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Environmental sustainability in cardiology: reducing the carbon footprint of the catheterization laboratory

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After 40 years of spectacular technological innovation, catheter ablation has become central to the treatment of cardiac arrhythmias, revolutionizing patient care but with no consideration for environmental sustainability. With climate change being the biggest threat to humanity, all stakeholders urgently need to promote more virtuous and circular practices in the catheterization laboratory.

Climate change is, without doubt, the biggest threat to humanity[1]. Ironically, the health sector itself is a major contributor to the global carbon footprint, accounting for nearly 5% of global greenhouse gas emissions. Medical care is thus indirectly responsible for deteriorating human health, among other devastating consequences. Every 4,000–5,000 tonnes of CO_2 added to the atmosphere is anticipated to lead to one excess death this century[2]. The race to net-zero emissions by 2050 is on, and reducing the environmental impact of technology-heavy fields, such as cardiac electrophysiology, is a priority.

Today's catheterization laboratory is the result of decades of dazzling scientific and technological innovation to treat cardiac arrhythmias. Catheter ablation translates into multiple technology-heavy systems and medical devices from an ever-growing and globalized electrophysiology market. It has previously been estimated that single-use medical devices used for atrial fibrillation ablation alone account for 125 tonnes of CO_2 each day worldwide[3]. Materials represented more than half of this carbon footprint, with catheters being the main contributors (39%). This finding is not surprising, considering the level of sophistication of catheters, the rare metals used in catheter electrodes and the complexity of the international, highly carbon-intensive supply chains. General anaesthesia offers some advantages over conscious sedation but has a high environmental impact, accounting for 25% of the carbon footprint of the catheterization procedure. On top of this number, one should add the carbon footprint of the radiography and ultrasonography machines, amplifiers, and mapping and ablation systems. Therefore, the electrophysiology laboratory is very far from being environmentally sustainable.

The good news — despite the obvious climate emergency — is the willingness of 62% of polled physicians to use more-sustainable practices, especially through the application of the circular economy approaches of 'reduce–reuse–recycle'[4] (Fig. 1). This large European survey of the European Heart Rhythm Association also demonstrated that more than 50% of electrophysiology catheters and two-thirds of their packaging are currently discarded directly after use, generating large amounts of complex-to-treat waste and highlighting the typical current linear model of 'take–make–dispose' in this field. Reducing the environmental impact of cardiac electrophysiology is a complex challenge because we have to keep innovating to deliver higher quality and safety to patients. Reconciling these apparently contradictory objectives requires a switch to circular models and supply chains (currently accounting for >70% of health-care emissions).

Reuse

Electrophysiology catheters have evolved from simple to complex, expensive, technology-packed single-use devices, with a lifetime of a few hours while being fully functional with preserved performances. Reusing catheters is the most effective way to reduce the carbon footprint of ablation procedures. This strategy has been predicted to reduce the global-warming impact of these procedures by 50.4% (ref. 5). Available evidence indicates that with appropriate oversight, standardization and validation of practices, catheter reprocessing and reuse is feasible, safe and cost-effective[6], as has been demonstrated in the past two decades in the USA and Germany. However, catheter recycling is still illegal in most European countries. There is an urgent need to review national policies to allow and promote catheter reuse, which is also an efficient way to secure their availability to treat patients — particularly in the current international geopolitical context and given the growing scarcity of resources.

Recycle

The circular-economy expert Walter R. Stahel says "reuse when you can, recycle when you can't reuse"[7]. Ablation procedures require multiple mapping and ablation catheters, sheaths, needles and patches. Single use translates into plastics, metals, rare metals, printed circuit boards and microchips being discarded directly after the procedure. Precious metals (platinum and gold) from catheter electrodes should be systematically recycled, given that they are scarce resources with highly polluting extraction methods. Precious metals are responsible for more than half of the environmental impact of catheters. Unfortunately, recycling complex medical devices is not a straightforward process. Barriers such as detailed knowledge of the product, capacity to separate the components and on-site recycling streams are substantial challenges.

Reduce

The best way to reduce the environmental impact of ablation procedures is, of course, to reduce their number. Nevertheless, we are witnessing the opposite trend worldwide, particularly for atrial fibrillation ablations (mainly in high-income countries), and this increase in procedures contributes to better patient care. However, prevention strategies should

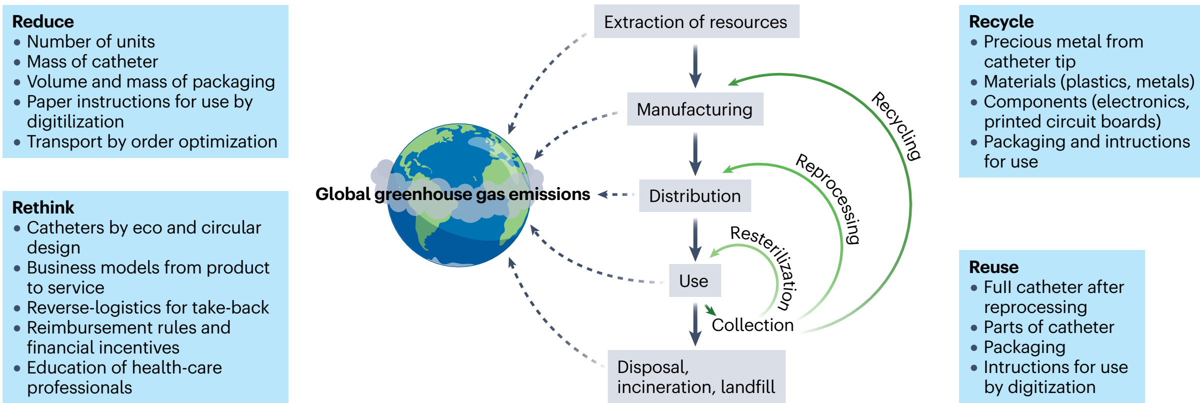

Fig. 1 | Reducing the environmental impact of cardiac electrophysiology catheters. Different options to reduce the environmental impact of cardiac electrophysiology practice by applying circular approaches that are based on strategies that close, slow and narrow materials and energy loops. The strategies, from least to most favourable, are: recycling the different components of the catheter and its packaging; reusing the catheter and its packaging; reducing the number and mass of catheters used; and rethinking the products, processes and models.

also be considered to reduce the incidence and severity of arrhythmias and, when ablation is really needed, strategies, technologies and energies should be chosen to reduce the rate of repeat procedures.

It is time to switch to climate-smart health care. Physicians have to consider the environmental and financial costs when considering a treatment. The medical community must be given access by the industry to assess systematically the environmental impact of every medical device (by providing the product's life cycle assessment or carbon footprint). In addition, scientific organizations have to include best environmental practices in their recommendations, together with best care. Moreover, the environmental impact should be a secondary end point in clinical trials.

Rethink

New paradigms are need. Devices, especially catheters, should be eco-designed for climate-smarter manufacturing, distribution, use and end-of-life management. Interestingly, this evolution has started in other industries (such as construction, energy and transport), but almost no change has happened in medicine. The materials used should be responsibly sourced and recyclable, with catheters packaged using the smallest volume possible. Circular design strategies should be the rule to allow reuse (design for durability and reprocessing) and recycling (design for disassembly). Frugal innovation aiming to use only the essential elements for patient care should also be favoured.

It is time for the industry to offer new, environmentally friendly business models such as the so-called green servitization[8,9]. For example, pay-per-procedure business models rather than pay-per-product would clearly improve environmental sustainability in the catheterization laboratory. This 'new deal' should also include new logistics services allowing circular practices, such as reverse logistics or take-back from industry for reuse or recycling.

Although physician engagement is crucial, it is only part of the solution. Major barriers have been identified at the institution and system levels. All stakeholders are central for climate-smart health care and only system-thinking approaches will guarantee a real positive effect for the different initiatives. Regulators have to authorize the reuse of catheters in every country; health regulatory agencies have to promote circular models by financial incentives; the industry has to provide eco-friendly products and business models; and hospitals and clinics have to set up efficient processes and services to facilitate reuse and recycling and strong education programmes of best environmental practices for medical and paramedical education.

Conclusions

We are now facing the indivisibility of planetary health, human health and health-care delivery[10]. The race to net-zero health-care delivery is on, and innovative medical fields such as cardiology should be fully engaged. Supporting environmental sustainability in the catheterization laboratory will not only reduce the carbon footprint but also help to improve social sustainability by facilitating patient access to ablation procedures worldwide. Rethinking the delivery of care to minimize its negative impact on the planet is also an opportunity towards optimized processes and costs.

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Competing interests

The authors declare no competing interests.