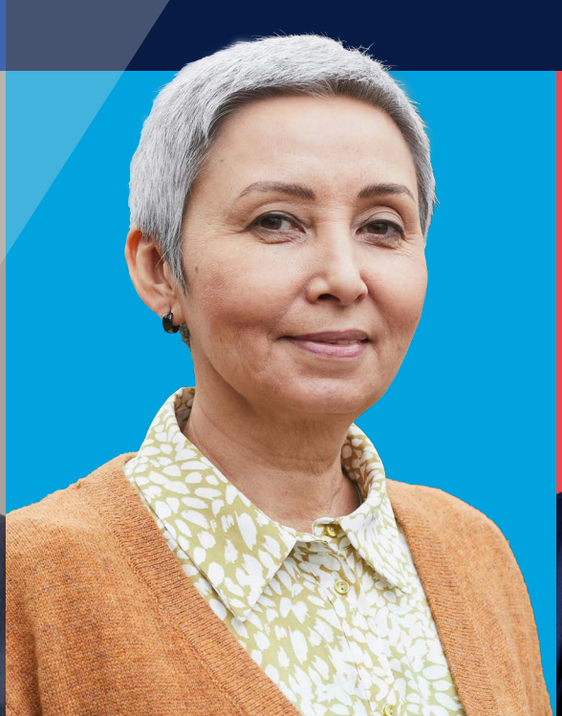
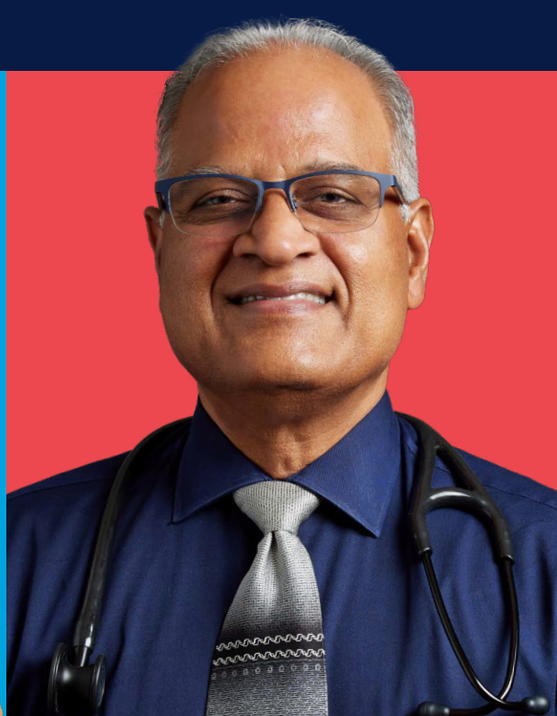
FRESENIUS MEDICAL CARE




Advancing and Personalizing Kidney Disease Care

2024 ANNUAL MEDICAL REPORT

FRESENIUS MEDICAL CARE

Mission

We provide the best possible care. Sustainably in diverse healthcare systems. For a growing number of patients around the world.

Fresenius Medical Care achieves optimal sustainable clinical, quality and technological standards in patient care through our commitment to developing innovative products and therapies.

The unique position of Fresenius Medical Care builds on many years of professional experience and continual innovation. Accordingly, the focus of our research and development effort is to maintain the technological and clinical edge needed to create innovative products and enhanced therapies. Our employees are united in our commitment to providing high-quality products and services and bringing the optimal sustainable medical and professional practices to patient care.

Letter from the CEO

“We’re setting new standards of care by generating high-quality patient outcomes based on a deep understanding of medicine, science, engineering, and patient care.”

Evolving the standard of kidney disease care is a vital part of our patient-centric mission at Fresenius Medical Care.

Life can be complex for people living with kidney disease, with unique challenges for each individual. Addressing this requires a personalized care approach designed to improve health outcomes that enable greater independence and quality of life.

Fresenius Medical Care is the world leader in engineering the medical devices and technologies that make diverse kidney therapies possible. The size, scale, and expertise of our Care Enablement business is pioneering the renal care of tomorrow with high-quality MedTech innovations.

Our Care Delivery business is dedicated to being the kidney care provider of choice for patients, physicians and payors across the healthcare spectrum. Supported by our Global Medical Office, we’re setting new standards of care by generating high-quality patient outcomes based on a deep understanding of medicine and science.

I am proud to introduce you to this year’s Annual Medical Report, where we discuss our work in evolving the standard of kidney disease care. It features insights from some of the foremost experts working in the field of renal care. They are insights that are powering solutions for individuals and families who want more and better-quality time to enjoy the precious gift of life.

When it comes to caring for patients and families, it takes all of us. Thank you for joining us in leading the way for those who need it most.

Helen Giza
Chief Executive Officer
Chair of the Management Board

Fresenius Medical Care
Annual Medical Report

The Annual Medical Report is published by the Global Medical Office at Fresenius Medical Care.

FRESENIUS MEDICAL CARE

Global Medical Office Communications

Comments, suggestions, editorial inquiries? We'd love to hear from you.
Please send questions and inquiries about editorial to GMOcommunications@freseniusmedicalcare.com.

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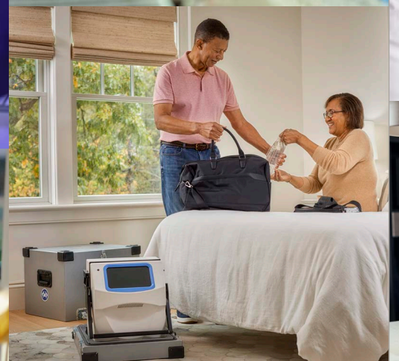
Kidney Disease: Evolving the Standard of Care

Franklin W. Maddux, MD, FACP

Fresenius Medical Care (FME) is a leader in addressing complex health challenges and is working to meet the complex needs of individual dialysis patients. People living with kidney disease deserve more personalized and targeted therapy choices, better clinical outcomes, and the greatest possible quality of life, no matter where they are in their treatment journey.



The future of healthcare will be personalized within a standardized framework and approach. For global health conditions like chronic kidney disease (CKD), genetic and genomic information will one day influence prescriptions and treatment decisions for an individual. Data and Artificial Intelligence (AI) will accelerate connecting care to not only the **right person** at the right time, but the **right treatment** at the right time. People will have greater access to better and diverse targeted therapies, giving them more power and choice.

For Fresenius Medical Care (FME), evolving the standard of kidney disease care toward this personalized future goes beyond a mere "box checking" exercise. Addressing the global expansion of recognized kidney disease while improving clinical outcomes, health, well-being, and quality of life for people living with advanced kidney disease requires a focus on meaningful measures that underpin what high-quality and efficient effective care looks like.

Clinical and Quality Agenda: A Structured Focus on Excellence in Kidney Care and Science

FME's Clinical and Quality Agenda (CQA) is the foundation of the company's global medical strategy and provides focus on several aspects required to deliver high-quality dialysis care today, and the research needed to advance quality care for the future.

First, the CQA articulates key areas of care with a focus on improving clinical outcomes and reducing complications (Figure 1).

FIGURE 1 | PURSUING CLINICAL EXCELLENCE REQUIRES CONTINUOUS QUALITY IMPROVEMENT FOCUSED ON THE MOST IMPORTANT ASPECTS OF CARE AND OUTCOMES.

CLINICAL & QUALITY AGENDA:

Clinical Excellence: Improve Clinical Outcomes and Reduce Complications Associated with End-Stage Kidney Disease (ESKD)

- **Lower Mortality**
- **Lower Hospitalization Rates**
- **Lower Rates of Serious Infections**
- **Reduce Falls**
- **Optimize Blood Pressure and Volume Management**
- **Achieve Anemia Targets**

The CQA also seeks to increase the use of individualized kidney replacement therapies and aims to work with people to identify the therapy that will help them achieve the best outcomes and experience (Figure 2).

FIGURE 2 | PERSON-CENTERED KIDNEY REPLACEMENT THERAPY INVOLVES TAILORING TREATMENTS TO INDIVIDUAL NEEDS AND PREFERENCES.

CLINICAL & QUALITY AGENDA:

Provide Person-Centered Kidney Replacement Therapy

- **Increase Access to High-volume hemodiafiltration (HVHDF)**
- **Increase Access to Kidney Transplantation**
- **Increase the Use of Home Dialysis**
- **Person-Centered Vascular Access for Dialysis**
- **Reduce Burden of Self-Care for Home Dialysis**

For people on dialysis, integrating patient-reported measures into care is necessary to improve the quality of care (Figure 3).

FIGURE 3 | FME SEEKS TO IMPROVE EACH PERSON'S OUTCOMES AND EXPERIENCE BY INTEGRATING PATIENT-REPORTED MEASURES INTO THEIR CARE.

CLINICAL & QUALITY AGENDA:

Integrate Patient-Reported Measures (PRMs) into Care

- **Decrease Dialysis-Associated Symptoms**
- **Excellence in Experience of Care**

We are sharpening our focus by increasing global access and diversifying therapeutic options for people with critical illnesses (Figure 4).

FIGURE 4 | INCREASING THERAPEUTIC OPTIONS FOR PEOPLE WITH CRITICAL ILLNESS IS IMPORTANT FOR IMPROVING CLINICAL OUTCOMES.

CLINICAL & QUALITY AGENDA:

Increase Therapeutic Options for People with Critical Illness

- **Expand Extracorporeal Therapies Available for Management of Cardiopulmonary Failure**
- **Expand Treatment Options for Acute Kidney Injury Requiring Dialysis (AKI-D) in Intensive Care Units**
- **Increase the Safety of Anticoagulation with Continuous Kidney Replacement Therapy (CKRT)**

As significant weather events increase in strength and frequency, pandemics and epidemics occur, and geopolitical conflicts impact key regions of the world, the need to solidify our emergency preparation and response plans to support people on dialysis, as well as our clinic staff and physicians, is evident. Whether it's a natural disaster, epidemic, pandemic, or geopolitical conflict, we need to be ready to respond efficiently and effectively (Figure 5).

FIGURE 5 | FME HAS DEVELOPED A GLOBAL DISASTER RESPONSE FRAMEWORK DESIGNED TO SUPPORT DIALYSIS TREATMENTS DURING CRISES AND EMERGENCIES.

CLINICAL & QUALITY AGENDA:

Enhance Global Disaster Preparedness

- **Global Disaster Preparedness**

FME takes pride in its strong collaboration with leading researchers in the field of kidney disease and uses the findings to innovate and improve care (Figure 6).

FIGURE 6 | ADVANCEMENTS IN KIDNEY DISEASE RESEARCH LEAD TO BETTER TREATMENTS, IMPROVED OUTCOMES, AND PERSONALIZED CARE.

CLINICAL & QUALITY AGENDA:

Advancing Kidney Disease Research

Advance Biomedical Research	Foster Meaningful Collaboration	Integrate Genomics into Research	Address Critical Gaps in Kidney Disease Research

We are committed to reducing health disparities and advancing health equity (Figure 7).

FIGURE 7 | TO REDUCE HEALTH DISPARITIES AND ACHIEVE HEALTH EQUITY, FME IS EXPANDING ITS FOCUS ON IDENTIFYING AND ADDRESSING HEALTH-RELATED SOCIAL NEEDS.

CLINICAL & QUALITY AGENDA:

Identify and Reduce Health Disparities to Improve Health Equity

Address Health-Related Social Needs	Use Data to Identify Health Disparities

Innovating Optimal Therapies: Power and Choice for People

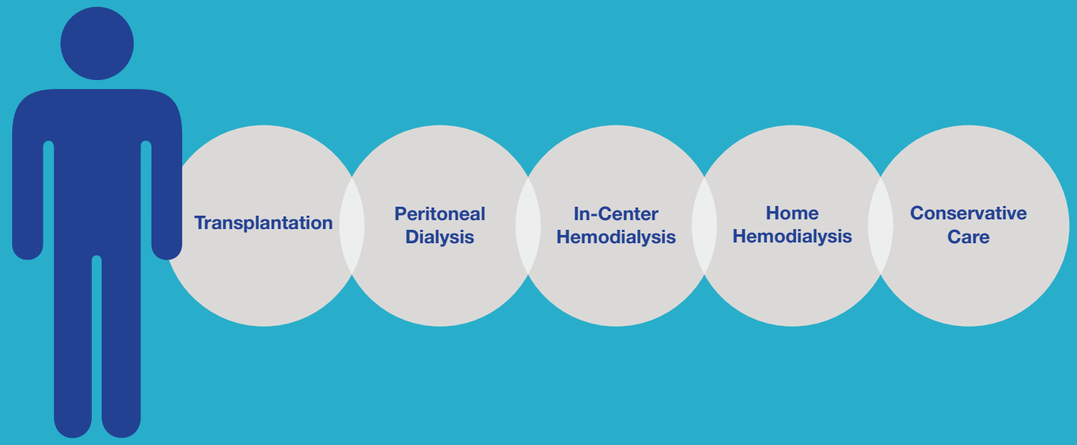
Achieving the best health outcomes, with the greatest independence and highest quality of life, requires diverse therapies that can meet each person's complex and unique needs. Therapies should help people feel better and live more productive lives on their own terms, while spending less time in healthcare facilities. Creating new therapies that continually improve the quality and efficacy of existing treatments is central to evolving an improved standard of care. Whether a person chooses in-center hemodialysis, peritoneal dialysis, or home dialysis, or is a candidate for a kidney transplant, FME provides therapy options that meet each individual's needs based on where they are in their care journey (Figure 8).

Evolving the Care Standard in Action: Introducing High-Volume Hemodiafiltration Dialysis to the United States

FME's leadership in medical device engineering and expertise in membrane technologies create opportunities for the Care Enablement MedTech division to lead the way in developing the most reliable and innovative machines and therapies to enhance our kidney replacement treatments which expand the duration and quality of life for people without kidney function.

Our 5008 & 6008 series machines and companion FX-CorAL dialyzers can deliver high-volume hemodiafiltration (HVHDF) for kidney replacement therapy. These innovations are great examples of FME's potential to evolve the standard of kidney care and expand the availability of these enhanced therapies.

FIGURE 8 | PEOPLE WITH KIDNEY DISEASE MAY ENCOUNTER ONE OR MORE OF THESE THERAPIES ALONG THEIR TREATMENT JOURNEY.



FME is both a longtime advocate as well as a global innovator for HVHDF as an improved dialysis therapy over conventional high-flux hemodialysis (HF-HD), utilizing physical principles of both diffusion and convection to modify blood in people with kidney failure. These techniques are used widely in many parts of the world and are being introduced in the United States.

5008 series dialysis machine

In 2023, the results of the European Union-funded CONVINCE study comparing the efficacy of HVHDF against HF-HD were released. The results showed a remarkable 23% decrease in all-cause mortality for patients treated with HVHDF, and an improvement in patient-reported outcomes.

In 2004, the use of online HDF in FME's EMEA-based NephroCare clinics was limited in general. After 2004, online HDF increased its share continuously among the dialysis techniques prescribed in the network. By June 2024, more than 61% of patients in our European Union clinics were treated by HVHDF.

In 2023, the U.S. Food and Drug Administration approved the 510(k) clearance for FME's 5008X dialysis machine to be used for HVHDF therapy in the United States. This milestone clears the way to bring this improved dialysis therapeutic alternative to people across the U.S. who did not previously have access to this form of therapy. FME leads through innovating improvements in care standards.

In our chapter **"Strategy to Expand High-Volume Hemodiafiltration Worldwide,"** our authors provide a detailed look at the clinical benefits and challenges to adopting HVHDF and provide recommended strategies to aid in broader implementation.

Expanding Access to Kidney Transplants

For many patients with end-stage kidney disease (ESKD), kidney transplantation is the optimal therapy for improving survival and quality of life. In addition to the shortage of available kidneys for transplantation, patients face several barriers and delays in navigating the transplant referral and evaluation process, culminating in reduced access to the transplant waiting list.

The evaluation, testing, and waitlisting practices of transplant centers are heterogeneous and are frequently not transparent to patients nor referring physicians. As a result, reliably tracking the progress of patients through the evaluation toward waitlisting remains difficult, with ample opportunities for patients to get stuck or simply lost in the process. At FME, we are working to identify process gaps for targeted interventions, so that more people who are referred for transplant complete their evaluation and are added to the waiting list when they are deemed acceptable by the transplant centers.

FME Signs Zero Health Gaps Pledge at 2023 World Economic Forum

On behalf of FME, Helen Giza, Chief Executive Officer, signed the Zero Health Gaps Pledge at the World Economic Forum in Davos, Switzerland in January 2023.

The Zero Health Gaps Pledge is part of the Global Health Equity Network (GHEN), which brings together key stakeholders from the public and private sectors to advance a collective vision of Zero Health Gaps, in line with the UN Sustainable Development Goals. In total, 36 companies from eight countries committed to sign the first-in-kind global pledge. By taking the pledge, FME is declaring its commitment to meaningful action and collaboration toward health equity.

"We believe that access to equitable and high-quality health care is a fundamental human right, and we are committed to working with global leaders and organizations to improve the lives of millions of people throughout the world," said Helen Giza. "We will also look inward and achieve clear, actionable steps to make our processes economically and environmentally sustainable, while increasing access to the care we provide in the global communities we serve."

READ MORE

Reducing Disparities of Care for People Living with Kidney Disease

The World Health Organization defines social determinants of health as "the non-medical factors that influence health outcomes." These can include the set of factors and circumstances that shape a person's daily life, such as socioeconomic condition, location, and economic, social, and political policies and systems.

In 2024, FME launched the Global Health Equity steering committee to examine and evolve our approach to identifying and addressing health disparities.

Read more about our efforts to reduce health disparities and address health-related social needs in our chapter entitled, **"Improving Food Security in People with End-Stage Kidney Disease"**.

Policies

FME continues to play a crucial role in providing expert comment on proposed policies affecting patients with kidney disease, as well as promulgating new and innovative ideas for future value-based care payment models. For example, FME has submitted **extensive commentary** on recent proposals by Centers for Medicare & Medicaid Services (CMS) to reform the organ procurement and kidney transplant system in the United States, **incentive payments to increase access to home dialysis modalities** and, most recently, **a proposal by CMS** to create a mandatory enrollment model for kidney transplant programs to incentivize increasing the total volume of kidney transplants.

Looking forward to the future structure of value-based care payment models after the Kidney Care Choices (KCC) model expires at the end of 2027, FME clinical leaders have proposed an **"end-to-end" payment model** that is fully "transplant inclusive".

Looking Ahead

As we consider additional ways to evolve the standard of care for kidney disease, it is important to recognize that new classes of drugs, such as glucagon-like peptide 1 (GLP1) receptor agonists and sodium-glucose transport protein 2 (SGLT2) inhibitors on those living with CKD and ESKD. In the chapter entitled **"Interventions to Improve Survival in People with End-Stage Kidney Disease on Dialysis,"** our authors note: "There is increasing interest in whether the benefits of SGLT2 inhibitors realized in patients with CKD provide mortality benefits in ESKD, and several studies examining this question are ongoing."

Artificial intelligence has the potential to have a profound impact on how healthcare is delivered. In our chapter entitled **"The Challenges and Benefits of Generative AI in Kidney Care,"** you can learn more about the potential that "may revolutionize several aspects of healthcare," including:

- Clinical insights and powerful prognostic tools
- Personalized care
- Efficiency and cost savings
- Tailored medical education
- Comprehensive use of data and knowledge

FME continues to play a crucial role in providing expert comment on proposed policies affecting nephrologists and patients with kidney disease, as well as promulgating new and innovative ideas for future value-based care payment models.

The content of the 2024 Annual Medical Report highlights the expertise and singular focus of FME employees in delivering our mission to *provide the best possible care to a growing number of people across diverse healthcare systems worldwide, sustainably*.

Franklin W. Maddux, MD, FACP
Global Chief Medical Officer, Member of the Management Board

Franklin W. Maddux oversees the delivery of high-quality, value-based care for the world's most expansive kidney care organization. His distinguished career encompasses more than three decades of experience as a physician, expert nephrologist, technology entrepreneur, and healthcare executive.

Dr. Maddux joined Fresenius Medical Care's (FME) North America region in 2009 after the company acquired Health IT Services Group, a leading electronic health record (EHR) software company, which he founded. He developed one of the first laboratory electronic data interchange programs for the U.S. dialysis industry and later created one of the first web-based EHR solutions, now marketed under Acumen Physician Solutions.

He previously served as chief medical officer and senior vice president for Specialty Care Services Group and is the former president of Virginia's Danville Urologic Clinic, where he was a practicing nephrologist for nearly two decades. His writings have appeared in leading medical journals, and his pioneering healthcare information technology innovations are part of the permanent collection of the National Museum of American History at the Smithsonian Institution.

An alumnus of Vanderbilt University, Dr. Maddux earned his medical degree from the School of Medicine at the University of North Carolina at Chapel Hill, where he holds a faculty appointment as clinical associate professor.

Strategy to Expand High-Volume Hemodiafiltration Worldwide

Stefano Stuard, MD, PhD
Michael S. Anger, MD, FACP, FASN

There is increased scientific evidence that hemodiafiltration (HDF) positively affects clinical outcomes for dialysis patients. However, healthcare policy and reimbursement rates are among the challenges that limit the broader adoption of HDF in many countries. Overcoming these barriers requires that health policy experts look beyond the initial higher cost of HDF to factor in the long-term benefits for both healthcare systems and people on hemodialysis.

Online hemodiafiltration (HDF) is a technologically advanced dialysis modality that utilizes a specifically designed high-flux dialyzer and a dedicated hemodialysis machine.

Online HDF efficiently removes small-molecular-weight uremic solutes mainly through diffusive transport. Simultaneously, medium-sized molecules, such as beta 2-microglobulin, are preferentially removed through convective clearance, which depends on several factors, including blood flow, ultrafiltration (UF) rate, and dialyzer membrane characteristics (pore size and permeability). To maximize the removal of middle-sized toxins through convection, UF exceeds the desired fluid loss, and replacement (substitution, Qsub) fluid is administered to achieve the target fluid balance (Figure 1).

The term “online” refers to the fact that the dialysis machine generates the Qsub fluid from ultrapure dialysate in real time. This eliminates the need for pre-prepared substitution fluid bags.

High-volume HDF is designed to enhance the advantages of online HDF by increasing the Qsub fluid production and consequently boosting the convective clearance, thus enhancing the overall effectiveness of the treatment.

Technical Aspects of HDF

HDF dates to the late 1960s when Henderson published the first article on the use of UF and fluid replacement as a method of blood cleansing,[1] and it has undergone continuous improvement since then.[2] Since the late 1970s, due to the need for large volumes of substitution solution, the fresh sterile and non-pyrogenic (ultrapure) fluid has been made from dialysate and reinfused as substitution fluid (online HDF).[3] The substitution fluid (Qsub) is obtained by the cold sterilization of dialysate, achieved via a two-step ultrafiltration process using sterilizing ultrafilters.

Online HDF treatment modalities can be categorized based on the point of Qsub administration within the extracorporeal circuit into four distinct types.[4,5] The Qsub is introduced before the blood enters the dialyzer in pre-dilution HDF. In post-dilution HDF, the Qsub is infused after the dialyzer into the venous drip chamber (Figure 2). Less commonly utilized, mixed-dilution and mid-dilution HDF infuse the Qsub at distinct points within the extracorporeal circuit. In mixed-dilution HDF, the fluid is added both before and after the dialyzer, whereas in mid-dilution HDF, it is introduced into the midpoint of the circuit.

FIGURE 1 | DIFFUSION AND CONVECTION PROCESS

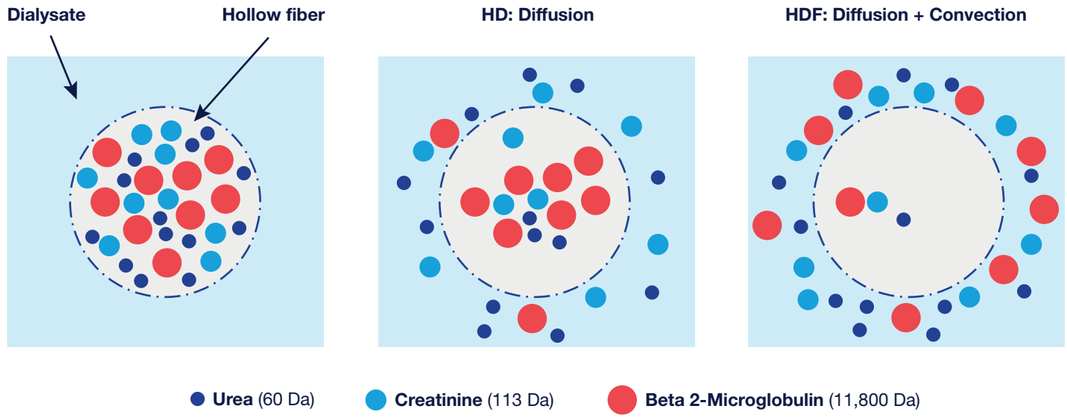
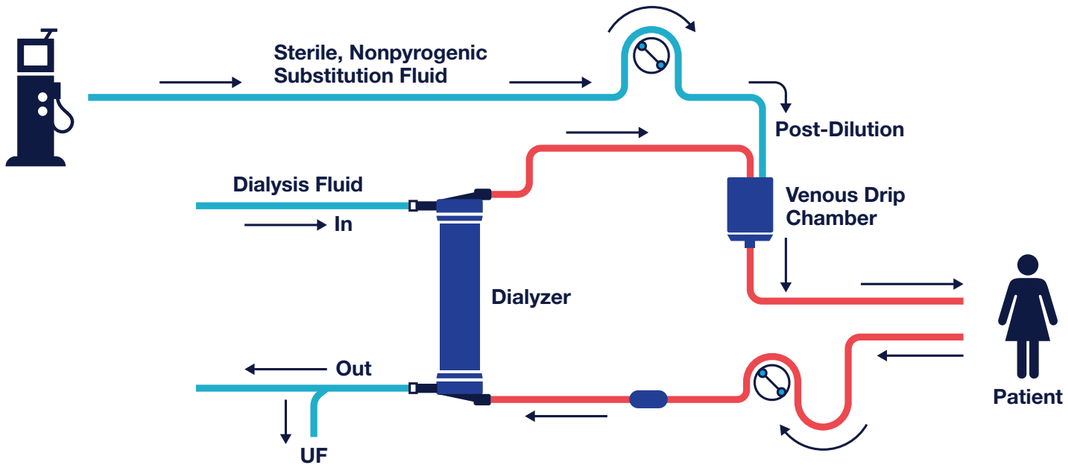


FIGURE 2 | POST-DILUTION ONLINE HEMODIAFILTRATION: THE SUBSTITUTION FLUID IS INFUSED IN THE VENOUS DRIP CHAMBER



In Asia, pre-dilution HDF is preferred due to the lower blood flow rate (Qb) requested. Conversely, post-dilution online HDF is the dominant modality in Europe, accounting for roughly 90% of convective dialysis procedures. Post-dilution online HDF allows for a more favorable balance between elevated low-middle molecule solute clearance removal rates and reduced use of substitution volume compared to other online HDF techniques. The high UF rate increases the risk of membrane fouling with increased transmembrane pressure (TMP), shortened membrane lifespan, and reduced clearances. These factors limit the filtration fraction (UF rate/plasma flow rate x 100%) to around 25%–30% of the Qb.[6] Various automated feedback control systems have been introduced to adjust the infusion rate of Qsub based on Qb and dialyzer TMP. These systems aim to streamline the execution of online HDF while optimizing the intradialytic Qsub.

To mitigate the increased TMP caused by the protein fouling, Qsub is automatically reduced to keep the treatment stable, significantly reducing the number of alarms during dialysis.[7] Among the others, Fresenius Medical Care's (FME) AutoSub plus automatically adapts Qsub according to the Qb, blood viscosity, TMP, and attenuation of pressure pulses. Membrane characteristics are fundamental to minimizing protein fouling. One of the most important is a hydrophilic modification of the synthetic membrane surface to reduce protein adsorption and lead to performance stability during treatments.[8,9,10,11,12]

Clinical Benefits

In recent reviews, the advantages of online HDF compared to high-flux hemodialysis (HF-HD) were summarized.[13,14] Online HDF has demonstrated a direct effect in decreasing the incidence of intradialytic hypotensive episodes, better hemodynamic stability unrelated to improved sodium balance,[15,16,17] and a positive impact on cardiac remodeling.[18,19,20,21] Patients undergoing HDF have exhibited reductions in chronic inflammatory states[21,22] and oxidative stress[22,23] alongside enhancements in endothelial function and cardiovascular stiffness,[24,25,26] progression of atherosclerosis,[27] sympathetic tone activity,[28] and arrhythmogenicity.[29] HDF contributes to improving anemia management,[30,31,32] nutritional status,[32,33] physical activity,[34] enhancement of quality of life,[33,35,36,37] and protection of residual kidney function.[38]

Four large randomized controlled trials (RCTs) have demonstrated the superiority of online HDF over HF-HD with respect to clinical outcomes, particularly in reducing the mortality of individuals with end-stage kidney disease (ESKD).[39,40,41,42] Peters et al. conducted an individual patient data meta-analysis of the four RCTs and found that online HDF was associated with a 14% reduction in all-cause mortality and a 23% reduction in cardiovascular mortality compared to HF-HD.[43] Many retrospective data analysis studies have yielded comparable results, showing a dose-response relationship between substitution/convective volume and survival rate.[44,45,46,47,48,49,50,51,52] Specifically, a substitution/convective volume exceeding 21/23 L per session has been associated with the most favorable effect on lowering mortality.[44,45,46,47,48] In the CONVINCE study, a multinational interventional randomized controlled trial funded by the European Union's Horizon 2020 Research and Innovation Program, 1,360 individuals with ESKD were recruited from 61 dialysis centers from public and private sectors in 8 countries.[53] The post-dilution high dose (volume) HDF (HVHDF), defined as convection volumes ≥ 23 L (range ±1 L) per session, reduced the risk of all-cause mortality by 23% compared to HF-HD.[53] A recent systematic review and meta-analysis of five RCTs showed that online HDF significantly reduced the risk of cardiovascular-related deaths by 25% and all-cause mortality by nearly 20% compared with the HD group; additionally, HDF effectively reduced the risk of infection-related mortality by 31%.[39, 40, 41, 53, 54, 55]

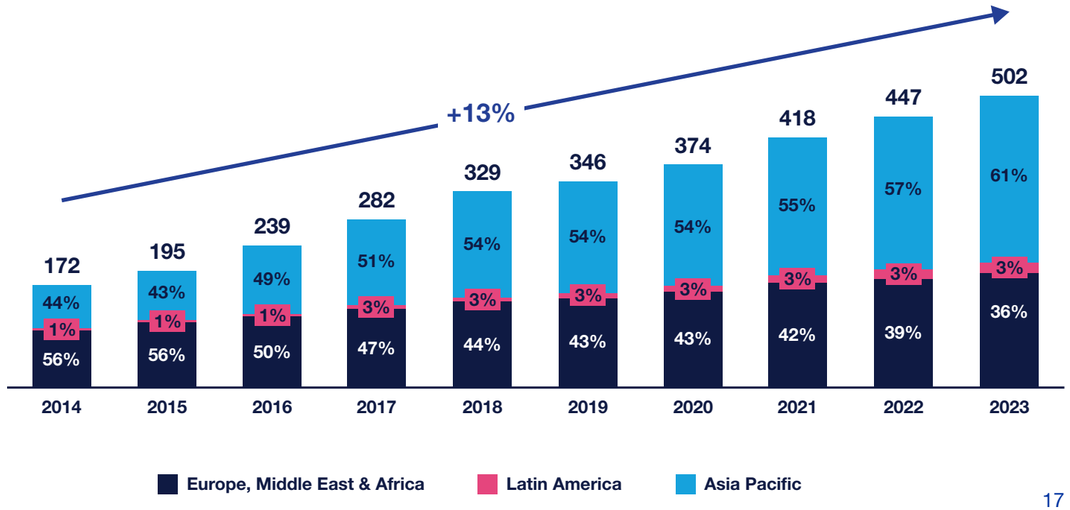
Challenges to Adoption

Despite the evidence that post-dilution HVHDF improves clinical outcomes and quality of life, its worldwide adoption remains limited. From 2014 to 2023, the number of HDF patients worldwide grew by an average of 13% per year (Figure 3).[58] Expanding HVHDF more globally requires addressing the barriers to adoption. Canaud et al. postulated that HVHDF acceptance might be affected by regulatory and technical issues, clinical evidence of benefit, and healthcare policies, including reimbursement rates.[57] All countries worldwide have approved online HDF's clinical use, and regulatory and technical aspects have become more accessible to address.[57] Despite the increased scientific evidence demonstrating the positive impact of HVHDF on clinical outcomes, healthcare policy and reimbursement rates remain the most significant challenges limiting the broader adoption of HVHDF in many countries. Japan has encouraged the use of HDF by approving its payment under national health insurance and setting higher reimbursement rates in 2012.[57] The number of patients treated by HDF has been rising since 2012 to reach 191,492 by the end of 2022, which accounted for 55.1% of all dialysis patients.[58] In 2022, approximately 31% of people with ESKD receiving hemodialysis in Europe were treated by online HDF,[56] though there is high variability between European countries. Some European countries have recognized the potential of HDF to improve patient outcomes while keeping healthcare costs stable, leading them to implement policies aimed at increasing its uptake. In 2018, the National Institute for Health and Care Excellence in the U.K. recognized the superiority of HDF in their guidelines.[59] Some countries have incentivized the uptake of HDF by offering higher reimbursement rates (e.g., Czech Republic). Others have introduced restrictions, either by specific indications (e.g., Poland), by setting a threshold limit (e.g., Italy), or by making HDF payment coverage dependent upon individual payer's/health insurance policies (e.g., Slovenia). In some European countries, HDF is allowed but reimbursed at the same rate as HF-HD.

Since 2004, HVHDF has been adopted as standard therapy in FME Europe, Middle East, and Africa (EMEA) NephroCare clinics. In January 2014, FME EMEA implemented an infusion volume greater than 21 L per session as a new quality key performance indicator (KPI) for patients receiving treatment with post-dilution online HDF. Over a decade, over half of all people with ESKD treated in FME EMEA clinics have been treated according to this target. As of 2023, more than 26,000 prevalent patients (dialysis vintage in FME clinics > 90 days, receiving 12–13 treatments/month) were treated using post-dilution online HDF with a mean convective volume of 26.4±4.9 L.

In contrast, there is some suggestion that using mid-medium cut-off dialyzers may be non-inferior to HVHDF in reducing all-cause mortality. The MOTheR study trial is an open-label multicenter prospective trial designed to evaluate the efficacy and safety of using a mid-medium cut-off dialyzer compared to HVHDF in dialysis patients in Spain for up to 36 months.[60] Preliminary data suggest it may be non-inferior in reducing all-cause mortality. Other potential benefits associated with HVHDF have not yet been reported for the MOTheR trial.[58]

FIGURE 3 | ONLINE-HDF PATIENT GROWTH (THOUSANDS) BY REGION AND GLOBAL AVERAGE ANNUAL INCREASE (HDF NOT YET IMPLEMENTED IN UNITED STATES)



Strategies for Adoption

To further expand HVHDF adoption worldwide, several strategies could be implemented:

1. Bridging the knowledge gap
2. Addressing sustainability concerns
3. Emphasizing long-term cost savings/value proposition
4. Fostering cross-functional collaboration for HVHDF advancement
5. Implementing patient empowerment

1. Through targeted workshops and training programs, knowledge gaps in HVHDF can be bridged effectively, significantly enhancing comprehension. Managing HVHDF programs, experiences, success stories, and lessons learned can be disseminated through identified reference centers, inspiring broader adoption. Standardization of HVHDF procedures, including implementing specific KPIs (e.g., treatment time ≥ 240 minutes, convective volume ≥ 23 L), minimizes variability, ensures adherence to best practices, and fosters efficient workflow. Additionally, integrated systems equipped with dedicated machines, dialyzers, and automated feedback controls for infusion rate adjustments can improve operational efficiency and help mitigate the learning curve for healthcare personnel.

2. Conducting health economic outcome studies assessing the comparative costs and outcomes associated with HVHDF versus traditional methods may provide valuable insights into its financial sustainability.

Shroff and the EUDIAL Working Group highlighted concerns regarding the sustainability and environmental impact of HVHDF due to the larger infusion volume required compared to conventional high-flux HD, and they speculated that the associated cost outweighs the benefits.[61] On the contrary, Canaud et al. demonstrated that optimally prescribed post-dilution online HDF emerges as the most environmentally friendly choice.[62] This approach not only excels in enhancing solute clearance across all molecular weights but also offers the potential to significantly reduce water and dialysate consumption by allowing lower dialysate flow rates without compromising clearances.[62]

3. Online HDF is capable of meeting the main clinical and financial challenges as well as the diverse expectations of various stakeholders (patients, physicians, industry healthcare providers, and funders).[63] While evidence suggests favorable patient outcomes with HVHDF, questions regarding its cost-effectiveness compared to high-flux HD persist. While the upfront investment in HVHDF infrastructure may initially seem restrictive, focusing on its long-term returns, such as reduced hospitalizations, increased survival, decreased medication requirements, and improved quality of life, legitimizes the initial expenditure.

4. Robust cross-functional networks involving researchers, healthcare organizations, industry partners, government agencies, and nephrology societies are essential for driving standard-setting, evidence-based practice, and innovation in HVHDF. This type of collaboration is essential to demonstrate this therapy's long-term savings and value proposition, including reduced hospitalizations and co-morbid events. Active engagement in multinational consortiums dedicated to advancing renal care, such as the CONVINCE study—which unites dialysis divisions in academic hospitals, general facilities, and private renal care providers—amplifies the focus on HVHDF and fosters cross-border learning. These alliances can potentially promote the dissemination of best practices across diverse contexts, accelerate knowledge generation, and support broader worldwide implementation of HVHDF, focusing on resource optimization, safety, efficacy, and environmental sustainability.

5. Promoting active patient participation in the decision-making process, in collaboration with patient associations, ensures that patient preferences and values are considered when selecting dialysis modalities. Providing accessible educational materials, including relevant information about potential benefits and drawbacks, can facilitate informed decision-making and encourage greater patient acceptance and active participation in HVHDF programs.

Conclusion

Achieving widespread adoption of HVHDF necessitates a multifaceted and collaborative strategy that addresses current challenges effectively. The proposed interventions should be implemented through a multistakeholder approach. By fostering the expansion of HVHDF, the overarching goal of enhancing patient care and clinical outcomes on a global scale while ensuring its sustainable delivery can be achieved.

While the upfront investment in HVHDF infrastructure may initially seem restrictive, focusing on its long-term returns, such as reduced hospitalizations, increased survival, decreased medication requirements, and improved quality of life, legitimizes the initial expenditure.

Dr. Stefano Stuard
Senior Vice President, Global Clinical Officer
Hemodiafiltration
Global Medical Office

Dr. Stefano Stuard joined Fresenius Medical Care in 2010 as a Medical Director in FME's NephroCare business in the Europe, Middle East, and Africa (EMEA) region. Dr. Stuard's career includes more than 14 years in clinical governance roles with Fresenius Medical Care's EMEA and Latin America regions. In his most recent role, he supported NephroCare medical leadership in his role as Chief Clinical Officer for the EMEA countries. Dr. Stuard has long been a champion of online hemodiafiltration as a kidney replacement therapy, overseeing its steady growth in NephroCare clinics. By June 2024, more than 61 percent of patients in our European Union clinics were treated by High-Volume Hemodiafiltration.

In his current role, Dr. Stuard will focus on educating nephrologists in FME's Care Delivery business segment and will support many of the aspects of our development of a comprehensive plan to make HDF therapy a standard of care. Dr. Stuard previously served as vice president and head of the EMEA Center of Excellence for Clinical and Therapeutic Governance and as a director/consultant for nephrology and dialysis departments in Italian public and private hospitals. He has published over 220 scientific publications in peer-reviewed journals. Dr. Stuard received his PhD in nephrology from the University of Bologna (Italy). He received his Doctor of Medicine and surgery as well as a post-graduate specialization in nephrology, *magna cum laude*, from the University of Chieti (Italy). He received an award from the European Society of Artificial Organs for his contribution in the field of artificial organs. Dr. Stuard is also a member of European Renal Association Kidney Relief in Disasters Task Force.

Dr. Michael Anger
Senior Vice President
Medical Officer, In Center Home Dialysis
Medical Officer, Quality & Regulatory
Global Medical Office

Dr. Anger's medical training and internal medicine residency were completed at Hahnemann University, and his adult and pediatric nephrology fellowships took place at the University of Colorado School of Medicine. He is a clinical professor of medicine at the University of Colorado School of Medicine, Fellow of the American College of Physicians, Fellow of the American Society of Nephrology, and member of the honor medical society, Alpha Omega Alpha. Prior to joining the Global Medical Office at Fresenius Medical Care, Dr. Anger had been the Chief Medical Officer of American Renal Associates as well as president and senior partner of Western Nephrology in Denver, Colorado, where he also led the research and interventional nephrology divisions.

Home Dialysis Today: More than a Different Place for ESKD Care

Brigitte Schiller, MD, FASN, FACP

Although it has been available for many years, home dialysis has faced an uneven reception, with global adoption still low. Today, however, kidney patients are increasingly demanding the life-altering freedom, flexibility, and control that home dialysis provides. New home dialysis options and technologies also hold promise for addressing critical equity and sustainability issues that are inherent in the current one-size-fits-all dialysis delivery environment.

"You may not control life's circumstances, but getting to be the *author of your life* means getting to control what you do with them."

Atul Gawande
Being Mortal: Illness, Medicine and What Matters in the End, *2014, p. 210*

Kidney Disease and Healthcare Are Changing

An estimated 700 million people are affected by chronic kidney disease (CKD) worldwide. About 2.6 million people received kidney replacement therapy in 2010. Estimates project that this number will be more than 5 million by 2030. These staggering statistics do not even consider the millions of people without access to dialysis therapy and who suffer premature deaths.[1] Future projections will update the trajectory to assess the effects of access to new reno-protective drugs.

The triple aim[2] was introduced as a framework for healthcare improvement through better population health, patient care experience, and decreased costs. Addressing the burnout of healthcare professionals and the need to advance health equity led to the quintuple aim[3] (Figure 1).

Indeed, all criteria of the quintuple aim need to be tackled to address the rising global burden of kidney disease. Kidney replacement therapy for end-stage kidney disease (ESKD) calls for transformational systemic change. The sustainability of high-quality care in regions where universal dialysis care is available requires novel solutions, given the ever-rising patient numbers and, hence, costs. Above all, access to dialysis needs to increase to improve health equity, especially in lower- and middle-income countries. Home dialysis is key to providing solutions for caring for people with kidney disease.

Home Dialysis: A Story of Mixed Results

Inspiring pioneer efforts dominated the beginning of home dialysis. Born out of necessity 60 years ago, home hemodialysis (HD) helped a 15-year-old girl live longer at a time when ESKD was a fatal disease.[4] About 50 years ago, Popovich introduced the concept of a portable/wearable dialysis option launching continuous ambulatory peritoneal dialysis (CAPD) as an alternative home dialysis option.[5] Today, two modality options are available for home dialysis: peritoneal dialysis (PD) delivered as CAPD or Automated Peritoneal Dialysis (APD), and home HD, with a day or nighttime schedule ranging from conventional three times per week to more frequent dialysis therapy.

The global use of home dialysis is low and varies widely due to complex reasons and dependencies including public policy, healthcare systems, geography, costs, and incentives, as well as culture (Figure 2).[6]

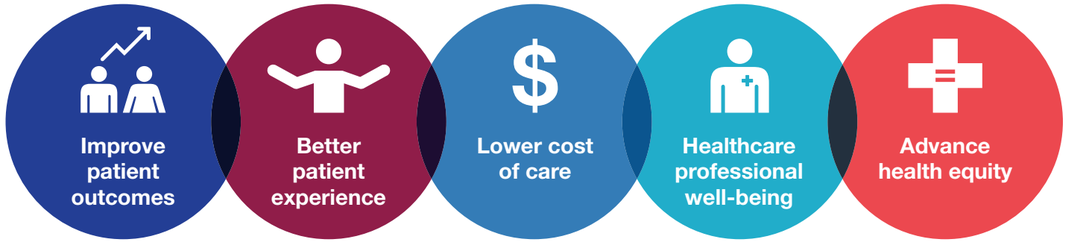
Home dialysis in the U.S. has been on a roller coaster ride since its introduction. More recently, reimbursement changes through the bundled payment in 2010 and the Advancing American Kidney Health Initiative policy in 2019 increased the prevalence of home dialysis to about 14% by 2021, PD contributing 11.6% and home HD 2.1%.[7]

Clinical outcome comparisons are limited to mostly observational studies, making it difficult to support a generalizable superiority of one modality over another. The body of evidence rather emphasizes dialysis modality prescriptions being individualized to the specific person, their clinical and non-modifiable characteristics, and their life circumstances. The benefit of intense HD delivered either through more frequent or extended-hours dialysis including nocturnal dialysis has been highlighted repeatedly.[8,9,10]

Nephrologists consider most people needing dialysis eligible for home dialysis based on their medical condition.[11] Furthermore, nephrologists state that they would prefer home dialysis in the hypothetical situation of dialysis need, a telling data point in a clinical area where science and evidence are augmented by the "art of medicine."[12,13]

The global use of home dialysis is low and varies widely due to complex reasons and dependencies including public policy, healthcare systems, geography, costs, and incentives, as well as culture (Figure 2).[6]

FIGURE 1 | QUINTUPLE AIM OF HEALTHCARE IMPROVEMENT (2022)



Home Dialysis | Afterthought No More!

One might say that home dialysis has been for many years an afterthought in the provision of kidney replacement therapy. This appears most evident in countries where center HD is by far the most common modality. Considering the astounding rise of CKD, the ensuing human burden, and increased cost in healthcare spending, novel approaches are called for. Home dialysis is ready for its moment in the limelight.

The embrace of home dialysis as an alternative kidney replacement therapy is fueled by several converging events that have given rise to a sense of crisis and created a moment of opportunity.

1. The Voice of the Patient

The most important driver towards home dialysis is the increasingly confident and insistent voice of the people needing dialysis. The one-size-fits-all approach prevalent for far too long must be reassessed through the lens of those who matter most in this community: the patients and families living with dialysis. Their request for therapies that enable a functioning life requires new answers. Life participation, the ability to participate in activities that are meaningful to patients, joins the rank of clinical outcome measures like survival, cardiovascular disease, and infection, highlighting people's expectations for life with dialysis.[14]

Considering the astounding rise of CKD, the ensuing human burden, and increased cost in healthcare spending, novel approaches are called for. Home dialysis is ready for its moment in the limelight.

There should be no surprise about this development. For the past 10 years quality improvement efforts have shifted from basic clinical parameters and care processes to more complex aspects of healthcare delivery including lowering mortality, reducing hospitalizations, and improving the patient experience. The most important goal is to advance people's quality of life, the metric that matters.[15]

A useful example is the 2020 ISPD practice recommendation for PD, which set forth a new mindset for a comprehensive, intuitive way of PD prescribing by promoting high-quality, **person-centered, goal-directed dialysis care** individualized to the person's clinical and personal needs to allow for a life with activity, purpose, and hope.[16]

Individualized home dialysis therapy allows more people to become the authors of their lives.

Humanizing dialysis is at the core of this necessary and welcome transformation for the complex realities of life with ESKD.

Home dialysis becomes more than dialysis in a different place, provides more than simply dialysis at home. It imparts control, flexibility, and autonomy by incorporating dialysis into lifestyle preferences. Humanizing dialysis is at the core of this necessary and welcome transformation to deal with the complex realities of life with ESKD.

This is consistent with the transformation of healthcare in general responding to expectations of a more person-centered care delivery system.

Home dialysis becomes more than dialysis in a different place, provides more than simply dialysis at home. It imparts control, flexibility, and autonomy by incorporating dialysis into lifestyle preferences.

2. Sustainability

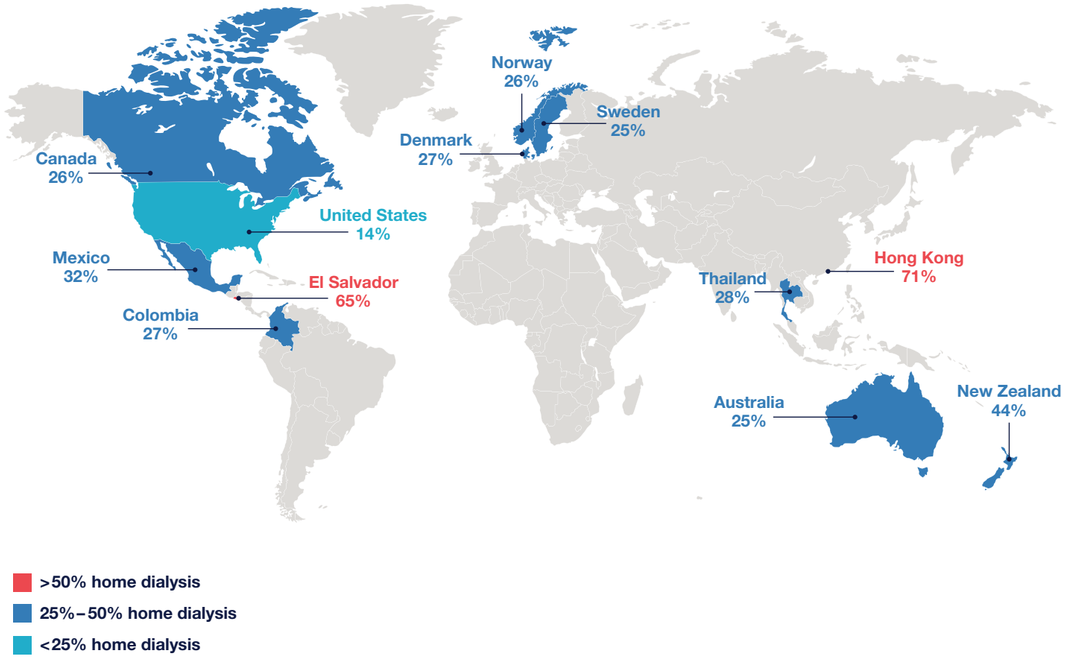
The sustainability of the current system is called into question for three different reasons: economic resources, climate change, and the healthcare workforce crisis. These realities affecting the status quo are global with country-/region-specific differences.[17]

Economic limitations in maintaining care for an increasingly older and medically complex population are a worldwide reality. The projected rise in CKD, already resulting in unanticipated demands for dialysis, will further worsen the imbalance of requirements and resources. Low- and middle-income countries are unable to provide access to all in need, a reality likely to worsen.

Climate change is associated with increasing risks for droughts, making water a prime resource that dialysis requires in large amounts. PD and low-flow home HD utilize less water and thus present a more sustainable therapy. Carbon footprint favors home dialysis with its fewer transportation requirements. Reducing waste products and point-of-care preparation for solutions needs to be addressed to extend the sustainability advantage of home therapies.

The third element threatening the sustainability of kidney replacement therapy is the overwhelming gap of healthcare professionals. The limitations are both in the number of people as well as in the expertise needed for high-quality care. A shortage of nurses in the ESKD community has long been anticipated, but the "great resignation" around the COVID-19 pandemic accelerated the crisis faster than expected. Similar trends exist for nephrologists and other members of the healthcare team. Home dialysis aided by technology to supplement human capabilities is needed to help mitigate this reality.

FIGURE 2 | INTERNATIONAL HOME DIALYSIS DISTRIBUTION, adapted from Perl J (6) 2023, page 847



3. Equity – Access to Care
Global access to healthcare varies, with the greatest disparities among historically disadvantaged populations. Access to dialysis is not a guarantee everywhere and demands progress.[18]

As affordability, sustainability, and scaling of dialysis care need to be considered to broaden access worldwide, home dialysis and foremost PD offer themselves as the most pragmatic opportunity.[19] High-income countries' equity challenges are evident in the uneven distribution of the use of home dialysis.

Home Dialysis | The Guiding Light to Address Unmet Needs. How to Get There?

Home dialysis emerging as a guiding principle to solve for improvement of the pivotal issues in ESKD care around the world requires a clear vision, disciplined approach, and alignment of all members of the kidney care community.

As affordability, sustainability, and scaling of dialysis care need to be considered to broaden access worldwide, home dialysis and foremost PD offer themselves as the most pragmatic opportunity.[19]

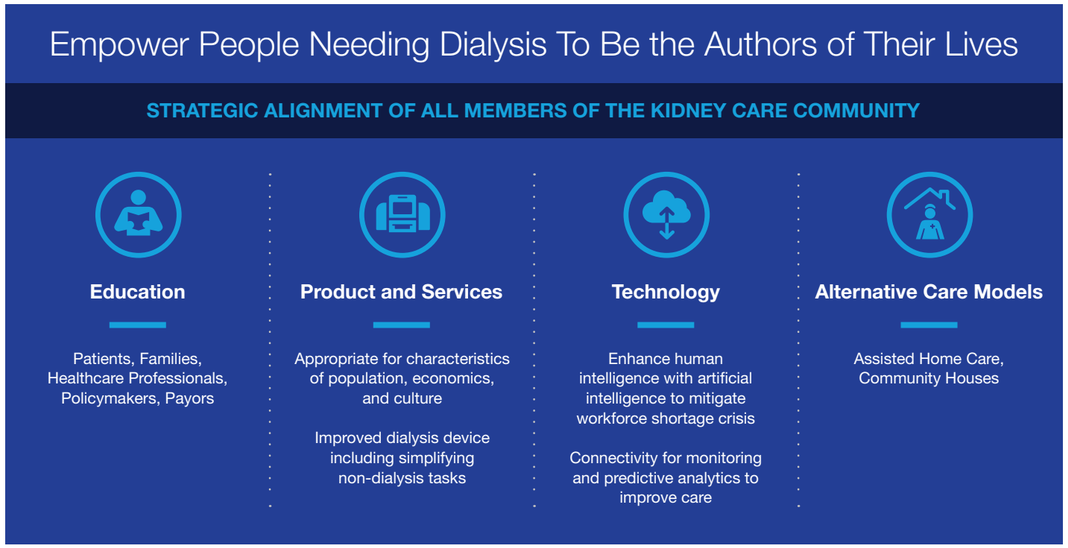
The goal is to create an environment to empower people needing dialysis. As home dialysis fosters control, autonomy, and flexibility to adapt dialysis to personal goals and choices in life, efforts to create a system that enables more people to take advantage of home therapies will center on education, products and services, technology, and alternative care models (Figure 3).

Education continues to be a foundational requirement for home dialysis starting with those needing dialysis and their families. High priority needs to center on the "how to" of home dialysis for healthcare professionals, policymakers, and payors. The success of home dialysis depends on creating the ecosystem that allows all participants to partner around the shared goal.[20,21]

Products for home dialysis need to be reliable, safe, and easy to use at home as well as for the professionals responsible for training and monitoring care. Advances in technology can deliver on these demands better than ever before. To solve known barriers, device improvements will also address non-dialysis-associated tasks like supply management, preparation of solutions, storage, and documentation.

Technology creates multiple opportunities. Smarter devices facilitating care delivery will mitigate the gaps created by the workforce shortage and the associated deficit of expertise. Remote therapy monitoring can deliver data for earlier detection of complications. The hope is that, in the future, AI will generate the basis for clinical algorithms supporting standardized and improved practice and risk prediction to alert the healthcare team of potential complications early.

FIGURE 3 | HOME DIALYSIS



A variety of alternative care delivery models exist in countries known for their successful implementation of home dialysis. Among these programs is assisted home dialysis, where support with the therapy is added at the start of home therapy and/or at challenging times of the journey like hospitalization or care partner issues.[22] Assisted support can also come in the form of financial support for care partners and costs for utilities at home. Lastly, a wider definition for "home dialysis" like community houses adds options. People perform dialysis therapy independently in a community place accounting for socioeconomic and cultural barriers.[23]

With shifting population characteristics, unrealized capability for global dialysis needs, sustainability concerns, and inequities in healthcare, medical and business leadership and policymakers are asked to listen to the concerns of patients, healthcare providers, economists, and climate scientists.

Home dialysis arises as a central answer addressing multiple issues as the right therapy, at the right time—and the right place—for many more people.

Technology creates multiple opportunities. Smarter devices facilitating care delivery will mitigate the gaps created by the workforce shortage and the associated deficit of expertise.

Enabling people to live the life they hope for. Providing dialysis so people can do what matters most to them, such as:

"I'd like to have more energy to play with my grandchildren."

"I would like to be more active again to not burden my family."

"I would like to be more independent and travel."

Dr. Brigitte Schiller
Medical Officer, Home Therapies
Global Medical Office

Dr. Schiller is a nephrologist with experience in direct patient care in private practice and academic institutions, research, quality improvement and physician leadership in administrative roles. She joined Fresenius Medical Care in January 2023 as SVP, Medical Officer, Home Therapies.

Dr. Schiller is passionate about contributing to the transformation of the care for patients with ESKD through patient advocacy, quality improvement and innovation including alternative care models. Dr. Schiller serves as an Adjunct Lecturer in the Division of Nephrology at Stanford University and is a member of the USRDS Contract Management Board.

Predicting Population Trends in Kidney Health Using Advanced Mathematical Modeling

Dr. Doris Fuertinger
Dr. David Jörg

As more novel therapies are being developed, advanced quantitative tools are essential in evaluating and predicting their impact on future populations with kidney disease. To better understand the complex interplay of demographic and medical factors, Fresenius Medical Care has created the Population Impact Model. This proprietary methodology uses public health trends and clinical data to test a spectrum of hypotheses and provide insights into the potential impact of new therapeutic approaches.

The landscape of kidney disease is ever-changing. Globally, changes in lifestyle have led to a steady increase in obesity and diabetes, major drivers of chronic kidney disease (CKD). On the other hand, the last couple of decades have seen tremendous progress in the form of improved treatments for CKD such as new drugs to slow the progression and/or treat the underlying etiology of kidney disease such as SGLT2 inhibitors (SGLT2i)[1,2,3] and GLP-1 receptor agonists (GLP1ra).[4] In addition, innovative dialytic therapies, such as high-volume hemodiafiltration (HVHDF), have documented beneficial impact on clinical outcomes in people with end-stage kidney disease (ESKD) on dialysis.[5] Advanced epidemiological-type models are an invaluable tool to assess the integrated impact that novel therapies and demographic changes in the population may have on the size and characteristics of future populations with kidney disease.

The size and demographic composition of the CKD population depend on the complex interplay of various factors. Every year, hundreds of thousands of people develop ESKD around the world, many of them receiving kidney replacement therapy, mostly hemodialysis. At the same time, both the prevention and treatment of kidney disease are steadily improving, facilitated by new drugs and technologies. Novel therapies such as HVHDF have proven survival benefits for people with ESKD on maintenance hemodialysis.[5] GLP1ra—originally developed as a treatment for type 2 diabetes—gained much attention for their potential to reduce weight and delay kidney disease progression.[4] These are but a few examples. While life expectancy shows a general trend towards longer life expectancy, sudden global events like the COVID-19 pandemic can have a significant impact on the population.[6,7]

In this complex situation, several questions arise:

- **How will new therapeutic drugs like GLP1ra and SGLT2i affect the progression of kidney disease at the population level?**
- **Will the mortality benefits of HVHDF change the age structure of people on dialysis?**
- **When will the effects of the COVID-19 pandemic on the ESKD population diminish?**

Estimating the impact of these developments on populations with kidney disease is a challenging task, not least because different demographic groups, especially younger and older individuals, may be affected differently.

Advanced epidemiological-type models are an invaluable tool to assess the integrated impact that novel therapies and demographic changes in the population may have on the size and characteristics of future populations with kidney disease.

Quantitative Population Impact Modeling

This is where transparent mathematical models capturing the epidemiology of kidney disease can provide quantitative insights and make a decisive difference. By capturing ongoing public health trends and combining them with the latest clinical insights on the effect and efficacy of novel therapeutics, such models can provide valuable insights into what populations with kidney disease will look like in the future.

Fresenius Medical Care's Global Medical Office has developed a proprietary, science-based systematic modeling approach: the Population Impact Model. It provides a quantitative tool to test a spectrum of hypotheses about the future impact of novel therapeutic interventions and large-scale public health disruptions in the kidney space. The Population Impact Model is specifically designed to:

(a) understand how the sizes and age distributions of populations with kidney disease evolve over time, and

(b) generate predictions for various scenarios including the effects of disruptive therapeutic developments like new drugs and treatments on disease progression, mortality, and other relevant factors.

In a first step, the model specifically addresses developments in the United States, Fresenius Medical Care's largest dialysis services market, predicting the development of the U.S. population with kidney disease over the next decade.

The Population Impact Model describes how the interplay of kidney disease incidence and progression, treatment, population aging, and mortality shape the size and age distribution of the CKD and ESKD populations over time (Figure 1). The mathematical principles underlying the model are the same as for widely established models of epidemiology, such as the ones used to predict COVID-19 incidence and prevalence during the pandemic.[8,9]

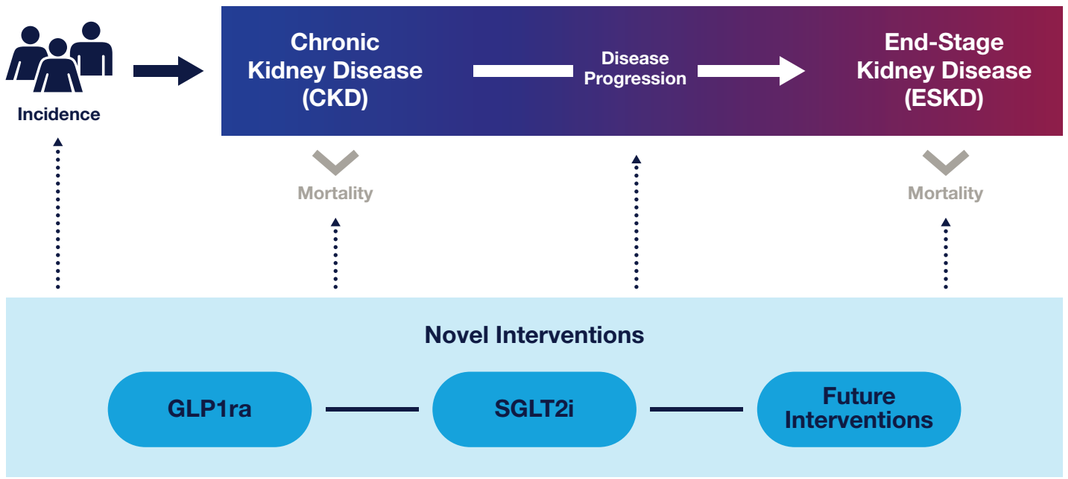
Public Health Trends in the United States

Any model prediction can only be as good as the data with which it is informed. Well-established publicly available databases like the United States Renal Data System (USRDS) and the National Health and Nutrition Examination Survey (NHANES) provide a wealth of data on the past and current state of populations with kidney disease in the United States.[10,11] However, to inform a systematic modeling approach and provide a basis for future predictions, the trends encoded in these datasets must be quantified:

- **How have ESKD incidence and mortality changed over the past decade, and how were they affected by the COVID-19 pandemic?**
- **Which proportion of people on dialysis received a kidney transplant, and how did this change over time for different age groups?**
- **How many persons developed CKD every year and at what age?**

By capturing ongoing public health trends and combining them with the latest clinical insights on the effect and efficacy of novel therapeutics, such models can provide valuable insights into what populations with kidney disease will look like in the future.

FIGURE 1 | SCHEMATIC OF THE POPULATION IMPACT MODEL



By applying advanced analytical methods, the data often reveal surprisingly robust temporal and aging patterns that encode systematic public health trends and shed light on the above questions for the past and present. These trends (and their disruptions) provide a robust foundation for predictions.

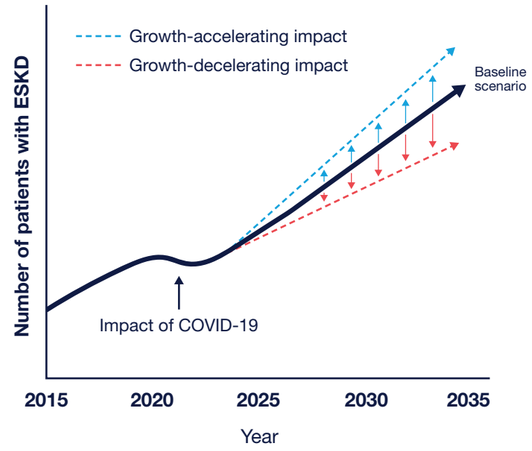
Assessing the Impact of Novel Drugs and Therapies

Once one understands current populations with kidney disease and the recent trends in kidney disease, then the crucial question is how these trends might be impacted by novel therapies. Clinical trials remain the primary source of knowledge about their safety and efficacy. They provide quantitative insights on how a therapeutic intervention changes the probability of kidney disease progression, death, and possibly other relevant clinical events for an individual. These insights can then be used to extrapolate an intervention's impact on the population scale (Figure 2). This, of course, also depends on how many and which patients are anticipated to have access to such novel interventions. Here, a modeling approach allows us to test different hypotheses (e.g., different anticipated prescription rates for a new drug in the coming years) and quantify how they affect the population.

Conclusions

Advanced epidemiological-type models provide a systematic and transparent tool to assess the population impact of current and future therapeutic innovations and public health megatrends. In particular, they help to disentangle the impacts of several concomitant developments in the kidney space, including the market introduction of new antidiabetic drugs and new kidney replacement therapies, pandemics, and other disruptions. Fresenius Medical Care is at the forefront of population impact modeling to inform medical, clinical, and business decisions. Continuous monitoring of therapeutic developments allows for regular updates to model assumptions and access to the latest predictions.

FIGURE 2 | ILLUSTRATION OF HOW EPIDEMIOLOGICAL MODELS CAN GENERATE PREDICTIONS ABOUT HOW NOVEL INTERVENTIONS CHANGE THE TRAJECTORY OF PATIENT POPULATIONS WITH KIDNEY DISEASE, DEPENDING ON THE RELATIVE IMPACT OF DIFFERENT INTERVENTIONS.



Dr. Doris Fuertinger
Head of Computational Medicine
Global Medical Office

Dr. Fuertinger is Head of the Computational Medicine Team within Fresenius Medical Care's Global Medical Office. She is an applied mathematician with an extensive background in physiology-based mathematical modeling, optimization and advanced computational methods. She has authored and co-authored multiple research papers and book chapters and is inventor on a number of international and U.S. patents held by Fresenius Medical Care.

Since joining Fresenius Medical Care in 2013 she had various roles at the Renal Research Institute, the Global Research and Development Department and the Global Medical Office. She pioneered concepts of in-silico clinical trials (i.e., computer based trials) that helped to shape and adjust clinical treatment protocols in the area of anemia and bone mineral metabolism. Dr. Fuertinger and her team further developed several state-of-the-art clinical decision support and automated therapy systems.

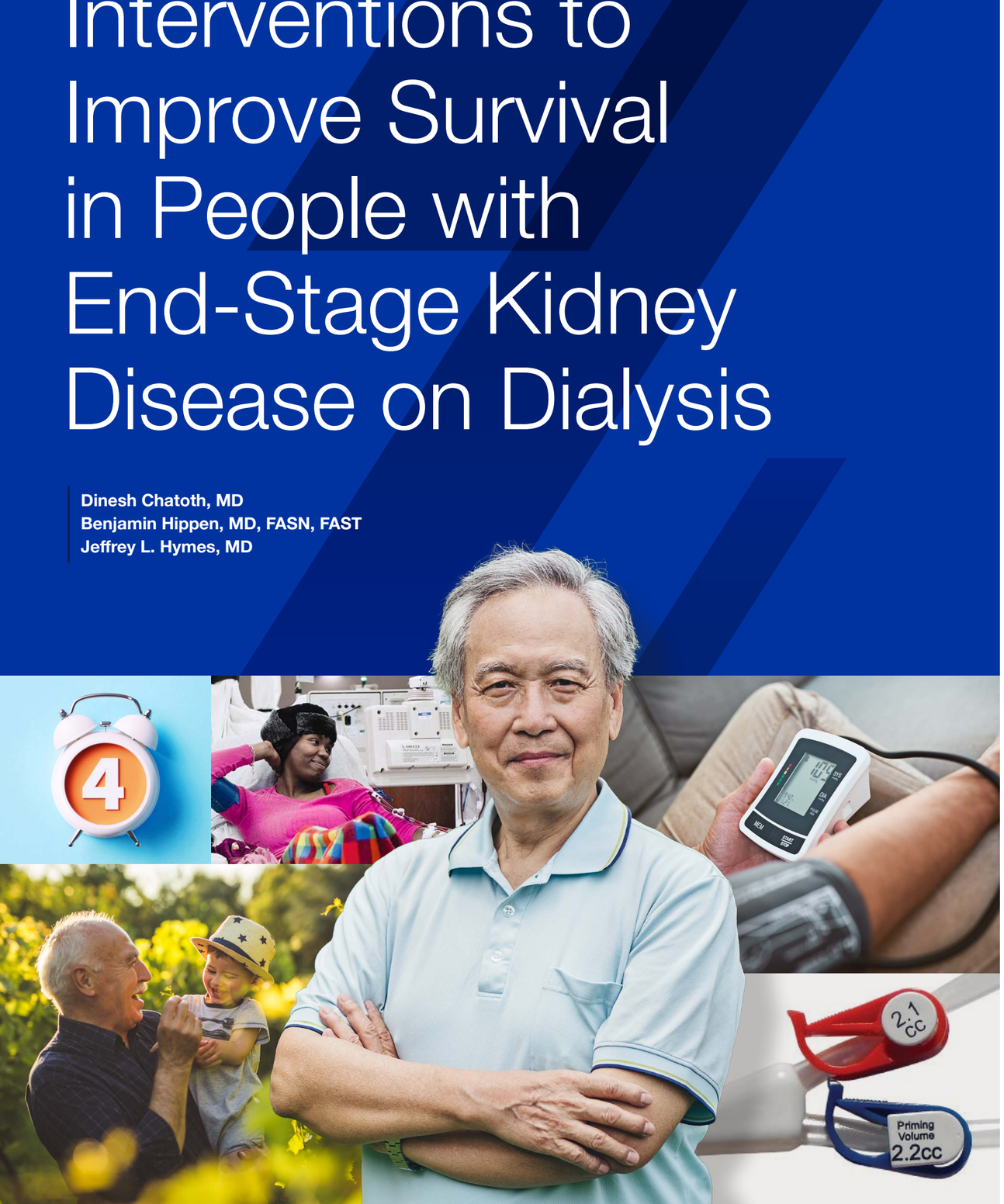
Dr. David Jörg
Principal Scientist, Computational Medicine and Health
Global Medical Office

Dr. Jörg is a Principal Scientist with Fresenius Medical Care's Computational Medicine Team within the Global Medical Office. He is a theoretical physicist by training and has a keen interest in bringing advanced mathematical modeling approaches to biomedical and healthcare applications.

Prior to joining Fresenius Medical Care in 2018, he conducted research at the intersection of biology and physics at the University of Cambridge, U.K., and the Max Planck Institute for the Physics of Complex Systems, Germany. He also served as an Organizer and turn-based Speaker of the Theory of Living Matter Group, a Cambridge-based researcher network.

Interventions to Improve Survival in People with End-Stage Kidney Disease on Dialysis

Dinesh Chatoth, MD
Benjamin Hippen, MD, FASN, FAST
Jeffrey L. Hymes, MD



Reducing premature death in people with end-stage kidney disease (ESKD) requires a multifaceted intervention strategy. People with ESKD are at risk due to life-threatening infections, cardiovascular issues, and dialysis-related issues. Therefore, Fresenius Medical Care is instituting and advocating for a range of practical interventions to improve quality of life and survival rates among people with ESKD, who are at ongoing risk of life-threatening infections, cardiovascular disease, and dialysis-related complications.

People with ESKD on dialysis have a higher risk of death than the general population, and these risks are particularly high in the first 90 days after initiating dialysis.[1] Cardiovascular (CV) disease is reported as the leading cause of mortality among people on dialysis followed by infection (Figure 1).[2]

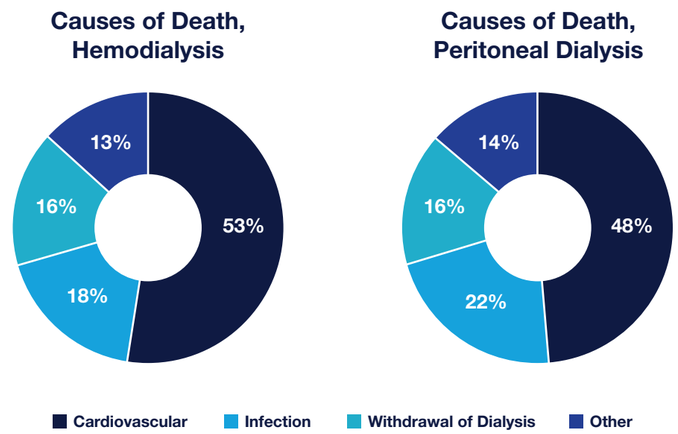
Prior to the onset of the COVID-19 pandemic, there was a slow but steady improvement in adjusted all-cause mortality among U.S. patients with ESKD from 179.8 deaths per 1000 patients in 2011 to 159.1 deaths per 1000 patients in 2019.[3] The crucial challenge continues to be reducing premature death in people with ESKD on dialysis. Evidence-based clinical interventions with the potential to lower CV and infection-related mortality in people with ESKD are of paramount importance in improving their quality and quantity of life.[4]

The crucial challenge continues to be reducing premature death in people with ESKD on dialysis. Evidence-based clinical interventions with the potential to lower CV and infection-related mortality in people with ESKD are of paramount importance in improving their quality and quantity of life.[4]

I. Interventions to Lower CV Mortality

Increasing the frequency and/or the duration of hemodialysis (HD) is often referred to as Extended HD (EHD). Several studies have examined the relationship between EHD and mortality.[5,6,7,8] While neither extended-nocturnal hemodialysis thrice-weekly nor 5-treatments/week daily dialysis have been shown to improve mortality, both types of EHD can reduce myocardial stress by lowering interdialytic weight gains and improve left ventricular hypertrophy by lowering blood pressure and optimizing volume status. The three-day weekend interdialytic time interval, which has been associated with increased all-cause, CV, and infection-related mortality,[9,10] can be avoided by prescribing more frequent HD.

FIGURE 1 | CAUSE OF DEATH AMONG PEOPLE WITH ESKD WITH A REPORTED CAUSE OF DEATH IN THE U.S., BY MODALITY



Many studies have shown that shorter-length dialysis sessions are associated with decreased survival. In a large national cohort of U.S. HD patients, session lengths shorter than 240 minutes showed significant association with increased all-cause mortality (Figure 2).[8] Prescribing at least 4 hours of HD may assist with better volume management and BP control, improve HD tolerance, and reduce mortality.

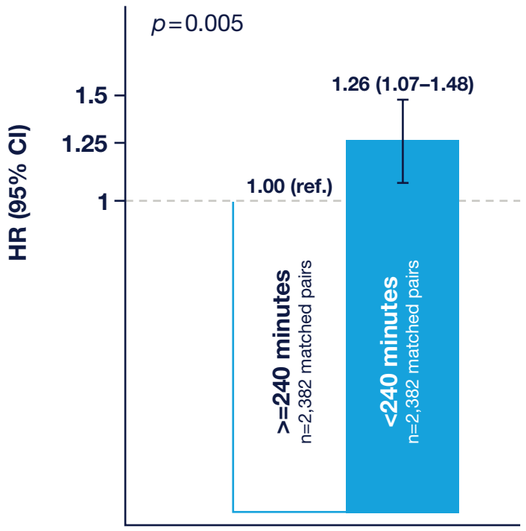
Missed and shortened HD treatments are associated with a higher risk of death,[9] with half of missed treatments due to treatment non-adherence.[10] Clearly, interventions that mitigate the effects of missed treatments due to nonadherence can potentially reduce the risk of hospitalization and mortality. Avoidance and rapid rescheduling of missed treatments are opportunities for reducing CV events and avoidable hospitalizations, with one study showing that missed and rescheduled treatments reduced rates of hospitalization in the subsequent 7 days by 20% compared to not rescheduling treatment (incidence rate ratio of 1.68 (1.29–2.21 95% Confidence Interval (CI)) for rescheduling versus 2.09 (1.76–2.49 95% CI) for not rescheduling).[10]

Interdialytic weight gain is a perennial challenge in the management of people with ESKD receiving in-center hemodialysis, and concomitant high ultrafiltration requirements are often associated with poor tolerance of the hemodialysis session and intradialytic hypotension. For patients with residual urine output, diuretics to maximize urine output is an underutilized intervention, with a recent study showing as many as 46% of incident HD patients prescribed diuretics 90 days after HD initiation, considerably higher than the 23% reported in a Dialysis Outcomes and Practice Patterns Study (DOPPS) publication from 2007.[11] High-dose diuretic use in ESKD has been associated with fewer hospitalizations, lower interdialytic weight gains, and reduced intradialytic hypotension episodes, though not with improved mortality.[12] The use of blood volume monitoring technology and bioimpedance can improve the accuracy of assessment of fluid overload.[13,14]

Targeted pharmacologic treatment of heart failure with reduced ejection fraction (HFrEF) has been shown to provide additional benefit.[15] Drug classes with established efficacy in HFrEF are often continued in the ESKD setting, but well-designed and sufficiently powered studies demonstrating mortality benefits are few and far between. There is increasing interest in whether the benefits of sodium-glucose cotransporter-2 inhibitors (SGLT2i) realized in patients with chronic kidney disease (CKD)[16,17,18] provide mortality benefits in ESKD, and several studies examining this question are ongoing.[19,20,21]

The multicenter CONVINCE trial recently demonstrated a mortality benefit for patients undergoing high-volume hemodiafiltration (HVHDF), reporting a reduction in all-cause mortality compared to conventional high-flux hemodialysis (Hazard Ratio (HR) 0.77, 0.65–0.93 95% CI).[22] Most of the benefits of HVHDF seem to be due to reduced CV mortality, and the benefits were particularly found in patients age > 65 (HR 0.68, 0.53–0.89 95% CI), patients without diabetes (HR 0.65, 0.48–0.87 95% CI), and patients with an arteriovenous (AV) fistula (HR 0.77, 0.64–0.94 95% CI). Additional real-world evidence will provide insight into other patient populations who may likewise benefit from HVHDF. It remains to be seen whether additional interventions to improve cardiovascular risk in patients with ESKD will be additive to the observed benefits of HVHDF.

FIGURE 2 | ASSOCIATION BETWEEN DIALYSIS SESSION LENGTH AND RELATIVE RISK OF DEATH IN PEOPLE ON HEMODIALYSIS[8]



II. Interventions to Lower Bacterial Infection-Related Mortality

The management of ESKD with HD increases the risk of bloodstream infections (BSIs) because it requires frequent access to the bloodstream via needles or central venous catheters (CVCs). Patients with ESKD are at additional risk for BSIs due to ESKD-related interventions in multiple arms of the immune system.[23] BSIs in people treated with hemodialysis have decreased steadily over the last decade with better infection control practices. The National Healthcare Safety Network (NHSN) reported a decrease in CVC-related BSIs from 2.16 infections per 100 patient months in 2014 to 1.21 infections per 100 patient months in 2019.[24] This finding was attributed to implementing a set of "core interventions" for BSI reduction, including patient and staff education, structured access observation, chlorhexidine use, and catheter hub disinfection, as well as antimicrobial ointment use at the catheter exit site.[25]

However, a recent meta-analysis has drawn attention to the high rates of bias and overall lack of well-designed clinical trials in this area.[26] Additional infection control measures used during the early part of the SARS-CoV-2 pandemic have been suggested as a cause for reduced BSI observed in 2020. Despite these observed improvements, there has been a growing trend toward CVC dialysis starts, a trend worsened by the COVID-19 pandemic.[27] System-level effort to improve the rate of timely permanent vascular access placement and maturation assessments is important, as is focusing on CVC avoidance at the time of dialysis initiation.

ClearGuard (Figure 3) is a chlorhexidine-impregnated cap-plus-dipstick designed to screw onto the arterial and venous hubs of a CVC. A couple of landmark studies have shown that ClearGuard use significantly reduced the risk of BSIs in dialysis patients (Figure 4).[28,29] Recently, the LOCK IT-100 Trial examined the efficacy of a CVC antibiotic lock solution containing taurolidine and heparin and demonstrated a 71% rate reduction and a 6% absolute risk reduction in BSIs compared to heparin alone.[30] While efforts to reduce the high prevalence of CVCs are important, the high rate of CVC use means that routinely deploying reliable and scalable approaches to reduce CVC infections must also be a patient safety priority.

Among people treated with peritoneal dialysis (PD), peritonitis has a negative impact on clinical outcomes. Several studies have shown that peritonitis is independently associated with higher risk of all-cause, infection-related, and CV mortality.[31] With increasing uptake of PD in the U.S., initiatives that lower peritonitis risk, such as the application of topical antibiotic cream to the PD catheter exit site, proper exit site care, and antimicrobial prophylaxis prior to invasive gastrointestinal or invasive gynecological procedures, are key to allowing patients to continue to use PD safely and effectively over the long term by quickly resolving or avoiding peritonitis.[32]

Approximately 20% of infections in people with ESKD on dialysis are due to pulmonary etiology and the mortality rate is more than 10-fold higher than the general population.[33] The COVID-19 pandemic brought into focus the important role of other respiratory illnesses, including influenza and *Streptococcus pneumoniae*. Vaccinations are a vital strategy for reducing morbidity and mortality in dialysis patients, who typically mount poor overall antibody response when compared to healthy individuals.

High-dose diuretic use in ESKD has been associated with fewer hospitalizations, lower interdialytic weight gains, and reduced intradialytic hypotension episodes, though not with improved mortality.[12]

FIGURE 3 | CLEARGUARD ANTIMICROBIAL BARRIER CAP

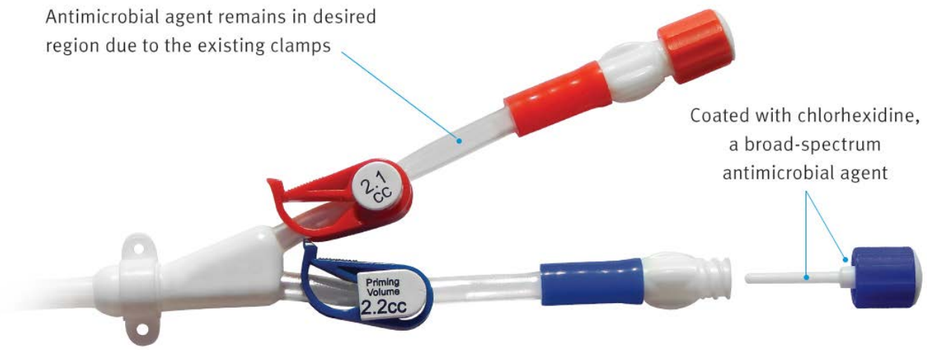
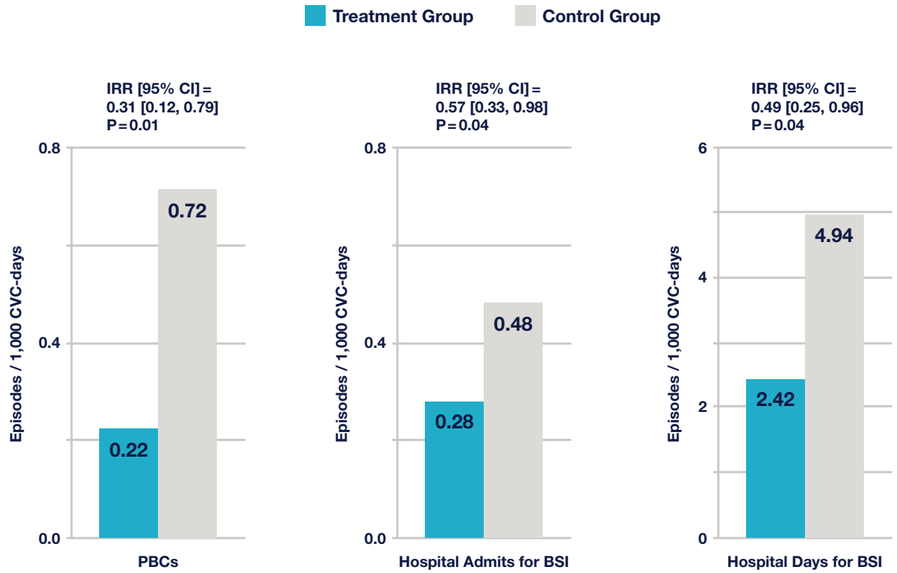


FIGURE 4 | REDUCTION IN CATHETER-RELATED BLOODSTREAM INFECTIONS WITH CLEARGUARD AND TAUROLIDINE/HEPARIN[28]



A primary series of COVID-19 vaccination reduced infection risks in patients with ESKD by 45% compared to unvaccinated patients.[34] In May 2022, approximately 70% of prevalent patients with ESKD had at least one COVID-19 vaccination, and about 50% received subsequent vaccinations.[35] Since September 2022, the fraction of patients with ESKD who remain up to date with COVID-19 vaccination has fallen well below 10%.[36] Even as the SARS-CoV-2 pandemic shifts to "endemic" status, redoubling efforts to ensure patients with ESKD receive updated COVID-19 vaccines remains one of the most effective preventive public health strategies.

Approximately 20% of infections in people with ESKD on dialysis are due to pulmonary etiology and the mortality rate is more than 10-fold higher than the general population.[33] The COVID-19 pandemic brought into focus the important role of other respiratory illnesses, including influenza and *Streptococcus pneumoniae*.

Influenza has been associated with pneumonia as well as multisystem complications leading to increased mortality in individuals with ESKD.[25] The Advisory Committee on Immunization Practices (ACIP) recommends yearly inactivated or recombinant quadrivalent influenza vaccine for people on dialysis.[37] ACIP also recommends that all people with ESKD should receive pneumococcal vaccination, which has been shown to reduce mortality, with frequency dependent on the vaccine type and vaccine history of the patient. Older data strongly suggests that both influenza and pneumococcal vaccination reduce all-cause mortality, with influenza vaccination alone yielding an adjusted odds ratio for mortality of 0.71 (0.65–0.77 95% CI), pneumococcal vaccination alone an adjusted odds ratio of 0.76 (0.70–0.82 95% CI), and both vaccines together an adjusted odds ratio of 0.61 (0.55–0.68 95% CI) for mortality, compared to receiving neither vaccine.[38]

Multifaceted interventions as outlined in Figure 5 can help reduce mortality in individuals with ESKD. Instituting these strategies remains a key priority for the Global Medical Office of Fresenius Medical Care.

FIGURE 5 | PRACTICAL INTERVENTIONS TO REDUCE MORTALITY IN PATIENTS WITH ESKD

- Reduce missed and shortened treatments
- Reduce interdialytic weight gains
  - **Routine reassessment of dry weight**
  - **Moderate sodium and fluid intake during interdialytic interval**
  - **Diuretic use if residual kidney function**
- Optimize dialysis session length for volume management
- Pharmacologic interventions in HFrEF
- Expansion of high-volume hemodiafiltration
- CVC avoidance and reduction strategies
- Routine utilization of catheter caps to reduce catheter infections
- Peritonitis risk reduction
- Widespread vaccination programs for SARS-CoV-2, influenza, and *Streptococcus pneumoniae*

Dinesh Chatoth, MD
Chief Clinical Officer
Chair, Pharmaceutical & Therapeutics Committee
Fresenius Kidney Care

Dr. Chatoth is the Chief Clinical Officer of Fresenius Kidney Care and serves as Chair of the Pharmaceutical & Therapeutics Committee. He is the former president and Chief Executive Officer of Georgia Nephrology, a 16-member physician practice in Atlanta, Georgia. Dr. Chatoth has also served in different leadership roles at the Gwinnett Health System in Georgia, including serving as the Chair of the Department of Medicine. He is also the former Co-Chair of the East Division Medical Advisory Board for Fresenius Medical Care. He has worked with the K-DOQI workgroup for Peritoneal Dialysis and currently serves as a member of the PDOPPS US Advisory Workgroup. He has a keen interest in promoting home dialysis as a modality of choice for patients requiring renal replacement therapy and oversees home therapy initiatives for the Global Medical Office.

Benjamin Hippen, MD, FASN, FAST
Global Head of Clinical Affairs, Global Medical Office
Chief Medical Officer, Care Delivery

As the Global Head of Clinical Affairs and Chief Medical Officer of Care Delivery, Dr. Hippen oversees the global clinical care delivery programs for Fresenius Medical Care, ensuring we deliver exceptional care and support to all patients under our care. Dr. Hippen specializes in ethical, organizational, and public policy issues including nephrology and transplantation. His contributions have advanced patient care initiatives and influenced broader clinical leadership, integrating transplantation into the dialogue among practicing nephrologists and within our Care Delivery framework.

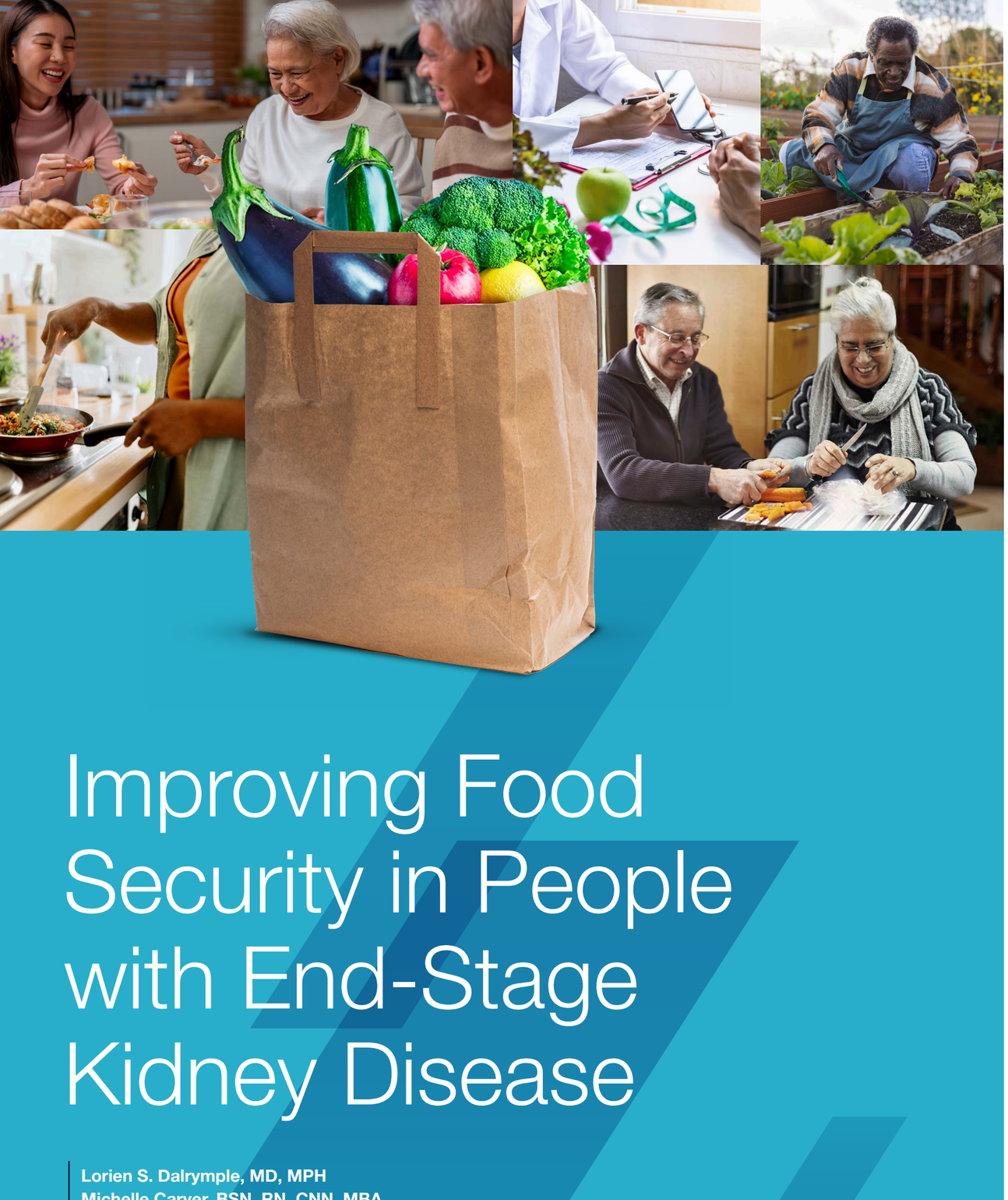
Dr. Hippen received an undergraduate degree from Rice University and completed his medical school and internal medicine residency training at the Baylor College of Medicine. Thereafter, he completed a general nephrology and transplant nephrology fellowship at the University of Alabama in Birmingham. After completing his nephrology and transplant training, Dr. Hippen joined Metrolina Nephrology Associates, P.A. in Charlotte, North Carolina, a 40-nephrologist private practice, where he served as the medical director of two in-center hemodialysis facilities and, for several years, served as the medical director of a home therapies facility. During his time in Charlotte, he became a Clinical Professor of Medicine at the UNC Chapel Hill School of Medicine. Prior to joining Fresenius Medical Care in September 2021, Dr. Hippen served terms on the Ethics Committee and Membership and Professional Standards Committees of the Organ Procurement and Transplantation Network, served on the Board of Directors and was the chair of the Medical Advisory Board of ESRD Network 6, and served on the founding physician practice board of InterWell Health. Consonant with his ongoing research interests in ethical, organizational, and public policy issues in nephrology and transplantation, Dr. Hippen is the author of more than 70 peer-reviewed articles, essays, reviews, and book chapters.

Jeffrey L. Hymes, MD
Senior Consultant to the Global Chief Medical Officer

Dr. Hymes joined FME as Associate Chief Medical Officer in 2007 after three decades in nephrology practice and governance. He became Senior Vice President and Associate CMO for FMCNA in 2012, and in 2020, became Chief Medical Officer, Care Delivery, and Executive Vice President, Global Head of Clinical Affairs, serving in this role until 2024.

He co-founded REN Corporation in 1986 and National Nephrology Associates (NNA) in 1998. He served as NNA's President and Chief Medical Officer from 1998 to 2004. He was President of Nephrology Associates, a 32-physician nephrology practice serving Middle Tennessee, from 1989 to 2012 and is a former member of the Renal Physician Association's Board of Directors.

He is a graduate of Yale College and the Albert Einstein College of Medicine. He served his medical internship and residency at Yale New Haven Medical Center and received subspecialty training in nephrology at Boston University. Dr. Hymes is board certified in internal medicine and nephrology and was previously certified in critical care.



Improving Food Security in People with End-Stage Kidney Disease

Lorien S. Dalrymple, MD, MPH
Michelle Carver, BSN, RN, CNN, MBA

Fresenius Medical Care is launching a national initiative in the U.S. to identify and address food insecurity. Interdisciplinary teams of dietitians, social workers, nurses and physicians will take a structured and comprehensive approach to address food insecurity, an important health-related social need.

To advance health equity, the Centers for Medicare and Medicaid Services (CMS) continues to implement screening for health-related social needs (HRSN) across federal healthcare reporting and payment programs. Notably, the CMS End-Stage Renal Disease Quality Incentive Program (ESRD QIP) has new requirements for performance years 2024 and 2025 related to health equity.[1] Each dialysis clinic in the U.S. is expected to demonstrate a commitment to health equity in 2024 and offer standardized screening for HRSN (e.g., food insecurity, housing instability, utility needs, transportation problems, and interpersonal safety) in 2025.[2] To reduce health disparities, advance health equity, and fulfill the CMS ESRD QIP requirements, Fresenius Kidney Care (FKC) has developed its Health Equity Strategic Plan 2024–2026. The plan has four primary goals (Figure 1), including a focus on identifying and addressing HRSN.

As part of the organization's expanded attention to social needs affecting health and well-being, FKC will launch a national quality improvement initiative across more than 2,600 clinics in the United States to assess for food insecurity and implement interventions to improve food security. Food insecurity was selected as the initial national quality improvement initiative focused on social needs due to its high prevalence, association with clinical outcomes, and available interventions and resources. Food insecurity may be one of the most critical social needs to address to improve health-related quality of life.[3]

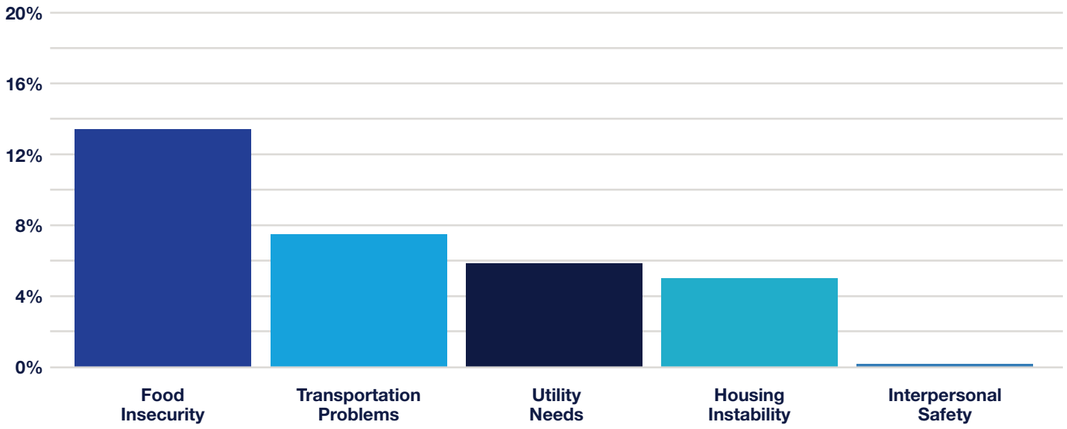
In 2022, an estimated 12.8% of U.S. households were food insecure at some point in the year.[4] Limited data exists on the prevalence of social needs such as food insecurity, housing instability, utility needs, transportation difficulties, and interpersonal safety among people with ESKD. In the state of Illinois, food insecurity was the most common social need reported among the more than 5,000 individuals with ESKD receiving care in FKC clinics screened for social needs (Figure 2)[5] using the Accountable Health Communities Health-Related Social Needs (AHC HRSN) screening tool.[6] More than 13% of individuals with ESKD screened positive for food insecurity, highlighting its importance.

Limited data exists on the prevalence of social needs such as food insecurity, housing instability, utility needs, transportation difficulties, and interpersonal safety among people with end-stage kidney disease (ESKD).

FIGURE 1 | FRESENIUS KIDNEY CARE HEALTH EQUITY STRATEGIC PLAN GOALS

1. Build trusting relationships, provide culturally informed care, and tailor communication according to linguistic, hearing, visual, and health literacy needs or preferences.
2. Identify disparities in care processes and intermediate clinical outcomes important to the care of people with ESKD.
3. Reduce health disparities by identifying and addressing health-related social needs.
4. Demonstrate commitment by organizational leaders to advance and prioritize health equity and reduce health disparities among people with ESKD.

FIGURE 2 | PREVALENICE OF HRSN AMONG PEOPLE WITH ESKD IN ILLINOIS



The Fresenius Kidney Care Food Security Quality Improvement Initiative

FKC will implement a national multi-year quality improvement initiative focused on improving food security for people on dialysis (Figure 3). The goal is to eliminate or lower the severity of food insecurity in the FKC population in the U.S. Addressing food insecurity in people living with ESKD requires an interdisciplinary approach involving dietitians, social workers, nurses, physicians, and community resources. The specific components of the food security initiative are:

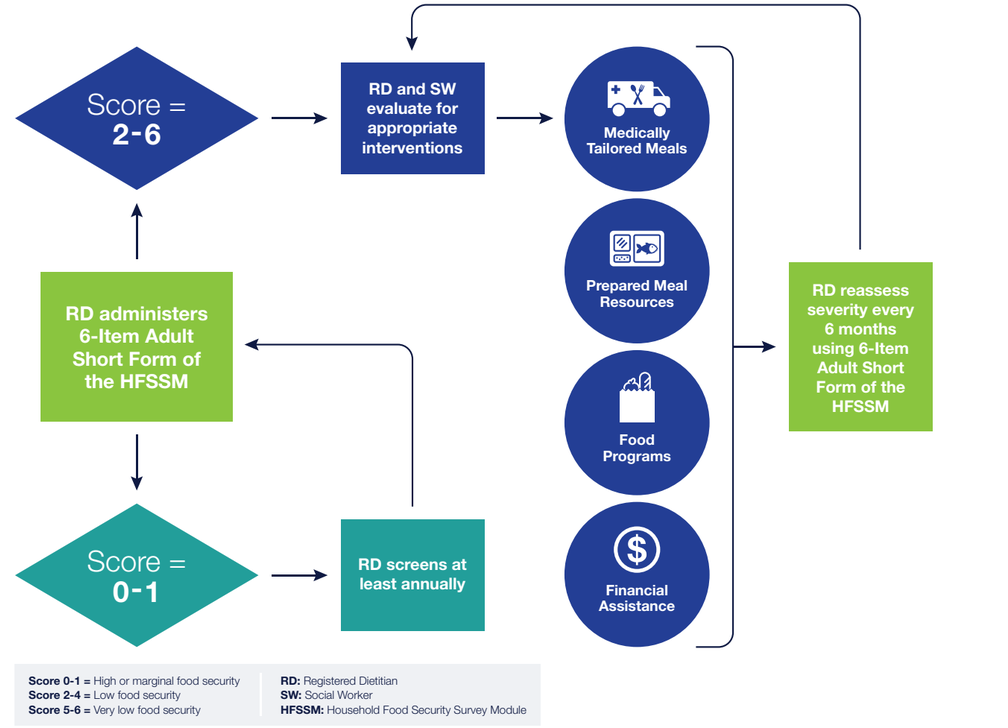
1) Screening and Identification: FKC dietitians will screen all adults receiving care in FKC clinics for food insecurity at least annually using the 6-Item Adult Short Form of the U.S. Household Food Security Survey Module (HFSSM).[7] The 6-Item Adult Short Form of the HFSSM is a shortened version of the U.S. Department of Agriculture's HFSSM and is designed to assess household food security, which refers to the availability and access to enough food for an active, healthy life for all household members.[8] Responses to the survey provide insight into the presence and severity of food insecurity experienced by households and can identify individuals in need of food assistance.[9]

2) Assessment and Interventions: Among those who screen positive for food insecurity, the severity of food insecurity will be classified as low or very low food security based on the responses to the 6-Item Adult Short Form of the HFSSM. The dietitian will conduct a detailed assessment of dietary needs and habits, cultural preferences, and access to nutritious food. Once the assessment is completed, dietitians and social workers will collaborate to provide interventions to address food insecurity. Types of interventions may include medically tailored meals, prepared meals, food programs, and/or financial assistance. Medically tailored meals are specially prepared meals designed to meet the specific nutritional needs of individuals with chronic illnesses or medical conditions.[10] These meals are carefully crafted by registered dietitians or nutritionists to provide the right balance of nutrients, vitamins, and minerals required to manage the individual's health condition effectively.[11] Prepared meals can include home delivery of pre-prepared meals designed for various dietary needs. These programs include Meals on Wheels, the Commodity Supplemental Food Program, and the Community Harvest Program and may be administered by government agencies, religious organizations, or community centers.[12] For individuals who are food insecure and need access to groceries, several resources and programs can help. Resources include food pantries and community food programs such as community kitchens, food cooperatives, and community gardens. Financial assistance for patients who are food insecure can come from various sources, including government programs, nonprofit organizations, and community initiatives. These interventions include the Supplemental Nutrition Assistance Program (SNAP),[13] Temporary Assistance for Needy Families (TANF),[14] and emergency assistance programs through local governments that offer emergency financial assistance programs to individuals and families facing immediate financial crises. These programs may provide one-time cash payments or vouchers to help cover basic needs, including food.

3) Reassessment and Follow-up: Among individuals identified as food insecure, the dietitians will reassess the severity of food insecurity every six months using the 6-Item Adult Short Form of the HFSSM, which will assess the effectiveness of interventions and ongoing needs.

Providing a structured approach with routine reassessment will allow for a comprehensive assessment of unmet needs and an assessment of the effectiveness of different interventions. The FKC interdisciplinary team has the expertise needed to effectively identify and lower food insecurity in individuals receiving care within FKC clinics. Addressing food insecurity using a standardized and holistic approach is paramount to improving the health and well-being of people living with ESKD.

FIGURE 3 | FRESENIUS KIDNEY CARE FOOD SECURITY QUALITY IMPROVEMENT INITIATIVE



Dr. Lorien Dalrymple
Senior Vice President, Head of Population Health and Medicine
Global Medical Office

Board certified in nephrology, Dr. Dalrymple received her Bachelor of Science in Psychology from Duke University, Medical Degree from the University of Colorado, and Master of Public Health from the University of Washington. She completed her Internal Medicine Residency and Nephrology Fellowship at the University of Washington.

Prior to joining Fresenius Medical Care in 2016, she was an Associate Professor of Medicine at the University of California Davis. She has undertaken numerous research studies related to kidney disease and the associated complications and is a member of the Kidney Medicine editorial board. She served as a co-chair of the National Quality Forum Renal Standing Committee and co-chaired the Kidney Health Initiative ESKD Data Standards project. In addition, she has served on Technical Expert Panels convened by the Centers for Medicare and Medicaid Services.

Michelle Carver
Chief Nursing Officer, Senior Vice President Nursing and Clinical Services
Care Delivery

Michelle Carver is the Chief Nursing Officer and Senior Vice President of Nursing and Clinical Services for Fresenius Kidney Care. With more than 25 years of experience in nephrology nursing care, her focus is developing and implementing standardized processes to improve clinical outcomes and experiences for dialysis patients. Michelle holds a Bachelor of Science degree in Nursing and an Executive MBA in Healthcare Administration. She has been a certified nephrology nurse since 2001.

A Bold Vision to Accelerate Adoption of Value-Based Kidney Care

George Hart, MD
Terry Ketchersid, MD, MBA

Interwell Health is the quality leader in value-based kidney care in the U.S. Interwell takes a team approach to patient care, focusing on CKD and ESKD patients whose significant disease burden is complicated by social needs. One crucial pillar of Interwell's strategy is the prevention of avoidable hospitalizations, combined with prompt follow-up doctor visits for every patient who has recently experienced an in-patient hospital stay. Internal data demonstrates that Interwell's holistic program improves patient outcomes while reducing annual costs for Medicare patients.

Within the U.S. healthcare system, in the past decade, there has been an accelerating shift away from traditional fee-for-service (FFS) payment models towards models focused on rewarding quality while lowering the total cost of care. This emphasis on value, not volume, offers opportunities to pay for comprehensive holistic care not available in a traditional FFS approach.

Fresenius Medical Care has been a pioneer and leader in value-based care (VBC) since 2014. The company created Interwell Health (Interwell) in 2019, a joint venture with nephrologists dedicated to working together in the transition from volume to value. This led to an innovative merger in 2022 between Fresenius Health Partners, the company's VBC division; Interwell Health, the leading nephrology provider network; Cricket Health, a pioneering digital technology and patient engagement company; and Acumen, the leading nephrology-specific electronic health record (EHR) built on the Epic platform.

Today, the new Interwell is growing rapidly to serve the needs of more than 122,000 people with chronic kidney disease (CKD), including those with end-stage kidney disease (ESKD), across a national scale and broad payer mix. Interwell is the largest participant and quality-leader in the government models for kidney care, while also contracting with large national and regional private insurers. The keys to Interwell's future success are implementing strategies that delay CKD progression, effectively managing the transition to ESKD for those whose kidney disease progresses, and reducing hospitalization and mortality rates for patients with advanced kidney disease.

Implementing New Care Models at Scale

To be successful, any value-based company must deliver results for patients and payers at scale backed by a sustainable financial model that includes both shared and full-risk contracts.

Interwell focuses on people living with CKD beginning in stage 3 through ESKD, managing people with significant disease burden complicated by social needs. Interwell's care model centers around a team that includes dietitians, social workers, nurses, and care coordinators, working with a person's nephrologist and primary care physician.

Interwell's model allows us to support the right patients at the right time wherever they are—at the doctor's office, in their home, or at a dialysis center. Interwell's model includes many unique aspects such as:

Predictive Analytics: Risk stratification for patients using Interwell's proprietary machine learning models to identify those most at risk of progression or hospitalization. Many of these machine learning capabilities were relaunched in 2023 to provide better accuracy over a longer period. Knowing who Interwell's patients are, what they need, and when they need it to manage their kidney disease drives the effectiveness of Interwell's clinical interventions.

Largest Provider Network: Collaboration with more than 1,800 nephrologists aligned on the incentives for improving outcomes. Interwell's care team approach is to move away from a siloed and fragmented healthcare delivery system to one that has both the patient and providers at the center.

Acumen Epic Connect: Most-adopted EHR built for nephrologists with new population health tools, access to Epic's Care Everywhere, and custom dashboards. Interwell Care Connect and Acumen Epic Connect enhance seamless communication of care between providers.

Dialysis Center Alignment: For those people transitioning to dialysis in one of Fresenius Kidney Care's 2,600 clinics, we offer coordinated remote care management focused on identifying patients at the highest risk for hospitalization within seven days as well as post-hospitalization transition management. This offers more timely interventions such as adjusting the dialysis prescription to better address adjusting clinical targets such as estimated dry weight.

Care Transition Program: Rapid outreach by a dedicated care team for all patients discharged from the hospital to ensure a visit with their nephrologist within 14 days.

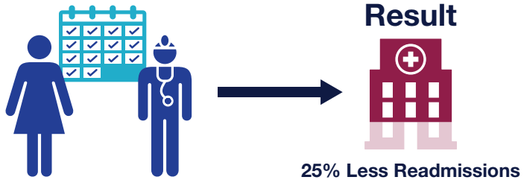
While there are many aspects to Interwell's VBC program, this discussion focuses on how the program addresses two of the largest drivers of costs.

Reducing Hospitalizations

Hospitalizations are not only expensive but create substantial burdens for patients and their caregivers. In addition, discharge from a hospital stay is a transition of care that can fragment patient care absent detailed attention to care coordination. The work to keep people healthier and out of the hospital has a major impact on the health and well-being of the population and success in a VBC program. Approximately one-third of the annual medical costs for Medicare beneficiaries for people living with CKD and ESKD are a result of inpatient hospitalization. Interwell's program focuses on managing patients holistically to prevent avoidable hospitalizations.[1]

Interwell's Care Transition program empowers a team to reach out to patients post-discharge to ensure they see a nephrologist within two weeks. Interwell's analysis of more than 11,000 members showed that those who visited a nephrologist within 14 days of discharge were almost 25 percent less likely to be readmitted within 30 days than those who did not see their doctor (Figure1). The results of all these efforts are healthier patients, fewer hospitalizations, and lower costs for payers.[2]

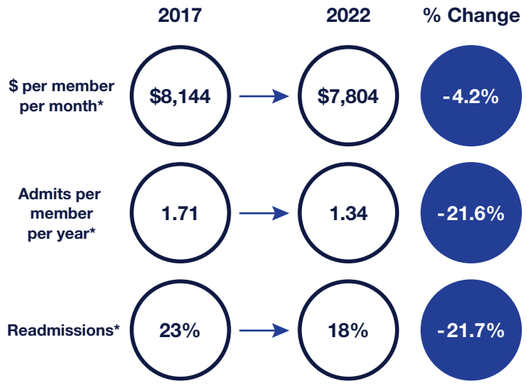
FIGURE 1 | SEEING A NEPHROLOGIST WITHIN 14 DAYS OF DISCHARGE EQUATES TO 25 PERCENT LOWER LIKELIHOOD FOR READMISSION



For one national Medicare Advantage payer, Interwell managed 7,500 members with ESKD to reduce costs per member per month (PMPM) by 4.22 percent, at a time when the Medicare fee-for-service benchmark rose by approximately 10 percent. Over a five-year period (2017–2022), admits per member per year dropped from 1.71 to 1.34, while readmissions dropped from 23 to 18 percent (Figure 2).

For a smaller regional payer, Interwell successfully reduced all-cause hospitalizations among people with late-stage CKD by 25 percent, lowering rates from a baseline of 1.06 admits per member per year (PMPY) to 0.79 PMPY over two years (2021–2022). For all people with ESKD, all-cause hospitalizations were lowered by 30 percent, from a baseline of 1.65 admits PMPY to 1.16 PMPY. These efforts resulted in a 13 percent lower cost of care and total savings of $3.6 million for this regional plan (Figure 3).

FIGURE 2 | RESULTS FROM A NATIONAL MEDICARE ADVANTAGE PAYER FOR ESKD



Improving Optimal Starts

The latest government payment model, Kidney Care Choices (KCC), rewards physicians for optimal starts. This is defined as transitioning from CKD with a pre-emptive kidney transplant, home peritoneal dialysis (PD), or starting home hemodialysis or in-center hemodialysis with a permanent arteriovenous (AV) access (AV graft or AV fistula) but not with a tunneled catheter. United States Renal Data System (USRDS) data show that up to 85 percent of new hemodialysis starts include some type of catheter.[1] A recent retrospective study found that optimal starts decrease post-dialysis costs by $16,565 per patient per year when compared to unplanned starts.[3]

Interwell utilizes a combination of resources to help practices improve optimal starts:

- Predictive analytics to help identify and target higher-risk patients
- Kidney disease education course and patient materials (Interwell Learning)
- Interwell Renal Care Coordinators (RCCs) embedded in physician practices
- Performance-based programs that align clinical and financial goals

Approximately one-third of the annual medical costs for Medicare beneficiaries for people living with CKD and ESKD are a result of inpatient hospitalization.

FIGURE 3 | STRONG CLINICAL AND FINANCIAL RESULTS FROM A REGIONAL HEALTH PLAN

CKD Stage 4 and 5

	2021 Baseline	2022	
$ per member per month	$2,240	$1,947	-13%
Admits per member per year	1.06	0.79	-25%

$1.97 Million Total Savings

ESKD

	2021 Baseline	2022	
$ per member per month	$9,600	$8,378	-13%
Admits per member per year	1.65	1.16	-30%

$1.69 Million Total Savings

Since the company's first contract in VBC in 2014, RCCs have been embedded into physician practices to help with care transition and education. This program now totals 80 RCCs embedded in 50 practices across the country. In the remaining situations, Interwell leverages remote nurses who work with patients telephonically in coordination with the practice. Interwell works closely with its nephrology partners to develop the specific processes, education, and training needed to drive success in the KCC program.

Interwell has also developed a specialized learning program for nephrology practices to use with their patients with CKD. In 2023, Interwell's affiliated practices using the Interwell Learning kidney disease education program observed a 68 percent optimal start rate, compared to a 57 percent optimal start rate for practices not using this program.

Real-World Impact

The shift to value requires new ways of working and more holistic approaches to care delivery. While the data already shows cost savings and improved outcomes, it's each story behind that data, from a pre-emptive transplant to delayed progression, that is a reason to celebrate the potential of value-based care.

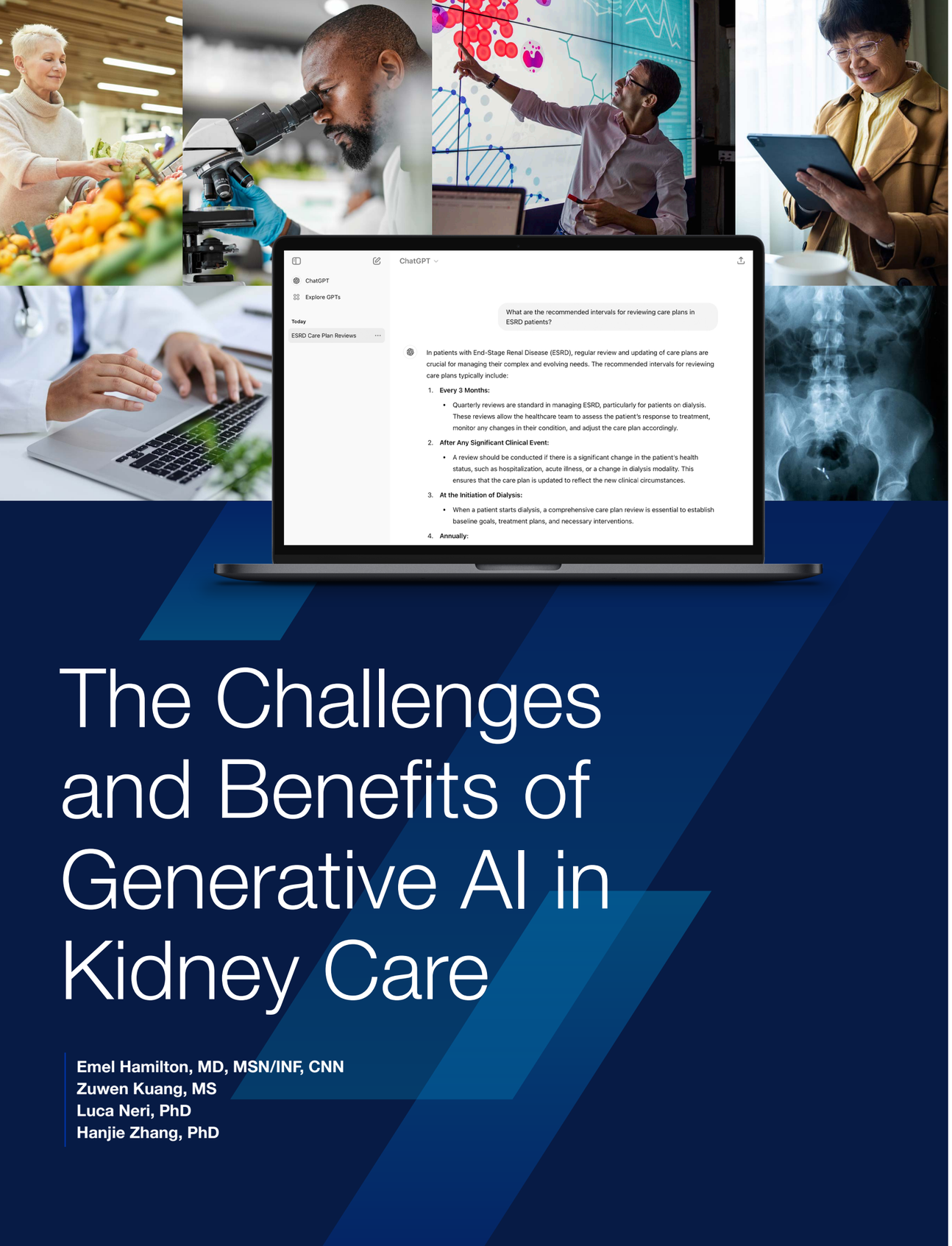
Dr. George Hart
Chief Medical Officer
Interwell Health

Dr. Hart is a native of eastern North Carolina and attended Wake Forest University for both his undergraduate and medical degrees. After finishing a nephrology fellowship at the Mayo Clinic he joined Metrolina Nephrology Associates (MNA) in 1992. For 15 years he served as medical director for the kidney and pancreas transplant programs at Carolinas Healthcare System. He was president of MNA from 2005–2022. Dr Hart was a medical director for various FKC dialysis units from 1995–2022 and serves on the Corporate Medical Advisory Board for Fresenius Medical Care. In March 2020, Dr Hart joined the leadership team of Interwell Health as Chief Medical Officer.

Dr. Terry Ketchersid
Senior Vice President, Medical Office
Interwell Health

Dr. Ketchersid received a BA in Chemistry from Austin College and his MD degree from The University of Texas Southwestern Medical School in Dallas. After completing an Internal Medicine residency in Dallas, and a Nephrology Fellowship at the University of Missouri, Dr. Ketchersid practiced nephrology for 15 years with the Danville Urologic Clinic, serving as the practice's President and CEO in 2004 and 2005. At Halifax Regional Health System, his roles included Chairman of the Pharmacy and Therapeutics Committee, Chief of Medicine, and Chief Quality Officer.

In 2007, Dr. Ketchersid completed the Executive MBA program at Duke University's Fuqua School of Business, earning the Fuqua Scholar honor. In 2008, he joined the Acumen Electronic Health Record Senior Management team where he served as the company's Chief Medical Officer 2009–2013. From 2014 to 2022 Dr. Ketchersid served as the Chief Medical Officer for Fresenius Medical Care's Integrated Care Group. In 2022 he joined Interwell Health as Senior Vice President within the organization's Medical Office. Dr. Ketchersid served on the board of directors for the Renal Physicians Association 2016–2022.



The Challenges and Benefits of Generative AI in Kidney Care

Emel Hamilton, MD, MSN/INF, CNN
Zuwen Kuang, MS
Luca Neri, PhD
Hanjie Zhang, PhD

While generative Artificial Intelligence (AI) has the potential to improve kidney care, it also poses substantial challenges. Applications under discussion touch on every aspect of treatment, including the creation of new prognostic tools and methodologies, personalized medical education for professionals and patients, and protocols that alleviate the burden of administrative tasks. FME is developing an AI framework for clinical workflows that considers both the benefits and risks that AI poses for the future of patient care.

The development of generative Artificial Intelligence (AI) has created excitement and prompted vigorous debate across various industries, including healthcare.[1] Dubbed "Gen AI," this novel technology transcends conventional rule-based systems, data analysis, and predictions. Departing from the familiar confines of traditional AI, generative AI ventures into uncharted territory where machines wield the power of creativity sans human intervention.[2]

Understanding Generative AI's Unconventional Pathways

Generative AI stands apart because of its ability to create human-like content—images, text, melodies, or even entire narratives—using complex computer algorithms. These differ from conventional machine learning algorithms that can generate simple outputs. Instead, generative models create new content based on an assortment of data on which they have been trained by weaving together semantic patterns and knowledge structures.[2,3]

Potential Benefits of Generative AI in Kidney Care

Generative AI systems, particularly large language models (LLMs), hold numerous potential applications and may revolutionize several aspects of healthcare.[4,5,6]

- **Clinical Insights and Powerful Prognostic Tools:** A recent systematic review highlighted that most published studies focus on the use of LLMs as medical chatbots and to generate patient information and clinical documentation as well as for patient education and to simplify imaging reports.[7] Generative AI and multimodal LLMs may have direct clinical applications, such as generating diagnostic [8,9,10,11] and prognostic [12,13] predictions, given their ability to encode medical knowledge and/or interpret medical signs and symptoms similar to semantic elements.[12,13] For instance, Kanda and colleagues utilized an early natural language processing (NLP) architecture, word2vec, to analyze chronic kidney disease (CKD) literature, accurately predicting death and end-stage kidney disease (ESKD) onset. With the advent of more advanced LLMs, coupled with fine-tuning in the medical domain, highly accurate outcome predictions can be generated directly from medical notes, referral letters, and patients' narratives without the need to document medical encounters in structured electronic health record systems, thus reducing documentation burden and limitations due to incomplete ontologies.[12,15]

- **Personalized Care:** New LLM architectures like pre-trained transformers offer broader possibilities for analyzing multimodal data and detecting nuanced associations. These advancements enable language-understanding technologies to learn patterns across various data types, such as comorbidity codes, lab tests, images, clinical narratives, and patient-reported outcomes. For example, Savcisens et al. demonstrated the effectiveness of this approach in predictive modeling using life-events data, showing that these models could accurately predict diverse outcomes such as early mortality and personality nuances by learning patterns from detailed event sequences.[16]

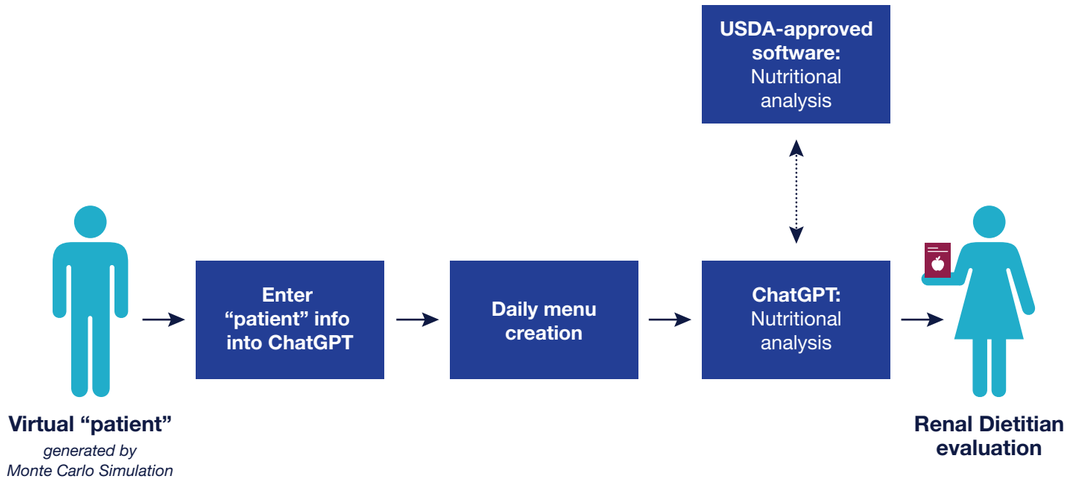
Departing from the familiar confines of traditional AI, generative AI ventures into uncharted territory where machines wield the power of creativity sans human intervention.[2]

- **Efficiency and Cost Savings:** Generative AI can alleviate the administrative burden on healthcare staff, including time-consuming non-medical tasks.[17,18,19,20,21,22,23] Streamlining these tasks can save time, minimize disruptions, and potentially enhance patient-clinician interactions. Studies show that LLMs can summarize medical notes and dialogues with high accuracy.[24,25] For instance, FME Global Medical Office and Santa Barbara Smart Health developed software leveraging GPT-4 to transcribe patient-physician interactions, achieving reliable abstraction of 33 medical elements, including pre-existing medical conditions, drug prescriptions, biochemical parameters, active problems, and treatment plans. The system produced a reliable and accurate summary of medical concepts in a small proof-of-concept study. FME is exploring how generative AI might streamline the process of collecting patient referral information, with the potential to expedite referrals and admissions and enhance data entry accuracy. We are also investigating the development of a ChatGPT-like tool to assist staff in offering targeted guidance for handling non-clinical tasks, with the goal of reducing staff burden and supporting new clinical leaders. This includes examining how the tool could navigate intricate requirements related to Worker's Compensation and the Conditions for Coverage for ESKD Facilities. Additionally, FME aims to reduce patient attrition and improve their experience.[26,27,28] By considering the implementation of an AI-guided referral pathway and AI-powered case management, we hope to assist FME's Continuity of Care team in identifying patients at high risk of attrition, conducting root cause analyses, and providing data-driven insights to case managers (Figure 1).

FME is exploring how generative AI might streamline the process of collecting patient referral information, with the potential to expedite referrals and admissions and enhance data entry accuracy.

FIGURE 1 | AI-POWERED CARE MANAGEMENT

FIGURE 2 | STUDY PROCESS FOR EVALUATING THE PERFORMANCE OF CHATGPT IN GENERATING NUTRITIONAL ADVICE FOR ESKD PATIENTS

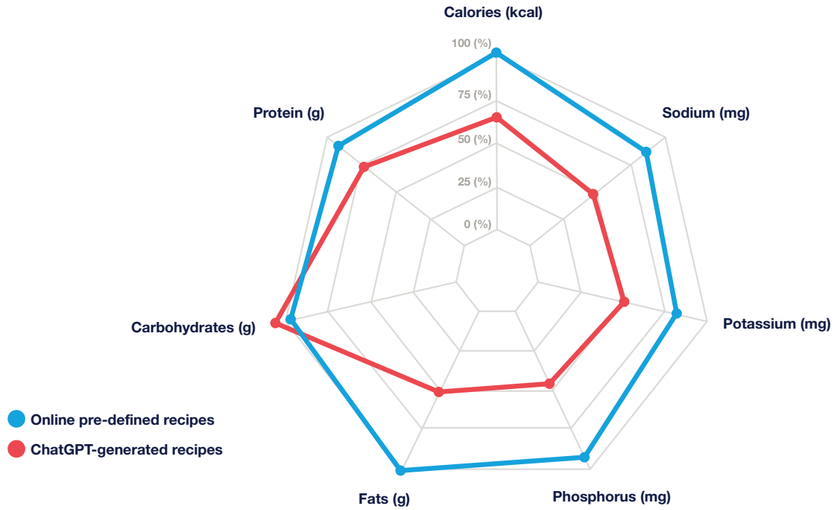


- **Tailored Medical Education:** Personalizing medical education for healthcare professionals and patients is another promising area of application for generative AI.[26,27,28] We utilized retrieval-augmented generation (RAG), a novel AI-driven approach, to efficiently process and extract meaningful information from published literature on uremic toxins. The process involved preparing a curated literature database, creating a vector database from curated literature, retrieving relevant information based on queries, and generating responses using LLMs incorporating retrieved information. Although RAG has significantly improved content generation, the potential for "hallucinations" persists, and the enhanced LLM outputs still require human verification. For more information on the hallucination topic, refer to "Potential Risks" below.

- **Comprehensive Use of Data and Knowledge:** Dietary management is crucial for patients with kidney failure undergoing dialysis, but personalized advice is challenging due to varying food preferences and other factors. By leveraging LLMs, there is potential to integrate patient demographics, clinical data, and food preferences to create tailored recipe recommendations.[29,30] Renal Research Institute (RRI) tested the emergent ability of LLM to generate sound nutritional advice for people with CKD (Figure 2). While this approach has limitations in precise nutritional analysis for people with CKD, it's important to note that this evaluation of LLM sheds light on the current knowledge base. For instance, in RRI's study, ChatGPT underestimated calories, protein, fat, phosphorus, potassium, and sodium content on ChatGPT-generated recipes when compared with U.S. Department of Agriculture (USDA)-approved software. These discrepancies are much smaller with online pre-defined recipes (Figure 3). While the underlying knowledge basis of GPT-4 falls short in supporting nutritional analysis for people with kidney disease, incorporating LLMs in more complex architectures may enhance the accuracy of nutritional estimation.[31,32,33]

Personalizing medical education for healthcare professionals and patients is another promising area of application for generative AI.[26,27,28]

FIGURE 3 | RELATIVE ESTIMATES OF NUTRITIONAL VALUES OF ONLINE PRE-DEFINED RECIPES AND CHATGPT-GENERATED RECIPES WHEN COMPARED WITH USDA-APPROVED SOFTWARE



Potential Risks of Generative AI in Kidney Care

Generative AI offers unprecedented potential to revolutionize patient care, diagnosis, and treatment methodologies. However, substantial risks remain.

- **Biased Outputs from Training Data:** Generative models learn from the data on which they are trained. If their training samples and datasets include biases, then those models can generate outputs that are ethically questionable.[6] In the realm of kidney care, such biases could propagate treatment disparities or inequalities.

- **Privacy and Security Concerns:** Generative AI's ability to generate synthetic data, which resembles real data, is tremendously useful in research and model training, but this capability comes with privacy implications. If the original datasets used to train the generative AI are not adequately secured, there is a risk that the synthetic data could inadvertently reveal sensitive personal information. Furthermore, machine learning systems in sensitive domains such as healthcare are particularly vulnerable to adversarial AI attacks where malicious actors can manipulate or exploit the models by introducing carefully crafted inputs to the system.[34,35]

- **Hallucinations in AI Responses:** In the context of generative AI, "hallucinations" refer to the generation of responses that are not logically or semantically coherent or are not relevant to the input prompt. These hallucinations can occur when generative AI formulates responses based on patterns or associations it has learned from its training data without fully understanding the meaning or context of the input prompt. This could pose serious risks to patient safety and well-being if implemented without proper verification or oversight.[36]

- **Transparency and Explainability Challenges:** Unlike traditional rule-based AI systems where decision-making logic is explicit and interpretable, generative AI models often operate as "black boxes," making it difficult for clinicians and patients to comprehend how generative AI arrived at a particular decision.[36] Addressing this risk requires meaningful human-AI collaboration, which involves integrating AI systems seamlessly into clinical workflows to enhance efficiency, accuracy, and patient outcomes while preserving the critical role of human expertise, empathy, and judgment in delivering high-quality care.[37]

Generative AI offers unprecedented potential to revolutionize patient care, diagnosis, and treatment methodologies. However, substantial risks remain.

Reflecting on Possibility

In our relentless pursuit of innovation, FME recognizes the immense potential of generative AI in revolutionizing clinical workflows. However, this potential must be harnessed responsibly. At FME, we are developing a trustworthy AI framework—one that prioritizes safety, security, and ethics. Our commitment extends beyond compliance to encompass the thoughtful integration of organizational values and change management principles. In this new era of healthcare, we remain steadfast in our mission to elevate patient care while upholding the highest standards of integrity and excellence.

At FME, we are developing a trustworthy AI framework—one that prioritizes safety, security, and ethics.

FME's use of generative AI tools such as ChatGPT is focused on research or quality assessment purposes and not used for patient care. Renal Research Institute is a wholly owned subsidiary of Fresenius Medical Care.

Dr. Emel Hamilton
Vice President and Global Leader of Clinical Systems
Global Medical Office

Dr. Hamilton is a multifaceted healthcare professional with a unique blend of medical expertise, nursing proficiency, and a deep understanding of clinical informatics. She earned her medical degree (MD) from Dokuz Eylül Üniversitesi in Turkey, laying a solid foundation for her comprehensive perspective on healthcare challenges. Further enhancing her skill set, she also holds a master's degree in nursing and clinical informatics (MSN/INF). Dr. Hamilton is a recognized expert in Health Information Exchange (HIE) and Electronic Health Records (EHR) nurse practice standards and has contributed several significant publications in the field. Her expertise extends beyond traditional healthcare boundaries into the realm of AI and her balanced perspective allows her to adeptly navigate the AI landscape, always with a keen eye on harnessing its potential while ensuring paramount importance to patient safety and data security. Currently, Dr. Hamilton holds the position of Vice President and Global Leader of Clinical Systems at Fresenius Medical Care. Her approach to healthcare challenges is inherently collaborative, recognizing the crucial roles played by both humans and machines.

Zuwen Kuang
Senior Vice President, Global Head of Data and Analytics
Fresenius Medical Care

Zuwen Kuang is a skilled and experienced digital healthcare executive with a proven track record of success in the field of data and analytics. As the Global Head of Data and Analytics in Digital Technology and Innovation at Fresenius Medical Care, she leads a team responsible for building enterprise big data platforms, delivering advanced analytics, AI/GenAI solutions and digital interoperability capabilities. This enables the transformation of healthcare data into intelligence that predicts trends and reveals actionable insights that influence long-term business growth.

Dr. Luca Neri
Senior Director, Clinical Advanced Analytics, EMEA, AP, LATAM
Global Medical Office

Dr. Neri leads the Data Science division for the EMEA, APAC, and LATAM regions of the Global Medical Office - Clinical Advanced Analytics department at Fresenius Medical Care. He joined Fresenius Medical Care in 2016. With almost 20 years of experience in epidemiology, outcomes research, and data science, Dr. Neri has acquired a broad range of analytical and methodological skills in the field of advanced analytics. The GMO-CAA Data Science team blends profound expertise in state-of-the-art machine learning techniques with dedication to the clinical integration of AI solutions in medical care.

Before joining Fresenius Medical Care, he held a postdoctoral position at the St. Louis University Center for Outcomes Research and was later appointed adjunct instructor of Health Management and Policy at the same institution. He also served as a scientific consultant and advisory board member for several commercial, scientific, and industrial clients and academic institutions. He earned his medical degree at the University of Milan School of Medicine, where he also earned a specialty degree and a PhD in environmental and occupational medicine.

Dr. Hanjie Zhang
Senior Director of Computational Statistics & Artificial Intelligence
Renal Research Institute

Hanjie Zhang, PhD joined Renal Research Institute in 2014. She received a master's degree in statistics from Columbia University, New York, and a PhD in medical science from the University of Maastricht, The Netherlands. Hanjie has been involved in the design of several large cluster-randomized clinical trials and complex statistical analysis. She is also involved in designing, developing, and deploying enterprise solutions across the artificial intelligence spectrum, such as machine learning, and deep learning. During her tenure with Renal Research Institute, Hanjie has authored over 30 research articles in leading kidney journals.

Responding to Natural Disasters and Geopolitical Conflicts

Robert P. Loeper, Vice President, Business Continuity & Disaster Response
Dr. Adrián M. Guinsburg, Vice President, Chief Clinical Officer, EMEA

Dialysis patients are at particular and added risk during natural disasters and armed conflicts. Infrastructure breakdowns, lack of clean water, and closure of dialysis centers disrupt critical treatments and jeopardize lives. The Fresenius Medical Care (FME) Global Disaster Response Team (GDRT) has developed protocols that allow them to deploy quickly in times of crisis. The team has extensive experience delivering supplies and medical personnel when and where they are needed worldwide.

For people who need safe and reliable dialysis services, situations such as natural disasters and geopolitical conflict can cause unpredictability and instability. Delivering care without access to critical services like reliable electrical power and clean water requires preparation and coordination. The FME GDRT keeps a close watch on situations where risk can escalate and is prepared to implement a comprehensive response strategy. Several Incident Command Teams staffed by volunteer leaders and managers are available to be dispatched on short notice (24–48 hours) for immediate disaster response. Their activities include arranging resources such as fuel, water, medical supplies, security, and meals to assist local management in restoring facility operations.

Critical components of emergency response efforts may include scheduling treatments outside of routine times and locations, ensuring supply chains remain intact, and maintaining proper hygiene and sanitation standards to prevent infections among people who need dialysis treatment, who are inherently more susceptible. During these crises, psychological support services are also critical, to help patients navigate associated stress and trauma.

A systematic literature review describes various effects of disasters on people undergoing dialysis treatment. Disruptions in dialysis care from loss of electricity, lack of clean water, blocked roads, lack of transportation, and closure of dialysis centers can lead to missed or shortened dialysis treatments. The clinical consequences can include increased emergency department visits, hospitalization, and mortality. Other reported effects include psychological repercussions, as disasters can cause or worsen depression and post-traumatic stress disorder. Moreover, during disasters, people who need dialysis treatment may encounter significant challenges. For example, relocation, if required, may result in prolonged periods away from family and social support networks. Supply shortages can lead to a lack of vital medical supplies and health care workers may not be available. The authors emphasize the importance of disaster preparedness for dialysis units.[1]

The role of peritoneal dialysis (PD) during natural disasters and conflicts has been highlighted in several publications.[2,3,4] The advantages of PD include simplicity, since manual PD exchanges can be done without electrical power and do not require a water supply. The ability to perform treatment at home reduces reliance on transportation to dialysis facilities. According to Auguste,[2] future disaster preparedness strategies should aim to increase the adoption of PD and consider it as an initial modality for replacement therapy for end-stage kidney disease (ESKD) patients in high-risk regions.

Children who require dialysis need specialized treatment and care, particularly in the context of natural disasters and conflict. Children with kidney conditions often have unique medical needs that must be addressed with sensitivity and expertise. During emergencies, ensuring the safety and well-being of children requiring specialized kidney care becomes even more critical due to their heightened vulnerability. Children who require hemodialysis (HD) may be at greater risk than adults on HD due to the limited availability of pediatric-sized equipment and personnel with pediatric dialysis experience. Additionally, children are usually less able to tolerate missed dialysis sessions.[5]

Disruptions in dialysis care from loss of electricity, lack of clean water, blocked roads, lack of transportation, and closure of dialysis centers can lead to missed or shortened dialysis treatments.

FME has responded to many emergencies related to natural disasters and geopolitical conflicts in the last five years. Specific examples of FME's response are described below.

Natural Disasters and Phenomena

NORTH AMERICA

In **September 2022**, Hurricane Ian, a Category 4 storm, was predicted to make landfall in Tampa, Florida. The storm took an unexpected turn, heavily damaging and disabling power for more than two million homes and businesses in southwestern Florida. Two DRT Incident Command Teams were deployed within 48 hours along with fuel and water tankers, food, supplies, and security personnel, to assist with reopening clinics and locating those who needed care. As a precautionary measure, Fresenius Kidney Care (FKC) closed 107 clinics in Central Florida and, within three days, all but one were open and all staff and patients were accounted for.

In **August 2023**, a Category 4 hurricane in the Pacific Ocean collided with another wind event to knock down power lines in Lahaina, Maui, igniting drought-stricken sugar cane fields into a wildfire. The fire ultimately destroyed the entire Lahaina community, affecting every resident.

While the FKC Kahana clinic outside Lahaina suffered little damage, in the aftermath of the fire, people could not access the facility. Another independent dialysis facility in Lahaina was heavily damaged, resulting in service interruption for 80 residents of Lahaina who required dialysis treatment. An FKC facility in Maulana, 20 miles from Lahaina, was able to open an additional shift and accommodate everyone in Lahaina.

As a testament to the teamwork and resilience of the FKC staff in Maui, all the people who were receiving treatment at the Kahana clinic were located within three days and received their required treatments the week of the fire. Nine people on home peritoneal dialysis (PD) who were without power switched from continuous cycler peritoneal dialysis (CCPD) to continuous ambulatory peritoneal dialysis (CAPD) and performed manual exchanges until power was restored. Three people on home hemodialysis (HD) converted to self-contained training packs (Express Packs) when the local water supply in Lahaina was reported as contaminated with cobalt, lead, and other materials, making it unusable for in-center and home HD. Express Packs do not require the introduction of a local water supply to complete the process. People with Kidney Community Emergency Response (KCER) ID cards identifying them as on dialysis were permitted to travel to the clinic in Maulana for treatment and return home without restriction. Water supplies in Maulana and Kahana were not contaminated.

During emergencies, ensuring the safety and well-being of children requiring specialized kidney care becomes even more critical due to their heightened vulnerability.

When clinics in southern Brazil were without road access, helicopters delivered essential dialysis supplies.

Local FKC leadership, in cooperation with the Hawaii Emergency Healthcare Management (HEHM) coalition, were able to provide the names of all their staff and people on dialysis to the authorities, allowing them priority access through Lahaina. HEHM also allowed the technical teams access to the Kahana facility to prepare the clinic for operations. FKC's GDRT shipped 100 fleece blankets to the centers and arranged hotel rooms for staff.

On **April 8, 2024**, the Great Northern American Eclipse covered a swath of North America from Mexico to Canada. Previous experiences with solar phenomena have seen impassable road congestion caused by eclipse enthusiasts, impacting the ability of emergency responders to access FKC clinics. More than 100 clinics in the path of totality were asked to close or alter operating hours to allow those needing to dialyze to do so in advance of the eclipse.

EUROPE, MIDDLE EAST, AND AFRICA (EMEA)

In **February 2023** Turkey experienced its deadliest earthquake in modern history, at 7.8 magnitude, and the deadliest worldwide since the 2010 earthquake in Haiti. An area about the size of Germany suffered widespread damage, and about 1.5 million people were left homeless.

FME operates more than 40 dialysis clinics in Turkey, two of which did not survive the earthquake. In the first week after the earthquake, in our effort to maintain access to care under these circumstances, we contacted all people on dialysis under our care to assess their status.

Fifty-five percent of people on dialysis in the earthquake zone were actively on home HD. Many of them had to stop this therapy for a variety of reasons, including extensive damage to their homes, the need to relocate, and lack of clean water, resulting in a high number of missed treatments across these clinics. Further research is needed to determine if people on home HD have a higher probability of complications or mortality due to shortened sessions during extended periods of uncertainty.

LATIN AMERICA

In **May 2024**, the GDRT responded to flooding in Rio Grande do Sul, Brazil. When record-breaking rainfall broke flood barriers, a FME Brazil Crisis Committee was created to work with the Brazilian Association of Dialysis and Transplant Centers to discuss solutions and negotiate support for access to dialysis care.

After establishing logistical support with the city's fire department and military forces, the Crisis Committee arranged to send essential goods for people on dialysis. All vehicles carrying medicines for dialysis clinics were labeled externally with this information to allow them to pass unencumbered.

ASIA PACIFIC

The many islands in the Asia-Pacific region face heightened vulnerability to natural disasters, which can disrupt hemodialysis services and lead to adverse effects for patients, similar to those discussed above.[6] For example, in May 2023 Super Typhoon Mawar disabled the power grid to all of Guam. All six of Guam's FKC clinics are equipped with generators, but three sustained storm damage. To assist with the recovery, GDRT arranged for more than 150 volunteers to engage in two-week assignments.

Members of the Brazilian Civil Defense team received Fresenius Medical Care dialysis supplies to be helicoptered to an area completely isolated by flooding.

Geopolitical Conflicts

Armed conflicts also disrupt medical care for people on dialysis, leading to missed treatments and an increased risk of infections, hospitalization, and death. Insecure environments hinder access to healthcare, exacerbating the vulnerability of those who require care. Psychological support is essential amid the trauma of conflict. Advance preparation is needed to ensure access to care, protect patients, and provide comprehensive support in conflict zones.[3,7,8,9,10,11]

Insecure environments hinder access to healthcare, exacerbating the vulnerability of those who require care.

In Brazil, owners of private planes volunteered to deliver essential dialysis supplies to an isolated region. Members of the military unloaded the planes after a 120-minute flight.

As a recent example, on **February 24, 2022**, foreign troops entered the territory of Ukraine. Before the war, the FME dialysis network in Ukraine operated three medical centers, providing hemodialysis therapy to 349 people with ESKD.[12] In addition, FME Ukraine delivered medical and dialysis supplies to almost all regions of Ukraine. The war imposed a significant burden on these frail, high-risk patients. Now in its third year, the war in Ukraine is causing immense suffering for its dialysis population and, at times, has called for heroic efforts from clinic staff.

FME leadership in coordination with the Ukraine Army arranged to have a train available for evacuation out of Kharkiv if the safety of the patients and staff becomes untenable. Guaranteeing dialysis treatment has been and remains an enormous challenge in Ukraine, and we are confident that the generosity and the courage of our dialysis staff in Ukraine, along with international aid, will help to mitigate this suffering.

In summary, natural disasters and geopolitical conflicts may jeopardize patient safety and treatment availability. Each day presents new opportunities for FME to prioritize the health and safety of the people on dialysis who entrust them with their care. Preparation is essential to provide timely and reliable care, access to essential medications, a clean and safe treatment environment, and psychological support in highly unstable situations. Organized and effective responses to natural disasters and geopolitical conflicts can significantly improve outcomes and quality of life for people who need kidney replacement therapies.

Each day presents new opportunities for FME to prioritize the health and safety of the people on dialysis who entrust them with their care.

When flooding made it impossible to unload supplies at the warehouse, local transportation companies took over and delivered dialysis products to cities in the Brazilian state of Rio Grande do Sul.

Robert P. Loeper
Vice President, Business Continuity & Disaster Response
Care Delivery

Bob leads the National Accounts Department for FME which provides contracted services for all FME facilities. Bob also serves as FME's Incident Commander and conducts emergency response training throughout the year for facility operation managers and Medical Directors. During his more than 35 year career with FME, Bob has managed dialysis facilities as an Administrator, Area Manager, and Regional Vice President in Georgia, Alabama, Florida, and Puerto Rico. Prior to his current role, he served as President of FreseniusRx from 2009–2012.

Bob was President of the Florida Renal Association (FRA) from 2005 to 2012 and currently is Legislative Chair for FRA. His leadership resulting in increasing the Florida Medicaid ESKD reimbursement for outpatient dialysis facilities, establishing a Chronic Kidney Disease / ESKD Advisory Committee with the Florida Agency for Healthcare Administration, obtaining direct outpatient reimbursement for renal IV pharmaceuticals, and helping secure legislation to allow Medi-gap coverage for all Florida Medicare beneficiaries under age 65. Bob served on the Board of Florida's Medicare Quality Improvement Organization (Florida ESKD Network 7) and the Board of the National Kidney Foundation of Florida (NKFF) for nine years. He was awarded the NKFF President's Award in 2006 and became a NKFF Honorary Trustee in 2007.

Bob earned a Bachelor of Science in Healthcare Administration from Penn State University and an MBA from Georgia State University. He is a certified Project Management Professional.

Dr. Adrián Guinsburg
Vice President, Chief Clinical Officer, EMEA

Dr. Guinsburg is the Chief Clinical Officer for FME in EMEA, overseeing Clinical Governance and Country Medical Directors in the region. He is a nephrologist who graduated from the School of Medicine in Universidad de Buenos Aires, Argentina, with a postgraduate formation in epidemiology in the School of Public Health, University of Michigan.

Dr. Guinsburg joined FME in 1997 as Medical Director and developed and managed the first regional clinical database across Latin America (EuClid Database LatAm). Most recently he served as Chief Clinical Officer and Head of Clinical Quality and Medical Governance for FME in Latin America, leading clinical, scientific, research, and Continuous Quality Improvement programs across the region. He is involved in clinical research as a Regional Coordinator for third-party clinical trials, with more than 15 years of experience as a Principal Investigator in phase 2, 3, and 4 studies in the renal domain. He has presented at more than 50 scientific conferences and has over 20 indexed publications in journals.

About the Global Medical Office

Franklin W. Maddux, MD, FACP

Global Chief Medical Officer, Member of the Management Board

Franklin W. Maddux oversees the delivery of high-quality, value-based care for the world's most expansive kidney care organization. His distinguished career encompasses more than three decades of experience as a physician, expert nephrologist, technology entrepreneur, and healthcare executive.

Dr. Maddux joined Fresenius Medical Care's (FME) North America region in 2009 after the company acquired Health IT Services Group, a leading electronic health record (EHR) software company, which he founded. He developed one of the first laboratory electronic data interchange programs for the U.S. dialysis industry and later created one of the first web-based EHR solutions, now marketed under Acumen Physician Solutions.

He previously served as chief medical officer and senior vice president for Specialty Care Services Group and is the former president of Virginia's Danville Urologic Clinic, where he was a practicing nephrologist for nearly two decades. His writings have appeared in leading medical journals, and his pioneering healthcare information technology innovations are part of the permanent collection of the National Museum of American History at the Smithsonian Institution.

An alumnus of Vanderbilt University, Dr. Maddux earned his medical degree from the School of Medicine at the University of North Carolina at Chapel Hill, where he holds a faculty appointment as clinical associate professor.

Lorien Dalrymple, MD, MPH

Senior Vice President, Head of Population Health and Medicine

Board certified in nephrology, Dr. Dalrymple received her Bachelor of Science in Psychology from Duke University, Medical Degree from the University of Colorado, and Master of Public Health from the University of Washington. She completed her Internal Medicine Residency and Nephrology Fellowship at the University of Washington.

Prior to joining Fresenius Medical Care in 2016, she was an Associate Professor of Medicine at the University of California Davis. She has undertaken numerous research studies related to kidney disease and the associated complications and is a member of the *Kidney Medicine* editorial board. She served as a co-chair of the National Quality Forum Renal Standing Committee and co-chaired the Kidney Health Initiative ESKD Data Standards project. In addition, she has served on multiple Technical Expert Panels convened by the Centers for Medicare and Medicaid Services.

Benjamin E. Hippen, MD, FASN, FAST

Global Head of Clinical Affairs, Global Medical Office
Chief Medical Officer, Care Delivery

Dr. Hippen oversees the global clinical care delivery programs for Fresenius Medical Care, ensuring we deliver exceptional care and support to all patients under our care. Dr. Hippen specializes in ethical, organizational, and public policy issues in nephrology and transplantation. His contributions have advanced patient care initiatives and influenced broader clinical leadership, integrating transplantation into the dialogue among practicing nephrologists and within our Care Delivery framework.

Dr. Hippen received an undergraduate degree from Rice University and completed his medical school and internal medicine residency training at the Baylor College of Medicine. Thereafter, he completed a general nephrology and transplant nephrology fellowship at the University of Alabama in Birmingham. After completing his nephrology and transplant training, Dr. Hippen joined Metrolina Nephrology Associates, P.A. in Charlotte, North Carolina, a 40-nephrologist private practice, where he served as the medical director of two in-center hemodialysis facilities and, for several years, served as the medical director of a home therapies facility. During his time in Charlotte, he became a Clinical Professor of Medicine at the UNC Chapel Hill School of Medicine. Prior to joining Fresenius Medical Care in September 2021, Dr. Hippen served terms on the Ethics Committee and Membership and Professional Standards Committees of the Organ Procurement and Transplantation Network, served on the Board of Directors and was the chair of the Medical Advisory Board of ESRD Network 6, and served on the founding physician practice board of InterWell Health. Consonant with his ongoing research interests in ethical, organizational, and public policy issues in nephrology and transplantation, Dr. Hippen is the author of more than 70 peer-reviewed articles, essays, reviews, and book chapters.

Jeffrey L. Hymes, MD

Senior Consultant to the Global Chief Medical Officer

Dr. Hymes joined FME as Associate Chief Medical Officer in 2007 after three decades in nephrology practice and governance. He became Senior Vice President and Associate CMO for FMCNA in 2012, and in 2020, became Chief Medical Officer, Care Delivery, and Executive Vice President, Global Head of Clinical Affairs, serving in this role until 2024.

He co-founded REN Corporation in 1986 and National Nephrology Associates (NNA) in 1998. He served as NNA's President and Chief Medical Officer from 1998 to 2004. He was President of Nephrology Associates, a 32-physician nephrology practice serving Middle Tennessee, from 1989 to 2012 and is a former member of the Renal Physician Association's Board of Directors.

He is a graduate of Yale College and the Albert Einstein College of Medicine. He served his medical internship and residency at Yale New Haven Medical Center and received subspecialty training in nephrology at Boston University. Dr. Hymes is board certified in internal medicine and nephrology and was previously certified in critical care.

Robert J. Kossmann, MD, FACP, FASN

Executive Vice President, Global Head of Medical Affairs, Chief Medical Officer, Care Enablement

Dr. Kossmann served as executive vice president and chief medical officer for FME North America from 2019 to 2021 and chief medical officer for FME's Renal Therapies Group, the company's medical equipment and renal pharmaceuticals division, from 2014 to 2019.

Dr. Kossmann has held a variety of leadership roles where he has provided guidance to the nephrology field, including as former president of the Renal Physicians Association (RPA); a founding member of RPA's Nephrology Coverage Advocacy Program (now Policy Advocacy Leadership program); a nephrology advisor to the American Medical Association's Relative Value Scale Update Committee; and founder of the New Mexico Renal Disease Collaborative Group.

A practicing nephrologist for two decades, Dr. Kossmann trained in nephrology at the University of Washington in Seattle and holds his bachelor's and Doctor of Medicine degrees from Case Western Reserve University in Cleveland, Ohio.

Peter Kotanko, MD, FASN

Emeritus Research Director

Dr. Kotanko is Emeritus Research Director at the Renal Research Institute (RRI), New York. Prior to joining RRI, from 1997 to 2007 he served as vice chair of a department of internal medicine at an academic teaching hospital in Graz, Austria. Prior to moving to Graz in 1989, he worked from 1982 to 1989 in the Department of Physiology and the University Clinic of Internal Medicine in Innsbruck, Austria. From 1995 to 1996 he trained in nephrology at the Hammersmith Hospital, London, United Kingdom.

He is Adjunct Professor of Medicine and Nephrology at the Icahn School of Medicine at Mount Sinai in New York and holds a teaching appointment at the Medical University of Innsbruck. He has authored and co-authored more than 350 publications and book chapters, and holds multiple patents in the field of kidney replacement therapy. He is an awardee of the 2019 KidneyX prize for innovations in dialysis and the 2021 KidneyX COVID-19 Kidney Care Challenge.

Manuela Stauss-Grabo, PhD

Senior Vice President, Clinical Research

Dr. Manuela Stauss-Grabo joined Fresenius Medical Care in 2013 and has since made significant contributions to the field of clinical research in nephrology. With over 20 years of experience, she currently serves as the Senior Vice President of Global Clinical Research in the Global Medical Office (GMO), where she leads a dedicated team focused on advancing the understanding and treatment of kidney disease. Dr. Stauss-Grabo's extensive background in biology and clinical research equips her with a unique perspective on the complexities of kidney health. Her leadership is instrumental in designing and implementing clinical studies that generate robust evidence, ultimately aimed at improving patient outcomes. She is passionate about bridging the gap between scientific research and practical application, ensuring that findings translate into effective therapies for patients suffering from kidneyrelated conditions. Under her guidance, the Fresenius Medical Care Clinical Research team, a global team of researchers, manages a diverse portfolio of national and international clinical studies. The team is responsible for overseeing all phases of research—from strategic concept development to detailed planning and execution—ensuring that each study adheres to the highest standards of quality, safety and compliance.

Dr. Stauss-Grabo received her Diploma in Biology from the Julius-Maximilians-University in Wuerzburg, Germany as a major in Biochemisty and completed her doctoral thesis titled "Investigations on the Pharmacokinetics of the Ivy Saponin Alpha-Hederin" under the supervision of Prof Dr Manfred Haake at the Institute of Pharmaceutical Chemistry, PhilippsUniversität Marburg, Germany. This pioneering research provided the first comprehensive description of how alpha-hederin, a key saponin found in Hedera helix (common ivy), is processed in the body. The study's findings were significant, as they laid the groundwork for understanding the medicinal properties of ivy extracts, which have long been used in traditional medicine for respiratory conditions in many countries worldwide.

Dr. Stauss-Grabo is committed to fostering collaboration among stakeholders in the healthcare community, including researchers, clinicians, and regulatory bodies. Her efforts not only enhance the scientific rigor of clinical trials but also promote innovative approaches to tackling kidney disease on a global scale. Through her work at Fresenius Medical Care, Dr. Stauss-Grabo continues to make a profound impact on the lives of patients by driving forward initiatives that aim to enhance treatment options and improve overall health outcomes in nephrology.

Stefano Stuard, MD, PhD

Senior Vice President, Global Clinical Officer
Hemodiafiltration

Dr. Stefano Stuard joined Fresenius Medical Care in 2010 as a Medical Director in FME's NephroCare business in the Europe, Middle East, and Africa (EMEA) region. Dr. Stuard's career includes more than 14 years in clinical governance roles with Fresenius Medical Care's EMEA and Latin America regions. In his most recent role, he supported NephroCare medical leadership in his role as Chief Clinical Officer for the EMEA countries. Dr. Stuard has long been a champion of online hemodiafiltration as a kidney replacement therapy, overseeing its steady growth in NephroCare clinics. By June 2024, more than 61 percent of patients in our European Union clinics were treated by High-Volume Hemodiafiltration.

In his current role, Dr. Stuard will focus on educating nephrologists in FME's Care Delivery business segment and will support many of the aspects of our development of a comprehensive plan to make HDF therapy a standard of care. Dr. Stuard previously served as vice president and head of the EMEA Center of Excellence for Clinical and Therapeutic Governance and as a director/consultant for nephrology and dialysis departments in Italian public and private hospitals. He has published over 220 scientific publications in peer-reviewed journals. Dr. Stuard received his PhD in nephrology from the University of Bologna (Italy). He received his Doctor of Medicine and surgery as well as a post-graduate specialization in nephrology, magna cum laude, from the University of Chieti (Italy). He received an award from the European Society of Artificial Organs for his contribution in the field of artificial organs. Dr. Stuard is also a member of European Renal Association Kidney Relief in Disasters Task Force.

Len A. Usvyat, PhD

Senior Vice President
Head of Renal Research Institute (RRI)

Dr. Len Usvyat brings his extensive expertise in clinical advanced analytics to the RRI, where he will lead with a clear focus on improving patient outcomes through data-driven insights. Under his leadership, the institute will prioritize harnessing analytics, particularly advanced analytics, to drive clinical innovation and support FME's Global Medical Office agenda. Dr. Usvyat's vision emphasizes leveraging data to enhance both the Care Delivery and Care Enablement segments, always keeping the well-being of patients at the center of every decision.

In his previous role leading Clinical Advanced Analytics team, Dr. Usvyat and his team advanced the use of real-world evidence and applied data science to improve the lives of people living with kidney disease. His team supported regulatory and post-market surveillance efforts, analyzed the clinical and cost-effectiveness of FME products, and integrated actionable data insights into patient care to drive improvements in treatment and outcomes on a global scale.

Dr. Usvyat also chaired FME's Predictive Analytics Steering Committee and was a founding member of the MONitoring Dialysis Outcomes (MONDO) initiative, a global collaboration among dialysis providers. He has published over 100 peer-reviewed manuscripts.

Dr. Usvyat holds a master's degree from the University of Pennsylvania and a doctorate from the University of Maastricht in the Netherlands.

Extended GMO Executive Team

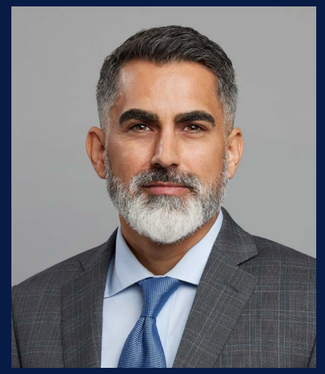
Syuhada Ahmad, MD

Senior Director, Global Medical Office Operations

Dr. Syuhada Ahmad leads GMO Operations within Population and Health Medicine. She earned her medical degree from Moscow Medical Academy, Russia, and has extensive experience in clinical quality, medical affairs, hospital operations, risk management, health informatics, and accreditations.

Dr. Ahmad oversees and drives a diverse array of medical projects in the Global Medical Office and GMO Enterprise Risk Management. She collaborates with stakeholders and leaders across the organization, providing strategic leadership and fostering essential partnerships for the success of medical risk, compliance, and operations programs.

Dr. Ahmad began her career with Fresenius Medical Care in Malaysia, moved to Hong Kong a few years later, and is now based in Bad Homburg, Germany.



Ryan A. Jimenez, EdM, APR

Senior Vice President, Head of Medical Communications

Ryan Jimenez joined FME in 2016 as vice president of Medical Office Relations for North America, where he led the development of the region's Medical Office communications strategies and capabilities.

With corporate communications, he led the development of the company's video broadcast network, including the creation of the Medical Office Live series of broadcast events across North America as executive producer.

He previously served as regional communications director for Four Seasons Hotels and Resorts, leading global communications campaigns in North America, EMEA, Latin America, and Asia, and is the former senior producer and global communications director for CNN's *Larry King Live*.

He was appointed by California Governor Arnold Schwarzenegger as communications director for the office of First Lady Maria Shriver and began his career in hospital communications at Catholic Healthcare West in the United States.

Ryan received his bachelor's degree from the Annenberg School of Communications and Journalism at the University of Southern California and holds his master's degree in organizational behavior and ethics from Harvard University.

Shelly Nash, DO, FACOOG, FACMI
Chief Medical Information Officer, Clinical Health Information Technology

A double board-certified physician, Shelly Nash is a seasoned physician executive with broad experience in informatics, advanced analytics, population health intelligence, enterprise-level care innovation and digital innovation. She has been part of large health systems, technology companies, in private practice as a physician, as well as a teaching attending at inner city Chicago hospitals. She truly believes that technology can improve the care of patients and the experience of providing care for clinicians if we are able to advance the field of informatics and become more patient and clinician-centric in our design of applications.

The Global Medical Office Emeriti Program

The GMO Emeritus / Emerita program is a distinction awarded to retiring Medical Officers who have the equivalent of 10 years full-time service to FME. They are nominated by the Global Chief Medical Officer and approved by the Management Board for meritorious service to the mission of the company and distinguished contributions to healthcare and society. Medical Officers Emeriti remain connected to FME through ongoing participation in thought leadership and scientific inquiry. Emeriti Officers can be called upon as advisors and subject-matter experts.

	DATE OF INDUCTION
Bernard Canaud, MD, PhD	December 31, 2022
Allan Collins, MD, FACP	February 17, 2022
Adelheid Gauly, PhD, MBA	June 14, 2022
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Norma Ofsthun, PhD	April 28, 2022
Thomas J.R. Roy, PhD	July 31, 2022
Ted Toffelmire, MD, FRCPC, FACP	December 1, 2023

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Strategy to Expand High-Volume Hemodiafiltration Worldwide
Stefano Stuard, MD, PhD, and Michael S. Anger, MD, FACP, FASN

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Home Dialysis Today: More than a Different Place for ESKD Care

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Predicting Population Trends in Kidney Health Using Advanced Mathematical Modeling

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Improving Food Security in People with End-Stage Kidney Disease

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A Bold Vision to Accelerate Adoption of Value-Based Kidney Care

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The Challenges and Benefits of Generative AI in Kidney Care

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Responding to Natural Disasters and Geopolitical Conflicts

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