting patient data is both an ethical obligation and a legal requirement. Individuals receiving HHD must be assured that their information is managed securely and transparently. This includes clear communication about how data are collected, who has access to them, and how they are used within the healthcare system. In the European context, these responsibilities are governed by the GDPR¹⁵, which sets strict standards for the protection of personal data.

Informed consent in the context of telehealth extends beyond traditional clinical consent. Individuals must understand not only the clinical aspects of their treatment but also the implications of using digital technologies. This includes awareness of potential risks, such as data breaches or limitations in remote monitoring, as well as the benefits associated with increased accessibility and support.¹⁵ Consent should therefore be viewed as an ongoing process that evolves alongside the use of digital tools.

The use of telehealth also raises questions related to autonomy and dependency. While digital solutions can support independence by enabling individuals to manage their treatment at home, they may also create new forms of reliance on technology. Ensuring that technology enhances rather than replaces human interaction is an important ethical consideration, particularly in maintaining trust and therapeutic relationships.

Finally, issues of equity in digital access must be addressed. Not all individuals have equal access to digital tools or the skills required to use them effectively. Factors such as digital literacy, socioeconomic status, and access to reliable technology can create disparities in care. Healthcare professionals have a responsibility to recognise these challenges and ensure that alternative forms of support are available when needed.

As illustrated in Table 1, ethical considerations related to privacy, data security, and telehealth are closely interconnected with broader principles of autonomy, justice, and person-centred care. Addressing these issues requires not only adherence to legal frameworks but also a commitment to supporting individuals in a way that is inclusive, transparent, and responsive to their needs.

Conclusion

Ethical and legal considerations are integral to the delivery of HHD. The shift to home-based care requires careful balancing of autonomy, safety, and responsibility, as well as attention to privacy and equity. Informed consent and shared decision-making must be understood as ongoing, relational processes that centre the individual's perspective. Ethical dilemmas arising from home-based care require flexible and reflective approaches that acknowledge the complexity of real-world contexts. By adopting a person-centred, ethically grounded approach, nephrology teams can support individuals in managing dialysis at home while ensuring that care remains safe, respectful, and equitable.

References

1. Slon-Roblero MF. Fostering a future of home dialysis: transforming kidney care in Europe. *Clin Kidney J.* 2024 Jun 5;17(Suppl 1):i1-i2.
2. Mapes MV, DePergola PA, McGee WT. Patient-Centered Care and Autonomy: Shared Decision-Making in Practice and a Suggestion for Practical Application in the Critically Ill. *J Intensive Care Med.* 2020 Nov;35(11):1352-1355.
3. Nygaard-Andersen B, Torbjørnsen A, Hougaard PF, Leonardsen AL, Wolf A, Funderup J. Home-Based Dialysis and Person-Centered Care: A Scoping Review. *Nephron.* 2025;149(8):463-478.
4. Rioux JP, Marshall MR, Faratro R, Hakim R, Simmonds R, Chan CT. Patient selection and training for home hemodialysis. *Hemodial Int.* 2015 Apr;19 Suppl 1:S71-9.
5. Britten N, Ekman I, Naldemirci Ö, Javinger M, Hedman H, Wolf A. Learning from Gothenburg model of person centred healthcare. *BMJ.* 2020 Sep 1;370:m2738.
6. Pugh J. Autonomy, Rationality, and Contemporary Bioethics [Internet]. Oxford (UK): Oxford University Press; 2020.
7. Winterbottom A, Mooney A, Russon L, Hipkiss V, Ziegler L, Funderup J, Williams R, Bekker HL. Integrating Clinical Reasoning Into a Patient Decision Aid for People Making Conservative Kidney Management and Dialysis Decisions: A User-Centered Intervention Development Design. *Kidney Med.* 2025 Feb 24;7(5):100984.
8. Torbjørnsen A, Nygaard-Andersen B, Kiani K, Leonardsen ACL, Wolf A, Pripp AH, Hougaard PF, Funderup J. Factors influencing home dialysis choice in Scandinavia: a cross-sectional study. Manuscript submitted for publication.
9. Breckenridge K, Bekker HL, Gibbons E, van der Veer SN, Abbott D, Briançon S, Cullen R, Garneata L, Jager KJ, Lønning K, Metcalfe W, Morton RL, Murtagh FE, Prutz K, Robertson S, Rychlik I, Schon S, Sharp L, Speyer E, Tentori F, Caskey FJ. How to routinely collect data on patient-reported outcome and experience measures in renal registries in Europe: an expert consensus meeting. *Nephrol Dial Transplant.* 2015 Oct;30(10):1605-14.
10. Funderup J, Jensen JD, Lomborg K. Shared decision-making in dialysis choice has potential to improve self-management in people with kidney disease: A qualitative follow-up study. *J Adv Nurs.* 2021 Apr;77(4):1878-1887.
11. de Rosenroll A, Higuchi KS, Dutton KS, Murray MA, Stacey D. Perspectives of significant others in dialysis modality decision-making: a qualitative study. *CANNT J.* 2013 Oct-Dec;23(4):17-24.
12. Beauchamp TL, Childress JF. Principles of Biomedical Ethics. 8th ed. Oxford: Oxford University Press; 2019.
13. Varkey B. Principles of Clinical Ethics and Their Application to Practice. *Med Princ Pract.* 2021;30(1):17-28.
14. Bonenkamp AA, van Gelder MK, Abrahams AC, Boereboom FTJ, Cornelis T, Luik AJ, Özyilmaz A, van der Sande FM, van Eck van der Sluijs A, Gerritsen KGF, van Jaarsveld BC. Home haemodialysis in the Netherlands: State of the art. *Neth J Med.* 2018 May;76(4):144-157.
15. European Union. General Data Protection Regulation (GDPR) (EU) 2016/679. 2016.

Chapter 12

Emerging Trends and the Future of Home Haemodialysis

Learning objectives

- To describe the engineering advances driving the miniaturisation of HD technology
- To explain the role of artificial intelligence and machine learning models in HHD and its current limitations
- To compare reimbursement policies influencing HHD uptake in the USA and in Europe
- To assess methods for evaluating patient and caregiver experience in HHD
- To identify the evolving workforce and training needs for the safe expansion of HHD
- To integrate technological, analytical, financial, patient-centred, and professional perspectives shaping the future of HHD

Introduction

For more than half a century, HHD has occupied a paradoxical position in the landscape of renal replacement therapy: clinically compelling, yet persistently underused. Merrill and Scribner began treating patients with HD machines outside the hospital walls in Boston and Seattle, respectively, in 1965, and by the 1970s nearly a third of all patients on dialysis in the USA were treated at home.¹ Nevertheless, HHD has not evolved into the default modality that this early trend might have suggested, either in the USA, or in Europe.²

In this chapter, we address how the barriers to HHD implementation are being challenged from several directions at once. Smaller dialysis machines, sorbent-based dialysate regeneration, and novel adsorptive membranes are key advances,³ and dialysis equipment can now travel with the patient.^{4,5} Telemedicine is also a reality. Every minute of blood flow rate, arterial and venous pressure, and UF volume can now be logged,⁶ and machine learning models trained on hundreds of thousands of sessions are beginning to predict complications such as intradialytic hypotension before they occur.^{7,8} Payment systems are also beginning to reward home modalities rather than merely permit them.⁹ And last but not least, patients

are being asked what they think of their care, through validated instruments specifically designed for home dialysis populations.¹⁰ Meanwhile, the professional responsibilities of nurses, technicians, and nephrologists are being redefined as moves from the dialysis unit to the patient's home, whether a spare room, a kitchen table, or even a suitcase.¹¹

Advances in Wearable and Portable Dialysis Technologies

For nearly two decades, the roadmap published by the Kidney Health Initiative has described an innovation pathway running from portable devices, through wearable ones, towards eventual implantable artificial kidneys, and recent commercial entrants have begun to shorten the distance between that vision and clinical reality. NextKidney has entered first-in-human trials of a portable HD machine designed for home use and for travel, small enough to fit airline carry-on dimensions, achieving this by regenerating a small volume of dialysate through sorbent cartridges in a closed loop instead of relying on the more than 150 litres of fresh dialysate required for a conventional four-hour session. Medtronic is developing a comparable transportable, sorbent-based HHD machine.⁴ Neither device is a true wearable in the sense that it is worn on the body during treatment. However, both devices are based on the same engineering concept: that the challenge of miniaturisation lies not in smaller pumps or screens, but in the much more difficult task of regenerating dialysate in a small, closed space.

The conceptual ancestor of nearly every modern wearable dialysis effort is the REDY sorbent system developed in the 1970s, which demonstrated that spent dialysate could be purified and recirculated rather than discarded after a single pass.³ The contemporary heir to that idea is the Wearable Artificial Kidney, whose most cited clinical evidence remains a USA FDA-approved human trial led by Gura and colleagues, in which a miniaturized, sorbent-based HD device worn by patients achieved effective clearance of uremic solutes while maintaining electrolyte and fluid homeostasis over 24 hours.¹² However, more than a decade after that trial, no wearable artificial kidney has yet reached routine clinical use, even as the underlying science has continued to mature.

Much of that subsequent maturation has happened not in clinical trials but in materials science. A comprehensive review by Loureiro

Ramada and colleagues frames the central engineering challenge: continuous regeneration of a small dialysate volume is the bottleneck on which portable, wearable, and implantable systems alike depend. Sorbent-based recycling remains the approach with the greatest near-term potential, while novel polymeric and inorganic membranes are simultaneously being developed to improve uremic toxin removal with less membrane fouling.¹³ A parallel and more recent review by Professor Wieringa and colleagues broadens this picture further, surveying chip-based nanoporous membranes and even solar-powered local dialysate preparation as additional pathways towards greater mobility, while explicitly invoking the "African mobile phone revolution" as a model for how technology-based KRT might leapfrog the infrastructural constraints that have limited dialysis access in much of the world.⁵

The underlying chemistry has its own dedicated literature. Fabiani and colleagues, from the University of Edinburgh, have produced a detailed comparative analysis of sorbent materials, ranking nanoporous adsorbents, polymers, and mixed-matrix membranes by their capacity to remove typical uremic toxins from dialysate while remaining stable, recyclable, and safe for repeated use, and paired that experimental work with computational modelling intended to screen candidate materials before they are synthesized.¹⁴ A related review from the same broad research effort frames the stakes in blunt practical terms: current HHD devices remain analogous to hospital machines, bulky, water-intensive, and demanding of costly home renovation, precisely because miniaturisation depends on reducing water consumption, which in turn depends on a dialysate regeneration unit able to purify and recirculate spent fluid.¹⁵ Not every approach to that problem relies on sorbents. Earlier preclinical work explored electro-oxidation, the direct electrochemical breakdown of urea, as an alternative regeneration strategy, testing a miniature dialysis device built around graphite electrodes and ion-exchange beads in an awake-goat model, a reminder that the field has pursued more than one chemical route towards the same destination of a small, closed, reusable dialysate loop.¹⁵

Device/system	Core mechanism	Stage of development
REDY sorbent system	Dialysate regeneration via sorbents (urea broken down by urease)	Historical precursor (1970s); conceptual basis for later designs
Wearable Artificial Kidney (WAK)	Sorbent-based, body-worn circuit; continuous uremic solute clearance	FDA-approved clinical trial; 24-hour proof of concept, not yet commercialized
NextKidney	Sorbent cartridge dialysate regeneration in a low-volume closed loop	First-in-human trials; carry-on luggage-sized design
Medtronic (transportable device)	Sorbent-based dialysate regeneration	Commercial launch announced
Electro-oxidation (goat model)	Direct electrochemical urea breakdown, sorbent-free	Preclinical stage (animal model)
Mixed-matrix / nanoporous membranes	Adsorption of uremic toxins via novel materials	Materials research; computational modelling
WEAKID project (EU)	ICT-enabled wearable artificial kidney	European research project, archived 2024 without a commercial product

Table 1 - Landscape of portable and wearable HD technologies.

We cannot forget, however, that the distance between a promising engineering concept and a device a patient can safely wear remains considerable. The same European Commission-funded project that helped to seed this research area nearly two decades ago, the ICT-enabled Wearable Artificial Kidney and Personal Renal Care System, was formally archived in 2024 without having produced a marketed device.¹⁶ While the 2016 Gura trial confronted basic physiological feasibility, the current concerns relate to reliability, manufacturability, and cost, which ultimately determine whether a working prototype becomes a product a health system can actually deploy.

Artificial Intelligence and Data Analytics in Home Haemodialysis

Every HD session, whether delivered in a clinic or at home, now produces an amount of physiological data that no human clinician could review in real time even if they wished to. Modern machines log arterial and venous line pressure, blood and dialysate flow rates, UF volume, and temperature on a minute-by-minute basis and increasingly capture beat-to-beat haemodynamic and respiratory signals as well, a volume and granularity of data that did not exist a decade ago.⁶

All this data help predict intradialytic hypotension, a complication that remains common, often dangerous, and stubbornly resistant to the preventive measures nephrology has relied on for decades.¹⁷ Lee and colleagues offered an early and influential demonstration that deep learning could meaningfully outperform conventional statistical approaches here, training a recurrent neural network on more than 1.6 million timestamped measurements drawn from 261,647 HD sessions to generate a real-time, continuously updated estimate of hypotension risk within the coming hour.¹⁸ The scale of that undertaking has since become something closer to a norm than an exception. A more recent study by Wang and colleagues built and externally validated machine learning models for intradialytic hypotension prediction using 26,690 sessions for training and a further 12,293 sessions drawn from a separate cohort for validation, explicitly testing the models against several different clinical definitions of hypotension to ensure the findings were not an artefact of how the outcome happened to be defined.¹⁹ A systematic review by Chaudhry and colleagues, surveying the field as a whole through April 2024, identified five eligible studies employing a striking diversity of algorithmic approaches, neural networks, decision trees, support vector machines, random forests, XGBoost, and LightGBM among them, suggesting a field still exploring which architecture best fits the problem rather than one that has converged on a single standard approach.¹⁷

What distinguishes the more recent wave of this research from its predecessors is a growing concern with whether these models can actually be deployed at the bedside, not merely published. One study developed and evaluated what its authors describe as an AI dashboard, a tool that displays, for every patient in an HD unit, a continuously updated probability of intradialytic hypotension derived from risk factors carried over from previous sessions as well as the current one, comparing eight distinct machine learning algorithms in the process of selecting which to deploy.²⁰ A separate methodological contribution addressed a different practical obstacle, namely patient privacy, by demonstrating that a deep learning model trained on de-identified, retrospective data from two separate centres could predict intradialytic hypotension without requiring the kind of identifiable, continuously linked patient records that often complicate multi-site research and deployment.²¹

However, modern AI-integrated tools can address much more than hypotension. Figure 1 represents the whole landscape of AI assistance options, from detection to clinical action, and the barriers to their routine clinical adoption. A broad narrative review of AI and machine learning applications in dialysis describes a landscape that now spans natural language processing of electronic health records to identify symptom burden more accurately than billing codes alone, deep learning models that classify arteriovenous access aneurysms from imaging, and machine learning systems that flag patients on HD at elevated risk of hospitalization or death.²² A related strand of research has begun to describe AI-enabled clinical decision support systems capable of recommending individualised doses of erythropoiesis-stimulating agents based on each patient's predicted response, drawing on multimodal inputs that include continuous dialysis monitoring data, laboratory values, imaging, and even genetic testing results.²³ Other applications target subtler clinical judgements. One body of work has applied machine learning to the long-standing challenge of estimating dry weight, the fluid status target around which ultrafiltration prescriptions are built. The results here counsel some caution: one comparative study found that three different machine learning methods achieved prediction accuracy below 40% for clinically defined overhydration status, a reminder that the mere availability of a sophisticated algorithm does not guarantee it outperforms simpler clinical judgment on every task.²⁴

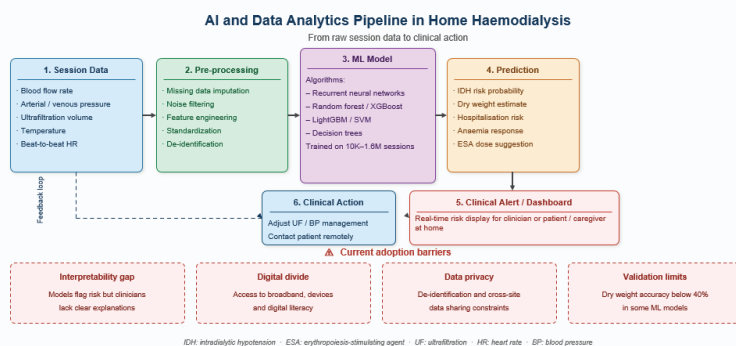


Figure 1 - Pipeline from raw HHD session data through pre-processing, machine learning prediction, and clinical alerting to action, with a feedback loop for continuous model refinement. Dashed boxes indicate current barriers to routine clinical adoption.

An earlier and influential review of artificial intelligence in dialysis, synthesising a 2018 expert meeting at the Hospital Universitari Bellvitge in Barcelona, Spain, anticipated much of this trajectory, concluding that the central barrier to clinical adoption was not the predictive accuracy of the algorithms themselves but the interpretability of their outputs: the gap between a model that flags elevated risk and a clinician or patient at home who understands why and what to do about it.²⁵ That gap, more than any remaining limitation in raw predictive power, is what now separates the considerable promise of AI-enabled HHD from its routine clinical reality.

Policy and Reimbursement Updates Supporting Home Haemodialysis Expansion

No engineering advance and no predictive algorithm reaches a patient's home unless the financial architecture surrounding dialysis care makes it possible, and often profitable, for a provider to put it there. This is the uncomfortable premise underlying nearly every policy analysis of HHD utilisation, and it is worth stating plainly before reviewing the specific mechanisms involved: reimbursement policy is not a peripheral administrative detail to this chapter's other four themes; it is frequently the deciding variable in whether they reach patients at all.⁴¹

In USA, the starting point for understanding this dynamic is the bundled payment structure introduced under the Medicare Prospective Payment System, which reimburses dialysis facilities the same base rate regardless of whether a treatment is delivered in-centre, through HHD, or through PD. A comprehensive review has argued that it functions as a structural disincentive since the fixed costs of training a patient for home therapy, intensive nursing time, equipment provisioning, and weeks of education are absorbed by the facility without a corresponding increase in payment, while a long-standing underutilisation of the separate Kidney Disease Education benefit has compounded the problem by leaving many patients unaware that home modalities are even an option.²

Policy has begun to respond, though unevenly and over a long horizon. The ESRD treatment Choices Model, finalised by the Centres for Medicare & Medicaid Services, mandatorily enrolls outpatient dialysis facilities, nephrology practices, and fee-for-service Medicare patients across roughly 30 per cent of the country, and operates through a deliberate structure of payment bonuses and

penalties designed specifically to increase the use of home dialysis and access to kidney transplantation.⁴² The most recent annual update to this architecture, the calendar year 2025 ESRD Prospective Payment System Final Rule, extends Medicare payment for dialysis delivered in the home setting to beneficiaries with AKI, a population previously excluded from home-based reimbursement entirely, while also revising the case-mix adjustments and quality incentive metrics that determine how facilities are scored and paid. The full regulatory text published in the Federal Register adds a further, more contested layer: beginning with payment year 2027, several social-determinants-of-health reporting measures are being removed from the ESRD Quality Incentive Program, even as the in-centre patient experience survey instrument is simultaneously being updated for 2028, changes that illustrate how the metrics used to hold dialysis providers accountable are themselves a live policy battleground, not a fixed backdrop.⁹ Read together, this sequence of rules describes a payment system still in the process of being re-engineered, towards the home setting that it has nominally favoured for over a decade without fully funding it.

Europe's experience complicates any assumption that this is simply a matter of catching up to a more advanced American model. A wide-ranging review of home dialysis uptake across the continent found that despite near-universal healthcare coverage, use of HHD remains both low and sharply uneven, highest in Scandinavian countries and lowest across Eastern and Central Europe. Authors trace this pattern less to clinical contraindication than to the same reimbursement logic operating in USA: nephrologist and facility payment in many European systems remains structurally tied to in-centre treatment volume, and a substantial proportion of dialysis units in countries including Italy, France, and Germany operate as private commercial enterprises with limited financial incentive to shift patients towards a modality that reduces facility-based revenue.²⁶ The response has been organisational as much as regulatory. In November 2023, a multidisciplinary policy forum convened at EuroPD meeting in Bruges, bringing together the principal stakeholder groups to confront this inequity directly. The resulting international consensus statement identified financial disincentives, insufficient weight given to patient preference, and gaps in workforce training as the dominant and, crucially, largely modifiable barriers to expanding home dialysis access across European health systems.²⁷

UK offers a more granular illustration of how reimbursement design can be deliberately calibrated to support home therapy rather than merely permit it. NHS England has established a national tariff structure for HHD that explicitly reimburses the costs that many other systems leave to the patient: home adaptation, electricity, water, sewage, and the costs associated with remote monitoring equipment, with eligibility assessed through a multidisciplinary visit from the renal team to the patient's home. Whether the underlying tariff itself is set at a level sufficient to expand access remains an open empirical question. Markov modelling analysis commissioned from the NHS payer perspective projects the five-year budget impact of increasing the proportion of patients on home-based dialysis under both the current reimbursement tariff and a hypothetical increased tariff of £575 per week for HHD. This data supports the idea that a more generous payment rate could expand home dialysis access while remaining fiscally sustainable for the public payer.²⁸

Taken together, the American and European evidence converges on a single, somewhat unglamorous conclusion: the technologies and algorithms described in the two preceding sections of this chapter do not fail or succeed on their engineering merits alone. They fail or succeed according to whether the entity bearing the upfront cost of training a patient and provisioning a home, typically the dialysis facility or health system rather than the patient, is paid in a way that makes doing so financially rational. Every policy reform reviewed in this section, the ESRD Treatment Choices Model, the AKI home dialysis payment extension, the EuroPD consensus recommendations, the NHS utility tariff, represents a different jurisdiction's attempt to solve precisely that alignment problem, with no single one of them yet fully solved.

Integrating Patient Feedback into Care Models

For decades, patient-reported insights were incorporated into dialysis clinical records predominantly through indirect means, if at all, refracted through laboratory values, hospitalization counts, and survival curves rather than asked for directly. That asymmetry has begun to close, and HHD has become an unlikely proving ground for the methodological work required to close it properly, because the experience of dialysing at home, alone or with a care partner, raises questions that in-centre instruments were never built to capture.

The clearest evidence of this gap, and of the effort to fill it, comes from the development of dedicated patient-reported experience measures for home dialysis populations. Until relatively recently, no such instrument existed: validated tools for assessing patient experience were available for in-centre HD, but nothing comparable had been built for PD or HHD specifically.²⁹ A structured, mixed-methods process combined a formal literature review with concept elicitation focus groups and interviews across 65 participants: twenty-one home dialysis patients, thirty-three home dialysis nurses, three patient care partners, and eight nephrologists, before a national prioritisation exercise narrowed an initial pool of candidate items into a workable measure.²⁹ The resulting instrument, once built, was then put through the same psychometric scrutiny any clinical tool would require: a subsequent validation study enrolled 495 eligible patients, including a Spanish-language cohort large enough to assess cross-linguistic performance, and confirmed a twelve-item composite scale, covering quality of home dialysis care and operations, with strong internal consistency and test-retest reliability sturdy enough to support its use in routine quality measurement rather than research alone.¹⁰

A systematic review synthesising twenty-four qualitative studies, encompassing 221 patients and 121 caregivers, identified a set of themes that sit in some tension with one another: a vulnerability specific to dialysing independently, including fear of self-cannulation and of being unqualified to manage a catastrophic complication alone, runs alongside a fear of social isolation and medical disconnection from the care team, and both coexist with what the review's authors term an opportunity to thrive, a re-establishment of identity, autonomy, and even strengthened family relationships that many patients and caregivers described as the most meaningful consequence of moving treatment into the home.³⁰ This is not a contradiction so much as an accurate description of a treatment modality that simultaneously demands more from patients and gives more back to them, and it is precisely the kind of nuance a mortality curve cannot register. A recent study carried out in Spain shows, however, that patients on HHD reported the best physical functioning, resembling controls and transplant patients in fatigue symptoms. This group also gave the best rating on healthcare received.³¹

An earlier, related effort pursued a narrower but conceptually important goal: a remote monitoring system explicitly engineered to enhance patients' perceived co-presence with their care team,

incorporating digital logbooks and emotion-sharing tools. A field test of the system found that logbook entries recording negative emotions occurred at a meaningfully higher rate than might otherwise have been visible to clinicians, evidence that emotional and not merely physiological monitoring carries clinical information of its own.³²

Institutional recognition of patient-reported outcomes has followed a similar arc from advocacy to mandate. The Centres for Medicare & Medicaid Services has required routine measurement of quality of life using KDQOL-36™ instrument for patients on HD, and a parallel initiative, the Renal Network's Patient Representative Program, now asks dialysis units to identify a patient representative specifically tasked with surfacing opportunities to improve patient-centred care from within the patient population itself, a structural acknowledgement that patient feedback is more reliably captured through a standing role than through periodic survey administration alone.³³ Another Spanish cooperative trial will elucidate whether expanded HD with medium cut off membranes could improve patient-reported outcomes.³⁴

Professional Responsibilities and Accountability

Every advance described in this chapter – the miniaturised device, the predictive algorithm, the reimbursement code, and the validated experience survey – ultimately reaches a patient through the hands and judgment of a clinician, and HHD places a particular strain on that final link in the chain. The dialysis unit, in this modality, has no fixed walls, no charge nurse and no guarantee that the person responsible for recognising a problem will be a trained professional at all. That displacement does not eliminate professional accountability; it redistributes it, often without redesigning the training, certification, and legal frameworks that were built for a different setting.

Training is the most visible point of strain, and the evidence suggests it has not kept pace with the modality's ambitions. A quality improvement study conducted through a structured review of training literature found that successful HHD programmes shared a recognisable set of features: frequent training sessions; early initiation of self-cannulation rather than deferring it to the end of preparation; a permanent and consistent team of training nurses rather than rotating staff; and individually tailored weekly schedules rather than a single fixed curriculum.¹¹ The same project's focus group work, conducted in collaboration with nurses from Helsinki University

Hospital, where patients are trained for HHD within six weeks, found that consistency of trainer and clarity of instruction mattered as much to successful outcomes as the technical content of the curriculum itself. This finding sits somewhat uncomfortably alongside evidence from the physician side of training. A survey of nephrology program directors and fellows across USA found that HHD education remains structurally underdeveloped at the very moment the Accreditation Council for Graduate Medical Education has begun requiring nephrology fellows to demonstrate competence in HHD specifically, a regulatory mandate that many programs reported being ill-equipped to meet because of a shortage of faculty expertise and a lack of dedicated training material.³⁵ Competence built poorly does not stay confined to the training period. A separate observational study linking nurses' competence directly to clinical performance found that nursing attitude and skill in HD care correlated significantly with whether patients achieved adequate dialysis, a finding that converts what might otherwise sound like an administrative training gap into a measurable difference in treatment adequacy.

The lived experience of delivering this care, as distinct from the formal requirements of training for it, has its own documented texture. A qualitative study built around in-depth, semi-structured interviews with HD nurses reported according to COREQ checklist for rigour, the overcoming of care barriers explicitly as a professional responsibility belonging to trained HD nurses, and the nurses themselves, in describing how they managed that responsibility, returned repeatedly to the necessity of teamwork as the mechanism that made safe, holistic care possible under the pressures of the role.³⁶ That emphasis on teamwork is not incidental; it reflects how accountability in HD care has always been distributed across a formally structured team rather than resting on any single individual, with each role's scope defined in relation to the others.

This concentration of responsibility carries a workforce cost that the literature has only recently begun to quantify directly. A national survey of dialysis patient care technicians in USA, documented levels of professional burnout and turnover intention substantial enough to raise concerns about the sustainability of the broader HD workforce.³⁷ A related ecological study examining staffing patterns across HD facilities nationally adds a structural dimension to that concern, suggesting that the capacity of a given facility to expand HHD training is itself constrained by how adequately that facility

is staffed in the first place, a constraint that operates upstream of any individual clinician's competence or commitment.³⁸ Underlying all of this sits a foundational governance structure that predates the recent expansion of home modalities but still defines it: every dialysis facility is required to maintain a medical director personally responsible for the integrity of its water treatment system and for its quality assessment and performance improvement programme, and a registered nurse meeting all relevant state practice requirements must be present whenever in-centre patients are being treated, a requirement that has no precise equivalent for the home setting and whose absence is, in a sense, the entire regulatory puzzle this section has been describing.³⁹

Read together, these threads suggest that professional accountability in HHD has not been weakened by the modality's move out of the clinic; it has been made more diffuse, more dependent on training infrastructure that remains uneven, and more reliant on a workforce showing measurable signs of strain. No wearable device, predictive algorithm, or favourable reimbursement rule changes that underlying reality.

Conclusion

Taken together, the five trends examined in this chapter, miniaturised dialysis technology, predictive analytics, reimbursement reform, patient-centred measurement, and evolving professional accountability, point to the same underlying conclusion: HHD is no longer constrained primarily by what is technically possible but by how well these converging capabilities are integrated into a single, coherent system of care. A smaller device is only as useful as the training program that teaches a patient to trust it; a predictive algorithm is only as valuable as the clinician equipped to interpret its alert; and a more generous reimbursement rate only expands access if the workforce delivering that care is adequately staffed and supported. The evidence reviewed across USA and Europe suggests that no single jurisdiction has yet solved this integration problem completely, but each has identified, in its policy and clinical literature, the specific piece it is still missing. The future of HHD will therefore be determined less by any singular technological breakthrough than by the deliberate, coordinated work of aligning engineering, data, financing, patient voice, and workforce capacity around the same patient at the same time.

References

1. Bennett PN, Schatell D, Shah KD. Psychosocial aspects in home hemodialysis: A review. *Hemodialysis International*. 2015 Apr 29;19(S1). doi:10.1111/hdi.12258
2. Hajj J, Laudanski K. Home Hemodialysis (HHD) Treatment as an Effective yet Underutilized Treatment Modality in the United States. *Healthcare*. 2017 Nov 28;5(4):90. doi:10.3390/healthcare5040090
3. AGAR JW. Review: Understanding sorbent dialysis systems. *Nephrology*. 2010 Jun 25;15(4):406–11. doi:10.1111/j.1440-1797.2010.01321.x
4. Groth T, Stegmayr BG, Ash SR, Kuchinka J, Wieringa FP, Fissell WH, et al. Wearable and implantable artificial kidney devices for end-stage kidney disease treatment: Current status and review. *Artif Organs*. 2023 Apr;47(4):649–66. doi:10.1111/aor.14396 PubMed PMID: 36129158.
5. Wieringa FP, Suran S, Søndergaard H, Ash S, Cummins C, Chaudhuri AR, et al. The Future of Technology-Based Kidney Replacement Therapies: An Update on Portable, Wearable, and Implantable Artificial Kidneys. *Am J Kidney Dis*. 2025 Jun;85(6):787–96. doi:10.1053/j.ajkd.2024.10.015 PubMed PMID: 39914734.
6. Chaudhuri S, Long A, Zhang H, Monaghan C, Larkin JW, Kotanko P, et al. Artificial intelligence enabled applications in kidney disease. *Semin Dial*. 2021 Jan 13;34(1):5–16. doi:10.1111/sdi.12915
7. Wang P, Xu N, Wu L, Hong Y, Qu Y, Ren Z, et al. Construction and application of machine learning models for predicting intradialytic hypotension. *PLoS One*. 2025;20(10):e0333357. doi:10.1371/journal.pone.0333357 PubMed PMID: 41061007.
8. Lee H, Yun D, Yoo J, Yoo K, Kim YC, Kim DK, et al. Deep Learning Model for Real-Time Prediction of Intradialytic Hypotension. *Clin J Am Soc Nephrol*. 2021 Mar 8;16(3):396–406. doi:10.2215/CJN.09280620 PubMed PMID: 33574056.
9. Medicare Program; End-Stage Renal Disease Prospective Payment System, Payment for Renal Dialysis Services Furnished to Individuals With Acute Kidney Injury, Conditions for Coverage for End-Stage Renal Disease Facilities, End-Stage Renal Disease Quality Incentive Program, and End-Stage Renal Disease Treatment Choices Model. *Federal Register [Internet]*. Health Equity. Available; 2024. Available from: www.cms.gov/pillar/health-equity.
10. Rivara MB, Prince DK, Leuther KK, Hussein WF, Mehrotra R, Edwards T, et al. Evaluation and Measurement Properties of a Patient-Reported Experience Measure for Home Dialysis. *Clin J Am Soc Nephrol*. 2024 May 1;19(5):602–9. doi:10.2215/CJN.000000000000429 PubMed PMID: 38261328.
11. Knudsen KK, Adrian C V, Jensen MH, Ilsøe S, Rugaard J, Poulsen SE, et al. Developing and Evaluating a Home Hemodialysis Training Program-A Quality Improvement Study. *Hemodial Int*. 2025 Oct;29(4):496–506. doi:10.1111/hdi.13252 PubMed PMID: 40391421.
12. Gura V, Rivara MB, Bieber S, Munshi R, Smith NC, Linke L, et al. A wearable artificial kidney for patients with end-stage renal disease. *JCI Insight*. 2016 Jun 2;1(8). doi:10.1172/jci.insight.86397

13. Ramada DL, de Vries J, Vollenbroek J, Noor N, ter Beek O, Mihăilă SM, et al. Portable, wearable and implantable artificial kidney systems: needs, opportunities and challenges. *Nat Rev Nephrol.* 2023 Aug 5;19(8):481–90. doi:10.1038/s41581-023-00726-9
14. Fabiani T, Zarghamidehaghani M, Boi C, Dimartino S, Kentish S, De Angelis MG. Sorbent-based dialysate regeneration for the wearable artificial kidney: Advancing material innovation via experimental and computational studies. *Sep Purif Technol.* 2025 Jul;360:130776. doi:10.1016/j.seppur.2024.130776
15. Dehaghani MZ, Fabiani T, De Angelis MG. Chemical engineering contribution to hemodialysis innovation: achieving the wearable artificial kidneys with nanomaterialbased dialysate regeneration. *Physical Sciences Reviews.* Walter de Gruyter GmbH; 2025. p. 279–99. doi:10.1515/psr-2024-0055
16. Gerritsen K. WEAKID - Clinical validation of miniature wearable dialysis machine - H2020. *Impact.* 2018 Jun 15;2018(3):55–7. doi:10.21820/23987073.2018.3.55
17. Chaudhry TZ, Yadav M, Bokhari SFH, Fatimah SR, Rehman A, Kamran M, et al. Artificial Intelligence and Machine Learning in Predicting Intradialytic Hypotension in Hemodialysis Patients: A Systematic Review. *Cureus.* 2024 Jul 25. doi:10.7759/cureus.65334
18. Lee H, Yun D, Yoo J, Yoo K, Kim YC, Kim DK, et al. Deep Learning Model for Real-Time Prediction of Intradialytic Hypotension. *Clinical Journal of the American Society of Nephrology.* 2021 Mar;16(3):396–406. doi:10.2215/CJN.09280620
19. Wang P, Xu N, Wu L, Hong Y, Qu Y, Ren Z, et al. Construction and application of machine learning models for predicting intradialytic hypotension. *PLoS One.* 2025 Oct 8;20(10):e0333357. doi:10.1371/journal.pone.0333357
20. Yang IN, Liu CF, Chien CC, Wang HY, Wang JJ, Shen YT, et al. Personalized prediction of intradialytic hypotension in clinical practice: Development and evaluation of a novel AI dashboard incorporating risk factors from previous and current dialysis sessions. *Int J Med Inform.* 2024 Oct;190:105538. doi:10.1016/j.ijmedinf.2024.105538 PubMed PMID: 38968689.
21. Kim HW, Heo SJ, Kim M, Lee J, Park KH, Lee G, et al. Deep Learning Model for Predicting Intradialytic Hypotension Without Privacy Infringement: A Retrospective Two-Center Study. *Front Med (Lausanne).* 2022 Jul 7;9. doi:10.3389/fmed.2022.878858
22. Clement David-Olawade A, Ogunbona MA, Olawuyi OF, Makanjuola BD, Alabi JO, Olawade DB. Artificial intelligence and machine learning applications in dialysis: Current applications, challenges, and future directions. *Clinica Chimica Acta.* 2026 Apr;586:120908. doi:10.1016/j.cca.2026.120908
23. Nobakht E, Raru W, Dadgar S, El Shamy O. Precision Dialysis: Leveraging Big Data and Artificial Intelligence. *Kidney Med.* 2024 Sep;6(9):100868. doi:10.1016/j.xkme.2024.100868 PubMed PMID: 39184285.
24. Sandys V, Sexton D, O'Seaghda C. Artificial intelligence and digital health for volume maintenance in hemodialysis patients. *Hemodialysis International.* 2022 Oct 23;26(4):480–95. doi:10.1111/hdi.13033

25. Hueso M, Vellido A, Montero N, Barbieri C, Ramos R, Angoso M, et al. Artificial Intelligence for the Artificial Kidney: Pointers to the Future of a Personalized Hemodialysis Therapy. *Kidney Dis (Basel)*. 2018 Feb;4(1):1–9. doi:10.1159/000486394 PubMed PMID: 29594137.
26. Brown EA, Brivio GB, Van Biesen W. Towards a better uptake of home dialysis in Europe: understanding the present and looking to the future. *Clin Kidney J*. 2024 May;17(Suppl 1):i3–12. doi:10.1093/ckj/sfae082 PubMed PMID: 38846418.
27. Davies SJ, Bammens B, de Barbieri I, Brown EA, van Cruchten J, Gallego D, et al. Addressing the inequity of access to home Dialysis in Europe: recommendations for action informed by an international consensus exercise. *BMC Nephrol*. 2025 Jun 3;26(1):276. doi:10.1186/s12882-025-04188-y PubMed PMID: 40461978.
28. Liu FX, Treharne C, Culleton B, Crowe L, Arici M. The financial impact of increasing home-based high dose haemodialysis and peritoneal dialysis. *BMC Nephrol*. 2014 Oct 2;15:161. doi:10.1186/1471-2369-15-161 PubMed PMID: 25278356.
29. Rivara MB, Edwards T, Patrick D, Anderson L, Himmelfarb J, Mehrotra R. Development and Content Validity of a Patient-Reported Experience Measure for Home Dialysis. *Clin J Am Soc Nephrol*. 2021 Apr 7;16(4):588–98. doi:10.2215/CJN.15570920 PubMed PMID: 33785497.
30. Walker RC, Hanson CS, Palmer SC, Howard K, Morton RL, Marshall MR, et al. Patient and caregiver perspectives on home hemodialysis: a systematic review. *Am J Kidney Dis*. 2015 Mar;65(3):451–63. doi:10.1053/j.ajkd.2014.10.020 PubMed PMID: 25582285.
31. Daza C, Herranz A, Molina P, Pérez-Alba A, Benet E, Renau E, et al. Comparative Analysis Of Patient-Reported Outcome And Experience Measures In Different Stages Of Chronic Kidney Disease. *Nefrología*. 2026 Jun;501593. doi:10.1016/j.nefro.2026.501593
32. Liu N, Kim J, Jung Y, Arisy A, Nicdao MA, Mikaheal M, et al. Remote Monitoring Systems for Chronic Patients on Home Hemodialysis: Field Test of a Copresence-Enhanced Design. *JMIR Hum Factors*. 2017 Aug 29;4(3):e21. doi:10.2196/humanfactors.7078
33. Porter AC, Fitzgibbon ML, Fischer MJ, Gallardo R, Berbaum ML, Lash JP, et al. Rationale and design of a patient-centered medical home intervention for patients with end-stage renal disease on hemodialysis. *Contemp Clin Trials*. 2015 May;42:1–8. doi:10.1016/j.cct.2015.02.006
34. Reque J, Vazquez Gomez M, Bielsa Gracia S, Quevedo Reina JC, Garcia Mendez I, Sanchez Alvarez JE, et al. Expanded Home Hemodialysis trial (HHDx): Study Design and Baseline Characteristics of a Pragmatic Real-World Cohort. *Blood Purif*. 2026 Jun 16;1–12. doi:10.1159/000553057
35. Gupta N, Howard AJ, Yuan CM. Program Director and Nephrology Fellow's Perceptions of Home Hemodialysis Education in the United States. *Kidney360*. 2025 Feb;6(2):257–64. doi:10.34067/KID.0000000644
36. Hermalia I, Yetti K, Adam M. Nurses competence and hemodialysis adequacy achievement. *Enferm Clin*. 2021 Apr;31:S126–9. doi:10.1016/j.enfcli.2020.12.006

37. Plantinga LC, Rickenbach F, Urbanski M, Hoge C, Douglas-Ajayi C, Morgan JC, et al. Professional Fulfillment, Burnout, and Turnover Intention Among US Dialysis Patient Care Technicians: A National Survey. *Am J Kidney Dis.* 2023 Jul;82(1):22-32.e1. doi:10.1053/j.ajkd.2022.12.017 PubMed PMID: 36906216.
38. Plantinga LC, Urbanski M, Hoge C, Rickenbach F, Douglas-Ajayi C, Morgan JC, et al. Patient Care Technician Staffing in US Hemodialysis Facilities: An Ecological Study. *Kidney Med.* 2024 Mar;6(3):100782. doi:10.1016/j.xkme.2023.100782
39. Kallenbach JZ. Review of hemodialysis for nurses and dialysis personnel. Elsevier; 2016. 419 p.

Chapter 13

The Green Side of Home Haemodialysis

Learning objectives

- To recognise the potential of greener HD approaches, including the transition from single-pass systems to closed-loop dialysate regeneration
- To apply the available tools to benchmark the ecological footprint of HD
- To analyse the environmental impact of single-pass HD, including water and energy consumption, waste generation, and patient travel
- To apply strategies that can reduce the environmental footprint of existing Single-Pass HD
- To promote HHD as a greener dialysis option
- To recognise that replacing single-pass HD with closed-loop dialysate regeneration can markedly reduce water and energy use
- To recognise implantable HD systems as a potential strategy to reduce the environmental impact of dialysis by eliminating the extracorporeal blood circuit and simplifying home and nocturnal dialysis

Introduction

Kidney diseases and the environment (both regarding pollution and global warming) have a bidirectional relationship: Pollution and global warming aggravate kidney diseases, whereas dialysis is among the most resource-intensive areas of healthcare.¹ This holds both for PD as for HD, although HD is more resource-intensive than PD. This chapter will furthermore focus on HD.

One HD session delivered using a typical in-centre machine consumes in the range of 370–600 L of drinkable water and 5–15 kWh of electricity (with the most optimal settings listed first and typical conventional settings listed last).^{2,3,4} Although Xie et al recently published a lower median electricity consumption of 2.45 – 3.30 kWh per treatment across four different HD machine-types (including disinfection cycles), they only measured the power consumed by the individual HD machines, and did not account for the water purification system (which contributes significantly to total energy per treatment).⁵

Overall, these data underscore the substantial environmental impact of HD, as reflected in population-level estimates. A German study found that chronic HD increases a person's ecological footprint by approximately 50% compared with the average population.⁶ At a broader scale, 1 year of HD treatments performed across Europe equals the energy consumption and greenhouse gas emissions of 2.5 million combustion-engine car return trips from Brussels to Istanbul. In parallel, the volume of consumed drinkable water equals 10,000 Olympic swimming pools, while the produced volume of plastic waste could fill 18,000 heavy goods vehicles.⁷

Beyond ecological concerns, haemodialysis also entails direct patient exposure to micro- and nanoplastics. In addition to plastic waste entering the environment and subsequently contaminating water and food, patients are also directly exposed to plastic particles through the extracorporeal circuit, where they may directly enter the bloodstream. In particular, roller pumps generate microscopic plastic particles due to continuous friction between the tubing walls, a process known as spallation.⁸

Given the above considerations, it is both economically and medically sound to promote best dialysis practices that minimise the consumption of water, energy, plastics, and packaging materials as well as reduce transportation. However, to enable objective comparisons between different practices the ecological footprint must be measured in a standardized manner, thereby avoiding inappropriate comparisons. To that end, the International Standardization Organization (ISO) published the standards ISO 14040 and ISO 14044.^{9,10} Moreover, a recent publication employed a webtool to enable standardized carbon footprint assessments across different centres, regions, and time periods.⁶

How can we reduce the ecological footprint of Haemodialysis without compromising treatment quality?

Prevention

Prevention is a highly effective strategy:¹¹

- Each mL/min/1,73m² reduction in the rate of GFR-decline per patient-year is estimated to save an amount of CO₂ equivalent to the yearly emissions of two average individuals.
- Slowing CKD progression by 2–3 mL/min/1,73m² GFR per year can delay the need for HD by approximately 10 years

(assuming a 30-year CKD illness trajectory). In particular, a 360° comprehensive approach to kidney disease, combining all available lifestyle modifications and pharmaceutical therapies, may not only slow progression (with GFR declines of 1.5 to 2 mL/min per year as a desirable target) but possibly (in some cases) even achieve disease regression or cure, thereby avoiding dialysis altogether.¹²

- Kidney transplantation also offers substantial potential to reduce carbon footprint.

Water and Electricity strongly intertwined drive the ecological footprint

Water and electricity are important consumables for HD and are closely interconnected.

Producing 1 litre of dialysate requires approximately 2.5-3 litres of high- quality tap water and a lot of energy for the purification process, particularly when considering reverse osmosis, which is the most widely used water purification technology. Before reaching the patient, the dialysate must be warmed up to body temperature. Subsequently, commonly used HD machines typically discard the dialysate into the sewer after it has passed through the dialyzer, in accordance with the “single-pass” principle (Fig 1). Placing an active or passive heat exchanger unit between the spent dialysate and incoming dialysate can recover up to two-thirds of the thermal energy, although without reducing water consumption.

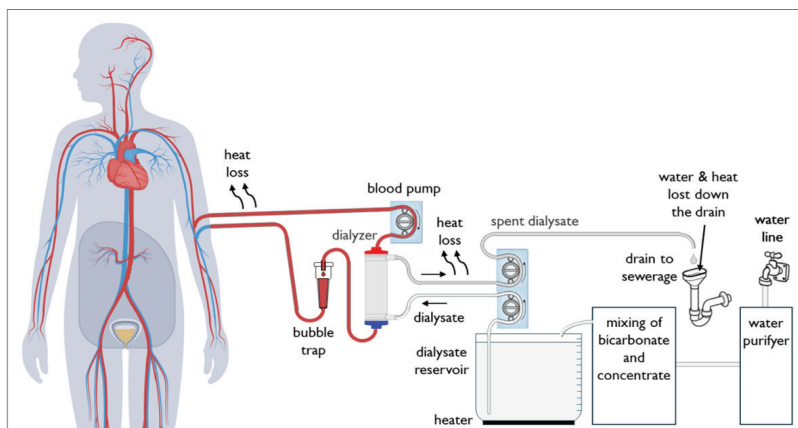


Fig 1: Simplified diagram of a single-pass haemodialysis system (without a heat-exchanger).

The largest component for the electric power consumption of a haemodialysis machine is the energy required to heat the dialysate to body temperature. Logically, the more water/dialysate is consumed, the more energy is needed to warm it to the set temperature. Quite a significant amount of energy can be saved by using a heat-exchanger (or more recently, and more effectively, a heat pump) between the incoming fresh dialysate and the spent dialysate on its way to the drain.

To reduce the total volume of spent dialysate and water, the optimal dialysate flow rate required to achieve sufficient solute clearance needs to be determined. Currently used dialysate flow rates of 500 to 800 mL/min largely reflect historical practice from the early days of haemodialysis. A meaningful reduction to 300-400 mL/min, tailored to individual patient needs and treatment goals, may be feasible and may yield about 10% water and energy savings without compromising clinical outcomes.

In addition to the haemodialysis machine, another major energy consumer is the water purification system. Its energy consumption depends on the required flow (or batch volume), the temperature of the incoming raw water, and its baseline purity. All these parameters typically vary over time; however, many water purification systems operate with fixed settings based on worst-case scenarios (i.e. maximum dialysate production at the lowest acceptable incoming water quality). As a result, reverse osmosis reject water is often discharged in greater volumes than necessary. While this approach ensures safety, more advanced water purification systems equipped with reliable well-placed measurement sensors and control algorithms to react upon such changes, can achieve significant savings without compromising treatment safety.

Additionally, energy consumption is further increased by lighting and heating of the treatment room, as haemodialysis patients typically desire relatively warm ambient temperatures during treatment.

Real-world studies in German Haemodialysis centres have shown that placing solar panels on available roof surfaces could reduce the consumption of electricity from the grid by about 10-20%.¹¹ In sunnier countries this percentage will even be accordingly higher.

In April 2025, KDIGO held a Controversies Conference about "Green Dialysis: Environmentally Sustainable Care, Growth, and

Innovation". Stakeholders from diverse backgrounds like physicians, nurses, engineers, dieticians and patients, examined how existing haemodialysis (both in-centre and home-based) and PD practices might be optimized, and identified opportunities for green innovations in dialysis care.¹³

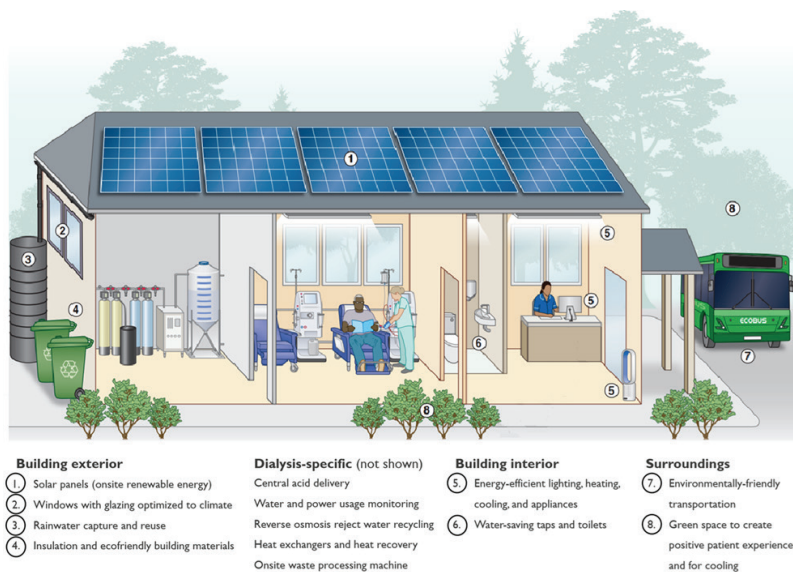


Fig 2: Features of good building design for HD clinics. The figure shows aspects of green building design that should be considered when designing and building a HD clinic. © 2026 Kidney Disease: Improving Global Outcomes (KDIGO). Published by Elsevier Inc. on behalf of the International Society of Nephrology. Used with permission by KDIGO. [https://www.kidney-international.org/article/S0085-2538\(26\)00079-7/fulltext](https://www.kidney-international.org/article/S0085-2538(26)00079-7/fulltext)¹³

Patient transportation: In-centre HD versus HHD

In in-centre HD, patient transportation can contribute significantly to the carbon footprint per treatment, accounting for approximately 20-30% in Germany¹¹ and up to 55% in Italy.⁴ Logically, this contribution is largely influenced by travel distance.

Home HD, especially for patients living far from dialysis clinics, therefore has a large potential for eco footprint reduction. However, this advantage may be diminished if for each treatment an assisting nurse is required to travel to the patient's home. In contrast, HHD performed through self-cannulation (or with support from a household

member) can significantly reduce the ecological footprint, especially when the provider coordinates delivery of new supplies with the collection of used materials that can be centrally recycled.

HHD is often performed using HD machines originally designed for in-centre use, which may require modifications to the home environment, including plumbing and electrical adaptations. These modifications incur additional costs and contribute to the overall eco-footprint. In contrast, machines specifically designed for home use that can operate without the need for specialised medical-grade electrical installations or dedicated drainage systems, reduce both logistical complexity and environmental impact. Such HD machines are increasingly becoming available.^{14,15,16} The not-for-profit organization Home Dialysis Central maintains a website with HHD devices that is periodically updated, available at:

<https://homedialysis.org/home-dialysis-basics/machines-and-supplies/hemodialysis-machines>

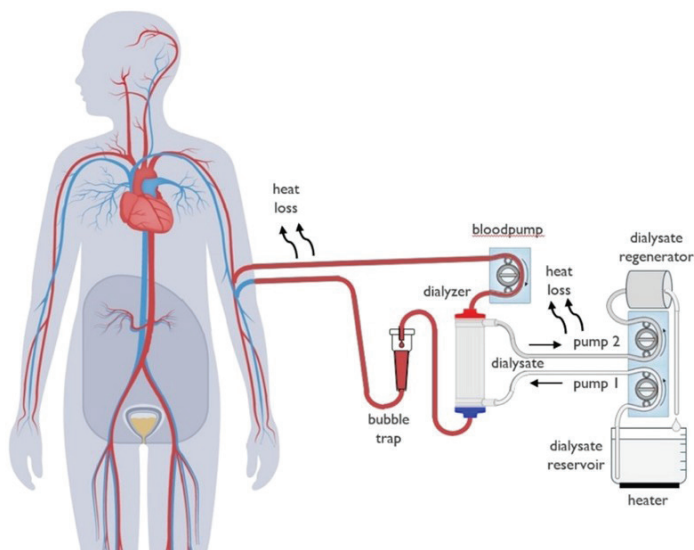


Fig 3: Strongly simplified diagram of a dialysate-regenerating HD system designed for home use or travel.

Patient nutrition: supporting both patient and planetary health

Due to the long times patients spend in dialysis clinics, they are often provided with meals or snacks. As with general dietary patterns, a vegetarian or vegan meal scheme can reduce the eco footprint of food provision by up to three-quarters compared with animal-based foods. Patients with kidney disease may be particularly susceptible to components of conventional animal-based diets, such as sodium and phosphate. Transitioning to plant-based in-dialysis meals may therefore simultaneously contribute to the health of both the patients and the planet by reducing the clinic's footprint up to 10%.¹⁷ Ensuring adequate protein intake from non-animal sources remains a key consideration. These meals also provide an opportunity for patient education on home dietary practices.

Reprocessing of haemodialysis filters

Although widely applied during the earlier decades of HD, reprocessing of HD filters is now rarely used in Europe. This shift was driven primarily by the reduced costs of dialyzers, which – from an economical point of view – rendered reprocessing obsolete. From a hygienic perspective, however, reprocessing dialyzers is feasible, provided that each reprocessed dialyzer is reused exclusively for the same patient (a condition that is readily met in the context of HHD). Evidence from USA supports the safety of this approach.¹⁸ Reflecting this, the European Green Dialysis project KitNewCare is reintroducing dialyzer reprocessing as a strategy to reduce environmental impact (see also <https://kitnewcare.eu/>).

The Future of Green Haemodialysis: eliminating the extracorporeal blood circuit

The international standard IEC 60601–2-16 (which specifies the requirements for HD devices), defines HD as follows:

*“Process whereby concentrations of water-soluble substances in a patient's blood and an excess of fluid of a patient are corrected by bidirectional diffusive transport and ultrafiltration across a semi-permeable membrane separating the blood from the dialysis fluid”.*¹⁹

This implies that, if the dialyser can be sufficiently miniaturised and designed for very long-term durability, HD could be performed using

an implantable filter. Such an approach would eliminate the need for an extracorporeal blood circuit, leaving only an extracorporeal dialysate circuit, for which a dialysate-regenerating system would be a logical solution.

Two recently published reviews describe two ongoing projects (one in USA, and another in EU) aimed at developing implantable HD filters using chip-based technologies.^{15,16}

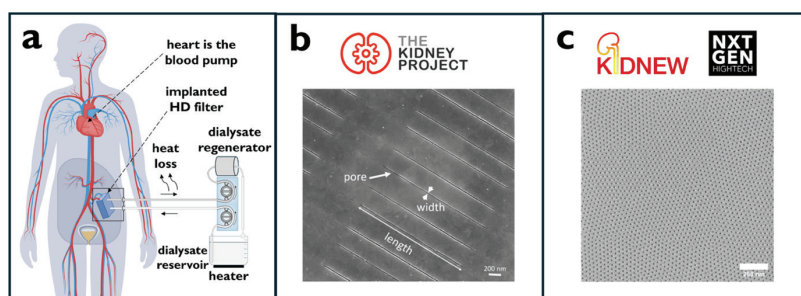


Fig 4: Concept for green dialysis: a) Simplified diagram of HD using an implanted HD filter combined with an extracorporeal dialysate circuit (here shown with dialysate regeneration); the heart forms the blood pump; b) Chip-based filter approach developed from the University of California San Francisco and Vanderbilt University, featuring slit-shaped pores; c) Chip-based filter from the EU-based KIDNEW and NXTGEN Hightech consortia.

Conclusion

HD is a life-sustaining therapy with a substantial environmental footprint, characterised by high consumption of water and energy, significant waste generation, and indirect impacts such as patient transportation. At the same time, its environmental burden is closely intertwined with patient care and is also associated with direct patient exposure to micro- and nanoplastics. Importantly, many strategies to reduce this footprint—such as prevention of CKD progression, optimisation of dialysis prescriptions, improved water and energy management, and expansion of home-based therapies—are fully compatible with high-quality and PCC.

The transition towards greener HD will depend on both the optimisation of current practices and the development of innovative technologies, including dialysate regeneration systems and implantable devices. By aligning environmental responsibility with clinical excellence, more sustainable kidney care can be delivered without compromising patient outcomes.

Further sources of information:

In 2025 KDIGO organized a conference in Berlin for interdisciplinary discussion on how dialysis might be made “greener”. Video recordings of the summarizing discussions are freely available via:

<https://kdigo.org/conferences/green-dialysis/>

The resulting KDIGO report summarizing the outcomes was “open access” published in 2026.¹³

In 2026, the German Society for Nephrology published a web-based carbon footprint assessment tool to benchmark haemodialysis carbon footprints.²⁰ A description is freely available via <https://doi.org/10.1093/ndt/gfaf263>

In 2023 the Green Nephrology group of the Francophone Society of Nephrology, Dialysis and Transplantation (SFNDT) published an excellent report on practical measures in several French hospitals.²¹ This guide is freely downloadable at:

https://www.era-online.org/wp-content/uploads/2023/09/SFNDT_EN_guide-complet_VF_HD.pdf

In the United Kingdom, an online carbon footprint calculator for in-center hemodialysis was developed, see: <https://ichdcarbon.org/>

Models developed in specific countries may need to be adapted to other local contexts, but they provide a valuable starting point.

References

1. Barraclough KA, Agar JWM. Green nephrology. *Nature Reviews Nephrology* volume 16, pages 257–268 (2020) DOI: 10.1038/s41581-019-0245-1
2. Bendine G, Autin F, Fabre B, Bardin O, Rabasco F, Cabanel JM, Chazot C (2020) Haemodialysis therapy and sustainable growth: a corporate experience in France. *Nephrol Dial Transplant* 35(12):2154–2160. <https://doi.org/10.1093/ndt/gfz284>
3. Barraclough KA, et al. Updating the Data: The Resource Consumption of Modern-Day Hemodialysis Systems. *Kidney International Reports*. 9(5):1521–1524. <https://doi.org/10.1016/j.ekir.2024.02.010>
4. Larkin J et al. Comparing environmental footprints of haemodialysis and online haemodiafiltration in Italy. *Int Urol Nephrol* (2026). <https://doi.org/10.1007/s11255-026-05033-3>
5. Xie H, Song M, Shen L. Research on electricity consumption of dialysis machines based on measurements. *Renal Replacement Therapy* (2025) 11:74. <https://doi.org/10.1186/s41100-025-00674-z>
6. Beige J, Pachmann M. _Dialyse auf dem Weg des Glasgower CO₂-Reduktionspfads – Auswirkungen nachhaltiger Techniken auf den realen Kohlenstoff-Footprint. _*Nephrologie aktuell* 2023; 27(01): 31-35 DOI: 10.1093/ndt/gfaf263
7. van Vredendaal OP et al. 2023 European Kidney Forum: The future of kidney care – investing in green nephrology to meet the European Green Deal targets. *Journal of Nephrology* (2025) 38:815–825 <https://doi.org/10.1007/s40620-025-02280-y>
8. Faria, M., Liu, Y. & Leonard, E.F. Particle spallation in a microfluidic blood processing device: the problem of using peristaltic pumps and silicon-based microfilters. *Int J Artif Organs* 2017; 40(10): 589-593. <https://doi.org/10.5301/ijao.5000609>
9. International Organization for Standardization (ISO). Environmental management, life cycle assessment, principles and framework, ISO 14040. ISO, Geneva (2006).
10. International Organization for Standardization (ISO). Environmental management, life cycle assessment, requirements and guidelines, ISO 14044. ISO, Geneva (2006).
11. Beige J., Pachmann M. Dialyse auf dem Weg des Glasgower CO₂-Reduktionspfads – Auswirkungen nachhaltiger Techniken auf den realen Kohlenstoff-Footprint. _*Nephrologie aktuell* 2023; 27(01): 31-35, DOI:10.1055/a-1987-1510
12. Navdeep Tangri N, Brendon L. Neuen BL, Cherney DZ, Tuttle KR, Perkovic V. From progression to remission: a new paradigm for success in chronic kidney disease. *Kidney International* (2026) 109, 17–21; <https://doi.org/10.1016/j.kint.2025.10.004>
13. Barraclough KA, Berman-Parks N, Jha V, Piccoli GB, Stigant C, Talbot B, Tarrass F, Cheung M, King JM, Grams ME, Jadoul M, Flythe JE, for Conference Participants, Green Dialysis: Environmentally Sustainable Care, Growth, and

- Innovation: Conclusions From a Kidney Disease: Improving Global Outcomes (KDIGO) Controversies Conference, Kidney International (2026), DOI: <https://doi.org/10.1016/j.kint.2026.01.015>
14. Wieringa F. Die Zukunft der Nierenersatztherapie Welche neuen Entwicklungen gibt es und wann sind sie einsetzbar? *Nephrologie aktuell* 2023; 27: 26–30, DOI 10.1055/a-1989-4035
 15. Wieringa F. P. et al. Transportable, portable, wearable and (partially) implantable haemodialysis systems: comparison of technologies and readiness levels. *Clinical Kidney Journal*, 2024, vol. 17, no. 9, sfae259 <https://doi.org/10.1093/ckj/sfae259>
 16. Wieringa, F. P. et al. The Future of Technology-Based Kidney Replacement Therapies: An Update on Portable, Wearable, and Implantable Artificial Kidneys. *Am J Kidney Dis.* 85(6):787-796. 2025. Doi:10.1053/j.ajkd.2024.10.015
 17. Knöller, S. & Fleig, S. Progressionshemmung der CKD im Spannungsfeld klimagesunder Ernährung. *Nephrologie* 18, 222–228 (2023). <https://doi.org/10.1007/s11560-023-00658-2>
 18. Feldman HI et al. Association of dialyzer reuse and hospitalization rates among hemodialysis patients in the US. *Am J Nephrol* 1999; 19 (6): 641–8, DOI: 10.1159/000013535
 19. International Standard IEC 60601-2-16. Particular Requirements for Basic Safety and Essential Performance of Haemodialysis, Haemodiafiltration and Haemofiltration Equipment. 6th edition 2025.
 20. Beige, J. et al. A website calculator to benchmark the carbon footprint of haemodialysis. *Nephrol Dial Transplant*, 2026, 0, 1–10. <https://doi.org/10.1093/ndt/gfaf263>
- Green Nephrology group of the Francophone Society of Nephrology, Dialysis and Transplantation (SFNDT). Toward green dialysis: Good practice guide. ERA 2023. SFNDT_EN_guide-complet_VF_HD.pdf

Epilogue

Home Haemodialysis, Person-Centred Care and the Future Role of Nephrology Nurses

The story of HHD is, in many ways, the story of modern kidney care. Since its early development, home haemodialysis has reflected a vision of care that extends beyond the walls of the hospital and places individuals at the centre of their own treatment journey. Throughout this guidebook, we have explored the historical foundations of HHD, the technical and clinical requirements for safe treatment, the importance of education and training, the psychosocial and ethical dimensions of care, and the innovations that are shaping the future of dialysis. Collectively, these chapters demonstrate that HHD is far more than a dialysis modality; it is a model of care that challenges traditional assumptions about where healthcare takes place, who delivers it, and how individuals participate in their own health management.

At the heart of this transformation lies a shift from provider-led care towards partnership-based care. HHD requires healthcare professionals to move beyond the role of treatment providers and become facilitators of learning, self-management, and shared responsibility. At the same time, individuals undertaking HHD are no longer passive recipients of treatment but active participants in decisions, treatment delivery, and long-term disease management. This transition represents one of the most significant cultural changes in nephrology practice over recent decades.

Within this evolving landscape, nephrology nurses occupy a unique and indispensable position. Historically, dialysis nursing focused primarily on the delivery and monitoring of treatment within hospital or satellite dialysis units. While these responsibilities remain important, the expansion of HHD has broadened the scope of nephrology nursing considerably. Today's nephrology nurses function not only as clinical experts but also as educators, coaches, counsellors, advocates, coordinators, and leaders.

The chapters in this guidebook repeatedly highlight the central role of nephrology nurses across the continuum of HHD care. Nurses contribute to modality education and informed decision-making, support vascular access management, provide structured training, facilitate self-cannulation, assess readiness for independent treatment, monitor safety and risk, deliver psychological support, and coordinate long-term follow-up. They also play a key role in programme development, quality improvement, and the implementation of emerging technologies. As HHD programmes continue to grow internationally, the contribution of nephrology nurses will become increasingly important in ensuring that care remains safe, effective, and responsive to individual needs.

However, the future of nephrology nursing cannot be defined solely by technical competence. The increasing complexity of healthcare, together with advances in digital technologies, telehealth, artificial intelligence, and remote monitoring, demands new professional capabilities. Nephrology nurses must be able to interpret data, support digital literacy, navigate ethical challenges, and integrate technological innovations into everyday care. Yet while technology will undoubtedly influence the future of HHD, it should never become the defining feature of care.

The defining feature of future HHD programmes should instead be person-centred care

PCC represents a fundamental commitment to recognising the individual as a person first and a recipient of healthcare second. It acknowledges that every individual brings unique experiences, values, goals, resources, and challenges that influence how they live with kidney disease and how they engage with treatment. In contrast to approaches that focus primarily on disease management, person-centred care seeks to understand what matters most to the person and how treatment can be integrated into their everyday life.

This perspective is particularly relevant in HHD because dialysis takes place within the individual's own environment. Treatment becomes intertwined with family life, employment, social relationships, personal aspirations, and daily routines. Consequently, successful HHD cannot be achieved solely through clinical expertise or technical proficiency. It requires healthcare professionals to understand the broader context of people's lives and to work in partnership with them to develop solutions that are both clinically appropriate and personally meaningful.

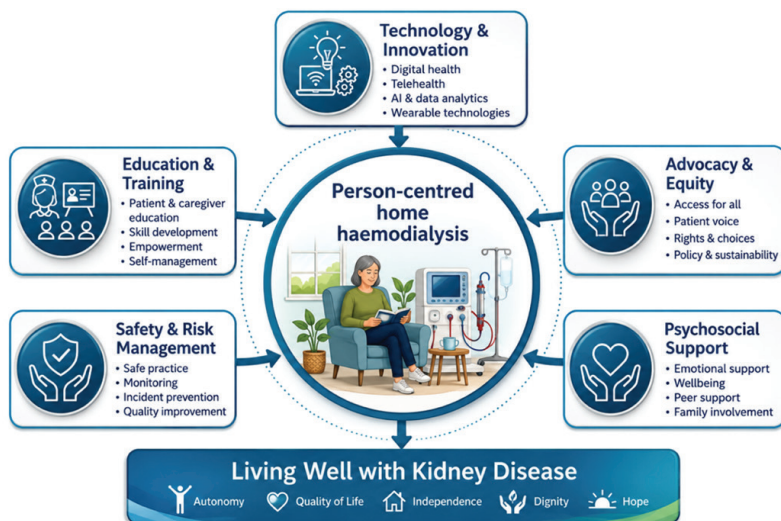
PCC also recognises that expertise is shared. Healthcare professionals contribute clinical knowledge and evidence-based recommendations, while individuals contribute expertise derived from living with kidney disease. The integration of these forms of knowledge enables informed decision-making, supports self-management, and promotes care that aligns with individual preferences and goals. For nephrology nurses, this means embracing collaborative relationships characterised by mutual respect, trust, and shared responsibility.

Looking forward, the future of HHD appears promising. Advances in portable and wearable dialysis technologies, developments in telehealth and remote monitoring, growing recognition of environmental sustainability, and increased emphasis on home-based care all have the potential to expand access to HHD and improve the experiences of those who choose this modality. At the same time, healthcare systems will continue to face challenges related to workforce capacity, health inequalities, digital inclusion, and equitable access to treatment options.

Addressing these challenges will require strong clinical leadership and continued advocacy. Nephrology nurses will play a vital role in ensuring that innovations are implemented responsibly, that emerging technologies remain aligned with ethical principles, and that all individuals have equitable opportunities to access home-based care. Their ability to bridge clinical expertise, education, psychosocial support, and person-centred practice positions them uniquely to lead the next phase of HHD development.

Ultimately, the success of HHD should not be measured solely by treatment adequacy, programme growth, or technological advancement. It's true success lies in enabling people to live the lives they wish to live while managing kidney disease. When individuals are supported to participate actively in decisions, develop confidence in self-management, maintain meaningful roles and relationships, and receive care that reflects their personal values and goals, HHD becomes more than a treatment, it becomes a means of living well with kidney disease.

As nephrology care continues to evolve, the enduring challenge will be to balance innovation with humanity, technology with relationships, and clinical excellence with person-centredness. By embracing these principles, nephrology nurses will remain at the forefront of advancing home haemodialysis and shaping a future in which care is not only delivered closer to home, but also closer to the person.



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