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Green nephrology: from evidence to action

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In the past 20 years, awareness of the huge environmental impact of kidney care has increased considerably. Although opportunities to reduce this impact have been identified and innovative approaches developed, implementation of these strategies remains slow. System-wide action is urgently required to improve the sustainability of kidney care.

Our planet is in crisis. Greenhouse gas emissions are accelerating climate breakdown; pollution is contaminating air, land and water; and biodiversity is collapsing. As the natural systems that sustain life unravel, human health is increasingly at risk. Environmental factors – including unsafe air, water, food and climate – already contribute to one in four deaths globally[1], and climate change is projected to cause an additional 14.5 million deaths by 2050 (ref. 2). The incidence and distribution of kidney disease is also expected to increase as environmental change accelerates.

Efforts to confront these challenges are underway, and some progress is being made. Yet, despite widespread recognition of the scale of the crisis, global action remains fragmented and inadequate, and business as usual persists. This disconnect is mirrored in nephrology. Awareness of the environmental impact of kidney care is growing and opportunities to reduce harm have been identified, but implementation remains slow. Promising innovations are emerging, but in most settings, funding and readiness for adoption continue to lag far behind.

Current knowledge and innovation

Two decades ago, environmental sustainability was absent from nephrology discourse. This situation began to change in the late 2000s, as life cycle assessments, audits and clinician advocacy highlighted the disproportionate environmental footprint of dialysis. Subsequent studies on multiple continents confirmed that the carbon footprint of in-centre haemodialysis far exceeds that of most other chronic therapies. Home dialysis therapies have a smaller footprint but still impose a sizeable burden[3]. Single-use plastics are the primary source of carbon emissions across dialysis modalities. Pharmaceuticals are also likely to contribute substantially, but quantification is hindered by restricted proprietary data. The patient transport required for in-centre haemodialysis increases the carbon footprint by ~20% and accounts for much of the higher burden compared with home dialysis[3]. In dialysis facilities, reverse osmosis systems are major drivers of water and energy consumption, using up to 750 l and 8.7 kW h per 4-h session[4]. All dialysis modalities generate vast amounts of waste, with limited recycling.

In response to these findings, attention has increasingly turned to identifying systemic, operational and technical solutions to lessen the environmental impact of kidney care. Prevention, early detection and slowing progression of kidney disease, kidney transplantation, and optimized supportive care offer the greatest reductions by deferring or avoiding the need for dialysis[5]. The emergence of disease-modifying therapies such as SGLT2 inhibitors, finerenone and GLP-1 receptor agonists has increased the scope for impact. A secondary analysis of the CREDENCE trial in patients with type 2 diabetes mellitus and chronic kidney disease (CKD) reported that addition of canagliflozin to usual care resulted in an estimated 20% reduction in carbon emissions due to avoidance of dialysis and hospitalizations[6].

> "The carbon footprint of in-centre haemodialysis far exceeds that of most other chronic therapies"

When dialysis is required, strategies such as incremental or delayed initiation; use of low dialysate flow, autoflow or ecoflow systems for haemodialysis; and use of targeted icodextrin in peritoneal dialysis can reduce the environmental impact. Compared to haemodialysis, haemodiafiltration may be water-saving when aiming for equivalent small and middle molecule clearance owing to its higher efficiency per litre of dialysate or substitution fluid[7]. Optimization of reverse osmosis settings, disinfection schedules, packaged acid and bicarbonate concentrate volumes, peritoneal dialysis effluent disposal systems, waste segregation, recycling and pathology testing schedules as well as use of remote monitoring and telehealth approaches can also improve the sustainability of kidney care.

Infrastructure choices are also important. Some haemodialysis machines and reverse osmosis systems are substantially more efficient than others and should be prioritized during upgrades. Further gains come from use of renewable energy, reuse of reverse osmosis reject water and use of central acid concentrate delivery (preferably via dry powder formulations).

Technological solutions include digital tools that target modifiable risk factors, such as wearable devices for physical activity tracking, cuffless blood pressure monitoring and platforms that support medication adherence. eHealth platforms can integrate data from these devices into electronic medical records. Point-of-care blood testing using micro-sampling devices may further support decentralized, lower-footprint care. In haemodialysis facilities, digital tools enable detailed monitoring of water and energy consumption to optimize resource use and operational efficiency. Portable regenerative devices for home haemodialysis and peritoneal dialysis hold promise for water, energy and transportation savings, though the ecological footprint of the regeneration cartridge may offset these benefits. Similarly, generation of peritoneal dialysate in patients' homes could reduce packaging, transport emissions and waste.

Technologies that enable reuse of spent dialysate are rarely applied in healthcare but may be of increasing importance as water scarcity intensifies. Forward osmosis is a potential water- and energy-efficient strategy for reuse of spent dialysate and dialysate production. Waste management innovations include on-site decontamination of biohazardous waste for conversion into recyclable resources and dialyzer regeneration machines that use environmentally safe cleaning processes.

The implementation gap

Despite these advances, meaningful change in practice has yet to materialize. Efforts to modify kidney disease trajectories remain inadequate, particularly in low-resource settings. Globally, only 54% of cases of hypertension are diagnosed and 21% of patients receive effective treatment; 61% of cases of diabetes are diagnosed and one-third of patients are undertreated; and 6–20% of people with CKD know that they have the disease[8]. Even after diagnosis, access to CKD care is often limited. In 2023, an international survey of nephrologists reported that 36% were unaware of indications for SGLT2 inhibitors and high medication costs limited the use of these drugs[9]. Transplantation is not available in 63% of low-income countries, and even in high-income countries, nearly half of eligible patients do not receive a transplant[10]. Supportive kidney care is available in only 53% of countries[10].

> "Meaningful change in practice has yet to materialize"

Furthermore, sustainable practices are poorly integrated into dialysis care. In Australia, despite long-standing engagement with green nephrology, only 7% of facilities include environmental training in staff induction, and fewer than 15% use renewable energy or recover reverse osmosis reject water[11]. In 2024, a global survey reported that only 22% of health care professionals were involved in sustainable kidney care initiatives and only 26% said that their organizations were taking action[12].

Barriers to innovation include limited funding for sustainability-focused research, insufficient resources for infrastructure (for example, for advanced reverse osmosis systems or decontamination equipment), regulatory constraints (for example, prohibitions on product reuse), and misaligned commercial incentives that prioritize short-term cost savings over sustainable investment. One potential solution is 'servitization' — a shift from selling products to providing services whereby suppliers of dialysis equipment and consumables remain responsible for maintenance and end-of-life management, thereby incentivizing more sustainable solutions.

Reasons for optimism

Some progress is being made, particularly in Europe and the UK, where supportive policy and regulatory frameworks integrate sustainability into procurement, service planning and oversight. The KitNewCare project is piloting clinical, organizational and technical interventions to reduce environmental impacts at four kidney centres and plans to scale to ten sites per European Union country within five years[13]. This project aims to reduce carbon emissions at each centre by at least 29% and develop evidence-based guidelines, training modules and workflow improvements to drive sustainable care. In the UK, the Centre for Sustainable Healthcare is helping kidney units to appoint 'green champions' to lead sustainability efforts and providing targeted guidance and resources to support these initiatives[14].

The International Society of Nephrology's GREEN-K initiative is a global partnership that advocates to embed sustainability into kidney care[5]. In particular, GREEN-K is developing a global sustainable procurement strategy for kidney care products and services. By aggregating demand across countries and institutions, this approach aims to give industry the commercial certainty needed to innovate. Most major nephrology societies have signalled intent to support the strategy.

Many national and regional societies have established green nephrology working groups, and most major nephrology conferences include dedicated sessions on environmental sustainability. In 2025, KDIGO hosted a Global Controversies Conference on green dialysis, which affirmed international recognition of the urgency and legitimacy of environmental sustainability in kidney care. We await recommendations from the conference.

Conclusions

Meeting the environmental challenge in kidney care requires a decisive shift from scattered efforts to system-wide action. Environmental sustainability must be treated with the same strategic focus that governments apply to economic policy and the same operational seriousness that the kidney care community applies to clinical outcomes and costs.

The case for action is clear, and the tools exist. What is now needed is the collective resolve to act.

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Competing interests

The authors declare no competing interests.