Green Nephrology

Anderson, Nicola; Cockwell, Paul; Aiyegbusi, Olalekan Lee; Calvert, Melanie

DOI:
10.12968/jokc.2023.8.2.77

Green Nephrology – the role of telemedicine and electronic patient reported outcomes

Chronic Kidney Disease (CKD) affects over 9% of the global population and is a public health priority (Bikbov et al. 2020), with significant numbers of individuals developing CKD as a consequence of one or more long-term conditions, such as diabetes or hypertension (Kovesdy 2022). Healthcare and societal systems are under increasing strain from the growing burden of managing patients with these long-term conditions; experiencing rising treatment costs, and workforce shortages (House of Commons Health and Social Care Committee 2022). Additionally climate change is increasingly affecting all aspects of human life, including the incidence and distribution of kidney diseases (Barraclough and Agar 2020; Rajan et al. 2022). Paradoxically the treatment of kidney diseases, particularly dialysis, has a significant environmental impact; utilising large amounts of energy and water with considerable waste generation. (Piccoli et al. 2020). Emissions of 3.8 tonnes per carbon dioxide equivalent (CO_2e) per patient per year were calculated in a study of thrice-weekly in-centre dialysis (Connor et al. 2011a); a figure more than seven times the mean per patient carbon footprint in UK healthcare (Brown et al. 2012). The environmental impact associated with transportation is also high, fluids for peritoneal dialysis are often transported long distances to point of care (Barraclough and Agar 2020), and while for other areas of specialist kidney care there are no accurate estimates of environmental impact, for transplantation, immune mediated disease, and advanced kidney care, these are likely to be substantial.

In 2019 the overall carbon emissions for the NHS in England was reported as 25·0 mega tonnes of CO_2e, with 10% of these emissions directly associated with travel (Tennison et al.

2021). In July 2022, the NHS became the first health system to legislate for net zero emissions targets (NHS England 2022). The plans to deliver net zero include targets for i) emissions directly controlled by the NHS and ii) emissions that can be influenced including those from patient and visitor travel to and from NHS services. Given the disproportionate environmental impact of specialist kidney care, the Green Nephrology Network was established in 2009 as part of the NHS Sustainable Healthcare programme (Barraclough and Agar 2020). Following a survey of attitude and practice patterns in UK Renal units on water use, power management, waste recycling and staff beliefs (Connor and Mortimer 2010), practice changes were proposed including the use of reverse osmosis water and plastic cap recycling and retro-fitting heat exchangers (Agar 2015; Connor and Mortimer 2010). More recently, a Sustainable Kidney Care Committee has been set up within the UK Kidney Association (UKKA), in partnership with the Centre for Sustainable Healthcare and the Sustainable Healthcare Coalition. The aim of this is to develop and implement a framework to support UK renal services to meet the NHS net zero goal by encouraging action for sustainability (UK Kidney Association (UKKA) 2022).

The role of telemedicine

The utility of telemedicine has been identified as a priority area for green nephrology research (Barraclough and Agar 2020). Telemedicine is the use of digital information and communications technology to provide and support healthcare remotely (Omboni et al. 2022). The feasibility of telemedicine was demonstrated during the COVID-19 pandemic when there was widespread adoption (Lew et al. 2021; Stauss et al. 2021). Separately, there is evidence that telemedicine reduces the healthcare carbon footprint, particularly through

reduced transport emissions (Morcillo Serra et al. 2022; Purohit 2021). Studies estimate savings range between 0.70–372 kg CO_2e per consultation (Connor et al. 2011b; Purohit 2021). However, these savings were highly context specific; for example, video-conferencing uses more energy than telephone systems (Purohit 2021). Savings were also dependent on factors such as medical specialty, geography and travel time: with greater specialisation correlating with increased savings from reduced travel, likely as tertiary centres covered larger catchment areas (Purohit 2021). This could be of particular relevance to renal care.

Telemedicine may also offer benefits additional to carbon savings (see Table 1).

Table 1: Proposed advantages of telemedicine

Care delivery by telemedicine	**Potential advantages**
Teleconsultation for outpatient visits	• Reduced CO_2e travel and facilities usage for patients, carers and staff • Convenience (reduced impact on work and employment)(Ewart et al. 2022; Purohit 2021; Stauss et al. 2021) • High satisfaction for patients (Young et al. 2021)
Remote monitoring including symptoms and health related quality of life (ePROs) Integration of remote data with existing electronic health records; incorporating real-time data collection, safety data and decision support tools to improve active surveillance Management of healthcare appointments using remote data	• Potential improvements in clinical and patient-reported outcomes • Avoidance of unnecessary appointments leading to cost, time and carbon savings • Better access for patients in rural/remote settings (Casey et al. 2013) • Improved resource allocation, fewer missed appointments (Lew et al. 2021), decreased waiting times
Virtual wards to provide short-term transitional care to patients upon hospital discharge	• Adverse event prevention (Unplanned dialysis unit and emergency department visits/hospitalisations) associated with care gaps (Raphael et

	al. 2015)
Remote monitoring of dialysis sessions by interdisciplinary dialysis teams – with simultaneous access to dialysis parameters i.e., arterial, venous, and transmembrane pressure, conductivity, temperature, ultrafiltration rate, blood volume, laboratory test results, medications, blood pressure and weight	• Supports increase in home therapies (reduced carbon footprint, less expensive than in-centre haemodialysis reduced infection risk, shorten duration of home training) (Stauss et al. 2021) • Remote monitoring of automated peritoneal dialysis has shown early detection and resolution of problems, improved compliance, reduced hospitalisations, and improved health-related quality of life (Milan Manani et al. 2020) • Avoid logistical supply problems – early identification of low supplies (Wallace et al. 2017) • Support incremental dialysis or pre-emptive transplantation
Online delivery of education sessions, medication inquiry systems, information to assist self-management	• Increase in autonomy, confidence (Magnus et al. 2017) • Patient activation and self-management skills, behaviour modification, medications adherence – Potential to reduce/delay CKD progression and need for kidney replacement therapy
Electronic review of primary care referrals by Renal Specialist	• Timely access to advice, reduced need for referrals, greater confidence in primary care to manage CKD patients, potential travel, cost, time and carbon savings (Hull et al. 2020)
Telemedicine supported clinical trials via primary care providers – remote consenting, safety monitoring, and data collection. Medicines delivered to home	• Carbon and cost savings • Increased recruitment of under-represented groups in research (i.e., rural communities)

Patient-reported outcomes to support telemedicine

Any innovations to counter the environmental impact of healthcare should be patient-centred and undergo careful evaluation: the goal of patient-centered care is a functional life with a focus on the reduction of suffering, while the broader goal of person-centered care is a meaningful life (Hakansson Eklund et al. 2019). One way to assess and evaluate the patient experience of kidney disease and/or treatments, such as their symptom burden, functional status and health-related quality of life (HRQOL), is through the measurement of patient-reported outcomes (PROs) (Calvert et al. 2019) . PROs are defined as "…any report of the status of a patient's health condition that comes directly from the patient, without interpretation of the patient's response by a clinician or anyone else." (U.S. Food and Drug Administration 2009). PROs can be measured using validated questionnaires known as patient-reported outcome measures (PROMs). PROMs may be "generic," measuring domains of interest i.e., HRQOL, regardless of the underlying disease process, or "disease-specific," assessing the impact of a specific disease and its associated symptoms and/or treatment (Anderson et al. 2019).

PRO data can be used alongside biomedical and clinician-reported outcomes to gain a more complete and holistic view of the effects and impact of CKD and treatment (Aiyegbusi et al. 2017). The rapid growth of digital technologies brings the opportunity to systematically collect PROs electronically (ePROs) (Meirte et al. 2020). These data can be used to manage individual patient care or at an aggregate level for research, audit/benchmarking, commissioning and service improvement (Calvert et al. 2019). Procurement, infrastructure and innovation have been highlighted as a key work stream for the UKKA Sustainable Kidney Care Committee; telemedicine and ePROs could have a role to support these sustainability initiatives by measuring those outcomes which matter to patients for multiple purposes. The

potential to remotely collect ePROs could remove the need for stable patients to attend routine in person appointments which could significantly reduce travel-related carbon emissions. However, there are challenges in the use of ePROs, such as respondent burden (Aiyegbusi et al. 2022) and concerns over impact on workflow (Anderson et al. 2022).

Future research

Potential benefits need to be considered in the context of treatment for patients with kidney disease overall and a systematic approach should be taken to the evaluation of telemedicine. Laboratory measurements are a crucial component of care for patients with kidney disease and efforts should ensure telemedicine is integrated with point of care testing. Telemedicine studies to date have largely been short-term feasibility studies with few participants, which are difficult to replicate due to a failure to adequately describe the intervention (Hailey 2016). Further research is required to fully determine benefits including carbon savings and to identify unintended rebound effects; such as exacerbation of existing health disparities, particularly for older and ethnic minority patients. These could be caused by poor access and/or connectivity to digital devices, as well as socioeconomic and language barriers that can impact health literacy and engagement with telemedicine (Calvert et al. 2022; Eneanya et al. 2021); coupled with impacts on workflow for clinicians. Telemedicine studies should consider equity of access in their study design, particularly for under-served populations (Calvert et al. 2022; Tong et al. 2022).

Additionally, a shift to telemedicine is not without any environmental impact. Energy and other natural resources are required to create and power digital devices, and there is

significant electronic waste with the acquisition of new and multiple devices. Research is needed to assess the impact of this digital pollution.

To conclude, while telemedicine offers hope to lessen the environmental impact of kidney care, informed implementation and careful evaluation is necessary to avoid unexpected adverse consequences.

References

Agar JW. 2015. Green dialysis: The environmental challenges ahead. Semin Dial. 28(2):186-192.

Aiyegbusi OL, Kyte D, Cockwell P, Anderson N, Calvert M. 2017. A patient-centred approach to measuring quality in kidney care: Patient-reported outcome measures and patient-reported experience measures. Curr Opin Nephrol Hypertens. 26(6):442-449.

Aiyegbusi OL, Roydhouse J, Rivera SC, Kamudoni P, Schache P, Wilson R, Stephens R, Calvert M. 2022. Key considerations to reduce or address respondent burden in patient-reported outcome (pro) data collection. Nat Commun. 13(1):6026.

Anderson N, Kyte D, McMullan C, Cockwell P, Aiyegbusi OL, Verdi R, Calvert MJ. 2022. Electronic patient-reported outcomes in chronic kidney disease. Nature Reviews Nephrology. 18(12):739-740.

Anderson NE, Calvert M, Cockwell P, Dutton M, Kyte D. 2019. The use of patient-reported outcomes in patients treated with maintenance hemodialysis: A perspective. Am J Kidney Dis. 74(3):399-406.

Barraclough KA, Agar JWM. 2020. Green nephrology. Nat Rev Nephrol. 16(5):257-268.

Bikbov B, Purcell CA, Levey AS, Smith M, Abdoli A, Abebe M, Adebayo OM, Afarideh M, Agarwal SK, Agudelo-Botero M et al. 2020. Global, regional, and national burden of chronic kidney disease, 1990–2017: A systematic analysis for the global burden of disease study 2017. The Lancet. 395(10225):709-733.

Brown LH, Buettner PG, Canyon DV. 2012. The energy burden and environmental impact of health services. Am J Public Health. 102(12):e76-82.

Calvert M, Kyte D, Price G, Valderas JM, Hjollund NH. 2019. Maximising the impact of patient reported outcome assessment for patients and society. BMJ. 364:k5267.

Calvert MJ, Cruz Rivera S, Retzer A, Hughes SE, Campbell L, Molony-Oates B, Aiyegbusi OL, Stover AM, Wilson R, McMullan C et al. 2022. Patient reported outcome assessment must be inclusive and equitable. Nature Medicine. 28:1120-1124.

Casey M, Hayes PS, Heaney D, Dowie L, Olaighin G, Matero M, Hun S, Knarvik U, Alrutz K, Eadie L et al. 2013. Implementing transnational telemedicine solutions: A connected health project in rural and remote areas of six northern periphery countries series on european collaborative projects. Eur J Gen Pract. 19(1):52-58.

Connor A, Lillywhite R, Cooke MW. 2011a. The carbon footprints of home and in-center maintenance hemodialysis in the united kingdom. Hemodial Int. 15(1):39-51.
Connor A, Mortimer F. 2010. The green nephrology survey of sustainability in renal units in england, scotland and wales. J Ren Care. 36(3):153-160.
Connor A, Mortimer F, Higgins R. 2011b. The follow-up of renal transplant recipients by telephone consultation: Three years experience from a single uk renal unit. Clin Med (Lond). 11(3):242-246.
Eneanya ND, Stallings TL, Shaffer J, Konu ME, Cohen JB, Schrauben SJ, Hogan JJ, Sawinski DL. 2021. Age and racial inequities in telemedicine internet support among nephrology outpatients during the covid-19 pandemic. Kidney Med. 3(5):868-870.
Ewart C, Baharani J, Wilkie M, Thomas N. 2022. Patient perspectives and experiences of remote consultations in people receiving kidney care: A scoping review. J Ren Care. 48(3):143-153.
Hailey D. 2016. Telehealth in nephrology care-promises and challenges. Am J Kidney Dis. 68(1):5-7.
Hakansson Eklund J, Holmstrom IK, Kumlin T, Kaminsky E, Skoglund K, Hoglander J, Sundler AJ, Conden E, Summer Meranius M. 2019. "Same same or different?" A review of reviews of person-centered and patient-centered care. Patient Educ Couns. 102(1):3-11.
Workforce: Recruitment, training and retention in health and social care. 2022. [accessed]. https://committees.parliament.uk/publications/23246/documents/171671/default/.
Hull SA, Rajabzadeh V, Thomas N, Hoong S, Dreyer G, Rainey H, Ashman N. 2020. Do virtual renal clinics improve access to kidney care? A preliminary impact evaluation of a virtual clinic in east london. BMC Nephrol. 21(1):10.
Kovesdy CP. 2022. Epidemiology of chronic kidney disease: An update 2022. Kidney International Supplements. 12(1):7-11.
Lew SQ, Wallace EL, Srivatana V, Warady BA, Watnick S, Hood J, White DL, Aggarwal V, Wilkie C, Naljayan MV et al. 2021. Telehealth for home dialysis in covid-19 and beyond: A perspective from the american society of nephrology covid-19 home dialysis subcommittee. Am J Kidney Dis. 77(1):142-148.
Magnus M, Sikka N, Cherian T, Lew SQ. 2017. Satisfaction and improvements in peritoneal dialysis outcomes associated with telehealth. Appl Clin Inform. 8(1):214-225.
Meirte J, Hellemans N, Anthonissen M, Denteneer L, Maertens K, Moortgat P, Van Daele U. 2020. Benefits and disadvantages of electronic patient-reported outcome measures: Systematic review. JMIR Perioper Med. 3(1):e15588.
Milan Manani S, Baretta M, Giuliani A, Virzi GM, Martino F, Crepaldi C, Ronco C. 2020. Remote monitoring in peritoneal dialysis: Benefits on clinical outcomes and on quality of life. Journal of Nephrology. 33:1301-1308.
Morcillo Serra C, Aroca Tanarro A, Cummings CM, Jimenez Fuertes A, Tomas Martinez JF. 2022. Impact on the reduction of co2 emissions due to the use of telemedicine. Sci Rep. 12(1):12507.
NHS England. 2022. Delivering a net zero national health service. https://www.england.nhs.uk/greenernhs/wp-content/uploads/sites/51/2022/07/B1728-delivering-a-net-zero-nhs-july-2022.pdf

Omboni S, Padwal RS, Alessa T, Benczúr B, Green BB, Hubbard I, Kario K, Khan NA, Konradi A, Logan AG et al. 2022. The worldwide impact of telemedicine during covid-19: Current evidence and recommendations for the future. Connect Health. 1:7-35.

Piccoli GB, Cupisti A, Aucella F, Regolisti G, Lomonte C, Ferraresi M, Claudia D, Ferraresi C, Russo R, La Milia V et al. 2020. Green nephrology and eco-dialysis: A position statement by the italian society of nephrology. J Nephrol. 33(4):681-698.

Purohit A, Smith, J.,Hibble, A. 2021. Does telemedicine reduce the carbon footprint of healthcare? A systematic review. Future Healthc J. 8(1):e85-e91.

Rajan T, Amin SO, Davis K, Finkle N, Glick N, Kahlon B, Martinusen D, Pederson K, Samanta R, Tarakji A et al. 2022. Redesigning kidney care for the anthropocene: A new framework for planetary health in nephrology. Can J Kidney Health Dis. 9:20543581221116215.

Raphael MJ, Nadeau-Fredette AC, Tennankore KK, Chan CT. 2015. A virtual ward for home hemodialysis patients - a pilot trial. Can J Kidney Health Dis. 2:37.

Stauss M, Floyd L, Becker S, Ponnusamy A, Woywodt A. 2021. Opportunities in the cloud or pie in the sky? Current status and future perspectives of telemedicine in nephrology. Clin Kidney J. 14(2):492-506.

Tennison I, Roschnik S, Ashby B, Boyd R, Hamilton I, Oreszczyn T, Owen A, Romanello M, Ruyssevelt P, Sherman JD et al. 2021. Health care's response to climate change: A carbon footprint assessment of the nhs in england. Lancet Planet Health. 5(2):e84-e92.

Tong A, Scholes-Robertson N, Hawley C, Viecelli AK, Carter SA, Levin A, Hemmelgarn BR, Harris T, Craig JC. 2022. Patient-centred clinical trial design. Nature Reviews Nephrology. 18(8):514-523.

U.S. Food and Drug Administration. 2009. Guidance for industry patient-reported outcome measures: Use in medical product development to support labeling claims. In: U.S. Department of Health and Human Services, editor. Rockville, MD.

Sustainable kidney care committee. 2022. [accessed]. https://ukkidney.org/sustainable-kidney-care-committee.

Wallace EL, Rosner MH, Alscher MD, Schmitt CP, Jain A, Tentori F, Firanek C, Rheuban KS, Florez-Arango J, Jha V et al. 2017. Remote patient management for home dialysis patients. Kidney Int Rep. 2(6):1009-1017.

Young A, Orchanian-Cheff A, Chan CT, Wald R, Ong SW. 2021. Video-based telemedicine for kidney disease care. Clinical Journal of the American Society of Nephrology. 16(12):1813-1823.

Key words

Green nephrology, telemedicine, patient-reported outcomes, sustainability, virtual care

Key points

- The nephrology community needs to fully assess and reduce the environmental impact of kidney care.
- As well as monitoring and reduction of resource usage (energy and water) and waste generation, we need to explore how new technologies such as telemedicine might reduce the carbon footprint of kidney care.
- Research which is both environmentally focused while remaining patient-centered should be promoted

Reflective questions

- What actions do you take as an individual and as a facility/unit to support the long-term sustainability of kidney care?
- Does your workplace have a 'green champion' – to develop and drive local green initiatives?
- Would your local population be able to participate in telemedicine initiatives or would there be barriers to use, such as poor digital and health literacy, which could affect equitable uptake of remote or virtual care?