Addressing the Environmental Impact of Kidney Care

Amy Yau, John W.M. Agar, and Katherine A. Barraclough

Over the last 2 centuries, the world population has increased exponentially to reach 7.7 billion in 2019.1 The same period has seen increased economic prosperity in all world regions but particularly in developed nations.2 This combination of population and economic growth has led to unsustainable levels of natural resource consumption.3 It has also led to escalating carbon emissions and climate change, with the latter now considered one of the greatest threats to public health, economies, and way of life, worldwide.4,5

Climate change presents specific challenges for the nephrology community. Numerous studies have shown associations of extreme heat events with acute kidney injury.6 Increased ambient temperature is a well-recognized risk factor for kidney stone formation.7 Although the causation of the disease entity known as chronic kidney disease of unknown origin remains enigmatic, there is general consensus that heat stress and dehydration are involved, either as primary drivers or exacerbating injury from an unidentified environmental or infectious toxin.6,7 As global temperatures continue to climb during the rest of this century, we can expect to see vastly increased numbers with these conditions. We can also expect increased frequency and severity of climate-related disasters such as tropical cyclones and flooding events, with associated disruptions to health care delivery, including kidney care.6 Although socially and economically disadvantaged populations will be disproportionately affected by these climate change effects, no population will be immune from them.4,5

Alongside this, caring for patients with kidney diseases involves substantial resource use and greenhouse gas emissions. Specifically, hemodialysis (HD) is a water- and power-hungry therapy that produces vast amounts of waste.8 Data from the United Kingdom suggest that the carbon emission effect of thrice-weekly in-center HD is more than 7 times that of the average patient in UK health care.8,9 Although peritoneal dialysis (PD) uses less water and less power than HD, it requires the regular transport of plastic-packaged fluid across and between countries from the point of manufacture to the point of care. Thus, although its environmental impact has been poorly studied, it is also likely to be large.

A limited number of dialysis services worldwide have worked to test and implement strategies to minimize environmental impact (Table 1).10-15 However, uptake of “green nephrology” practice has been far from widespread.

As rates of kidney disease and demand for services grow globally, there is a need for a fundamental shift in the way that kidney care is delivered. The focus must be on reducing environmental impact while realizing the economic rewards that come with lower resource use. This will not only improve the long-term sustainability of kidney care but also ensure that it is delivered without inadvertently contributing to environment-related harm to health.

In our view, key steps to progress in this field include awareness building, improved collection of data pertaining to resource use across the range of kidney replacement therapies, solutions-focused research, and an improved regulatory and policy environment. Only with concerted effort across all these domains will we see the transformative change that is required.

Building Awareness

Increasingly, medical schools are embedding planetary health and environmental sustainability theory into curricula. However, there is no similar teaching in postgraduate medical education and training. Structured incorporation into nephrology training programs would encourage our trainees to develop the mindset to consider environment-health links and the sustainability impact of their everyday clinical practice. It would also ensure they have the knowledge and skills required for them to enact change.

There is also a key role for nephrology societies to play. Actions that would build awareness include prioritizing the inclusion of topic papers in society journals and
environmentally themed educational sessions in society meetings, designing new educational tools and programs, and identifying and supporting “champions” to spearhead this movement. Whereas some societies have taken preliminary steps in this direction, there is much further for them to go and other key societies must follow.

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<thead>
<tr>
<th>Individual Dialysis Services</th>
<th>Measures</th>
<th>Costs and Benefits</th>
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<tbody>
<tr>
<td>Australia</td>
<td>Installation of HD RO reject water capture and reuse infrastructure in the hospital and home settings</td>
<td>Investment costs of ~AUD $5,500 in the hospital setting and AUD $1,500-$2,000 in the home setting; savings of ~350 L of water per treatment¹</td>
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<tr>
<td>Australia</td>
<td>Installation of a solar power system on a home HD unit</td>
<td>Investment cost of AUD $16,219; 91% reduction in grid power consumption; 76.5% reduction in power costs; return on investment in 7-8 y</td>
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<tr>
<td>UK</td>
<td>Installation of RO reject water capture and reuse infrastructure in a new dialysis unit build</td>
<td>Investment cost of £2,500; annual savings of 4,492,000 L of water and £10,558²</td>
</tr>
<tr>
<td>UK</td>
<td>Installation of baling machine to compact cardboard and plastic waste</td>
<td>Investment cost of £3,500 and annual running cost of £587; annual diversion of 1 ton of cardboard and 4.2 tons of plastic from landfill; annual savings of 8.665 tons of CO₂e and £4,150</td>
</tr>
<tr>
<td>UK</td>
<td>Improved recycling and diversion of waste from clinical to domestic waste streams across 6 HD units</td>
<td>Annual savings of 86 tons of CO₂e and £15,567</td>
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<tr>
<td>Italy</td>
<td>Emptying of residual fluid from receptacles before their disposal; staff training in best practice waste management</td>
<td>Up to 7 kg less hazardous waste generated and an average of €10 saved per HD treatment</td>
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<tr>
<th>Fresenius Medical Care (NephroCare)</th>
<th>Measures</th>
<th>Costs and Benefits</th>
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<tr>
<td>Electricity</td>
<td>Individualized meters for measuring per–dialysis treatment electricity consumption; upgrade to more energy-efficient lighting; progressive replacement of dialysis machines to more energy-efficient alternatives; installation of motion detectors and timers to automatically control lighting; reduced facility size³; air conditioning programming; downsizing of administration offices; movement of a dialysis unit to a high environmental quality building</td>
<td>Reduction in electricity use from 23.11 to 16.26 kWh/session and savings of 92,400 tons of CO₂e over the 13-y study period</td>
</tr>
<tr>
<td>Water</td>
<td>Individualized meters for measuring per–dialysis treatment water consumption; progressive replacement of dialysis machines to more water-efficient alternatives; upgrades to water treatment systems</td>
<td>Reduction in water use from 801 to 382 L/session and savings of 17.5 tons of CO₂e over the 13-y study period</td>
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<tr>
<td>Care-related waste</td>
<td>Staff training in optimum waste management; caregiver training for waste sorting; regular audits</td>
<td>Reduction in waste from 1.77 to 1.11 kg/session and savings of 10,000 tons of CO₂e over the 13-y study period</td>
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<tr>
<th>UK Green Nephrology Programme</th>
<th>Measures</th>
<th>Costs and Benefits</th>
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<tr>
<td>Infrastructure projects</td>
<td>RO reject water capture and reuse; installation of baling machines for plastic and cardboard recycling; upgrades to more energy-efficient lighting; central delivery of acid for HD; retrofitting of heat exchangers to HD machines; upgrade to water treatment plant</td>
<td>Investment costs of £121,000; annual savings of 12 million L of water, 84 tons of CO₂e, and £57,000</td>
</tr>
<tr>
<td>Process innovations</td>
<td>Paperless laboratory reporting; waste reductions in food, linen, and dialysis consumables; improved waste segregation</td>
<td>No capital costs; annual savings of 183 tons of CO₂e and £186,000</td>
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<td>Model of care innovations</td>
<td>Increased use of telecommunications</td>
<td>Savings of 6 tons of CO₂e were estimated from 3 specific projects in their pilot phase⁴</td>
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Note: Based on data from Agar et al.,¹⁰ Agar et al.,¹¹ Connor et al.,¹² Heart of England NHS Foundation Trust,¹³ NHS Greater Glasgow and Clyde,¹⁴ Piccoli et al.,¹⁵ Bendine et al.,¹⁶ and Limb.²⁰

Abbreviations: CO₂e, carbon dioxide equivalents; HD, hemodialysis; RO, reverse osmosis; UK, United Kingdom.

¹Financial savings not reported or not quantified.
²Assuming unit running at full capacity.
³Investment costs and financial savings not reported.
⁴While remaining within the regulated floor surface to dialysis chair ratio for France.
Improved Data Collection

There is also a clear need for better characterization of baseline resource use and carbon emissions across the range of kidney replacement therapies. The very limited data that are available relate mainly to facility-based HD and are many years old, with the consequence that they fail to reflect inputs into and outputs from current machines and reverse osmosis systems. The environmental impact of home HD and PD has been examined in only 1 study each, and there has been no study of the effect of kidney transplantation. Targeted research should be encouraged and incentivized by national and international societies and governments alike. Without understanding our use, we cannot improve it.

There is also a need for the regular collection and reporting of resource use data by dialysis services. In 2005, NephroCare (the European network of dialysis units belonging to Fresenius Medical Care) began documenting electricity and water consumption and care-related waste production from each of its dialysis centers in France. This allowed for the development of key performance indicators and environmental improvement targets, as well as the formation of action plans to meet them. By 2018, power and water consumption and waste production across these units had decreased by 29.6%, 52.0%, and 38.9%, respectively (Table 1), although the yearly number of dialysis sessions had more than doubled, demonstrating the power of resource use data collection and reporting.

Furthermore, the resource and carbon impact of alternate models of service provision, such as increased use of home-based dialysis therapies or kidney transplantation, must be examined. Ideally, this work should be commissioned at the government level with results used alongside health outcome and financial cost data to inform decision making and service planning. This will ensure that health gains from kidney care are maximized for the available environmental and financial resources over time.

Notably, last year the US President signed an Executive Order for a sweeping set of initiatives collectively known as Advancing American Kidney Health (AAKH). AAKH aims, among other things, to markedly increase incident home dialysis use and kidney transplantation. In the design of AAKH, it seems that no consideration was given to the environmental effects of the proposed new care models. Given that natural resource constraints will without doubt increase over time with effects on costs, this is in our view a major omission.

Solutions-Focused Research

There has been little progress during the last 2 decades with regard to dialysis technologies. Although the efficiency of HD machines and reverse osmosis systems has improved somewhat, these remain water and power voracious. Consumable use for both HD and PD also remains high, with most items designed for single use and without the ability to be recycled, be repurposed, or to biodegrade at the end of life.

A need exists for meaningful collaboration between the nephrology community, industry groups, and other disciplines with the aim of finding solutions. Again, nephrology societies and government bodies can assist through facilitating collaboration, ensuring environmental improvement is firmly on the research agenda, and allocating funding accordingly.

The Regulatory and Policy Environment

However, above all, a supportive regulatory environment is needed to drive widespread change. This can disrupt entrenched attitudes and provide confidence and guidance to those leading the change. Supportive legislation will also typically accelerate the implementation and spread of environmentally sustainable practices and normalize them socially.

Illustrating this, the UK Climate Change Act 2008 requires that the country reduce its greenhouse gas emissions to net zero by 2050 from 1990 levels. It also requires the UK government to set legally binding emissions targets every 5 years and prepare and report on proposals for meeting them.

This legislation imposed a requirement on the UK health care system to set its own emission reduction targets. This led to the creation of a Sustainable Development Unit tasked with developing the tools, policy, and research required to deliver environmentally sustainable health care. The result has been remarkable reductions in UK health care emissions over time, as well as associated financial savings from reduced electricity and water consumption and waste generation that are now >£90 million annually.

Within this context, a UK “Green Nephrology Programme” was established in 2009 to drive environmental improvements in kidney care. With the support of the Sustainable Development Unit, this program surveyed baseline practice, drove environmentally focused research, and worked with stakeholders, particularly those delivering care at the local level, to test and implement a range of infrastructure projects, process innovations, and alternative service models (Table 1). By so doing, it succeeded in dramatically shifting both practice and culture within UK dialysis services to a degree not seen previously.

Unfortunately, a supportive regulatory environment is still lacking in many countries, including in our home countries. In our view, this is above all due to entrenched ideologies at the government level, backed by dubious economic arguments surrounding the costs of decarbonization and other environmental protection without due consideration of the potential for costs savings from acting or the losses of inaction.

In countries such as ours, change at the government level is most likely to follow increased pressure from civil society. Health care professionals can be powerful advocates for change, in part because of their social standing...
but also because of the power of the message that environmental protection is a requisite for health. National nephrology societies can also be powerful advocacy bodies and so must push for environmentally focused legislation and policy platforms.

In the absence of a supportive regulatory environment, policy reform can still occur at the institutional and/or kidney care service level. For instance, local policies should mandate the collection of resource use data, require that environmental and social effects are considered alongside financial costs when procuring goods and services, ensure that service contracts with provider companies include environmental clauses, and specify that new facilities and major redevelopments aim for a best practice level of environmental performance, including applying proven water and energy efficiency measures and principles of passive ecobuilding design.

Conclusion
As the climate crisis accelerates and the demand for kidney care grows, there is a pressing need to address the resource use and carbon profile of kidney care delivery. This will require fundamental changes to attitudes, institutions, and practices. Although there is a large role for the nephrology community to play in building awareness and driving change, government leadership is also vital. When this is lacking, it is our view that it is incumbent on the nephrology community to push for this.

Article Information

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Support: None.

Financial Disclosure: Dr Barraclough has received research grants from Fresenius Medical Care and Baxter Healthcare. The other authors declare that they have no relevant financial interests.

Peer Review: Received April 27, 2020, in response to an invitation from the journal. Evaluated by 3 external peer reviewers, with direct editorial input from the Feature Editor and a Deputy Editor. Accepted in revised form September 2, 2020.

Publication Information: © 2020 by the National Kidney Foundation, Inc. Published by Elsevier Inc. All rights reserved. Published online November 7, 2020 with doi 10.1053/j.ajkd.2020.09.011

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