ISN GREEN NEPHROLOGY TOOLKIT

Emerging Leaders Program (ELP) Second Cohort
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International Society of Nephrology

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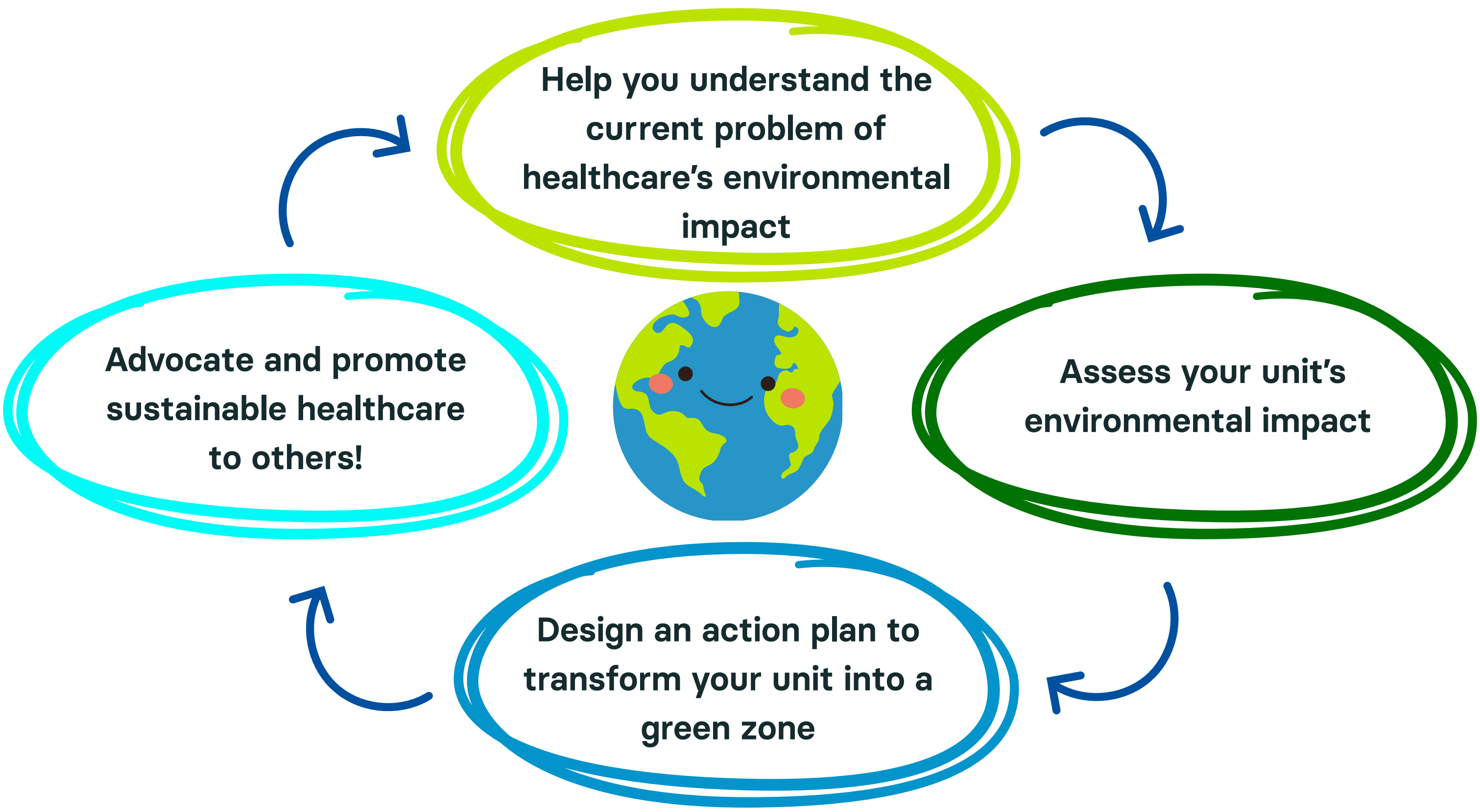
1. ABOUT THE TOOLKIT

For decades we have known about the environmental impact of healthcare. During this time, many countries have made formal commitments to deliver health-related services in a more environmentally sustainable way. These strategies can only be delivered if health care providers adopt them. To enhance awareness, provide knowledge and offer a framework to facilitate the implementation of straightforward yet impactful changes to achieve environmentally sustainable kidney care, the ISN Emerging Leaders Program[1] Cohort 2 have developed this Toolkit, which is supported by the GREEN-K steering committee[2] (an ISN-led international, joint initiative of leading national and regional kidney societies on environmentally sustainable kidney care). This Toolkit is aimed at all healthcare professionals interested in implementing sustainable change in their healthcare facility. It provides the necessary knowledge and framework to support you to implement simple but significant changes in your setting. The “Green Nephrology Cycle” allows you to join at any stage.



ABOUT US

1.1 EMERGING LEADERS SECOND COHORT

We are the 2022-24 cohort of the ISN Emerging Leaders Program, a collaborative leadership initiative for early-career professionals. We chose to focus our efforts on promoting the implementation of environmentally friendly practices in kidney care[3] in the fight against climate and broader environmental change.

The cohort is mentored by Professor Vivekanand Jha and supported by ISN staff Dr Charu Malik (Executive Director of the ISN) and Anh Tran (ISN Programs Coordinator).

We hope you find this resource useful.
The ISN Emerging Leaders Cohort 2022-2024.

Chairs of the Green Nephrology Toolkit

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1.2 ISN GREEN-K INITIATIVE

The 'GREEN-K' initiative – Global Environmental Evolution in Nephrology and Kidney Care – has a vision of 'Sustainable kidney care for a healthy planet and healthy kidneys', and mission to 'Promote and support environmentally sustainable and resilient kidney care globally through advocacy, education, and collaboration'.

STEERING COMMITTEE

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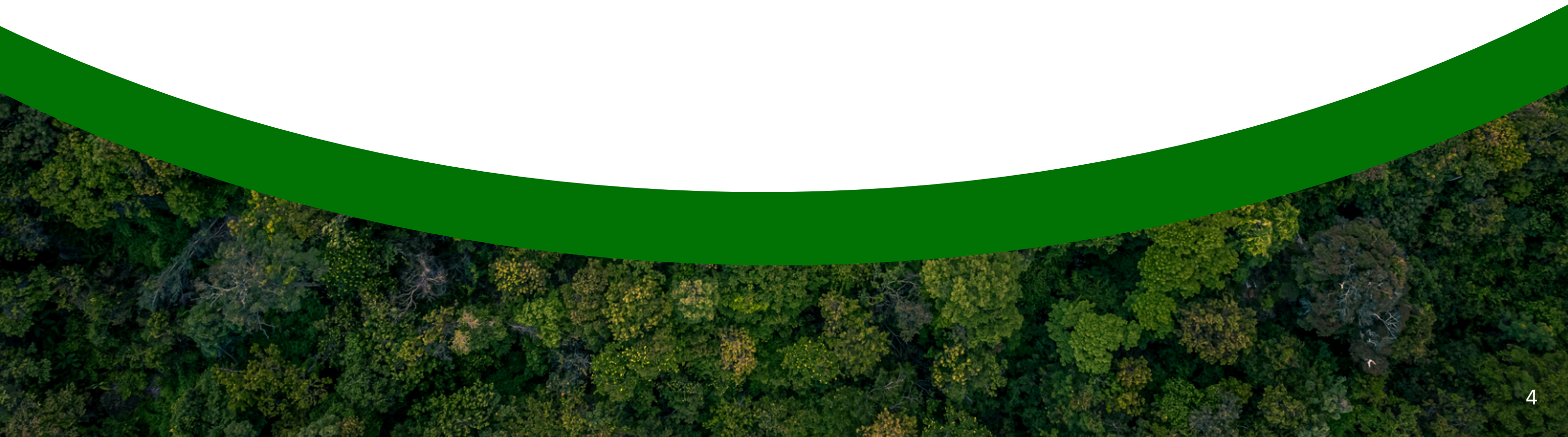
2. THE ENVIRONMENTAL IMPACT OF KIDNEY CARE

The accelerating environmental degradation resulting from modernization and climate change is an urgent threat[4] to human health. Indeed, we are already experiencing a surge of heat stress related acute kidney injury and possibly kidney diseases from vector-borne diseases[5] across the globe. Extreme weather has resulted in the loss of human lives and extensive damage to both infrastructure and landscapes. Water scarcity and declining biodiversity also negatively affect human health. Climate change[6] is rapidly and irreversibly changing our planet and it is imperative that we urgently reduce a wide range of environmental impacts, including greenhouse gas emissions, water usage, and waste production.

The healthcare sector[7] is an important contributor to climate change and environmental decline. The sector has a large carbon footprint, contributing an estimated 4% - 6% of global greenhouse gas emissions, and as high as 8% in some high-income countries. Medical supply chains account for 70% of this carbon footprint. Kidney care is certainly no different and contributes significantly to the carbon footprint. As one example, hemodialysis requires repeated, high usage of energy, water supply, and produces significant quantities of waste, making dialysis a significant contributor to environmental harm. The problem was exacerbated by the recent COVID-19 pandemic, which created a superimposed wave of medical waste in the face of single-use personal protective equipment and diagnostic tools.

As recognition of the environmental impact of health care has grown, many countries have made a formal commitment to providing health-related services in a more environmentally sustainable way. Transitioning to “green healthcare” involves improving the environmental sustainability of healthcare, through changing practices and the utilization of available resources in an eco-friendly manner. This commitment includes reducing unnecessary consumption of resources, using renewably sourced power, and investing in preventative care. However, creating sustainable health care is challenging, requiring parity between the necessity to deliver high-quality care and addressing the needs of the environment.



Contrary to common misconceptions, adopting "green nephrology"[8] policies can actually be cost-effective, through better water and electricity savings in addition to reducing waste and carbon footprints. For example, the Green Nephrology Network, an NHS Sustainable Healthcare Programme in the United Kingdom, has saved an estimated 10 million pounds in their healthcare system annually as the result of environmentally friendly water and electricity saving initiatives. Indeed, one dialysis unit reported savings of up to 4 million liters of water per year with a new, more efficient water treatment system[9].

As an initiative of the ISN, our group (ISN-ELP cohort 2) conducted a scoping review[10] and observed a lack of data documenting the viewpoints of healthcare professionals (HCPs). The scoping review, as based on 381 of 13987 references screened, highlights a paucity of published original research while showing a marked increase in the number of publications on the subject in the last few years albeit predominantly in the form of opinion pieces and reviews from HCPs.

We also conducted a survey[11], and discovered that a significant proportion of HCPs (98% of the 972 participants) in nephrology acknowledge climate change and express concerns about its impact. Yet, only a small fraction is involved in initiatives to combat climate change effects on kidney health (14%) or initiatives in sustainable nephrology (22%). Over half of the participants in our survey did not feel knowledgeable on these subjects.

Based on the insights garnered from this data, ISN-ELP cohort 2 has crafted this toolkit with the objective of enhancing awareness and offering a framework to facilitate the implementation of straightforward yet impactful changes in promoting sustainable care within nephrology.

Remember that becoming environment-friendly is an ongoing process, and it requires commitment and participation from everyone involved.

3. IMPORTANCE OF PREVENTION

Before even considering delving into this toolkit, which mostly focuses on dialysis practices, it is important to bear in mind that prevention of chronic kidney disease (CKD) is perhaps the most effective way to reduce the environmental impact of kidney care by decreasing the need for resource intensive treatments like dialysis.

CKD prevention involves early screening and detection, appropriate and prompt use of effective therapeutic agents, lifestyle modifications with balanced diet and regular physical activities, and smoking cessation. Although the production of these effective drugs has its inherent environmental footprint, the net greenhouse gas balance is beneficial[12].

Other means include the promotion of kidney transplantation[12] and home-based dialysis[13]. Transplantation has the lowest environmental burden among all of the kidney replacement therapies. Home-based dialysis, such as peritoneal dialysis, carries a much-reduced environmental burden as compared to in-center dialysis. Even for home hemodialysis, studies have shown that most regime (except long daily dialysis with high dialysate flow rate) may be beneficial for quality of life, clinical outcome, and reduced environmental impact, as compared to in-center dialysis and even automated peritoneal dialysis[14].

De-prescribing[15] is also very important in reducing the environmental impact of healthcare. The pharmaceutical industry has a significant carbon footprint. By minimizing unnecessary medication use, de-prescribing can lower the carbon footprint associated with drug manufacturing, packaging, transportation, and disposal, as well as reducing the amount of pharmaceutical waste entering the environment. A UK study estimated that a 5% reduction in drug consumption in a 200-bed hospital could reduce greenhouse gas emissions by over 100 tones annually, equivalent to thousands of car trips[16].

All of these should be encouraged and done concurrently with improving the sustainability of kidney and dialysis care!

4. ASSESS THE CARBON FOOTPRINT OF YOUR UNIT

There are many compelling reasons to estimate the carbon footprint in your unit. By estimating the carbon footprint:

- it allows you to identify major sources of emissions in your unit, such that relevant stakeholders can be informed and actions be taken to reduce these emissions

- it allows you to quantify the amount of greenhouse gases emitted in your unit, which can then be assessed against a reduction target set by you or according to your local regulations
- the quantified amount can be used for comparison regularly and benchmarking among peers locally and internationally through an envisioned registry in the future

One commonly used method is the "Life cycle assessment (LCA)", which has emerged as the gold standard environmental impact methodology, with quantification of a comprehensive suite of environmental impact of products, processes, and services.

It aims to evaluate the environmental impact generated directly and indirectly by an activity over all the stages of its lifecycle, from the extraction of raw materials such as gas and iron ore, to the manufacturing and distribution of goods, through the treatment itself, and then the waste handling and end-of-life of all products.

The International Organisation for Standardisation (ISO) has developed a standardized framework for conducting an LCA[17]. In fact, they have developed a series of frameworks which provide more sophisticated tools for quantifying, monitoring, reporting and validating or verifying of greenhouse gases emissions and removals.

LCA has been applied in a dialysis unit. Sehgal et al. recently assessed the carbon footprint arising from 209,481 in-center hemodialysis treatments across 15 units in the US[18]. They were able to quantify the footprint and found that the annual emissions per facility averaged 769,374 kg CO2-eq (95% CI, 709,388 to 848,180 kg CO2-eq), equivalent to emissions from the annual energy use in 93 homes; and emissions per hemodialysis treatment are equivalent to driving an average automobile for 238 km (149 miles)! These values may be higher than other regions such as Europe, which use more renewable energy source than coal and gases.

Importantly, they were able to demonstrate a substantial variation in carbon footprints across these 15 facilities run by the same organization, which presents potential opportunities to reduce emissions. However, one would need an environmental scientist to be able to perform a full LCA well. Thus, it is easier to simply use currently available online calculators[19] to estimate your carbon footprint. Regardless, one can always start by tracking your resource usage (energy, water, waste) and then work to reduce these.

Here are some basic steps to get you started:

4.1 IDENTIFY THE SOURCES OF CARBON EMISSIONS:

Before you can calculate the carbon emissions in your unit, you need to identify the sources of emissions. This may include electricity consumption, heating and cooling, transportation of staff and patients, use of medical equipment, and waste management.

In order to be comprehensive, you may perform a complete LCA by analyzing the entire life cycle of the services, “from the cradle to the grave” approach. However, it is also possible to assess specific life cycle stage(s) focusing on a particular area of emissions of interest.

4.2 COLLECT RELEVANT DATA ON ENERGY CONSUMPTION:

To calculate the carbon emissions from energy consumption, you will need to collect data on the unit's energy use. This may include data on electricity consumption, natural gas and fuel oil use.

4.3 CALCULATE CARBON EMISSIONS:

Once you have collected the data on energy consumption, you can use emission conversion factors to calculate carbon emissions. For example, the global power sector produced on average 0.481kg of CO_2 emissions for every 1 kWh of electricity generated in 2023.

For further details of the emission conversion factors, you could refer to the yearly updated Emission conversion factors for greenhouse gas reporting, produced by the Department for Environment Food & Rural Affairs (DEFRA)[20] from the UK Government. Better yet, this in-center HD carbon calculator[21] would be a very good resource to start your calculation!

4.4 CONSIDER OTHER SOURCES OF EMISSIONS:

In addition to energy consumption, there may be other sources of carbon emissions that need to be considered, such as transportation and waste management. For example, you may need to calculate emissions from staff commuting to work or emissions from the disposal of medical waste.

There is no simple equation to calculate exact carbon emissions from transport, as the emissions depend on several factors such as the type of vehicle, fuel efficiency, distance travelled, and the type of fuel used.

However, the following simplified equation can be used to estimate carbon emissions from a particular journey, using data of emission factor from DEFRA:

$$\text{Carbon emissions} = \frac{\text{Distance travelled} \times \text{Vehicle emission factors}}{\text{Number of passengers}}$$

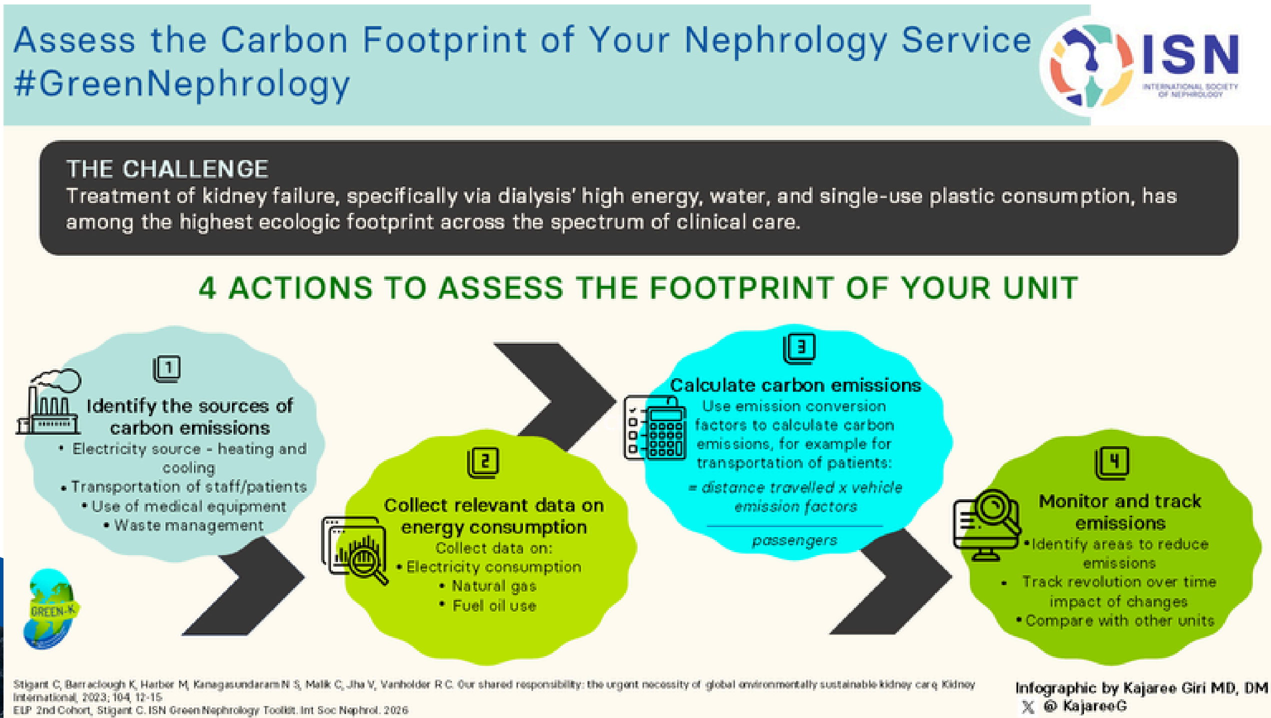
Where:

- Distance travelled is the total distance covered by the vehicle in miles or kilometres.
- Vehicle emission factors depending on the type and size of the vehicle
- Number of passengers is the total number of people in the vehicle, including the driver.

This equation assumes that all carbon emissions come from the fuel burned by the vehicle, and it does not account for other emissions sources such as manufacturing and disposal of the vehicle, maintenance, and infrastructure.

4.5 MONITOR AND TRACK EMISSIONS:

Once you have calculated the carbon emissions of your unit, it is important to monitor and track these emissions over time. This will help you identify areas where you can reduce emissions and track the impact of any changes you make. As mentioned, this value can be used to compare against a reduction target set by you or according to your local regulations, and for benchmarking among peers locally and internationally!



ADDITIONAL RESOURCES

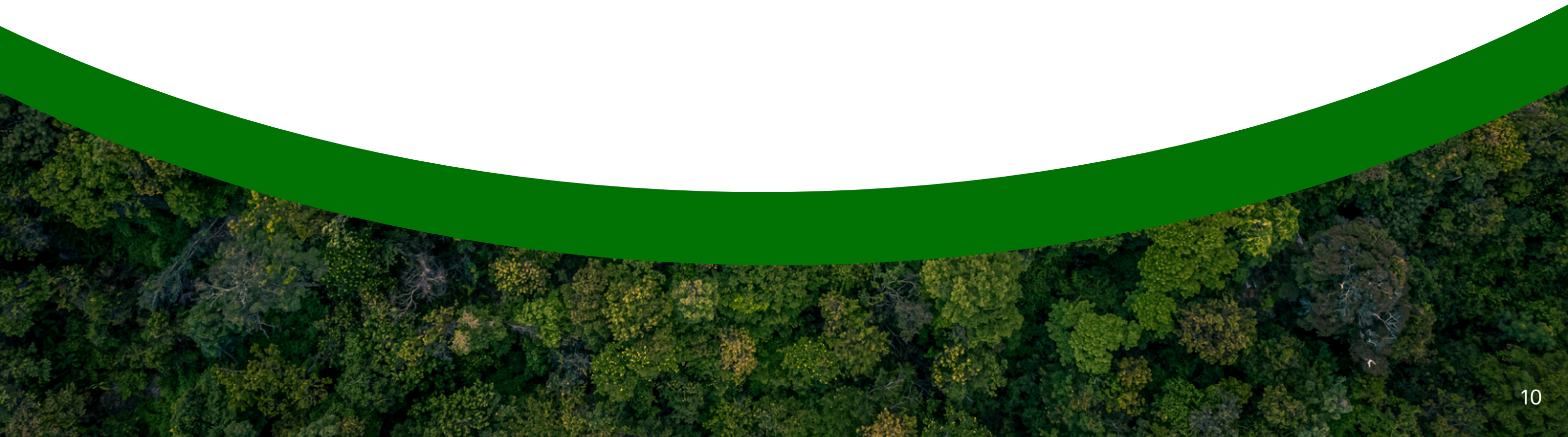
1. “Climate Impact Checkup" by Health Care Without Harm and Global Green and Healthy Hospitals[20]. This resource provides a detailed guide to calculating carbon emissions in the healthcare sector, including hospitals. It includes information on how to collect data on energy consumption, transportation, and waste management, and how to calculate emissions from these sources.

2. "Greening Health Care: How Hospitals Can Heal the Planet" by Kathy Gerwig[22]. This book provides practical guidance on how hospitals can reduce their environmental impact, including carbon emissions. It includes case studies of hospitals that have successfully reduced their emissions and offers tips on how other hospitals can follow their example.

3. "Carbon footprinting in healthcare" by the NHS Sustainable Development Unit[23]. This resource provides guidance on how to calculate carbon emissions in the healthcare sector, including hospitals. It includes information on how to collect data on energy consumption and transportation, and provides conversion factors for calculating emissions[24].

4. "Greening Office Toolkit: For Clinicians and Office Managers" by The Canadian Coalition for Green Health Care[25]. This toolkit provides guidance on how hospitals can reduce their environmental impact, including carbon emissions. It includes information on how to calculate emissions from energy consumption and transportation, and offers tips on how to reduce emissions in these areas.

5. "Healthcare Emissions Impact Calculator" by the Health Care Without Harm and Practice Greenhealth[26]. This online tool helps hospitals calculate the carbon emissions associated with their energy use. It includes data on electricity consumption, natural gas use, and fuel oil use, and provides conversion factors for calculating emissions.



Resources from the EPA:

- How to Conduct a Records Examination
- Use this worksheet to record data on waste generation at your facility and cost information

5.2 FACILITY WALK THROUGH

A facility walk through is literally as it states: a tour walking through your organization's facility, while observing the different activities in the visited area and talking with employees/managers about waste-producing activities and equipment. This is a relatively quick and simple way to examine a unit's waste generation and disposal practices. It also provides an opportunity to observe the connection between the types of waste generated and the actual waste-generating activities or processes.

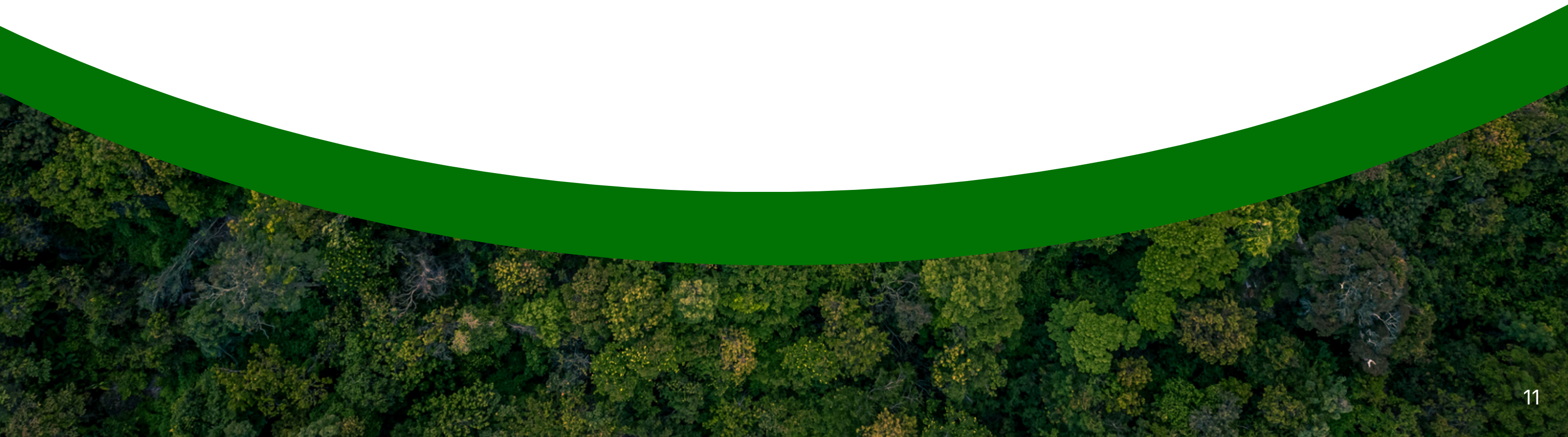
Specifically, a walk through will allow the team to:

- Observe the types and relative amounts of waste produced
- Identify waste-producing activities and equipment
- Detect inefficiencies in operations or in the way waste moves through the organization
- Observe the layout and operations of various departments
- Assess existing space and equipment that can be used for storage, processing recyclables, and other activities
- Assess current waste reduction efforts
- Collect additional information through interviews with supervisors and employees

The strengths of using this method are that it:

- Allows first-hand examination of facility operations
- Provides qualitative information about major waste components and waste-generating processes, which may allow comparison with other units
- Reveals waste reduction opportunities
- Requires less time and effort than sorting waste

Similar to record examination, this method may not identify all the wastes generated in the facility and may not be an actual representation (given waste-producing activities in a unit may vary throughout the time of the day) if the walkthrough is only conducted once and not regularly.



Resources from EPA:

- How to Conduct a Facility Walk Through
- Record the details of your facility walk-through on this worksheet

5. ESTIMATE WASTE PRODUCED IN YOUR UNIT

A waste assessment helps to identify waste generated at a facility; estimate the amount and types of waste produced; and, review current waste reduction practices to assess their effectiveness, such that particular areas in which waste reduction efforts will be most effective can be identified.

The United States Environmental Protection Agency (EPA)[27] has provided very nice templates/aids for the three common approaches in conducting a waste assessment.

5.1 RECORDS EXAMINATION

Records examination can provide insights into your unit's waste generation and removal practices/patterns. Furthermore, reviewing such records over a period of time may reveal pricing and waste volume trends that can help inform the unit's next waste and recycling contract.

In order to perform such methods, one would need to review the unit's various records:

- Purchasing, inventory, maintenance, and operating logs
- Previous supply, equipment, and raw materials invoices
- Waste hauling and disposal records and contracts
- Contracts with recycling facilities and earned revenues from recycling

The strengths of using this method are that:

- A total weight/volumes of waste generated can be estimated
- A major potential waste product can be traced back to the point of origin
- The most costly waste can be identified
- The financial benefits of reuse/recycling including total revenues can be documented and reviewed, which reinforces the importance of reuse/recycling through subsequent cost-benefit analysis.

This method requires less time and effort than the other approaches. However, there are limitations. This method may not provide quantitative data about specific waste components; it also may not provide qualitative data on how or why wastes are generated; and, it may require substantial effort to collect and analyze data.

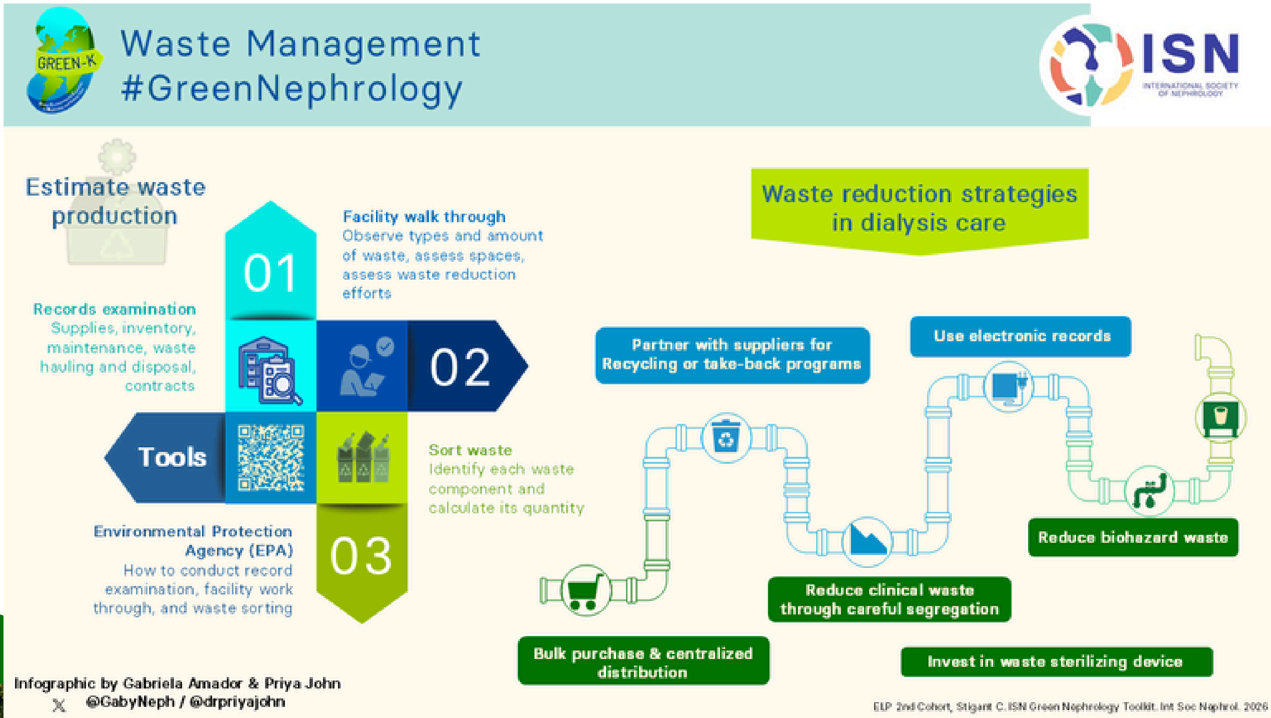
5.3 WASTE SORT

A waste sort involves the physical collection of all the waste generated in a specific time period (e.g. in a day) and the sorting and weighing of the representative sample of your organization's waste. One could decide whether to perform the waste sort for the entire facility’s workflow or a specific aspect/ area of operation. The goal is to identify each waste component and calculate its percentage of your organization's total waste generation. The strength of this method is that it provides quantitative data on the total waste generation and/or specific waste components.

However, this method requires considerably more time and effort than the other approaches. It also may not be representative especially if it is done for one day only, as waste generation may vary significantly each day. Multi-day sampling may provide a more accurate representation of your organization's waste generation. Finally, this method does not provide qualitative data on how or why wastes are generated.

Resources from EPA:

- How to Conduct a Waste Sort
- Record the findings of your waste sort on this worksheet



6. DESIGN AND IMPLEMENT AN ACTION PLAN

6.1. IN YOUR UNIT

Once the carbon footprint and the waste product generated in your unit has been estimated, one could evaluate the impact, and implement strategies to reduce energy, water usage and waste generation, through changing practices and utilizing available resources in a more environmentally sustainable way. Examples would include minimizing waste generated in procurement and improve efficiency in waste disposal.

Turning your nephrology department into an environmentally-friendly one involves adopting environmentally sustainable practices that reduce your carbon footprint and promote eco-friendly initiatives. Here's a step-by-step action plan to help you achieve this goal (another nice example is the CASCADES[28] Canada effort):

1. **Conduct an Environmental Audit:** Begin by assessing your current practices and identifying areas where improvements can be made. Look into energy consumption, waste generation, water usage, and purchasing habits. This audit will serve as a baseline to measure your progress.
2. **Form a Green Team:** Assemble a team of motivated individuals from different departments who are passionate about sustainability. This team will be responsible for leading the green initiatives and promoting eco-friendly practices throughout the department.
3. **Set Green Goals and Targets:** Establish clear and achievable environmental goals and targets for the department. These should be specific, measurable, attainable, relevant, and time-bound (SMART) objectives. Examples include reducing energy consumption by a certain percentage, minimizing water wastage, and recycling a specific amount of waste.
4. **Educate Staff and Patients:** Raise awareness among the department's staff and patients about the importance of going green. Conduct workshops, seminars, or distribute informational materials to educate everyone on eco-friendly practices and their benefits.

5. **Energy Efficiency Measures:** Identify ways to improve energy efficiency within the department. This may include:

   a. Replacing old equipment with energy-efficient models.
   b. Using energy-efficient lighting (LEDs).
   c. Encouraging staff to turn off lights and equipment when not in use.
   d. Implementing a policy for optimizing heating, ventilation, and air conditioning (HVAC) settings.
   e. Try to find or install clean energy sources.

6. **Waste Management and Recycling:** Implement a comprehensive waste management program. Set up clearly labelled recycling bins for paper, plastic, glass, and other recyclables. Minimize single-use items and encourage the use of reusable alternatives such as stainless steel or glass containers.

7. **Water Conservation:** Promote water-saving practices in the department, such as reviewing reverse osmosis (RO) machine settings, re-purpose RO reject water, fixing leaks promptly, installing water-saving faucets, encouraging, encouraging staff to use water judiciously and installing a water salvaging system.

8. **Green Purchasing Policy:** Develop a green purchasing policy that prioritizes eco-friendly and sustainable products. Choose medical supplies and equipment that are energy-efficient and have minimal environmental impact.

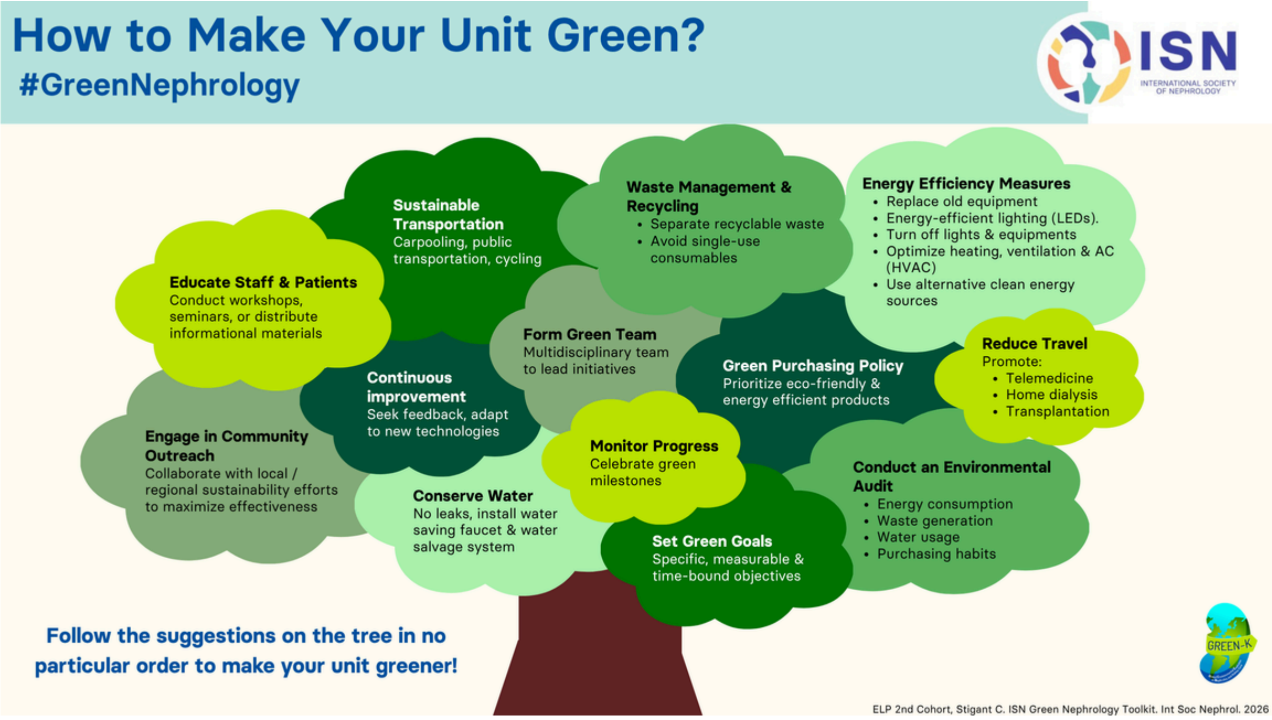
9. **Sustainable Transportation:** Encourage staff to use sustainable transportation options, such as carpooling, public transportation, or cycling to work.

10. **Promote Telemedicine:** Whenever possible and appropriate, promote the use of telemedicine to reduce the need for patients to travel to the clinic, thereby cutting down on transportation emissions.

11. **Engage in Community Outreach:** Extend your green initiatives beyond the department by participating in community events focused on sustainability. Collaborate with local environmental organizations to make a broader impact.

12. **Monitor and Celebrate Progress:** Regularly track your progress toward achieving your green goals. Celebrate milestones and successes, with possibility to compare and collaborate with other units, to boost morale and motivate everyone to continue their efforts.

13. **Continuous Improvement:** Keep the green team active and continuously seeking ways to improve sustainability practices within the department. Adapt to new technologies and best practices as they emerge.



6.2. POSSIBLE ACTIONS IN YOUR REGIONAL/NATIONAL SOCIETY

While the steps above are mostly focused on setting up a green team in your **local center**, the GREEN-K initiative has also written a roadmap for anyone considering setting up an environmentally sustainable kidney care program/committee at a **regional** society level.

FIRST STEPS

- **Engage a colleague(s).** Widespread change is more than what one dedicated person can achieve alone, and collaborating with others not only makes the process more effective but also more enjoyable.

- **Consider the health and kidney care delivery vulnerabilities posed by climate change in your region.** Such threats may vary from floods to water scarcity to emerging pathogens to plastic waste management, or supply chain interruptions. When framed as a key component of addressing local challenges integral to the improvement of the health of people living with kidney disease, the necessity of environmentally sustainable kidney care (ESKC) will be better understood.

    - Identify local or regional sustainability challenges and priorities. A basic understanding of your region's societal and health systems' environmental ambitions, regulations, and decarbonization/ resiliency targets and/or legal framework provides additional impetus for involvement.

- **Propose an ESKC themed committee**. Approach your National / Regional Society with the proposal of an ESKC themed committee. A well-structured proposal should include: (1) a clear definition of the problem and the urgency of addressing it, (2) identification of key areas for targeted intervention, (3) an outline of the resources required (if any), and (4) a summary of the anticipated benefits to your society—such as enhanced reputation, increased member engagement, and potential financial advantages. Referencing similar committees established within other societies can help normalize the concept and improve the likelihood of a positive reception.

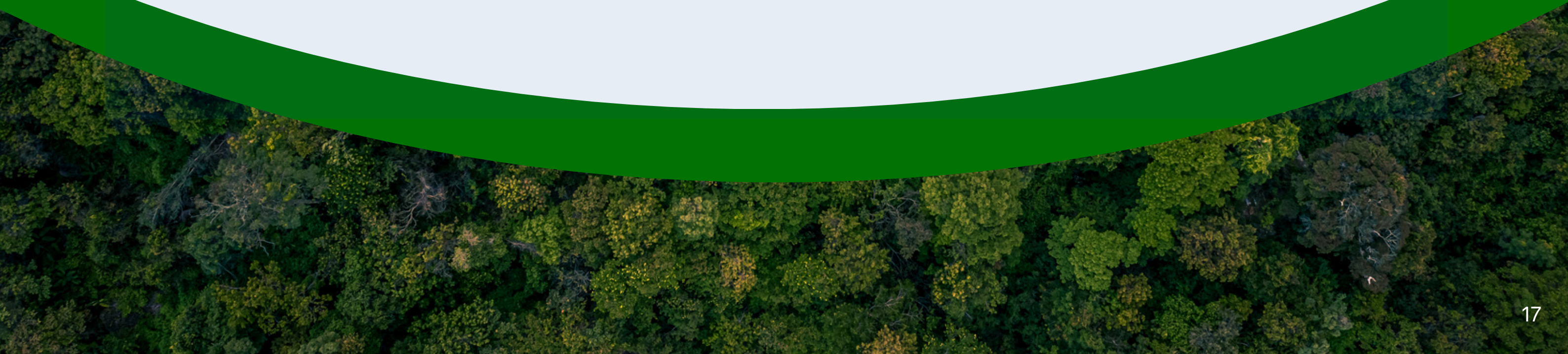
  If full committee status is not feasible, consider continued networking both within and beyond your society (continued education, presenting at rounds, undertaking a sustainability themed quality improvement initiative, informal or project-specific networking with similarly motivated colleagues in your jurisdiction (including those with expertise in planetary health and/or professionals with sustainability knowledge across diverse specialties), and/or collaborating with international colleagues on specific projects).

- **Seek broad representation.** Once a committee is approved, it is beneficial to obtain broad representation of motivated practitioners by both geography and discipline (administrative, technical, nursing, and physician, patients). This fosters the creation of region-wide bi-directional communication networks that allow stakeholders to communicate and amplify sustainability innovations to the greater network, hence mobilizing knowledge and action across the entire Society.

  An additional key recommendation is that trainees should be purposefully involved. Actively engaging them in ESKC-themed quality improvement initiatives not only supports leadership development but also serves as an effective mechanism for generating and disseminating new knowledge across the network. Ideally, environmental sustainability should be included in nephrology teaching and training curricula.

- **Set the tone for your committee**. Regions that have recently established ESKC programs inform that grounding in planetary health ethics and principles is a motivating and orienting initial step[28].

  Create ethics-centerd vision and mission statements – committee discussions are imperative to ensure all become invested in the shared purpose. Consider taking the Planetary Health Pledge[29], and consider organizational endorsement of the Sao Paolo Declaration on Planetary Health[30].



- **Develop an action plan.** Seek inspiration through perusal of international colleagues' / committees' websites. These can provide information on what sustainability ideas, workstreams, and implementation are prioritized and effective in other settings, and in turn, provide you with direction about where to start. Reach out to international colleagues if you require more detail about initiatives – knowledge sharing and collective learning are critical. To get 'runs on the board', it is often wise to start simple initiatives that are likely to succeed, do not require capital input and may in fact save money.

- **Ensure that support is built into the process from the outset.** While ESKC involvement and practice can be incredibly rewarding, and a very positive antidote to the ecological grief experienced by many in its growing workforce, it can also be challenging for many reasons. Lean on and support colleagues as we together work toward a more positive vision of our shared future.

SUBSEQUENT STEPS

Specific actions that ESKC committees (and when appropriate per regional norms in conjunction with their Societies) can take, inspired by experience and the foundational thinking of the GREEN-K steering committee[31]:

a) Research and knowledge generation:

- Request that your Society formally recognizes ESKC / 'green nephrology' as a dedicated research field
- If no member(s) has stepped forward, consider nominating a sustainability lead or group
- Develop and disseminate existing ESKC teaching materials, and facilitate the development of environment-oriented teaching curricula for kidney care providers (administrators, technicians, nurses, and physicians) at both undergraduate and postgraduate stages of training
- Inform the local kidney care community about the emerging national and international regulatory requirements for health system decarbonization, water conservation, environmental sustainability, climate resilient health systems, phasing out of toxic chemicals, and circularity/ waste minimization, as these can help position ESKC where it belongs, as a new standard of quality kidney care
- Appeal for dedicated funding for ESKC themed projects
- Encourage active research in ESKC, and for ESKC researchers to promote and profile their findings at academic symposia (local, regional, and international)
- Encourage your Society to establish an annual research prize recognizing the highest quality environmentally focused research conducted by its members.
- Encourage your Society to include environmentally themed presentations, including from keynote speakers, at local and national conferences
- Promote development of new processes, incentives, and competencies for reducing carbon footprint of clinical trials in nephrology, and expanded skills in knowledge and processing of environmental data
- Seek potential secondary benefits of environmentally responsible practices, such as economic savings and positive social impact
- Encourage Society to organize case sharing and benchmarking for collaboration and comparison among units of the region

b) Clinical practice, care pathways, and practice standards:

- Promote the patient, cost, and environmental benefits of early diagnosis, prevention of progression, and uptake of transplantation and home dialysis
- Develop, broadly disseminate, and iteratively update high-impact recommendations for low carbon kidney care

- Encourage education and empowerment of people living with kidney disease to expect and demand sustainable care provision and optimal stewardship of kidney care therapies without affecting their quality of life
- Promote creation of green kidney care champions in all regions, and call for dedicated funding or expense reimbursement scheme for these position(s)
- Stimulate national and regional kidney care Societies to develop green kidney care action plans that are aligned with local, national, and/or international standards
- Stimulate national and regional kidney care Societies to develop climate resilient / disaster mitigation and response plans that are aligned with local, national, and/or international standards
- Consider development of ESKC practice checklists or scorecards to aid implementation

c) Identify, collect, and iteratively improve the process improve via key performance indicators:

- Encourage the development of energy and emissions monitoring, and data collection and reporting systems, and promote sharing of these data
- Develop a publicly available repository of environmental performance metrics, allowing comparison between units, programs, and regions
- Encourage embedding of Sustainability in Quality Improvement within health care improvement programs and advance practitioner literacy in this field
- Consider use of available emissions calculators[19]

d) Engage and collaborate with non-nephrology sustainability networks to 'de-silo' expertise, and amplify sustainability practices:

- Hospital environmental committees
- Regional health authority sustainability programs
- Planetary health community and practitioners in other disciplines (i.e. medical practitioners in other specialties, climate scientists, engineers, polymer chemists, toxicologists)
- Establish communications network for regular practice and knowledge sharing between expert / practitioner groups in different settings

e) Develop procurement pathways and standards for medications, dialysis equipment, and consumables, and communicate these standards broadly, highlighting that 70% of healthcare emissions arise from supply chains[32]:

- Reach out to those involved in procurement in your healthcare area to develop an understanding of the key decision makers and the processes and regulations governing procurement.
- Communicate with regional industry representatives to learn what ESKC products and services are available. If not currently available, identify non-industry / non-market barriers to their availability.
- Consider joining GREEN-K's sustainable procurement strategy, and advocate for your Society to endorse, and procure, using the GREEN-K Joint Statement of Procurement to industry for innovative ESKC products and services*
- Advocate for and promote industry-aided transition to low carbon and zero waste dialysis therapies via:
  - Strategic procurement
  - Well-publicized green industry challenges

f) Create climate resilient kidney care systems:

- Facilitate conversations within the global kidney care community for developing resilience, adaptation, and mutual aid systems within kidney care pathways in face of future climate and social shocks, aided by the experience of kidney care practitioners[33]

g) Network with ISN regional representatives to link with the global community of ESKC providers.

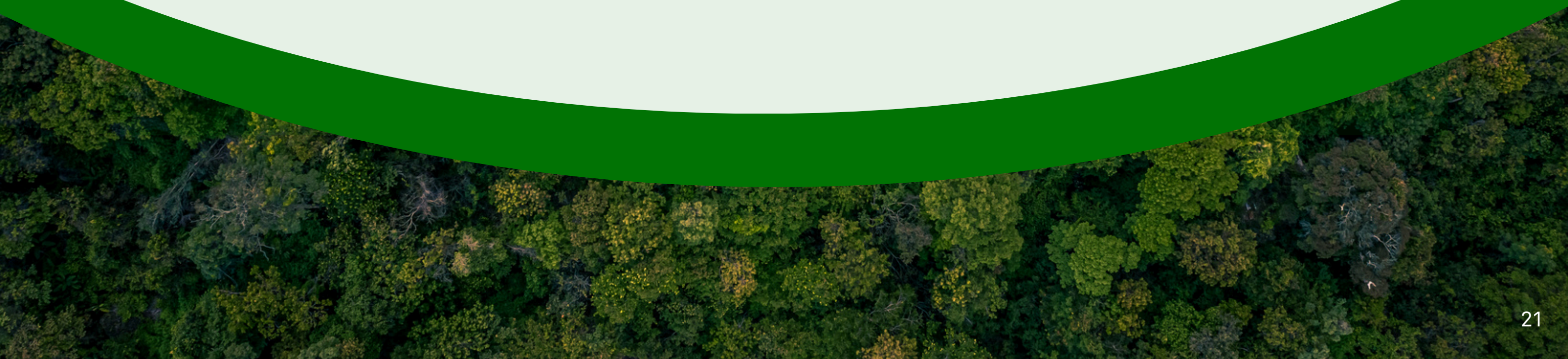
Remember that becoming environment-friendly is an ongoing process, and it requires commitment and participation from everyone involved. By implementing these actions, you'll not only reduce the department's environmental impact but also create a healthier and more sustainable environment for both staff and patients, as well as diminishing expense and increase the overall quality of life.

6.3 FURTHER CONSIDERATIONS

However, while it is important to be "environmentally sustainable", for us, future generations and the planet, there are many potential barriers you should think about. In order to balance the needs of your center, below are some of the aspects to consider:

1. Clinical safety: "Primum non nocere"

Patient safety is paramount and it is part of the foundation of modern medicine as enshrined by the Declaration of Geneva[34].



We do not advocate any changes or action plans that will compromise patient's and public safety and quality of life, however economical or beneficial to the environment they are under any circumstances.

2. Financial implications

Becoming "environmentally sustainable" is often mistakenly regarded as "too expensive" and "inefficient"; it is believed by some to significantly increase the financial burden of an organization. While up-front infrastructure costs might exist (e.g. upgraded dialysis machine or RO unit, solar panels, insulation etc), many reports show savings over and above return on initial investment within a relatively brief timeframe. Contrary to these misconceptions, adopting "green nephrology" policies[35] can thus improve cost-effectiveness and increase productivity.

3. Medicolegal consideration

It will be important to consult your local legal adviser and review the law in your jurisdiction, as there may be specific legal requirements for certain waste disposal in your countries.

For example, the disposals of medical waste are often heavily regulated and monitored in many countries. Improper management of discarded needles and other sharps can pose a health risk to the public and waste workers. Discarded needles may expose waste workers to potential needle stick injuries and potential infection when containers break open inside garbage trucks or needles are mistakenly sent to recycling facilities.

Not only would this cause harm to the public, this would carry significant medicolegal consequences.

4. Start small, go big ... and one step at a time

"Rome wasn't built in a day"

It would be impossible to transform your center into a "Green" unit overnight. It is important to establish both short and long-term goals. These objectives need to be realistic and achievable, while the goals can outline the overall vision to drive direction and strategy.

It would also be very important to review these objectives regularly so that they may be modified and be realigned with the long-term goals in an ever-changing world with emerging challenges.

A development roadmap and a strategic plan with prespecified time points/targets would be very useful.

5. Appoint Green Nephrology Champions in your unit!

Dedicated personnel can serve as "champions" to ensure the "green policies" are implemented and maintained. They can also act as an advocate to promote and broadcast your "Green policies" beyond your unit in your hospital. Once the number of these dedicated personnel has reached a "critical mass", they can foster a community of practice which can contribute to the development of "Green Nephrology" in your local area and not just your own unit!

Obviously, they need to be as committed and dedicated as you! Talk to your colleagues and teams about mutual vision and commitment, and to identify like-minded people to reach local sustainability goals.

7. SPECIFIC TECHNICAL ISSUES

This section will focus on the technical issues of some of the kidney replacement therapies and ways to improve the environmental profile of these treatment modalities.

7.1 HEMODIALYSIS

Hemodialysis is one of the most water intensive medical treatments. On average, the water usage is estimated to be around 0.5 m^3/session or 500 liters/session/patient equivalent to78m^3/patient/year[11]. It is also the most widely used kidney replacement therapy, with about 90% of all dialysis patients being on hemodialysis. In fact, there are about 3.4 million patients estimated to be on hemodialysis in 2022 according to the 2022 Global Renal Replacement Therapy Annual Report. Given the rise in the prevalence of chronic kidney disease and the subsequent huge burden of kidney replacement therapy, the environmental cost from these treatments is expected to rise significantly, causing a huge burden to the environment. Therefore, there are increasing incentives to minimize the water demand and reduce the water wastage. The recycling and repurposing of water will be discussed in later sections.

7.1.1 REDUCING DEMAND BY DEFERRING DIALYSIS

Deferring the start of dialysis may be a possible way to be eco-friendly through reducing the demand of water usage for dialysis.

However, there have been previous misconceptions that delaying dialysis initiation may increase morbidity and mortality; while early start dialysis may improve patient survival. This concern was rebuked by the pivotal IDEAL (Initiating Dialysis Early And Late) study. This study demonstrated that starting dialysis at a much lower estimated glomerular filtration rate (eGFR) than that usually retained in western countries was not associated with an increase in mortality. At a median follow-up of 3.6 years, there was no significant difference in survival, cardiovascular events, infections, or dialysis complications between early or late initiation of dialysis.

Given the findings of the IDEAL study, as well as those of several large observational studies, most guidelines now advocate delaying dialysis initiation in asymptomatic patients until their eGFR reaches 6 ml/min per 1.73 m^2 or the appearance of clinical indications.

With this in mind, deferring hemodialysis would reduce water and energy consumption, waste and carbon emissions. For example, for every patient-month of dialysis delay, the amount of water saved is approximately 6000 L (12 sessions X 500 L)!

Key Point: Consider deferring the start of dialysis in asymptomatic patients with kidney failure until their eGFR reaches 6 ml/min per 1.73 m2 or the appearance of clinical indications.

7.1.2 INCREMENTAL HEMODIALYSIS

The concept of incremental dialysis is not new but there has been increasing interest in considering it. Incremental hemodialysis is the process of performing <3 sessions of dialysis per week or limiting dialysis dose by duration at the initial onset of treatment to provide a more gradual transition, mimicking the progressive nature of kidney disease.

Practicing incremental hemodialysis, for those newly started on dialysis and still with substantial amount of residual kidney function, may lead to a significant amount of water saved. Indeed, for every patient-month dialysis increment, the water amount spared is 2000 L (4 omitted sessions × 500 L).

Apart from the potential environmental and financial cost saving implication with incremental hemodialysis, there may also be possible added clinical benefit.

Studies have shown that incremental hemodialysis start may provide an opportunity to optimize patient survival and improve the quality of life, especially considering the high mortality rates during the first months of dialysis and the survival benefits in patients with preserved residual kidney function.

Key Point: Practicing incremental hemodialysis may reduce its environment impact such as water and energy consumption, and might also have clinical benefit with less risk in the first few months of dialysis initiation. Suitable patients, primarily those with good residual kidney function, should be considered for incremental hemodialysis.

7.1.3 CHOOSING DIALYSATE CONCENTRATION WISELY

The removal of waste products in hemodialysis relies on exchange of molecules between blood and specially prepared dialysate. Usually, the ready-to-use dialysis fluid is prepared in an hemodialysis machine from concentrates supplied by the manufacturer. Currently, there are 3 available options for dialysate delivery: liquid concentrate delivered in plastic containers (bags or canisters), powder for dilution with treated water or semidry concentrates delivered in returnable barrels.

As consumables transport often has significant environmental impact, one could consider selecting a dialysate concentrate preparation and delivery system that has the least environmental impact with less carbon footprint from transport (if it is available locally – liaise with local providers/industrial partners).

For example, the transport of powdered dialysate concentrate will have less environmental impact and better economic implication with less storage space required (Table 1)[36].

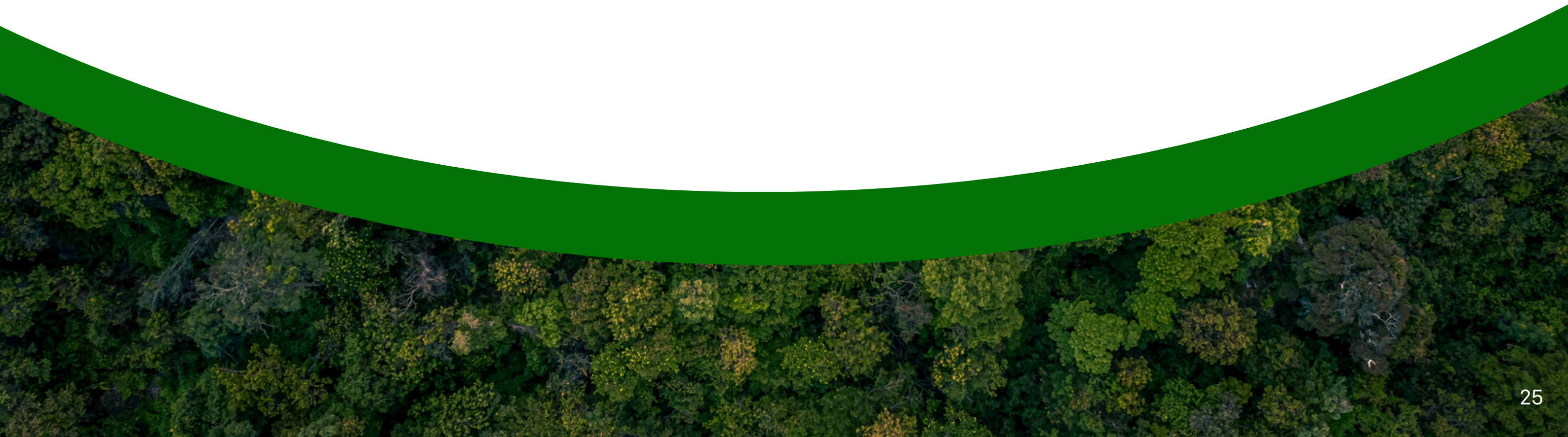


Table 1: Carbon footprint produced during transport different types of dialysis concentrates

	Liquid concentrate (1:44)	Semidry concentrate (1:44)	Powder concentrate (1:33)
Number of patients	120	120	120
Number of dialysis sessions	18,720	18,720	18,720
Liters of concentrates needed	74,880	74,880	93,600
Number of containers	7,488 (10 L canisters)	100 (barrels)	936 (carton boxes)
Weight of freight, kg/year	93,600	34,900	23,400
Number of pallets/barrels	125	100	39
Delivery frequency	2 × month	2 × month	2 × month
Carbon footprint, g CO2/ton/km	120	120	120
Distance from supplier to dialysis center, km	100	100	100
Carbon footprint, kg CO2/year	1,123	419	280
Storage space needed (one delivery), sqm	5	3	2

An alternative option is to develop a central delivery system within the dialysis unit, where suppliers can deliver products in bulk, which would limit packaging, waste, transport and greenhouse gas emissions. (See Section 4. Procurement)

Key Point: Consider choosing a dialysate concentrate delivery system with less carbon footprint (from transport in particular!). Powdered preparation seems to have less environmental impact and better economic implication with less storage space required.

7.1.4 DIALYSATE FLOW RATE

The standard flow rate is 500mL/min, which can be optimized to reduce water, electricity, acid and bicarbonate consumption, by modifying the dialysate flow rate according to the patient's need. Studies have shown that decreasing the flow rate from 500ml/min to 400ml/min does not seem to worsen patient outcomes, at least in short term and for patients with a lower body weight[37]. Long term studies are required.

In fact, modern hemodialysis machines are equipped with the modules which automatically reduce flow rate of dialysis fluid to the patient blood flow and minimize dialysate consumption during preparation and after reinfusion. Utilizing these functions fully may help to reduce the amount of water and dialysate concentrate being consumed.

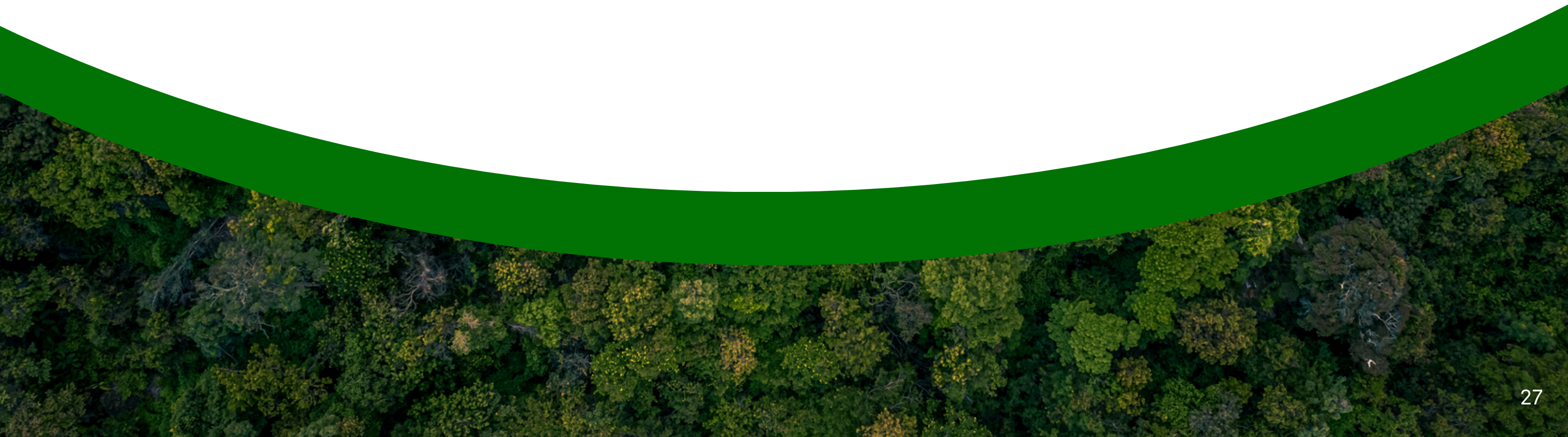
Key Point: Reducing the dialysate flow rate safely may help reduce water use. Close monitoring would be key to avoid overzealous reduction in dialysate flow rate at the expense of patient's care, until long term data are available to reflect its safety.

7.1.5 REUSE-RECYCLE OF DIALYSIS WASTEWATER

Consideration can be given to reusing waste water discharged by reverse osmosis systems. Potential applications include sanitary facilities, rehabilitation pools in hospitals, laundry, watering of green spaces, local agriculture, etc. A recent paper by Chang et al highlighted their successful stories on reusing dialysis reverse osmosis reject water through an innovative reject-water reuse program combining aquaculture, hydroponic and horticulture activities with hemodialysis[38]!

However, one should note that the waste water has a moderate salinity (from 1.5 to 3g/l max). Thus, it may be necessary to treat or dilute this water to reduce salinity and comply with standards and recommendations, depending on the intended use. An example of demineralization through electrodialysis to allow the reuse of reverse osmosis (RO) rejects can be found here[39].

Key Point: Reuse-recycling of this reject water would help further reduce fresh water consumption. Speak to your hospital management and infection control team to discuss the reuse-recycle of dialysis wastewater and the various applications it can be used for!



7.1.6 OPTIMISING REVERSE OSMOSIS PLANT SETTINGS AND DIALYSIS MACHINE DISINFECTION SCHEDULES

One can consider simple measures such as optimizing your reverse osmosis system to avoid over-production of treated water, of which the excess is usually discarded unused. Minimizing unnecessary disinfections will also reduce power and water usage. Evidence showed that these measures are safe and here are some case studies guidance on optimizing reverse osmosis plant settings[40] and hemodialysis machine disinfection schedule[41] from the Australian and New Zealand Society of Nephrology (ANZSN).

Key Point: Review and optimize your reverse osmosis plant and disinfection schedule to avoid over-production of water and to minimize unnecessary disinfections, use only what you need.

7.1.7 REUSE-RECYCLE OF SPENT DIALYSATE

The process of regenerating spent dialysate is certainly an attractive option, as it is estimated that only a few liters of water may be enough for a hemodialysis session using this technique. The method involves filtration and purification of the spent dialysate by adsorption, absorption and ion exchange, through a sorbent cartridge. This technique is also being used in the WAK (Wearable Artificial Kidney) and new machines based on this principle are currently being evaluated[42].

Currently, this practice is not recommended given the potential risk of contamination and infection. However, there is emerging data suggesting that this is feasible, at least in area with critical water constraint[43]. Further research is required before it is ready to use.

Key Point: The reuse-recycling of spent dialysate is more controversial and is not recommended given the potential risk of infection. Further research is required before we can consider the usage of these spent dialysate.

7.1.8 CONSIDER ALTERNATIVE TO HEPARIN

The use of heparin has been a common practice in hemodialysis to provide anticoagulation. However, the production of heparin is actually very resource demanding, with the raw material being derived from the intestinal mucosa of pigs. It is estimated that 1 pig has to be slaughtered per 13 dialysis sessions and the carbon footprint of raising 1 pig is about 670 kg CO_2 equivalent.

In addition to this carbon impact, the solvents used during the production pollute air and water, with water contamination also caused by detergents and disinfectants used in the process. Thus, it may be important to consider alternatives and innovations to provide such alternative (e.g a dialysis membrane that does not activate platelets or thrombin inhibitors) is much needed.

Currently, citrate with a Calcium-free and Magnesium-free dialysis fluid and intravenous supplementation of Calcium and Magnesium may be a green alternative to heparin in hemodialysis, but one may need to be mindful of side effects such as metabolic alkalosis. Trials are needed to assess the safety profile of long-term usage of citrate. Other emerging herparin-free agents such Argatroban is also being developed and assessed.

Key Point: The production of heparin has a very high carbon footprint and alternative anticoagulant such as citrate with a Calcium-free and Magnesium-free dialysis fluid and intravenous supplementation of Calcium and Magnesium may be a green alternative. Trials are needed to assess the safety profile of long-term usage of citrate as well as the feasibility that it is a greener option.

7.2 PERITONEAL DIALYSIS

Similar to hemodialysis, peritoneal dialysis also consumes a large amount of energy as there are the issues of transport and wastage of the plastic bags. The production of these dialysate bags may require a much larger amount of water than previously perceived. Therefore, there is a drive to reduce the environmental impact of peritoneal dialysis as well. Furthermore, CAPD is considered to have less environmental burden than APD given its better carbon footprint[43] and plastic wastage[44].

7.2.1 REDUCING DEMAND BY DEFERRING DIALYSIS

Similar to hemodialysis, this notion can also be applied to peritoneal dialysis. See 6.1.1 for further details.

7.2.2 INCREMENTAL PERITONEAL DIALYSIS

The practice of incremental dialysis can also be applied to peritoneal dialysis with an aim to reduce environmental burden. In fact, patients newly started on peritoneal dialysis may be better suited as compared to those on hemodialysis, because these patients tend to have a better preservation of residual kidney function with fair amount of urine output.

The current standard of care in peritoneal dialysis is incremental, and this patient-friendly, resource-wise, and planet-friendly approach is acknowledged in the International Society for Peritoneal Dialysis guidelines[45].

There are different strategies for prescribing incremental peritoneal dialysis. Common approaches include a reduced volume for each dialysate dwell (e.g 1.5 - 2.0 L per dwell); reduced number of exchanges daily (e.g 2 – 3 exchanges per day); or, patients can have 1 to 2 days off as an alternative incremental approach (4-6 days of peritoneal dialysis per week). One should note that applying this strategy should be patient-centered and goal directed. Furthermore, frequent monitoring may be needed to allow closer adjustment and to avoid risk of under-dialysis.

Regardless, the environmental benefit of incremental peritoneal dialysis is clear. The rationale is that costs incurred to the health care system would be much reduced because less dialysate solutions are being used and there is less plastic waste generated, with less carbon impact[46]. For example, a recent study by Nardeli et al. found that intermittent peritoneal dialysis prescription of 1, 2, or 3 exchanges per day leads to reduction in plastic waste of 139.2, 100.8, or 56.6 kg/patient-year and a reduction in water consumption of 25,056, 18,144, or 10,196 L/patient-year, respectively[47]!

Taken together, practitioners should consider the adoption of incremental peritoneal dialysis in practice given that it can be more cost-effective with a reduced environmental footprint compared to standard peritoneal dialysis.

Key Point: Similar to hemodialysis, incremental peritoneal dialysis may help to reduce the environmental burden (through reduction in consumable use, water use and waste production), as well as offer possible, as well as offer possible clinical benefit with less risk in the early month of starting dialysis. Again, it is important to select suitable patients with good residual kidney function and good compliance.

7.2.3 RECYCLING PLASTIC WASTE

Apart from water from dialysate, peritoneal dialysis actually generates a lot of plastic waste. A recent paper estimated the amount of recyclable plastic waste from a standard peritoneal dialysis therapy. They found that the annual volume of recyclable plastic generated by peritoneal dialysis is significant (in their center, a single patient generated about 21.5 kg to 32.3 kg for Polypropylene (PP) plastic, and 81.4 kg to 118 kg for polyvinyl chloride (PVC) per year.

They extrapolated their data and estimated that the annual worldwide peritoneal dialysis recyclable PP and PVC plastics usage are staggering, exceeding 7 million kg and 30 million kg, respectively, which are equivalent in weight of about 2 and 8 full Olympic size swimming pools (5 million Kg and 20 million Kg), respectively[48]!

Thus, it would be important to consider recycling to reduce the environmental burden. In fact, several industrial partners have started a recycling program for used peritoneal dialysis bags and plastics. For example, Vantive Pte Ltd have started recycling programs in certain regions[49] while Fresenius Medical Care GmbH have developed advices for home dialysis waste recycling[50].

Key Point: Peritoneal dialysis generates a lot of plastics waste from the used dialysate bags and all the packaging. Speak to your local peritoneal dialysis suppliers regarding your intention to recycle and also logistics of the recycling program (they may already have established program internationally, which can then be applied locally).

7.2.4 REVIEW AND REDUCE WASTAGE

Some simple measures may be helpful to reduce unnecessary waste while performing peritoneal dialysis care. For example, ensuring good hand hygiene may reduce the need of plastic gloves, while avoiding excessive usage of unnecessary equipment such as gauze may help reduce wastage.

Key Point: Practicing good hand hygiene may not only reduce risk of peritonitis, but may help reduce the need for gloves. Reviewing what you need before opening unnecessary packaging and equipment may help reduce excess left-over after a procedure.

7.3 TELEMEDICINE

Telemedicine has been gaining popularity in recent years, following the COVID pandemic, with an initial aim of minimize patient transportation, and transmission risk.

In addition, the use of telemedicine and mobile technologies may also help to reduce environmental impact of kidney care, by reducing transportation-related carbon emissions and extending outreach in remote areas. The use of telemedicine and mobile technologies would be topical and timely as there is also an increased drive to promote home dialysis worldwide.

However, telemedicine requires a certain degree of computer-literacy for the participants and some infrastructure that may have some upfront environmental costs in terms of manufacture and procurement, but this model could have the double benefit of supervising patient care and building local capacity of telemedicine, which will have longer term returns on many levels. Furthermore, it will be important to ensure the services provided maintain high-quality privacy and security safeguards on handling personal and confidential patient data.

7.3.1 TELECONSULTATION AND REMOTE MONITORING

Teleconsultation refers to virtual interactions that happen between a clinician and a patient for the purpose of providing diagnostic or therapeutic advice through electronic means, instead of physical interactions in the usual clinic setting. It allows patients to be seen without the need to travel physically to the clinic, which would otherwise contribute to the carbon footprints in transportation.

In addition to reducing greenhouse gases from patient's travel, teleconsultation has been shown to be cost effective. For examples, telemedicine may be beneficial for patients who may otherwise be interrupted from work or care-giving activities[51].

Contrary to the common belief, teleconsultations can be easy to set up and convenient to use with little more than a web camera and video call software subject to local policy on patient's privacy and confidentiality. Here is a website providing details on how to set up a telemedicine service[52].

Remote monitoring may also help reduce the environmental impact by allowing early detection of a clinical problem; thereby decreasing the need for hospitalizations and the number of follow-up sessions; and, ultimately reducing the need to travel to the hospital. Remote monitoring technology is currently being applied in patients on dialysis, both peritoneal and home hemodialysis, in particular[51].

Key Point: Speak to your local telecom suppliers and e-health providers on the set up of telemedicine for consultations and remote monitoring.

7.3.2 ELECTRONIC RECORD AND E-LAB SCREENING

With telemedicine set up, electronic health record and e-lab screening would also help in reducing the environmental burden, mainly through the reduction of the amount of paper used.

People who rely on dialysis therapies have historically had frequent blood electrolytes monitoring and follow-up, printed reports of which consume a huge quantity of paper. However, these paper records and laboratory reports, once signed off, are often stored in areas which can be difficult to access (e.g. medical record office), or sometimes are disposed of immediately. Furthermore, it is also important to review the appropriateness of frequent lab testing, as there are emerging data suggesting that frequent lab testing in kidney care generally is of low value.

Key Point: Speak to your local telecom suppliers and e-health providers on the set up of telemedicine for electronic health record and paperless laboratory screening.

7.4 PROCUREMENT

The majority of a program's carbon emissions originate from procurement, including the energy and resources used to manufacture, package, and transport consumables and medical equipment. Thus, improving how and in what form consumables and medical equipment are procured and transported can help save money, carbon and materials.

In order to achieve this, one needs to include environmental and sustainable development criteria, with adequate weighting in the procurement tender process, in the product selection process and supplier specification. It is anticipated that procuring sustainably will encourage and incentivize industry partners to develop sustainably sourced, produced, and transported kidney care products with an ultimate goal of a circular supply chain with zero waste instead of a "single use" linear supply chain.

One can also consider a centralized purchasing and distribution method to limit packaging, waste, transport and greenhouse gas emissions. For example, acid used in dialysis is commonly delivered in cans, but often not all of the contents are used. Switching to a centralized delivery service, using bulk storage tanks, reduces the wastage of acid and of the cans. Furthermore, a centralized method may encourage the purchase of a dialysate acid with higher concentrations. By reconstituting the acid concentrate on site, one can reduce the amount of liquid being transported; the amount of plastic packaging and the waste of residual concentrates presented in containers; and, reduce the carbon footprint associated with transporting these containers.

Another example already mentioned is the purchase of dialysate in dry powdered form, which is only mixed to the right concentration with the addition of water onsite. This significantly saves significant travel costs and carbon emissions. See 6.1.2 for more details.

7.5 ENERGY MANAGEMENT

There are many ways of reducing energy consumption, which can be specifically divided into general measures and measures related to dialysis.

7.5.1 GENERAL MEASURES

- Increase staff awareness about energy wastage and encourage energy-saving actions (e.g. turn off the lights, the heating, close the blinds, etc).
- Choose energy suppliers that support renewable energy development.
- Consider replacing appliances with energy-efficient alternatives
- Choose natural lighting whenever possible or use LED lighting. Also install motion sensors with light timers and twilight switches.
- Active heating and cooling systems only when rooms or building areas are populated, or when equipment or supplies require temperature control

7.5.2 MEASURES SPECIFIC TO DIALYSIS

- In case of renewing dialysis machines when it is necessary, consider machines that incorporate functions (e.g. low power/sleep mode) to optimize energy consumption, in particular via an automatic dialysate flow function[53].
- Install heat exchangers with a dual-flow system if not already installed. The lost heat from the used dialysate can be captured and be transferred to the incoming fresh dialysate via the exchanger, which can minimize the energy used to heat up the dialysate.
- Consider to increase practices of CAPD for suitable patients, which would reduce the energy usage (e.g from APD). From those needing APD, consider to use modern cyclers with much better energy consumption profile.

7.6 WATER MANAGEMENT

Kidney care, dialysis in particular, consumes large amounts of water and it would be important to optimize the water usage so as to reduce wastage. In particular, it may be useful to install meters to track the amount of water consumed for pretreatment and dialysis, so as to review the optimization of water consumption regularly. Other methods for optimizing water usage and to reduce wastage include:

- Reduce water demand (e.g. deferring dialysis and reduce usage through incremental dialysis - see 6.1.1 & 6.1.3 for details)
- Renewing and upgrading the water treatment plants for newer and more efficient water-saving equipment such as allowing RO reject water recirculation
- Minimize any injection of disinfectant, permanent or temporary chlorination, or periodic disinfection of the device followed by rinsing with water, as this water is lost
- Optimize regeneration frequencies for softeners, activated carbon, sand filters, night-time thermal disinfection and flushes, so that these actions are only carried out when necessary
- Replace washroom toilets and faucets with alternatives that use less water
- As mentioned, some of the rejected reverse osmosis water can be recirculated or recycled (see 6.1.5 for details)
  - to provide water for hospital laundries and toilet facilities
  - to create steam used in sterilization and sanitation systems in wards
- Rainwater harvesting is an ecological alternative that provides free water

7.7 WASTE DISPOSAL

Waste can be classified into hazardous and non-hazardous waste. Despite the misconception of waste in healthcare being clinical waste, the majority of waste is actually non-hazardous (around 85%), meaning that these can be readily recycled similar to domestic waste. In addition, one should also include pharmaceutical waste when considering disposal. Unused medications are often discarded through municipal waste systems (simply by flushing them into the toilet or disposing them directly to landfills sites). Improper disposal may allow active pharmaceutical components to enter soil and water sources, leading to environmental contamination and potential public health risks.

Proper pharmaceuticals waste handling is particularly important among patients with chronic kidney disease or kidney failure, as they are often on a proliferation of medications including heparin used in dialysis. Community take-back programs at local pharmacies or hospitals may be an effective way to ensure medicines are properly discarded and re-purposed.

Awareness of the environmental impacts of leftover medicines remains low among the public and general healthcare professionals; and should also be strengthened through education and public promotion.

It is important to distinguish the non-hazardous waste from the hazardous waste in the sorting process (triage). This is because incinerating and transporting hazardous waste emits 3 times more greenhouse gases than treating the non-hazardous waste! Even if the waste is not incinerated but chemically sterilized for landfill, the environmental burden could still be significant as compared to simple disposal to landfill.

Below is the classification taken from European Works Council (EWC) guide on waste classification:

Hazardous waste

Pathological waste: human tissues, organs or fluids, body parts

Sharps waste: syringes, needles, disposable scalpels and blades, etc

Infectious waste: contaminated with blood and other body fluids:

- Dialysis filter
- Connection and disconnection sets
- Contaminated single-use material: drapes, gauzes, compresses, bandages, etc

Non-hazardous waste

Waste whose collection and disposal are not subject to special requirements to prevent infection:

- Dressings, plasters, linen, disposable clothing, diapers
- Single-use gloves and unsoiled compresses, small equipment packaging, apron, mask, overblouse, gown, etc.
- Medical bags (nutrition, bicarbonate,
- physiological serum...)

As for kidney care and particularly dialysis care, much of the waste produced can actually be recycled. These include a large amount of packaging and wrapping of pharmaceutical products and medical devices, generating a high quantity of paper, cardboard, plastic, polystyrene, etc. Furthermore, many medical devices and consumables are single use. Below are some tips of how to minimize waste production and maximize waste recycling. Remember always consider the 3Rs:

Reduce **Reuse** **Recycle**

1. Consider centralized distribution and bulk purchase to minimize transportation costs
2. Liaise with suppliers regarding waste take-back or recycling schemes
3. Identify safe opportunities for reducing clinical waste (e.g. uncontaminated material may not need to be incinerated via the clinical waste pathway)
4. Identify equipment that could be safely removed from the dialysis process.
5. As mentioned in section 3.2, electronic records and laboratory reports may help reduce the amount of paper usage and wastage.
6. Reduce biohazard waste (e.g. draining the dialysis lines may help to reduce the weight of discarded dialysis circuits)
7. Purchase a device for converting hazardous waste into non-hazardous waste

8. SPECIAL CONSIDERATIONS

High-income countries (HICs) and low and middle-income countries (LMICs) often have different challenges given the difference in population demographics, income level and socioeconomic policy priorities. Regardless of settings, health promotion, early diagnosis, preventive strategies are essential – everywhere, in order to achieve more equitable, sustainable, and resilient kidney care and kidney outcomes.

For HICs, focus on reducing demands and redundancy may be the way forward to improve sustainability of kidney care and help reducing the environmental impact. One example of reduction in consumption is the shifting from single-use to reusable medical devices, resulting in fewer devices being manufactured. Another example is reducing low-value care (i.e., care that may have costs [financial, climate, and harm] out of proportion to potential benefits [physical and psychosocial] for individuals and/or society)[54].

In LMICs with limited resources, there are many challenges and obstacles to implementing environmentally sustainable kidney care (ESKC).

The rising prevalence of CKD in these regions, with hemodialysis often being the only available treatment, puts healthcare systems under significant strain. Barriers include political and economic instability, difficult accessibility to healthcare, poor recognition of kidney disease as a public health problem, low degree of implementation of environmentally sustainable kidney care, and poor waste management infrastructure.

Our recent survey determined that a considerable number of kidney HCPs[11] are worried about the implications of climate change. However, only a small number are involved in sustainable kidney care activities, regardless of income level. This is mostly due to lack of education and training, insufficient human resources, poor remuneration, and competing priorities.

Addressing these barriers requires collaborative efforts and strategic initiatives to promote ESKC in LMICs. Recommendations include:

AT GLOBAL LEVEL

- Recognizing kidney disease as an important non-communicable disease (NCD)
- Enhancing communication with stakeholders
- Investing in research and fostering international cooperation

AT REGIONAL LEVEL

- Improving healthcare accessibility
- Cultivating local expertise
- Developing or expanding kidney transplantation programs
- Investing in preventative measures
- Optimizing telemedicine practices
- Enhancing waste management
- Encouraging local manufacturing.

For the nephrology community, implementing best practices, promoting "transplant first" and “home dialysis” initiatives, joining forces to obtain more affordable and sustainable products, and ensuring inclusion of local healthcare providers are crucial. Additionally, understanding the demographic and cultural/religious backgrounds of the patients is mandatory for best choosing the proper communication tools and suitable educating maneuvers as well as fostering public acceptance of sustainable practice.

Talking in numbers, here are some examples of programs that have successfully reduced carbon emission from kidney care services:

- In Australia, installation of infrastructure for reusing hemodialysis Reverse Osmosis rejected water saved up to 350L of water per treatment. In the UK, this saved about 4.5 million liters of water and 10,500 GBP (13,800 USD) annually in UK.
- Using renewable energy sources like solar power in Australia reduced power costs by up to 76.5% and decreased power consumption by 91%.
- Diverting waste from clinical to domestic waste in the UK can CO_2 emission by up to 14.5 tons and saved approximately 2,500 GBP (3,300 USD) per unit.

Our key advocating message to LMICs is that reducing the environmental impact of healthcare does not compromise care quality and offers economic benefits through lower resource use. Collective guidance from professional organizations and coordinated action from industry partners are pivotal to ensure successful implementation of sustainability measures.

9. ADVOCATE FOR SUSTAINABLE CARE

While it is important to take the first step and transform one center into one with sustainable kidney care, it is equally important to reach out and collaborate to advocate for green nephrology globally. Examples of advocacy groups include:

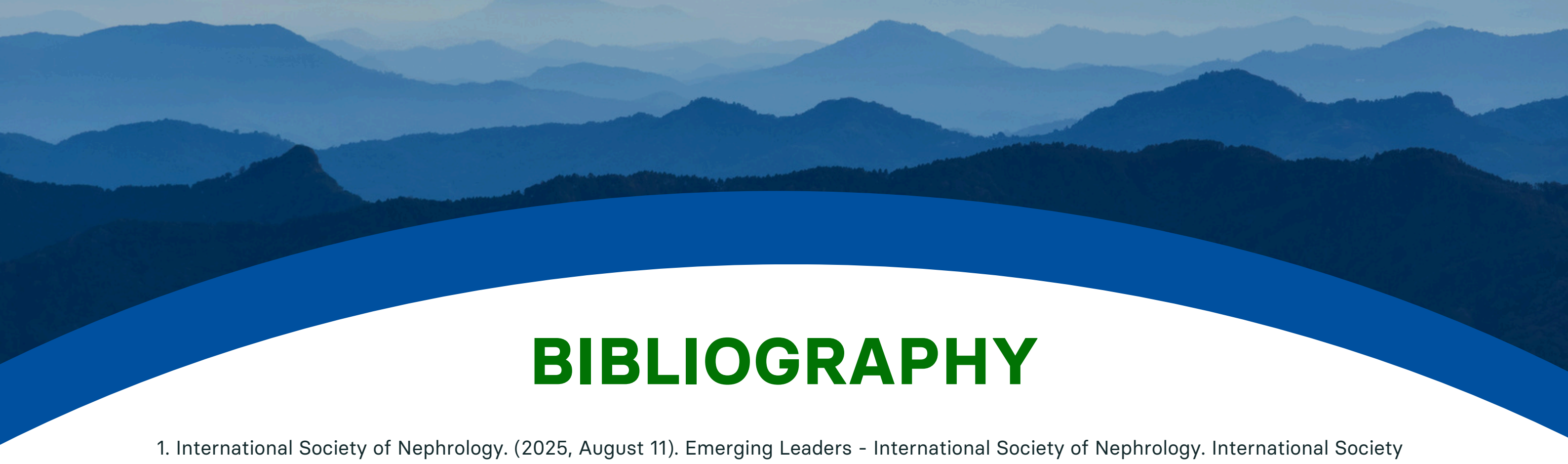
The Global Environmental Evolution in Nephrology and Kidney Care Initiative – GREEN-K initiative[2] has a vision of 'Sustainable kidney care for a healthy planet and healthy kidneys', and mission to 'Promote and support environmentally sustainable and resilient kidney care globally through advocacy, education, and collaboration'.

The UK Kidney Association has a similar advocacy program (Kidney Unit Sustainability Champions Scheme)[55], which aims to encourage collaboration to meet national targets, to improve dissemination of best practice and be a sustainability point of contact for individual's kidney center.

The SFNDT, the French-speaking society of Nephrology, Dialysis and Transplantation, also advocates for Green Nephrology and has produced a best practices guide[56].

KitNewCare[57] is a significant public-private multi-partnership from across the sector, including academia and industry, dialysis and other technology providers. They aim to provide innovative solutions that not only offer a high level of care for individuals with kidney diseases, but do so in an environmentally sustainable manner.

Join us to help lead the fight against climate change!



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GET IN TOUCH

If you have any experience and feedback to share, please send us an email. We welcome any comments with an aim to improve this toolkit and find ways to further promote environmentally sustainable kidney care!

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