A Survey of Environmental Sustainability Practices in Dialysis Facilities in Australia and New Zealand

Benjamin Talbot, Katherine Barraclough, Matthew Sypek, Pedro Gois, Leila Arnold, Stephen McDonald, and John Knight

Abstract

Background and objectives Climate change is the biggest global health threat of the twenty-first century. Health care itself is a significant contributor to greenhouse gas emissions, and dialysis programs contribute disproportionately. Nephrology societies have called for increased recognition and action to minimize the environmental effect of dialysis care, but little data exist regarding environmental sustainability practices within dialysis facilities worldwide. This survey reports a baseline of environmental sustainability practices of dialysis facilities in Australia and New Zealand.

Design, setting, participants, & measurements An online survey was used to collect data regarding key areas of environmental sustainability practices within dialysis facilities between November 2019 and December 2020. An invitation to complete the survey was sent to the heads of all dialysis facilities in Australia and New Zealand.

Results Responses were received from 132 dialysis facilities, representing 33% (122 of 365) of dialysis services within Australia and New Zealand. Most responses were from public satellite facilities (53 of 132; 40%), in-center dialysis facilities (33 of 132; 25%), and co-located dialysis and home therapies facilities (28 of 132; 21%). Opportunities for improvement in environmental sustainability practices were identified in three domains. (1) Culture. A minority of facilities reported having an environmental sustainability strategy in place (44 of 132; 33%) or undertaking sustainability audits (27 of 132; 20%). Only 7% (nine of 132) reported the inclusion of environmental training in staff induction programs. (2) Building design, infrastructure, and energy use. Few facilities reported the use of renewable energy (18 of 132; 14%), reclaiming reverse osmosis reject water (16 of 126; 13%), or the use of motion-sensor light switches (58 of 131; 44%). (3) Operations. A minority of facilities reported waste management education (47 of 131; 36%), auditing waste generation (23 of 132; 17%), or that environmental sustainability was considered in procurement decisions (33 of 132; 25%).

Conclusions Environmental sustainability is not currently prioritized in clinical practice, building design and infrastructure, or management systems in Australian and New Zealand dialysis facilities responding to this survey.

CJASN 17: 1792–1799, 2022. doi: https://doi.org/10.2215/CJN.08090722

Introduction

Climate change is considered the biggest global health threat of the twenty-first century (1). Although it has been suggested that health care professionals must lead in responding to the health threat of climate change (2), health care itself is a significant contributor to greenhouse gas emissions (3,4), and within health care, dialysis programs have a disproportionately large carbon footprint, waste generation, and resource consumption profile (5). Despite this, little data currently exist regarding environmental sustainability practices within dialysis facilities worldwide.

In Australasia, climate trends and extreme weather events have already combined to cause irreversible change to natural systems, increasing health effects and socioeconomic costs (6). Yet, in 2018, Australia and New Zealand were among the highest global producers of per capita greenhouse gas emissions (7), with health care responsible for 7% of total emissions in Australia (3) and up to 8% in Aotearoa New Zealand (8). Growing recognition of the environmental effect of health care has led to ten medical colleges within Australia declaring climate change a health emergency and launching the Healthy Climate Future campaign (9). The Australian Medical Association and the Doctors for the Environment Australia have also called on the Australian health care sector to reduce carbon emissions by 80% by 2030 and achieve net zero by 2040 (10). Achieving these ambitious targets, which mirror those set by the National Health Service in England (11), will take concerted effort from each specialty, in addition to support from government and health policy.

In 2011, the per patient annual carbon footprint of conventional satellite hemodialysis (HD) in Australia...
was approximately 10.2 t CO₂-eq, which represented more than half an average Australian household's annual emissions at that time (12). Although fewer data exist regarding peritoneal dialysis, its environmental effect is also likely to be substantial (13). Currently, 17,588 patients are treated with dialysis across Australia and New Zealand, representing between 567 and 590 per million population (14). Although this presents a huge opportunity for greenhouse gas emissions reduction, progress toward environmentally sustainable kidney care in Australia and New Zealand remains in the early stages, with available data regarding baseline environmental attitudes, knowledge, and practice patterns currently limited to a single state (Victoria) (15).

This survey of environmental sustainability practices within dialysis facilities in Australia and New Zealand seeks to expand existing data and provide a baseline against which improvements can be made.

Materials and Methods
Study Design, Recruitment, and Data Collection
Between November 2019 and December 2020, an online survey was used to collect data regarding key areas of environmental sustainability practices within dialysis care, including environmental strategy, building infrastructure and energy use (lighting, heating, and electrical equipment), water, waste management, transport, procurement practices, paper use, and climate change preparedness (Supplemental Material). An invitation to complete the survey was sent to the heads of all dialysis facilities in Australia and New Zealand, with the option of delegating the task to an appropriate person within their facility. A single follow-up telephone call was made to non-responding dialysis facilities to ensure the link had been received and encourage participation. The individual completing the survey remained anonymous. Data were recorded electronically using REDCap 8.3.2 (2019 Vanderbilt University). The study received ethical approval from the University of New South Wales Human Research Ethics Committee (HC190771).

Data Linkage
Following closure of the survey, data linkage was used to associate dialysis facility–specific metadata held by the Australia and New Zealand Dialysis and Transplant Registry (ANZDATA) to survey responses. ANZDATA is a clinical quality registry that collects data on the treatment and outcomes of patients with kidney failure in Australia and New Zealand. Dialysis services recorded within ANZDATA may incorporate multiple facilities; for example, a home therapies dialysis facility and a co-located in-center or satellite dialysis facility may be recorded under a single dialysis service code. No patient-level data linkage was performed for this study.

To aid interpretation of data, both the number of responses to each question and the proportion of responses out of the total number of respondents are presented because not all respondents answered every question.

Results
Responses to the survey were received from 132 dialysis facilities, representing 122 different dialysis services and 33% (122 of 365) of dialysis services listed within the ANZDATA registry (Table 1). Responders were overwhelmingly nurse unit managers or dialysis nurses (118 of 132; 89%), with nephrologists (seven of 132; 5%) and service managers (five of 132; 4%) completing the majority of remaining surveys. Most responses were from dialysis facilities in Victoria (52 of 132; 39%) and New South Wales (35 of 132; 27%), although when the number of responding services is viewed as a proportion of the total number of services within each state, Tasmania ranked the highest, with responses received from 100% (four of four) of dialysis services (Table 1). Most responses were from public satellite facilities (53 of 132; 40%), followed

Table 1. Dialysis facilities that responded to the survey of environmental sustainability practices in Australia and New Zealand

<table>
<thead>
<tr>
<th>State</th>
<th>No. of Dialysis Facilities Responding, n</th>
<th>No. of Dialysis Facilities Representing as a Proportion of the Total No. of Dialysis Facilities Included in Analyses, %</th>
<th>No. of Dialysis Services Represented by Responding Facilities</th>
<th>No. of Dialysis Services in State</th>
<th>Proportion of Dialysis Services within the Region that Responded, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australian Capital Territory</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>17</td>
</tr>
<tr>
<td>New South Wales</td>
<td>35</td>
<td>27</td>
<td>33</td>
<td>91</td>
<td>36</td>
</tr>
<tr>
<td>Northern Territory</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>17</td>
<td>24</td>
</tr>
<tr>
<td>Queensland</td>
<td>19</td>
<td>14</td>
<td>16</td>
<td>71</td>
<td>23</td>
</tr>
<tr>
<td>South Australia</td>
<td>7</td>
<td>5</td>
<td>6</td>
<td>27</td>
<td>22</td>
</tr>
<tr>
<td>Tasmania</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>Victoria</td>
<td>52</td>
<td>39</td>
<td>48</td>
<td>92</td>
<td>52</td>
</tr>
<tr>
<td>Western Australia</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>28</td>
<td>14</td>
</tr>
<tr>
<td>New Zealand</td>
<td>6</td>
<td>5</td>
<td>6</td>
<td>29</td>
<td>21</td>
</tr>
</tbody>
</table>

The number of dialysis facilities responding (n) is shown as a proportion (percentage) of the total number of responding facilities included in the analysis. Dialysis services recorded within the Australia and New Zealand Dialysis and Transplant Registry may incorporate multiple facilities; therefore, the number of dialysis services represented by responding dialysis facilities is also presented as the number of responding services in each state and the proportion (percentage) of the total number of services within each state. No., number.
by in-center dialysis facilities (33 of 132; 25%) and co-located
dialysis and home therapies facilities (28 of 132; 21%) (Figure 1).

Environmental Strategy (Policies, Plans, and Initiatives)
A minority of facilities reported having an environmental
sustainability strategy in place (44 of 132; 33%), whereas
even fewer reported ever having undertaken a sustainability
audit (27 of 132; 20%). Thirty-nine percent (51 of 131) of
facilities reported a formal green group within their organi-
zation, and 26 of 131 (20%) had a formal green group within
their department. Despite this, 70% (92 of 132) of facilities
reported efforts to raise awareness of environmental sustain-
ability, which was mostly through either informal discussion
(87 of 92; 95%) or having systems in place to allow staff to
provide suggestions around carbon reduction and recycling
(36 of 92; 39%). Less than half of responding units (63 of 132;
48%) had previously attempted to introduce a “green” pro-
ject, but of those that had, 81% (51 of 63) felt that it had been
successful. Only 7% (nine of 132) of dialysis facilities
reported the inclusion of environmental training in staff
induction programs (Figure 2).

Building Infrastructure and Energy Use
Lighting. Although the majority of responding facilities
reported that lights were switched off when not required
most or all of the time (114 of 127; 90%), less than half had
motion-sensor light switches (58 of 131; 44%). Fluorescent
tube lighting was the most common lighting type within
responding facilities (62 of 130; 48%), with a lesser number
reporting the use of light-emitting diode lighting (35 of
130; 27%).

Heating. Most facilities reported that appropriate tem-
peratures were generally maintained (103 of 132; 78%), although
a lesser number had accessible thermostats or heating con-
trols (72 of 132; 55%). Sixty-one percent of facilities reported
shading over north-facing windows (79 of 130).

Electrical Equipment. Almost all facilities reported con-
figuring computers/monitors (125 of 132; 95%) and photo-
copiers (118 of 132; 89%) to automatically enter sleep or
hibernation mode when not in use. Fewer reported actively encouraging staff to shut computers down (85 of 132; 64%), and less than half indicated that energy-efficient appliances were preferentially purchased (61 of 131; 47%).

**Energy Supply.** Nearly half of respondents were unaware of whether renewable energy was used within their dialysis facility (56 of 132; 42%). A minority of facilities reported use of renewable energy (18 of 132; 14%), with solar energy predominating (13 of 18; 72%).

**Water**
The majority of responding facilities reported dual flush toilets (106 of 132; 80%); however, water-saving taps were present in less than half of the facilities (58 of 128; 45%). Of the 126 facilities providing HD treatments, 13% (16 of 126) reported reclaiming reverse osmosis reject water, which was mostly redirected for use in toilets or gardens. Roof rainwater salvage occurred in 17% (22 of 131) of units.

**Waste Management**
More than half of facilities reported recycling bins in clinical areas for hard plastics (89 of 132; 67%), but fewer than half had recycling bins for soft plastics (41 of 131; 31%) or polyvinyl chloride (50 of 132; 38%). Sixty-seven percent of facilities reported collection of pallets by dialysis product suppliers on delivery (89 of 132), but in the facilities where this did not occur, only 41% (seven of 17) recycled them themselves (Figure 3).

Efforts to recycle were described as good or moderate in half of dialysis facilities (65 of 129; 50%). Formal staff education regarding optimal waste management was reported by only 36% (47 of 131), and auditing of the amount of waste generated was reported by less than one fifth of the facilities (23 of 132; 17%) (Figure 3).

**Transport**
Fifty-eight percent (77 of 132) of facilities reported secure parking for bicycles, with similar availability of showers/changing facilities (75 of 132; 57%) and public transport access (76 of 132; 58%). Carpool/share programs for staff were available at 17% (22 of 132) of facilities. Transport services for patients on dialysis were available at 37% (49 of 132) of facilities, and information about public transport was provided to patients in 44% (58 of 132). Walking and cycling were encouraged where appropriate to patients in only 14% (19 of 132) of facilities, and low-emission vehicles were used for patient transport in 2% (two of 132). The use of phone or videoconference was reported in more than half of facilities for consultations with patients (80 of 132; 61%) and for regular staff meetings that would usually require staff to travel (77 of 130; 59%) (Figure 4).

**Procurement Practices**
A minority of facilities reported that sustainability was considered when choosing products or suppliers (33 of 132; 25%). Products were mostly delivered weekly (84 of 132; 64%), with delivery frequency determined by storage space in the majority of facilities (96 of 132; 73%).

**Paper**
Electronic health records were in use in 67% (88 of 132) of facilities. Printing was actively discouraged in 77% (102 of 132), and double-sided printing was reported as routine in 84% (111 of 132). The use of recycled paper for copying was reported by 61% (80 of 131). Automatic hand dryers were
infrequently used in place of paper towels, with availability reported in clinical areas by only 2% (three of 131) and public areas by 13% (17 of 131).

**Climate Preparedness**
Most facilities reported educating patients regarding preparedness for extreme weather events (112 of 132; 85%), while 82% (106 of 130) reported having a defined emergency strategy in place for these.

**Home Therapies**
Thirty-five home training facilities responded to the survey, representing 35 of 102 (34%) home training services in Australia and New Zealand. These were either co-located dialysis and home therapy facilities (28 of 35; 80%) or stand-alone home therapies facilities (seven of 35; 20%).

Only 40% (14 of 35) of home therapy facilities reported access of patients to either cardboard or polyvinyl chloride recycling. Of the 29 home HD facilities, around half reported having patients who reclaimed reverse osmosis reject water at home (15 of 29; 52%), although in most cases (13 of 15; 87%), only a minority (1%–25%) of patients at the facility were involved. Formal assistance to help establish water capture or reuse systems was provided in only 24% (seven of 29) of facilities. Forty-one percent (12 of 29) of home HD facilities reported patients using renewable energy, although formal assistance to establish such sources of power was offered by only one facility (one of 29; 3%).

**Discussion**
This study provides a baseline for environmental sustainability practices within dialysis facilities in Australia and New Zealand. It highlights major deficiencies and thereby opportunities in three major domains.

Environmental sustainability practices, education, and improvements are currently not prioritized. Most facilities reported only informal efforts to raise awareness of environmental sustainability, and strategies or policies to drive this were not often in place. The survey indicated that audits were infrequent, that few facilities included formal training in staff induction programs, that green groups were not prominent in either dialysis facilities or umbrella organizations, and that green projects had been instigated in less than half of facilities.

Environmental sustainability has not been prioritized in dialysis facility development to date. Although responding facilities reported attempts to minimize energy use where possible (e.g., switching off lights or configuring electronic devices to enter hibernation modes), these attempts were not universal. Environmentally sustainable building design features were reported in the minority of facilities.

Environmental sustainability has not been prioritized in dialysis facility development to date. Although responding facilities reported attempts to minimize energy use where possible (e.g., switching off lights or configuring electronic devices to enter hibernation modes), these attempts were not universal. Environmentally sustainable building design features were reported in the minority of facilities.

Responds suggest that waste management systems are mostly inadequate, with recycling and collection of dialysis pallets not available in all facilities and audits of waste generation only infrequently performed. Use of paper was not optimized in all facilities, and sustainability was not often considered in procurement decisions.

These results suggest that although environmental awareness may have increased in the nephrology sector overall (16,17), little progress has been made in terms of unified
environmental sustainability strategies and practices in Australia and New Zealand since the survey of Victorian facilities was conducted in 2017 (15). It should also be noted that the facilities responding to this survey are likely to represent the most environmentally engaged facilities in Australia and New Zealand, suggesting that overall environmental performance is likely to be even poorer than the results of this survey suggest. The fact that only 5% of responders were nephrologists is important, possibly reflecting a lack of perceived responsibility with regard to environmental sustainability among this group. Targeted engagement may therefore be important in generating the change that is needed.

In recognition of this lack of progress and the need for meaningful change in environmental sustainability practices in kidney care in Australia and New Zealand, the Australia New Zealand Society of Nephrology, through its Environmental Sustainability Committee, has proposed two major initiatives:

1. A comprehensive set of environmentally sustainable design guidelines, which are to be appended to the Australasian Health Infrastructure Alliance guidelines for dialysis facilities, to help integrate best-practice sustainability considerations into dialysis facility design, construction, and operation;

2. A Green Stars program to provide a framework through which kidney care services can be supported in implementing green initiatives and demonstrate their achievements against a set of national criteria.

It is important to acknowledge that infrastructure implementation, such as installing water-saving taps and energy-efficient lighting and retrofitting reverse osmosis reject water salvage, may involve up-front costs and that opportunities to introduce such changes may be more restricted where dialysis facilities are placed within larger hospitals or leased buildings. However, these measures are typically cost saving in the medium term and should therefore be encouraged through formal support from hospitals, health services, and governments. A number of simple measures that were absent in a proportion of dialysis facilities surveyed, such as ensuring that all lights and electrical equipment are switched off when not required, universal use of recycled paper and doublesided printing, and appropriate shading for sun-facing windows, should be a requirement in all dialysis facilities (and health care facilities more broadly) and could be maintained through staff education at little or no additional cost.

One area where this survey has demonstrated a change from the earlier surveys in Victoria (15) and the United Kingdom (18) is in the increased frequency of videoconferencing for consultations with patients and to replace in-person staff meetings. Where appropriate, the ongoing use of telemedicine may be beneficial in reducing the carbon footprint of travel related to dialysis care and improving convenience; however, digital platforms also contribute a carbon footprint, and a formal analysis of telehealth is necessary to adequately inform improvement initiatives.

Nephrology societies around the world advocate for expanding home therapies treatment programs, which can increase patient autonomy, improve quality of life, and reduce financial costs (19). Home HD is, however, associated with a higher carbon footprint (20) and water consumption profile (21) than in-center HD. Accordingly, priority should be given to providing formal assistance (practical and financial) to patients on home HD to enable them to utilize renewable energy and recapture reverse osmosis reject water.

The support of industry is critical in reducing the environmental effect of dialysis care. As a nephrology community, we must move toward incorporating sustainability criteria into procurement contracts, transferring the responsibility for waste and environmental innovation to dialysis companies from financially stretched health services. Contracts should necessitate recycling of waste by dialysis providers and incentivize improvements and development among competitors at all stages of the product life cycle. This shift will be particularly important in supporting environmental sustainability practices in lower- and middle-income countries, where dialysis provision is forecast to grow the most (22). Disruptive innovations, such as the Ellen Medical Devices Point-of-Care Affordable Peritoneal Dialysis System (23) and sorbent technologies for dialysis regeneration (24), may also offer environmental savings in the future, and further research should be prioritized. Dialyzer reuse may offer another opportunity, with the potential to lead to large reductions in raw material use and medical waste generation (25). However, there would simultaneously be increased liquid waste from the germicides used for dialyzer disinfection, notwithstanding that questions remain about safety. Both life cycle environmental research and high-quality studies of the safety would be required before this could be recommended.

This study has several limitations. Compromises were necessary in the design of the survey to ensure that it remained user-friendly and minimally burdensome. High-quality data addressing key areas of environmental sustainability practices were sought, but it was not feasible to incorporate every aspect of dialysis care. Despite the use of different recruitment strategies, 33% of dialysis services in Australia and New Zealand responded. Moreover, responders were volunteers and therefore may represent dialysis facilities with an interest in environmental sustainability. This could have biased responses, and it is possible that our results are not representative. The nature of this survey limited quantitative data collection, and some of the data collected were subjective. Hopefully, however, as environmental auditing increases in dialysis facilities in the future, our ability to collect objective data will also increase.

This study provides a baseline for environmental sustainability practices in dialysis facilities in Australia and New Zealand and proves the feasibility for broad surveying of environmental attitudes, knowledge, and practice patterns. In turn, this allows for better understanding of differences and opportunities for change across world regions.

Disclosures

L. Arnold reports employment with and ownership interest in M and M Renal Limited. K. Barraclough reports research funding from Fresenius Medical Care. P. Gois reports consultancy agreements with the atypical Hemolytic Uremic Syndrome Board Committee of Alexion Pharmaceuticals; honoraria from Alexion Pharmaceuticals (atypical Hemolytic Uremic Syndrome Board Committee); a patent request in Brazil (under analysis) for the secondary use of allopurinol for rhabdomyolysis; and serving as a reviewer editor of Frontiers in Physiology–Renal and as a section editor of International Journal of Environmental Research and Public Health. J. Knight reports employment with Ellen Medical Devices, which is developing the
Affordable Dialysis Program; ownership interest in Ellen Medical Devices and Johnson & Johnson; serving as a mentor for the Medtech Actuator; and other interests or relationships with the Australian and New Zealand Society of Nephrology, The George Institute for Global Health, the International Society of Nephrology, The University of Sydney, and University of New South Wales. S. McDonald reports ownership interest in AMP Limited; reports research funding from Astellas Pharmaceuticals and Baxter Healthcare; and has had advisory or leadership roles with Fresenius Kidney Care Australia. B. Talbot reports employment with Ellen Medical Devices, which is developing the Affordable Dialysis Program; ownership interest in Ellen Medical Devices; research funding from Ellen Medical Devices; a scientific leadership role at George Clinical; and other interests or relationships with The George Institute for Global Health. B. Talbot reports receipt of a Scientia scholarship from the University of New South Wales, Sydney, Australia to complete a PhD in medical education. The remaining author has nothing to disclose.

Funding
None.

Acknowledgments
We thank ANZDATA for their support in this study.

Author Contributions
K. Barracough, J. Knight, and B. Talbot conceptualized the study; B. Talbot was responsible for data curation; B. Talbot was responsible for formal analysis; K. Barracough, P. Gois, J. Knight, S. McDonald, M. Sypek, and B. Talbot were responsible for methodology; B. Talbot was responsible for project administration; K. Barracough and J. Knight provided supervision; B. Talbot wrote the original draft; and L. Arnold, K. Barracough, P. Gois, J. Knight, S. McDonald, and M. Sypek reviewed and edited the manuscript.

Data Sharing Statement
Deidentified data may be made available for sharing but are subject to ethics committee approval.

Supplemental Material
This article contains the following supplemental material online at http://cjASN.asnjournals.org/lookup/suppl/doi:10.2215/CJN.08090722/-/DCSupplemental.

Supplemental Material
The environmental survey of dialysis practices in Australia and New Zealand.

References


Received: July 8, 2022 Accepted: October 19, 2022

Published online ahead of print. Publication date available at www.cjasn.org.