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EDITORIAL

Nephrology: achieving sustainability

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The Brundtland report defines sustainability as meeting the need for the present without compromising the ability of future generations to meet their needs [1]. Unfortunately, it is only too evident that we are not living in a sustainable fashion and thus, to protect the future, we have a moral duty as a society to concentrate on achieving sustainability, globally. This is applicable to each and every one of us; no-one is exempt. Medical professionals must accept responsibility for addressing practices that are detrimental to achieving sustainability and nephrologists, particularly, work in a specialty where patient management may pose a significant threat to the environment. It is, therefore, imperative that we not only acknowledge this but that we take significant steps towards redressing the balance of sustainability.

There are two key issues that require attention: the impact of environmental change on kidney health and the impact on the environment from the care of patients with kidney disease. It is increasingly clear that the changing environment can have detrimental effects on human health and this issue is discussed in depth elsewhere [2, 3]. This Editorial complements previous discussions and focuses on the second issue, highlighting new information and defining a route map to guide the nephrology community towards a common goal of sustainability [4, 5].

REDUCING THE ENVIRONMENTAL IMPACT OF DIALYSIS

Two recently published papers are particularly worthy of comment [6, 7]. Australian nephrologists have been pioneers in this field and the environmental impact of dialysis has long been high on their agenda. A comprehensive review by Katherine Barraclough and John Agar succinctly summarizes current knowledge and presents a set of measures that can be undertaken in dialysis facilities to reduce the effect of dialysis on the environment [7].

Despite this, there is a paucity of data looking at nephrology practice and sustainability. Bendine *et al.* [6] sought to remedy this and prospectively collected data from 2005, with subsequent changes in environmental parameters that they describe in detail, in Fresenius dialysis centres in France [6]. Initially, an integrated management system was implemented with three focus areas: quality, environment and security.

Environmental commitment begins with eco-reporting, and Bendine *et al.* identified three key performance indicators (KPIs): electricity consumption, expressed in kilowatt-hours per dialysis session (kWh/session); water consumption, expressed as litres per dialysis session (L/session); and care-related waste production, expressed as kilograms/session (kg/session). To enable quantification of these KPIs, meters to measure water and power consumption directly related to the dialysis procedure were installed. These dedicated meters were added to the water treatment system and allowed water consumption related to dialysis therapy (dialysate production) to be quantified separately from water utilized for other activities (e.g cleaning and handwashing). Additionally, members of staff were given training about data collection and its purpose, and a dedicated member of unit staff was given responsibility for the collection.

In the second phase, data were collected, centrally analysed and used for benchmarking. Based on the initial results, plans for improvements were designed and implemented, including changes to equipment and reduction of inefficiencies in the dialysis process. Annual targets are pro-actively adjusted based on the collected data. The most recent data for 2018 reports KPIs for almost 400 000 dialysis sessions: 16.3 kWh electricity, 382 L water and 1.1 kg of waste, all per dialysis session. This represents a significant improvement compared with figures at the time of the study conception in 2005: 23.1 kWh electricity, 801 L water and 1.8 kg of waste, while in that period the number of sessions more than doubled. Targets for the future seek to improve these parameters further, demonstrating confidence that ongoing improvement is readily achievable.

For most clinicians, these numbers will be unfamiliar and there are virtually no data in the literature to allow comparison. Where available, comparison is difficult because it is unclear whether the methodology to assess these variables is identical. Thus, for now, this study represents the most useful set of information.

What can we learn from this study? First, the methodology is described in sufficient detail to enable others to design and implement a similar approach within their own centres. Changes in equipment and improvement of the dialysis procedure itself were established. Currently, most dialysis centres do not routinely evaluate the described KPIs and do not include sustainability as part of their evaluation list when selecting new machines and materials. Dialysis centres should start to do that as sustainability remains at the forefront of the global agenda.

Secondly, the outcomes should be used as a benchmark and a start point for sustainability standard setting. In Table 1, calculations for Europe are presented based on these numbers. It is very clear that dialysis represents an enormous environmental burden, and thus change must be effected as a priority.

In the dialysis unit of University Medical Center Utrecht, a similar analysis was carried out (previously unpublished information). Outcomes were per session: 10.1 kWh of electricity, 385 L water and 1.8 kg of waste. Carbon footprint, defined as the sum of greenhouse gas emissions released in relation to an organization, product or service, expressed as carbon dioxide equivalents (CO_2e), was calculated to be 30 kg CO_2 per session, i.e. 4.68 ton CO_2/year (Figure 1). In the UK, the equivalent figure for in-centre haemodialysis was 3.8 ton CO_2/year. The average production per patient in Australia seems much higher, at 10.2 ton CO_2/year [7]. However, in this calculation, medication was also taken into account and was 37.5% of the total. In a single-centre study, home dialysis produced 7.2 ton CO_2 per patient per year and although it is dependent upon the dialysis schedule [7], regardless it translates into a significant reduction in patient transport-related emissions. The mean Australian and Dutch annual per capita emissions are 15.4 and 15.8 ton CO_2, respectively [7, 11]. Therefore, regardless of how the environmental impact of haemodialysis is expressed, the burden is enormous and a cause for concern. In both the Australian and Dutch calculations, waste handling and energy consumption are major contributors; here, the reverse osmosis process consumed 60% or more of the total energy. A comparative analysis of the results in various countries also underlines the need for standardization of methodology of assessment.

Table 1. Estimation of the environmental burden of haemodialysis based on data presented in Ref. [6]

Environmental burden per session: 16.3 kWh electricity, 382 L water and 1.1 kg of waste
Estimation of number of haemodialysis patients in Europe: 333 000
333 000 × 16.3 kWh × 3 (sessions per week) × 52 (weeks) = 846 752 400 kWh of energy/year
57 142 800 kg of waste/year
19 844 136 000 L of water/year
For comparison:
Olympic swimming pool: 50 m × 25 m × 2 m = 2500 m^3 = 2 500 000 L
Male adult elephant 6000 kg
Average Dutch family of five persons consumes 4371 kWh/year
Medium size full electric car consumes between 0.1 and 0.2 kWh/km => one haemodialysis session equals 100 km drive
=> water: 7938 Olympic pools/year, i.e. 21.7 pools/day
=> waste: per year weight equivalent of 9524 elephants
=> energy: city of 193 721 families, i.e. 968 603 persons or 5 194 800 000 km in an electric car

Notes: estimation of global number of haemodialysis patients: 2.993 million (nine times Europe). Number of haemodialysis patients in Europe based on information from the ERA-EDTA Registry and global numbers taken from Ref. [8]. Energy consumption of average Dutch family taken from Ref. [9].

TRANSPARENCY AND RAISING AWARENESS

Dialysis allows for systematic collection of clinical and operational data across different care settings. Analysis of these data has the potential for health management by revealing opportunities to improve patients care but also processes. In 2016, the Chief Medical Officers of dialysis service providers [Fresenius Medical Care (FMC) Europe Middle East Africa, FMC North America and FMC Asia Pacific Hong Kong China, Diaverum Renal Services Group, DaVita HealthCare Partners, Braun Avitum AG] active on five continents and treating more than 500 000 patients started a collaboration aimed at identifying, sharing and promoting the implementation of known best clinical practices in their networks [12]. This initiative has great potential. It is very likely that these organizations have much more unpublished data on the abovementioned KPIs and other related parameters. The Chief Medical Officers should be encouraged to broaden the targets mentioned in their final paragraph: 'create national and international standards, and to create supportive performance metrics for value based health care performance'. Environmental variables should become an integral part of these targets. Some of the organizations also manufacture dialysis materials and use likely their own materials in their centres, as is the case for the analysis by Bendine *et al.* [6]. Other organizations have multiple suppliers of materials and equipment, which makes it possible to identify differences between materials from different manufactures.

Thus, as a community, we must call upon the organizations behind this well-conceived and important initiative described in 2016 in *The Lancet* to come forward and help with the next steps [12]. Providing key data, transparently, should be the first action of this group. This would give visibility to the complexities of sustainability in nephrology and crucially, raise awareness. Partnering with professional organizations such as the ERA-EDTA is also key to promoting awareness. For the haemodialysis procedure itself, the inefficiency of reverse osmosis, both in energy and in water handling, together with waste production seem the most important targets to address, at least initially.

Much remains unknown. There is very limited information on peritoneal dialysis; the transport of heavy materials (fluids) and large usage of disposable products mean that the environmental impact is presumably substantial. More data on home haemodialysis are needed. Life cycle impact analysis of individual pharmaceutical products and of medical devices is also likely to be considerable, but again such information is not readily available in the public domain.

WHERE DO WE GO FROM HERE?

The European Commission has announced that the creation of a sustainable society is a top priority. This includes the healthcare sector, which produces, on average, 4.4% of the global carbon footprint [13]. Worryingly, most European countries are considerably above this global average and are among the major emitters when expressed per capita. Environmental and sustainability commitments defined by global and European institutions require implementation and pose an enormous task for the healthcare sector. In some countries, such as the UK and the Netherlands, nationwide initiatives have already commenced [14, 15]. In order to progress this area in nephrology, professional organizations like the ERA-EDTA and national societies are essential. The ERA-EDTA is acutely aware of its moral responsibility towards future generations and is eager to both initiate and support activities that could help to achieve global sustainability. To aid these goals, we have previously summarized activities that we can undertake as an organization [4, 5].

At our annual congress in June 2020, there were dedicated sessions specifically addressing sustainability. The COVID-19 pandemic had forced us to adapt and our congress was, for the first time, held as a wholly virtual meeting. This posed many challenges and there were undoubtedly many advantages of a face to face meeting; for the environment, a virtual meeting offered enormous benefits and for the nephrology community, it served as a morale booster in unprecedented times.

In order for measures taken by the ERA-EDTA to be effective, close collaboration with the industries active in our field is essential. The reality is that the industries must consider themselves at least partly responsible for the fate of their products once they have left their factories. Furthermore, the big dialysis chains should share their knowledge and experience in this respect. This is not the time for embargo. The Fresenius initiative was started as an effort to reduce internal costs, but is now labelled as a green initiative. It is of fundamental importance to appreciate that ‘green initiatives’ can often be economically very attractive.

We are at the beginning of an era in which we need to dramatically lower the environmental burden of our activities. Responsibility for this lies with us all. Prevention of the need for dialysis would be the best option for many reasons, including from an environmental perspective. However, renal replacement therapies will be necessary for many years to come, and as

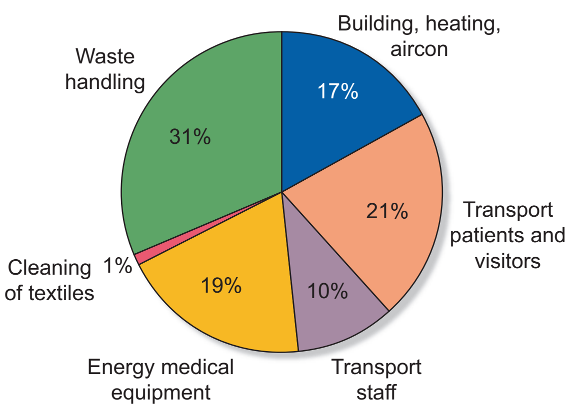

FIGURE 1: Estimation of carbon footprint of haemodialysis in University Medical Center, Utrecht: 30 kg CO_2 equivalent per session (Green House Gas protocol [10]), which equals approximately 4.68 ton CO_2 per year. Figure shows percentages of the contribution of various activities to the carbon footprint. Medication use is not taken into account.

Table 2. Activities to be initiated by various stakeholders to move to more sustainable nephrology care

Dialysis staff of any centre	Dialysis industries	Dialysis provider chains
Create awareness in the staff	Innovate and develop materials and equipment with lower environmental impact	Deliver data on relevant KPIs in clinical practice
Implement programme for monitoring and reporting on relevant variables such as waste production, water and energy consumption	Accept co-responsibility on the fate of equipment and materials once they have left the factories	Analyse practice pattern differences, identify country, region, centre and product differences, and define ‘best practices’
Define activities to reduce environmental impact. Express expectations to supplier industries (to help) to reduce, reuse, recycle and refuse	Develop programmes to reduce, reuse and recycle materials. Even better is to refuse (i.e. to eliminate the necessity of use)	Share experience with programmes to lower environmental impact of dialysis with others
Consider environmental burden of care when choosing new equipment and materials	Develop learning programmes (for instance together with ERA-EDTA) for customers on how to reduce environmental impact	Develop learning programmes (for instance together with ERA-EDTA) for customers on how to reduce environmental impact

physicians, we must show leadership and initiate activities to reduce the impact of our work. In Europe and Australia, clear first steps have been taken [4–7]. However, the big dialysis provider chains and industries should not limit their activities to a publication in *The Lancet*, but rather show that they accept their responsibilities and act accordingly, leading by example to allow movement towards sustainable nephrology care [12]. Some examples are presented in Table 2. The old adage, actions speak louder than words, has never been truer and here, we must work together.

CONFLICT OF INTEREST STATEMENT

None declared. The authors are ERA-EDTA Council Members.

(See related article by Bendine *et al*. Haemodialysis therapy and sustainable growth: a corporate experience in France. *Nephrol Dial Transplant* 2020; 35: 2154–2160)

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Revisiting serum creatinine as an indicator of muscle mass and a predictor of mortality among patients on hemodialysis

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Muscle atrophy and protein energy wasting are commonly observed in patients with end-stage kidney disease (ESKD) [1]. Progressive decline in muscle mass has been linked to limitations in physical functioning, which lead in turn to frailty, disability and decreased survival [1, 2]. Although there is general agreement that loss of muscle mass is harmful and may be preventable or reversible, there is no clear consensus on a clinically useful reference standard for surveillance [3].

Methods that are widely used to assess muscle mass in the general population may not perform well in the ESKD population. Anthropometric measures, which include midarm circumference, midarm muscle circumference and calf circumference measurements, are quick and inexpensive to obtain. However, these measures are subject to imprecision among individuals with ESKD, in whom hydration status may be highly variable [4]. Other techniques for estimating muscle mass include magnetic resonance imaging (MRI), dual-energy X-ray absorptiometry (DEXA) and bioelectrical impedance spectroscopy (BIS). MRI can provide 3D images of skeletal muscle for total body muscle mass estimation, but its use is constrained by high cost and limited availability. DEXA is considered an accurate reference standard for assessing lean body mass in the general population and is more cost-effective than MRI. DEXA allows for rapid measurement of three body compartments, including lean body mass as a proxy for muscle mass. However, in the setting of overhydration, patients may be

