

CKJ REVIEW

No more waiting: 10 tips to turn kidney transplantation green

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ABSTRACT

To date, the environmental impact of kidney transplantation has received much less attention than that of dialysis. Facilitating a pre-emptive transplant is probably one of the most environmentally friendly interventions available in kidney care, as it avoids dialysis, with its requirements for water and energy. However, transplant assessment also requires scrutiny, as it involves a multitude of tests, often with duplication of tests and sometimes with little, if any, evidence (e.g. cardiac testing of asymptomatic patients). Organ retrieval often involves air travel of either the organ or a surgical team, although more innovative approaches, such as drone transport, are being tested. Transplant anaesthesia also has an environmental footprint linked to volatile substances. Surgical tray optimization is well established in other surgical specialties to reduce the effects of repeatedly sterilizing instruments that are only rarely used. Post-transplant patients have a lot of regular blood tests, and it is time we scrutinise those and find a better balance between safe care and environmental footprint. Virtual appointments have become much more common since the COVID-19 pandemic and we should use them where appropriate, for example in long-term care of stable transplant patients. Transplantation is a very research-oriented specialty, and this also has an environmental footprint that is amenable to intervention. In addition, our congresses and conferences have an environmental footprint, and it is for us to promote meetings with just as much learning and interaction but less travel, waste and energy use. The opportunities are there for us to take and our tips provide ideas for clinical teams to turn kidney transplantation into a showcase for excellent, safe and environmentally friendly care in nephrology.

Keywords: clinical nephrology, green nephrology, innovation, kidney transplantation, sustainability

Received: 6.1.2026; accepted: 2.3.2026

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INTRODUCTION

The last decade has seen increasing interest in green nephrology—broadly understood as improving the environmental sustainability of kidney care. This development was prompted by incontrovertible evidence of human-made climate change and also by earlier interest in the environmental footprint of other specialties [1, 2]. However, so far the focus has been very much on dialysis, and particularly in-centre haemodialysis, with its spectacular environmental footprint relating to water consumption and waste [3]. In comparison, the environmental footprint of transplantation has received much less attention. This is surprising given that transplantation is a dynamic field with constant innovation. Furthermore, rising temperatures pose significant risks to kidney transplant recipients due to their increased vulnerability to dehydration [4]. Finally, evidence has emerged to link pollution [5] and adverse outcomes after transplantation. The move towards more environmentally friendly healthcare has met with an important objection known as healthcare exceptionalism [6, 7]. This objection makes the case that healthcare is different from other areas because it provides such an important role that should not be compromised by environmental concerns. The question of just how much weight should be placed on this perceived ‘exceptional’ status of healthcare and to what extent it should be a barrier to attempts to introduce more environmentally sustainable approaches to healthcare is an important question for medical ethics [8, 9] (but beyond the scope of this article). There remains an unobjectionable position that where more environmentally friendly approaches are available within healthcare, which have no negative consequences on the quality of care, these should be adopted. What are these approaches? Here we aim to provide 10 practical tips to improve the environmental footprint of kidney transplantation.

TIP 1: CONSIDER THE ENVIRONMENTAL FOOTPRINT OF TRANSPLANT ASSESSMENT, AVOID UNNECESSARY TESTS AND REDUCE ASSOCIATED TRAVEL

It is important to appreciate that transplant assessment and waitlisting have a significant environmental footprint, particularly where a transplant centre covers a large geographical area. Potential recipients and donors each undergo a variety of evaluations and tests that range from basic laboratory tests and virology to tissue typing and extensive cardiovascular workup and imaging. A recent analysis in the UK calculated that the carbon footprint of preoperative evaluation for a potential living kidney donor is 114.2 kg of carbon dioxide (CO₂) [10]. This may not sound like much but is equivalent to the CO₂ emissions from 127 pounds of coal burned [11]. It should also be noted that not all potential live donors go ahead with donation. On the basis of these numbers, even a small transplant centre evaluating 100 potential donors per year would create 11 400 kg of CO₂ through live donor workup alone—the equivalent of 524 propane cylinders used for home barbecues [11].

One avoidable source of emissions is duplicate or unnecessary diagnostic testing [12]. A study involving patients undergoing general surgery procedures found that 75% of patients underwent unnecessary blood work, generating 974 CO₂ equivalents (CO₂e) per patient [13]. Patients with CKD stage 5 who are being assessed for transplantation or reviewed on the waiting list often undergo duplicate investigations by attending their routine clinic appointments and preoperative assessments con-

currently [14]. Duplication often occurs when transplant centres are not provided with results of previous investigations done elsewhere, such as electrocardiogram or echocardiogram, and simply repeat these tests, as this is viewed as less cumbersome than trying to obtain those results. Eliminating duplication through agreed clinical protocols and electronic information sharing (with appropriate information governance) can reduce carbon emissions and increase patient satisfaction, while providing a more streamlined transplant waitlisting pathway. Cardiac testing of asymptomatic low-risk transplant candidates is a good example of a testing approach that incurs a significant environmental footprint with little evidence to justify it [15]. We should also reconsider repeat testing while patients are seen as part of an annual review on the transplant waiting list. Many of these tests lack sufficient evidence, particularly in younger patients. As an example, the annual face-to-face review of an asymptomatic 30-year-old patient with reflux nephropathy who is active and works full time is unlikely to be of any clinical benefit but will incur an environmental footprint. We would suggest that transplant centres review their policies for annual retesting, especially in patients who are young, well and active on the waiting list, and that the kidney transplant community should develop a clearer evidence base in this area for all patients.

Travel accounts for most of the carbon footprint during preoperative assessments [10] and reducing it is crucial to reduce carbon emissions, e.g. by redesigning the transplant listing pathway with coordinated single-day visits and laboratory testing and imaging at local hospitals [10]. Yohanna et al. [16] describe a good experience with the implementation of a 1-day assessment for live donors. Depending on local infrastructure and access to resources, this could be facilitated in a day hospital or through similar ambulatory care settings. A similar framework change regarding preoperative assessment for liver transplant managed to reduce emissions from 618 to 179 kg CO₂e per patient [17]. Similar data for recipient and live donor assessments are currently lacking. Telemedicine provides another avenue to reduce travel for patients [18]. Alternatively, for patients residing far from transplant centres, deploying visiting clinicians can also reduce the need for travel. In the future, remote sampling techniques could also reduce the need for commuting. As an example, Neoteryx microsampling (Trajan Scientific, Ringwood, VIC, Australia) allows patients to generate a capillary blood sample at home using a kit. This technology currently allows for measurement of serum creatinine and tacrolimus [19] but it is anticipated that this approach, or a similar technology, will also allow measurement of other tests done as part of transplant assessment, such as markers of infection, liver function tests, haemoglobin A1c and others.

TIP 2: REDUCE THE ENVIRONMENTAL FOOTPRINT OF ORGAN RETRIEVAL, CONSIDER DONOR TRANSPORT AND EVALUATE THE USE OF DRONES

Organ retrieval can involve significant environmental impact related to energy consumption, surgical equipment, waste generation and travel [20]. In addition to the targets for environmental impact in theatres in general (see Tip 4), organ retrieval has some unique components. At present, algorithms for matching, retrieval and organ allocation focus on distance and likelihood of a successful transplant, but they do not take into account the environmental footprint. Innovative perfusion could improve the environmental footprint of organ retrieval [21]. Machine perfusion



Figure 1: Velos helicopter-style drone used in a 100-mile organ drone run in southern Maryland. The craft is all electric, supports ≈ 20 kg and can reach speeds of 50–70 mph depending on ambient conditions and payload weight. With kind permission from Dr Joseph Scalea, Professor of Transplant Surgery, Charleston, SC, USA [20].

can achieve prolonged preservation of solid organs, thereby easing logistics [22]. Optimized logistics [23] with less critical time scales in deceased donation can allow for more environmentally friendly ways of transport. More widespread use of local surgical teams for retrieval would also help in this regard.

In live donor (LD) transplantation, donors' commute also contributes. One study in split LD liver transplantation revealed a carbon footprint of 815 mT of CO₂ for a cohort of donors from early 2020 to autumn 2021 [24]. Options to reduce the carbon footprint of organ transport include the use of road transport instead of short flights and standard flights instead of charters. It may also be possible to move donors to local retrieval centres, and specialised donor care units have become the standard of care in deceased donation in the USA [25].

Transport of organs with drones is another exciting option (Fig. 1) [26]. Drone use could reduce the environmental footprint through avoidance of charter or helicopter flights or by facilitating organ transport on a commercial flight with onward transport via drone. However, most studies currently focus on feasibility and safety, not on environmental benefit. A study in Dorset, in the UK, on drone transport of pathology samples showed an impressive decrease in CO₂ emissions compared with transport via van [27] and it is likely that drone transport of organs will de-

liver a significant environmental benefit [28], although precise data are still lacking. Outside transplantation, the transport of blood products via drones in Rwanda is perhaps the only example of drone use in medicine at scale [29]. In comparison, transport of organs is much more difficult given the tight time scale and consequences if transport fails. It is therefore not surprising that pilot studies have used custom-built drones with two engines and not a commercially available type of drone [26]. There is also a lot more work to do in terms of regulation and governance [28, 30], and transport of organs via drones will likely require not just further extensive testing and the establishment of technical standards but also changes in national laws and regulations.

TIP 3: PROMOTE PRE-EMPTIVE TRANSPLANTATION TO REDUCE THE ENVIRONMENTAL FOOTPRINT ASSOCIATED WITH DIALYSIS

While the carbon footprint of kidney transplantation has not been fully characterized, the burdensome role of dialysis treatments is well described [31, 32]. Pre-emptive transplantation is

therefore a potent solution in reducing carbon emissions. Life-cycle assessments suggest that transplantation may reduce carbon emissions by 95% and 90% compared with haemodialysis and peritoneal dialysis, respectively [32, 33]. Each successful kidney transplant has been estimated to save 2.0–3.6 tons CO₂e per year compared with continuing dialysis [26]. Despite pre-emptive transplantation's benefits, only 4% of European patients' initial renal replacement therapy is a kidney transplant [34, 31]. To expand pre-emptive transplantation, system-level actions are required aimed at promoting earlier referral, better donor identification and coordinated multidisciplinary care [35]. Living-donor programs provide a strong opportunity for increasing pre-emptive transplantation rates, improving outcomes and reducing the number of patients dependent on dialysis [30]. International strategies including matching programs, awareness campaigns, outreach to regional clinics and primary care education are instrumental in integrating pre-emptive transplantation pathways [35]. What is clear is that pre-emptive transplantation reduces the environmental footprint of care through avoiding dialysis [32, 34]. Others have speculated that the environmental impact of transplantation may follow the same course as that of cost, with high cost and environmental impact early and savings later on [12]. Further research is needed to quantify the environmental benefit of pre-emptive transplantation with a more detailed assessment of the preoperative, intra-operative and postoperative pathway of donors and recipients and their environmental footprint compared with dialysis [12].

TIP 4: REDUCE WASTE DURING TRANSPLANT SURGERY, CONSIDER TRAY OPTIMIZATION AND PROMOTE VIRTUAL CROSS-MATCH

Operating theatres are resource-intensive environments and contribute significantly to the environmental impact of care [36, 37], using as much as six times the energy as the rest of the hospital and producing 50–70% of the waste [38]. The environmental impact of theatres also relates to equipment and water use. The Intercollegiate Green Theatre Checklist in the UK [39] describes evidence-based guidance to address these factors, from surgical preparation through to postoperative care. Smart energy approaches are also crucial to reducing the carbon footprint of theatres and simple changes to heating and ventilation have been shown to cut energy consumption by 30% [40]. Over time, surgical trays accumulate instruments for rare scenarios [41] and large, overfilled trays increase the material and energy involved in washing, packaging and autoclaving [42]. A systematic approach to reviewing surgical trays in transplant theatres can reduce the carbon footprint significantly and also improve cost and staff satisfaction [43]. The principles of reduce, reuse and replace can be applied extensively in transplant theatres without compromising patient safety. While *in vitro* physical cross-match has been the gold standard for decades, advancements in human leucocyte antigen identification and molecular typing now permit 'virtual' cross-matching (VXM) with a very high degree of safety and reduction in cold ischaemic time [44]. A recent collaborative document from the USA confirms that VXM is gaining traction, although challenges remain [45]. Given the time, labour and laboratory improvements associated with VXM, it should be considered for as many patients as possible. Centres can learn from more innovative peers where the majority of transplants are performed with VXM and physician cross-matching is reserved for selected cases [46]. National benchmarking of the

amount of VXM use in each centre should be encouraged to aid improvement in this area.

TIP 5: CONSIDER THE ENVIRONMENTAL FOOTPRINT OF ANAESTHESIA AND REDUCE THE USE OF VOLATILE AGENTS

As nephrologists, we do not often consider this aspect of the environmental footprint of each kidney transplant. In the UK, anaesthetic gases account for 2% of all emissions caused by the National Health Service (NHS), which equates to 2.5% of global anaesthetic greenhouse gas emissions [47] (Fig. 2). Volatile anaesthetics have varying global warming potentials (GWPs), although much progress has been made already by the removal of desflurane (100-year GWP 2540) from the NHS formulary and gradual decommissioning of piped nitrous oxide (100-year GWP 310). Volatile gas capture and recycling are still in their infancy, but this approach represents another interesting option to reduce the environmental impact of volatile anaesthetics [48]. In comparison, total intravenous anaesthesia (TIVA) with propofol is generally seen as less problematic, but there are concerns around the plastic waste from the consumables used in TIVA [49]. Taking this into account, recent modelling that includes all drugs and consumables suggests that for the first 22 minutes the carbon footprint of a median consumption sevoflurane anaesthetic was lower than for TIVA but beyond the first 22 minutes, for every hour of anaesthesia TIVA's carbon footprint increased by 0.04–0.6 kgCO₂e compared with 4.01 kgCO₂e for sevoflurane [50].

TIP 6: THINK ABOUT THE CARBON FOOTPRINT OF PROFESSIONAL DEVELOPMENT AND SCIENTIFIC MEETINGS

Each year, transplant professionals meet at regional and national meetings and also come together for several international meetings, with the American Transplant Congress (ATC) firmly established as the most significant scientific meeting. To our knowledge, the environmental footprint of the ATC is currently unknown but other congresses have been examined in quite some detail [51, 52]. The 2023 European Renal Association (ERA) congress was estimated to produce 5808 tons of CO₂ through air travel alone, an equivalent to 356 cars driving the distance of the Earth's circumference [53]. More granular detail on the environmental footprint of such congresses is currently emerging and the subsequent 2024 ERA congress was estimated to produce 17 732 tons of CO₂ emissions [54]. The difference in the 2023 meeting in Milan may be explained at least in part by the more central European location of the latter, an effect that was also postulated for American Thoracic Society congresses in San Diego compared with Toronto [55]. It is important to acknowledge that accommodation, local transport, waste, catering and materials also have an effect, thus providing opportunities for intervention. Scientific organisations, such as the ERA, have begun to scrutinise all aspects of their congresses in this respect, ranging from public transport to the provision of food and heating/air conditioning of the congress venue. As a profession, we should start a period of creative thinking, become more transparent about the environmental footprint of all of our educational activities [56] and aim to reduce that footprint [57].

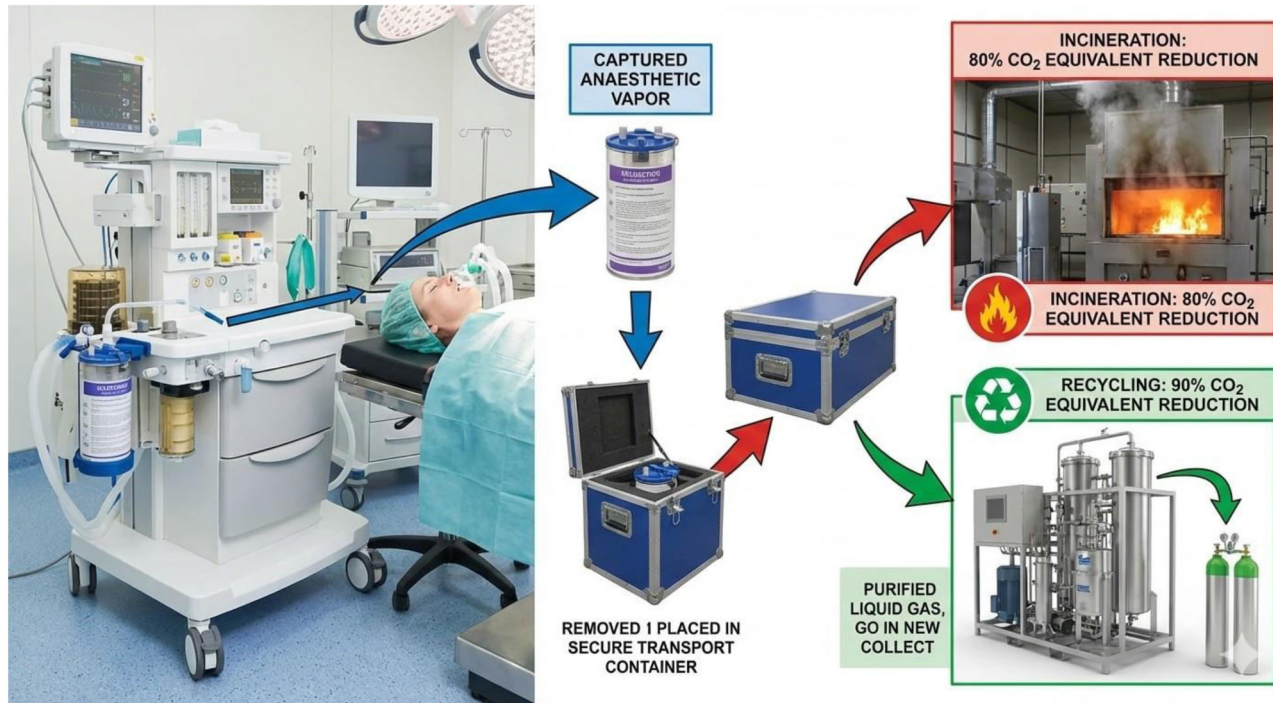


Figure 2: Capture and process options for anaesthetic gases, based on current estimates [1].

TIP 7: REDUCE UNNECESSARY AND DUPLICATE LABORATORY TESTS DURING TRANSPLANT AFTERCARE AND PROMOTE TESTING CLOSE TO HOME

Unnecessary testing and duplication are common features of medical practice across all specialties, often caused by a lack of interoperability of electronic health records [58]. Post-transplant care is no exception. Testing for polyomavirus is a good example of potential overtesting, and recent guidelines [59] highlight the lack of evidence for frequent testing, and particularly for the frequency with which screening tests should be done in patients with stable transplant function. Duplicate testing regularly occurs in many healthcare systems where the clinical responsibilities are not clearly defined—e.g. a general practitioner or internist or local nephrologist may test the kidney function only for it to be repeated by the transplant centre. It is upon us as a transplant community to take on this challenge, reassess what level of routine tests is required and produce guidelines to minimise this issue. Clear delineation of responsibility for results can help further.

Testing closer to home is a key opportunity for environmental improvement but requires infrastructure and funding. Ensuring patient travel is minimised for preclinic tests (doing them at the patients' nearest health centre) while making sure all the right tests are done, and that the results are available to the transplant specialist at the correct time for remote review, could significantly impact the environmental footprint of post-transplant care. Testing from home with a capillary blood test for tacrolimus and serum creatinine is also already available [60] and early experience is positive [19]. More widespread use of this technology is currently hampered by the cost of this approach, which includes not only the costs of the kits and implementation in local laboratories but also those caused by the additional infrastructure, e.g. through storage and sending out the kits.

TIP 8: OFFER VIRTUAL APPOINTMENTS FOR ROUTINE FOLLOW-UP AND DEVELOP VIRTUAL PATIENT EDUCATION EVENTS

Virtual consultations are increasing overall, with a third of all appointments in primary care carried out remotely in the UK [61]. Video consultations are generally very safe in transplant aftercare, especially where there is provider continuity. These are ideal for stable patients after the first year post-transplant. However, risks of virtual consultations are also real [62], perhaps especially when an acutely unwell patient is assessed virtually by a clinician who has not seen that patient before. It is therefore very important to retain the option to call a patient in for a face-to-face appointment when required [62]. Our transplant patients increasingly use virtual and online services in other aspects of their lives, e.g. when they apply for a mortgage or discuss findings after they have taken their car in for service, and this leads to a growing expectation that at least a part of their healthcare is also available remotely. In addition, many transplant patients work, often full time, so convenience is another big advantage of video consultations, particularly where patients commute long distances to attend outpatient clinics face to face. Moore *et al.* [18] estimated a reduction in CO₂ output of 11 718 kg in 2 years when converting routine appointments from face-to-face to video in a renal centre covering a large geographical area. The effect is likely considerably smaller in centres with smaller or urban catchment areas.

It is important to note that digital processes also have an environmental footprint [63] and to provide care options for patients who are less technology literate [64]. Access to laboratory tests and imaging across the catchment area are also important prerequisites for widespread use of remote consultation and a lack of such access is a major hurdle in some countries, especially where laboratory medicine is provided by

Table 1: Suggested key performance indicators and characteristics of an environmentally friendly transplant program in 2035.

All aspects of the transplant pathway are mapped in terms of their environmental footprint.
 Where possible and environmentally advantageous, drones are routinely employed in organ retrieval and transport.
 All letters are sent out electronically and QR codes for web-based patient information are available to reduce printing of leaflets.
 TIVA is the default for transplant anaesthesia.
 The surgical pathway has been addressed using tray optimization.
 All teams have a continuing professional development carbon budget and there is a conscious effort towards virtual meetings where possible.
 There has been a conscious effort to reduce duplicate and low-value laboratory tests, such as urine culture for asymptomatic transplant patients.
 The transplant program has named sustainability champions in transplant nephrology, transplant surgery and in the anaesthetic department.
 Virtual follow-up appointments are offered where clinically safe, e.g. for routine long-term follow-up of stable patients.
 The environmental footprint of all transplant research is in the public domain.

multiple commercial providers. Furthermore, it is worth considering where patients will do their blood tests for clinic appointments if they are to be seen in video consultations. Innovative approaches with either point-of-care kits at home or through home-based blood sampling have been described [60].

Patient information events can also be done virtually, and some dedicated video consultation platforms, such as AttendAnywhere, offer functionality for group meetings. Platforms such as Zoom or Teams are also suitable. It is important to note that conducting such group meetings requires good planning, e.g. to avoid patients unintentionally sharing confidential and personal information. Providers should consider written consent and a short code-of-conduct leaflet sent out in advance of the event.

TIP 9: CONSIDER THE CARBON FOOTPRINT OF TRANSPLANT RESEARCH

Overall, research often receives very little, if any, attention when the environmental footprint of medicine is scrutinised. A 2023 survey confirmed that even in newly initiated research projects greenhouse gas emissions are often ignored during the planning phase [65]. The carbon footprint of clinical trials and of laboratory research is considerable. A 2023 study into the carbon footprint of two clinical trials in cancer research suggested that the two trials provided 72 tonnes and 89 tonnes, respectively [66]. However, there is also reason to be optimistic and hope for a more sustainable research landscape. A recent study described savings of 136 tonnes of CO₂e simply through the use of virtual meetings and innovative data collection [67]. Interviews of study participants through telemedicine may be possible, e.g. for follow-up visits where physical examination or venepuncture are not required. A joint conference between the Medical Research Council, NHS and National Institutes of Health [68] resulted in a sector-wide Concordat for the Environmental Sustainability of Research and Innovation Practice [69], covering all aspects of environmental sustainability. We suggest that all new trials in nephrology should start collecting data on their environmental footprint and that data should be shared and part of the publication. Reducing emissions from travel is an easy win when it comes to both individual and group action. Sustainable procurement should be the norm, prioritising reducing or avoiding environmental impact. The opportunity for nephrology research to show leadership and ambition in delivering on environmental sustainability is there for the taking and we suggest sharing best practices [69].

TIP 10: REVIEW ALL CLINICAL PATHWAYS AND USE TRANSPLANTATION AS A SHOWCASE FOR EXCELLENT ENVIRONMENTALLY FRIENDLY CARE

Kidney transplantation is well placed to provide a showcase for how high-quality care can be delivered in an environmentally friendly way and use clinical pathways that are amenable to standardisation. As above, one good example is cardiac workup, where the kidney transplant community should work cooperatively to reduce unnecessary cardiac testing and produce safe, evidence-based protocols. Unnecessary cardiac testing without evidence not only adds to the environmental footprint of care but also causes extra costs and delays timely transplant waitlisting, with an obvious effect on pre-emptive transplant rates and survival [15]. Reversing this trend with attention to functional assessments (6-minute walk tests, Duke Activity Scoring Index use [70] and frailty [71]) can improve clinical pathways and environmental sustainability simultaneously. Recent work by the UK Living Kidney Donor Network and the Centre for Sustainable Healthcare has showcased the development of tools to improve environmental sustainability in clinical care pathways in transplantation, with a specific focus on living kidney donor workup [10]. UK application of this toolkit has rapidly revealed overlap with quality improvement, generating several workstreams of improvement in one UK pilot region (Yorkshire and the Humber) alone and providing a model for sustainability quality improvement tools that are needed in transplantation as a whole. This is an area that should be prioritised for funding and development.

Pathway analysis should be the norm for all transplant programs, and this should lead to a rolling scheme of regular analysis and improvement, e.g. every 3–5 years (Table 1). This approach enables services to identify areas of poor practice, reduce waste and unnecessary travel through testing and increase pre-emptive and living kidney donor transplantation, aiming for a service that delivers excellent care that is evidence-based, cost-effective and best for the environment.

CONCLUSIONS

Dialysis and many other areas of nephrology are increasingly viewed through the lens of green nephrology. Now is the time for transplantation to follow. We would like to suggest that there is room for kidney transplantation to not just catch up with other areas of our specialty but to surpass them and become a showcase of green nephrology and a beacon of hope for other similar fields of medicine. The use of innovative technology and a commitment to proactive service development are key features of solid organ transplantation. These attributes should help in

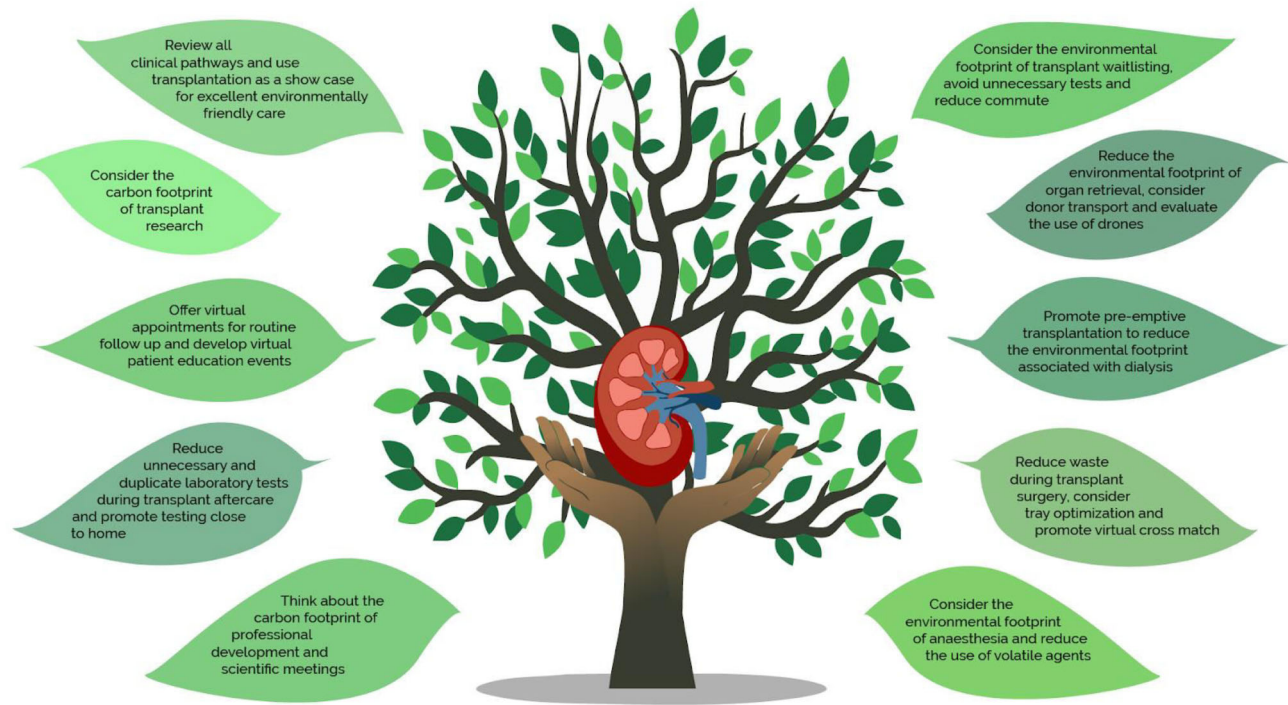


Figure 3: 10 tips to improve the environmental footprint of transplantation.

our next endeavour: to turn transplantation green. Our prime focus as clinicians remains to safely transplant as many patients as possible, but this is not a contradiction of our commitment to more environmentally sustainable transplant nephrology. We have to move away from the concept that care can only be either excellent and safe or environmentally friendly, which wrongly suggests conflict between these things. What we really need to find instead is the 'sweet spot' where improved environmental footprint aligns with excellent and safe care. Our 10 tips represent a mix of what is already doable and what is possible in the near and mid-term future. Some of our suggestions, such as the use of drones (Tip 1), capillary blood sampling at home (Tip 7) and video consultations (Tip 8) for routine transplant aftercare will require more work and also funding and input from multiple stakeholders before they can be implemented as part of clinical routine. Others, however, are largely within our grasp as a transplant community: as teams, we can decide to stop asking for low-value or harmful tests as part of waitlisting (Tip 1), optimise surgical trays (Tip 4) and attend as many meetings as possible virtually (Tip 6). We hope that our 10 tips (Fig. 3) will be used, shared and improved further by others in the field.

AUTHORS' CONTRIBUTIONS

AWoywodt provided initial outline and oversight, and collated references. Authors drafted sections relevant to their specialist knowledge, then all authors reviewed and contributed to the final draft. MWS ensured overall flow and final checks.

CONFLICT OF INTEREST STATEMENT

MWS chairs the Environmental Sustainability in Transplantation (ESIT) work within the Organ and Tissue Donation and Transplantation Directorate of NHS Blood and Transplant

JOC co-chairs the ESIT work within the Organ and Tissue Donation and Transplantation Directorate of NHS Blood and Transplant

AWoywodt is on the editorial board of *Clinical Kidney Journal* and serves as associate editor

AWrigley, AK and AE declare no conflicts of interest.

FUNDING

MWS receives funding from the UK Medical Research Council for research in BK virus in kidney transplantation, and funding from NHS Blood and Transplant to lead the Environmental Sustainability in Transplantation work within the Organ and Tissue Donation and Transplantation Directorate.

DATA AVAILABILITY STATEMENT

No new data were generated or analysed in support of this research.

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Received: 6.1.2026; accepted: 2.3.2026

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